Research Article

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Second-Order Recursions of First-Order Cybernetics: An "Experimental Epistemology"

https://doi.org/10.1515/opphil-2022-0207
received September 7, 2021; accepted April 8, 2022

Abstract: This article examines central tensions in cybernetics, defined as the study of self-organization, communication, automated feedback in organisms, and other distributed informational networks, from its wartime beginnings to its contemporary adaptations. By examining aspects of both first- and second-order cybernetics, the article introduces an epistemological standpoint that highlights the tension between its definition as a theory of recursion and a theory of control, prediction, and actionability. I begin by examining the historical outcomes of the Macy Conferences (1946–1954) to provide a context for cybernetics' initial development for scientific epistemology, ethics, and socio-political thought. I draw extensively from Norbert Wiener, Heinz von Foerster, Ross Ashby, and Gregory Bateson, key figures of this movement. I then elaborate upon certain premises of cybernetics (Ashby's coupling mechanism, Bateson's notion of the myth of power) to further elucidate an intellectual history from which to begin to construct a cybernetic epistemology. I conclude by offering the second-order cybernetic concept of *recursivity* as a model and method for ethico-epistemological questioning that can account for both the constructive potential and the limitations of cybernetics in science and society.

Keywords: cybernetics, contingency, coupling, epistemology, flexibility, paradox, recursion, systems theory

In a self-reflexive gesture, Cretan Epimenides mischievously proclaims that "All Cretans are liars," introducing to occidental consciousness a logical double-bind in which if he is lying, he is telling the truth because all Cretans are liars, and if he is telling the truth, he is lying because all Cretans are liars. The Epimenides' paradox is the logical condition from which Alfred North Whitehead and Bertrand Russell begin their epoch-defining work on Western mathematics in *Principia Mathematica*.[1] The proposition that all propositions asserted by a Cretan are false introduces a "law of excluded middle" into the frame of the proposition of that sort, where a proposition must either be true or false, creating a "vicious cycle fallacy" of erroneously assuming partial truths as logical totalities.[2] A theory of logical types is the logicians' attempt at posing a solution for vicious cycle fallacies of infinite recursion: if assumptions made within a framework of organized classes of information cannot be validated with propositions from the framework itself, there

1 Russell and Whitehead, "The Theory of Logical Types," 46.
2 Ibid., 38–40.

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must be a form of judgement that transcends what is judged to arrive at somewhere new. The only way out of recursive repetition is through recursion at a higher logical type.

A model I wish to refer to as a point of entry into the experience of logical recursion is the Ouroboros, the icon of the organism "condemned" to return all the time to bite their own tails and relive their own beginnings. The circular movement of the Ouroboros, as an external structure embodying its internal workings, propagates the mythical conditions of its existence at the cost of its own parameters of functioning. The unfolding consequences of its actions rejoin into its conditions for the next loop of movement, perpetually becoming the composer of its own creation. What is made actionable is what grants its freedom, at the same time it is confined in its own structural loop from knowledge of the set of constraints determining that very movement. At the same time, however, recursion seeks to reproduce the process of thought and consciousness as a possibility of faith in a return, at another category of learning. This article attempts to understand cybernetics as an Ouroboros moving towards a field of technological application from a theory of recursive systems, and back again. At the demands of a society transforming itself into a highly intelligent war machine, Norbert Wiener, the first pioneer in cybernetics, developed the very term from the Greek root *kybernetes*, "steersman, guide or governor," because he required a vocabulary to explain the dynamics of control and communication when preemptively measuring the movements of an oppositional power's flying aircraft.[3] Wiener first introduced the notion that one needs to make a number of observations to predict the future position of the gunner and its actions, for the pilot will change course in response to enemy fire. He saw, however, that the gunner will adjust in turn, leading to a cycle of adjustments and re-adjustments of a system's parameters of behaviour partaking in circular arcs of correction. Wiener, therefore, believed that cybernetics "takes the view that the structure of the machine or of the organism is an index of the performance that may be expected from it": in other words, it is to the study of inherited patterns of learning and behaviour that an idea of a structured system may begin to emerge.[4] The Macy Conferences, held in between 1946 and 1951, attempted to translate this problem of predicting the future decisions and movements of the "opacity of the other" into an expansive, transdisciplinary concern for communication, informational feedback, and effective organization.[5] According to Claus Pias, these annual meetings were formed with the intention of drawing analogous relations between models of cybernetic activity in various contexts, aspiring to mutual agreement of a "cybernetic episteme" that would clarify basic questions of interface between the human, animal, and machine.[6] Cybernetics therefore did not exist as a discipline, but as what occurred in the flexible overlap between applications in fields such as applied mathematics, computer science, mechanical and electrical engineering, linguistics, psychology, theoretical physics, biology, business management, anthropology, among others.

"First-order" and "second-order" are part of the cybernetic vocabulary accounting for the historical movement of paradigmatic foundations that constitute the area of study. "First-order" refers to the first generation of cybernetics focused on questions of self-organization and automated feedback in organisms and other distributed informational networks. First-order cybernetics accounts for Wiener's aircraft, the engineer's perspective of controlling the output of a system through input feedback, whereas second-order cybernetics emphasizes the necessity for a reflexive participant observer to participate in the feedback. The shift to "second-order" cybernetics, then, marks the examination of observ*ing* systems, what Mead explains as "a new organization, centered upon our knowledge and interest in circular self-corrective systems and our capacity to deal with the situations to which they may be productively applied."[7] With much continuity with the physical work of first-order cybernetics, second-order analysis however includes concerns of self-referentiality, autonomy, ethics, and epistemology as the main topics of its concern.

3 Halpern, "Dreams for Our Perceptual Present," 288.
4 Wiener, *The Human Use of Human Beings,* 57–8.
5 Galison, "The Ontology of the Enemy," 256.
6 Pias, "The Age of Cybernetics," 17.
7 Mead, "Cybernetics of Cybernetics," 1–11.

What constitutes the primary tension in the transition between first-order and second-order cybernetics, however, is its contradiction between insisting on a theory of future prediction, purpose, and directionality (residues of the "first-order" work of Norbert Wiener, John von Neumann, and Ross Ashby) simultaneously as it disclosed a theory of recursive process. "Cyberneticians" such as Bateson, Margaret Mead, Gordon Pask, Humberto Maturana, Francisco Varela, and Heinz von Foerster, in a conscious attempt to distance from its military origins, branched away from modelling regulatory processes in automated systems and delved into more abstract concerns of communication in biology and society. Unable to directly resolve its internal contradictions, cybernetics as the science of circular causality and feedback redefined its status as a "meta-epistemology," the science – underlying all other sciences – tasked with evaluating science as an exercise.[8] The complexity of self-reference in individual, scientific, and social action became the most pressing object of inquiry in "second-order" cybernetics. One could ask what sort of cultural shifts would occur if people could hold an idea of the individual, society, and environment as integrated in a recursive system, constantly building upon itself in an ongoing process of adaptive change. This "second-order" turn would have to address the problem of mastery and detrimental application endemic to its own development as an interlocking area of study since the beginning of the Macy conferences. The process of becoming self-aware of its own power within its forms of actionability – as well as within the collectively shared idea of scientific progress that enables such activity – posed new paradoxes of how to act within parameters of possibility in order to transcend what is currently actionable.

In the ideological whiplash of World War II, the cybernetics of the Macy Conferences faced an internal paradox akin to Epimenides' logical bind. The cyberneticist's ideal of cultivating a scientific standpoint for an "age of information," as a method and language to describe entanglements of complex ecological and social systems, was directly contradicted by its own applications in the United States during and after the World War. Cybernetics was thus imagined through new and unprecedented controls of information: robotics and computer intelligence, telecommunication networks, system analysis, military command-control operations, and evolutionary models of market economics. As the study of feedback processes through measures of adaptive performance, cybernetics is able to predict the future behaviour of enemy others and contingent states, reduce the present uncertainty of its operator, and objectify decision-making processes with quantitative data at the level of global policy. Cybernetics today is imperceptibly prevalent in such areas in service of great economic activity, but it seems to me that *because* of such technical success, its epistemological groundwork has been relegated to a largely forgotten branch of social sciences and humanities. Its technological possibilities propagate in popular imagination and widespread usage, yet this creativity fails to extend into a recursive understanding of its own values and contexts, its epistemic–ethical considerations.

With this context in mind, this article will refocus "cybernetics" not so much as an applicable tool for scientific and technological advancement, but as an experimental epistemology with its own distinct set of concepts located within and alongside an intricate history of turbulence. I wish to understand how a theory, first developed from wartime epistemology, then consolidated with the intention for cross-disciplinary scientific understanding, in turn produced a form of actionability so effective in its adaptability that it can redefine the question of knowledge. Cybernetic knowledge does not immediately point to a recursive process of understanding its own values, but functions as the accumulation of knowledge for the processing power of prediction. It seems to me that long after obtaining second-order knowledge of cybernetics, we continue to produce first-order applications of control and domination. At odds with the content of its ideas, which cannot include itself in its own scope and must be made at a level of learning higher than the ideas to which it refers, I argue that cybernetics exists in a state of contradiction when faced with the difficulty of integrating the "hard" sciences with economic-social concerns and influencing "soft" social sciences with knowledge about physical data. By organizing this article into three parts, each section outlining the context, parameters, and mythology of cybernetics, respectively, I hope to develop an understanding of cybernetics as a form of actionability requiring a recursive adjustment of learning, including but not limited to a process of redefining its own historical conventions.

8 von Foerster, "Cybernetics of Epistemology," in *Understanding Understanding*, 244.

From my standpoint as a cybernetic theorist in the twenty-first century anachronistically studying the historical developments of the discipline/movement, I recognize there are unspoken reasons that cybernetics has been relatively forgotten both conceptually and methodologically into the twenty-first century. A significant reason, I think, is because from its inception as a category, "cybernetics" concerned itself not so much with individual theories or separated paradises of application but with the interface of epistemologies through which such experimentation with objects and concepts could emerge in the first place. Through a confluence between our dominating scientific-technological ventures with our deeply concealed epistemology, the "cybernetics of cybernetics," a term originated by Margaret Mead in 1968 and popularized by Heinz von Foerster in 1979 to explain the study of self-directive, recursive systems, requires a method of pausing and looking at your own processes in order to understand before attempting to utilize them.[9] Cybernetics must give itself to the task of searching for clarity pertaining to the overpowering responsibility presupposed in mastery before any attempt at its powerful and profitable application. This involves a practice of suspending the impulse towards present actionability in order to make the recursive insight actionable at a difference in the whole ecology at a later time.

Gregory Bateson, one of the first participants in the development of cybernetics at the Macy Conferences, defines the concept of "hubris" as a belief in dominance over self, other, and planetary ecology.[10] He believed that an idea, if believed in by enough people with enough certainty and met with enough technical execution, produces "by-products" in the real, embodied world at large – so that those very ideas, whether they demonstrate systemic destruction or restoration, are nurtured into the texture of everyday life. All that is necessary to maintain the human's role as masters of life, death, dependence, matter, time, history, morality, and so on are simultaneously *causes* of the global catastrophe in forms we could not control nor even predict. Human mastery is condemned into movement away from the human; we have inaugurated ourselves as steersmen of the global system without recognizing that our domination must be dominated, our mastery mastered in order to undo (and redo) our own counterproductive and seemingly disastrous trajectories of growth. Bateson concludes his argument with a succinct summary of the problem of hubris: "The creature that wins against its environment destroys itself."[11] The meta-level task of this article, then, is to intervene into the unquestioned presumption that epistemology has linearly "progressed" throughout history, or that its improvement, such as it has been, has been unambiguous. The problem of progress at hand is the hubris of scientific and entrepreneurial arrogance – an unchecked ideology presupposing that human productivity can adequately counter or "cure" the systemic-scale problems it has created. I am not interested, however, in classifying the technological developments of cybernetics as intrinsically good or evil or the theoretical developments of cybernetics as morally neutral. Theory and its application is a conjoined cybernetic model of its own. Together they constitute a coupling system that inextricably connects the activity of knowledge and experiment, while embedding material outcomes into social relations that form the context of this activity in the first place. Furthermore, I am cognizant of global material urgencies of climate change, ecological disaster, social upheaval, class disparity – whole mental–cultural–societal–ecological systems in crisis that require, in the most general sense, a set of livable premises that integrate the "self" into the workings of a recursive ecology.

Just as Wiener and Bateson, dyadically imagined as two opposing poles of cybernetics, were equally troubled by the oil embargo, industrialized uses of pesticides such as dichlorodiphenyltrichloroethane, trade union militancy, and other crises during their lifetimes, this article is an attempt to bring to the forefront another application of cybernetics to design new orders of knowledge as an "experimental epistemology" in times of new (and old) crises.[12] Phrased as such by Warren McCulloch during the Macy

9 Mead, "Cybernetics of Cybernetics," 1–11; and von Foerster, "Cybernetics of Cybernetics," in *Understanding Understanding*, 283–6.

10 Bateson, "The Roots of Ecological Crisis," in *Steps to an Ecology of Mind*, 490.

11 Ibid., 493.

12 Ramage, "Norbert and Gregory," 736. Wary of reductive categorization, the difference between Wiener as the mathematician and engineer treating information as a valueless quantitative object capable of perfect transmission in the lines of Claude Shannon, and Bateson as the anthropologist and naturalist treating information as a "difference that makes a difference" in

Conferences, an experimental epistemology arranges disparate elements pertaining to the study of circular organization to develop a clearer understanding of nature and society.[13] Furthermore, ideally, this experimental epistemology could tentatively eliminate in the boundaries between concepts of "man and nature, man and machine, subject and object, *psyche* and *techne*," for it recognizes that such separations (and other largely unconscious epistemological premises) enter into scientific, historical, and social domains of normative conclusions.[14] What makes an epistemology experimental, however, is that it is unending, processual, and emergent. A process of ascertaining the concrete parameters of cybernetic subject matter (such as feedback, entropy, and circular communication) is necessary in order to approach present issues of ecological contingency and "our" relation to it. As Wiener writes, "A society without feedback is, simply enough, an ideal held by many Fascists, Strong Men in Business, and Government."[15] A conceptual model of circularity poses a paradox of actionability, an inability to command and control the by-products of technodominant activity, but the recognition as such is an epistemological task immanently important for social effectiveness. By positioning cybernetics as an experimental epistemology – a relevant site of thought about the systemicities of larger external environments – cybernetics may be re-contextualized as a salient venue from which recursions of scientific and social acumen could emerge.

1 Context: The Macy conferences and into the twenty-first century

Cybernetics arises as a field of inquiry when a set of effectors (an engine, a computer, a network of muscles, etc.) are connected to a sensory organ which in turn enacts its signals upon the effectors. What distinguishes a cybernetic system from a noncybernetic, or linear system, is its circular organization of activity. In cybernetic organization, a systematic circulation of information fuels a general set of complex processes directed towards a certain programmed trajectory of purpose. A vast network of interdisciplinary study grew from this first-order set of considerations around circularity, where systems theory branched out to include fields such as mechanical engineering, evolutionary biology, philosophy of logic, anthropology, psychology, neuroscience, among others. After the second World War, figures like Norbert Wiener, Ross Ashby, Heinz von Foerster, and Gregory Bateson worked on the many ramifications of this circular theory of communication and message exchange. They came to the realization that, besides the theory of the transmission of messages in electrical engineering, there was not a larger field that took into serious scientific consideration the study of language, the study of message transmission as a means of controlling machinery and society, and the theoretical modulations of the scientific method that would emerge from a schematic study of feedback, entropy, and circularity in human, animal, and mechanical systems. It is from this set of common concerns that various scientists, humanists, and professionals partook in the first Macy conference in 1946 under the direction of Frank Fremont-Smith, forming a series of annual meetings that would go on for the next 20 years. Bertrand Russell and Alan Turing could not attend for personal reasons, and Albert Einstein declined his invitation in a letter saying that cybernetics was not the most reputable field, that it "is just a new branch of 'applied mathematics'... that will become useful for specialists but too 'superficial' for general use."[16] In a sense, Einstein predicted the contemporary state of cybernetics today as a highly esoteric vocabulary for applied mechanical engineering and computer science, that is, too abstract for theoretical resonance in any other context.

processes of human and non-human meaning formation, is nonetheless clear. Ramage separates the "hard" strand of cybernetics with Wiener and the "soft" strand with Bateson, but the integration of both strands within the history, theory, and actionability of cybernetics as an experimental epistemology is the central problem for the scope of the article.

13 Pias, *Cybernetics*, 19.

14 Ibid.

15 Wiener, *The Human Use of Human Beings*, xvii.

16 Pias, *Cybernetics*, 13.

Knowing full well the impossible hubris of trying to prove Albert Einstein wrong, I believe that an attempt at a second-order recursion of certain cybernetic principles, that is, a return to primary concepts at a higher level of organization, could provide a set of conceptual–methodological orientations to encounter this problem of application in varying disciplines. What is required is a more organized, transparent epistemological position on the part of the cyberneticist – past and present. The Macy conferences themselves were a meeting of individuals in vastly different fields who all held similar notions that science required intercommunication between its branches. Moreover, they agreed that a shared epistemology of recursive communication within science was necessary to achieve the level of efficacy and problem-solving that society required, from aiding medical research to understanding the dynamics of communication in armament races. It was around the Ninth Conference in 1952 that a cybernetic interest in the conference on cybernetics itself started to emerge as an epistemological experiment. This means that not only were the conferences formed with the intention of gathering the "ingredients needed for a general theory," but it became important to pay attention to the affective rhythms of the fellow participants alongside one's own logical schema.[17] Claus Pias, the editor of the transcripts of the Macy Conferences published and revised in 2016, writes: "The epistemological shifts of the cyberneticists were governed by details – by blinks of the eye, intonations, and gestures... The common component of their language lay elsewhere: not on the verbal level but rather in a sort of *ethos* within which tones of voice serve as a common currency of communications."[18] It became clear at the conferences that any talk about recursive communication must include awareness of the meta-context of epistemological presuppositions before any discourse on what is being communicated on the surface level.

Pias' observations of the metacontext of the Conferences can be clarified through Bateson's research on *metacommunication* ("meta" is defined as "behind, beneath, by means of") in interpersonal communication and psychotherapy at the Mental Research Institute in Palo Alto, California, between 1952 and 1962. Working with veterans in family group therapy settings, Bateson, along with the members of his double-bind research group, developed his famous double-bind theory observing such metacommunicative tangles present in the communication patterns of family systems impacted by alcoholism and schizophrenia.[19] Metacommunication in this context refers to the processes of communication beneath the level of conscious language, behind every word and gesture, by means of which we affirm the relational, corrective, and playful nature of socio-ecological interaction. For example, two dogs engaged in play may tacitly send the metamessage "This is play" so that a nip or bark does not perpetuate into combat.[20] For Bateson, the gap that exists between the processes of perception and the conscious awareness of its occurrence consists of the latent foundation of one's preconceived thoughts: "I know which way I aim my eyes and I am conscious of the product of perception but I know nothing of the *middle process* by which the images are formed. That middle process is governed by presuppositions."[21] Any kind of communicative act to explain a facet of the world is informed by a set of epistemological presuppositions. These are the unstated, largely unconscious assumptions and expectations about the world every person has, but which is not wholly their own. This means that perception of the world – what seems to be "my" own experience or interpretation – depends upon a tacit basis of beliefs about what sort of world this is. This basis is formed from education, childhood, genetics, past experience, socioeconomic and political contexts, and so on, which are not controlled by "me," or are singularly "mine." Presuppositions form an epistemological context in which "objective reality," what is happening in the world, is abstracted – or made accessible at the scale of one's own body. One of the later members of Bateson's double-bind research group, Paul Watzlawick, transformed his observations of the communication patterns present at the Macy Conferences into psychotherapeutic models for couples therapy. Watzlawick observed that in both a system of scholars across various

17 Ibid., 14.
18 Ibid.
19 Lipset, *Gregory Bateson: The Legacy of a Scientist*, 202–15.
20 Bateson, "A Theory of Play and Fantasy," in *Steps to an Ecology of Mind*, 178–80.
21 Bateson and Bateson, *Angel's Fear: An Epistemology of the Sacred*, 92–3.

disciplines and a dysfunctional family, communication was often either equipped with a complex logical syntax but an inadequate semantics for relationship, or with the semantic potential for relationships but with no logical syntax.[22] The "cybernetics of cybernetics" of intellectual discourse, then, would begin to take seriously the differences in individuals' verbalizations (the symbolic or digital schema) and the affective tones of verbal interlocution (the real or digital schema) with the goal of creating an awareness of cybernetics at the level of its own discursive unfolding. Such a form of recursive communication would bring to the forefront this context of epistemological presuppositions in the very content of the communication occurring on the surface level.

Bateson observed that when individuals remained mired in an inability to communicate on the tacit level of relating to others and to their own internal milieu, their ways of adapting in order to survive precluded an ability to learn (change). This class of phenomena was loosely named "addiction": a pathological attachment to a trajectory of adaptation due to disturbances and error in communication.[23] In the double-bind model, pitfalls in relationship occur when the subject is caught between a primary negative injunction of adapting by way of characterological restraints and a secondary injunction that is fundamentally at odds with the first *at another logical type*: the need to change in order to adapt.[24] The double-bind experience, however, discloses an epistemological insight: the actions, processes, and technologies that adapt a form of actionability to intelligently persist in the present can easily be the progression of dysfunction in the future. A system operating in its economy of flexibility cannot remain long without change, but its ability to change (learn) is precluded by an *addiction to adaptation* – locking into its processes of selection or "preference" that appears very efficient in the short-term. A higher logical type of learning, however, would ask the learner what it would be like to experiment with the form and process of one's learning – if some form of redemption from the sin of epistemological error, beyond the retributive punishment of the double-bind, was possible.

Cybernetics as a study of circularity provided a paradigmatic epoch of scientific understanding for the likes of Bateson, a key figure in the development of first-order cybernetics since the Macy Conferences, allowing him to define epistemology as a "meta-science": the science of understanding the process of knowing how one knows what one knows, where metapatterns of encountering and acquiring knowledge *are* the very objects or principles at the heart of the matter.[25] Bateson applied cybernetics as the conceptual framework for his interdisciplinary research – on communication patterns between dolphins and other cetaceans, on double-bind theory through the study of schizophrenia, on the interface of theology and alcoholism, and so on – just as it aspired to develop forms of computational machines, intelligence control systems, and data-driven weaponry with unprecedented complexity. Along with great epistemological insight for systems thinking, cybernetics also made it conceivable to program conscious human targets and the grand scale of societies, economies, and politics could be shaped according to will – as long as appropriately oriented mechanisms of communication and control were in place. In a later essay "From Versailles to Cybernetics," Bateson thus proclaimed:

> I think that cybernetics is the biggest bite out of the fruit of the Tree of Knowledge that mankind has taken in the last 2000 years. But most of such bites out of the apple have proved to be rather indigestible – usually for cybernetic reasons. Cybernetics has integrity within itself, to help us to not be seduced by it into more lunacy, but we cannot trust *it* to keep us from sin.[26]

He thus distanced himself from the cyberneticians and participants of the Macy Conferences later on in his life because of the seemingly ever-expanding potentiality of cybernetics as a field of actionability. This was

22 Watzlawick et al., *Pragmatics of Human Communication*, 101.
23 Bateson, "The Cybernetics of Self: A Theory of Alcoholism," in *Steps to an Ecology of Mind*, 309–37.
24 Bateson, "Toward a Theory of Schizophrenia," in *Steps to an Ecology of Mind*, 206–7.
25 Bateson and Bateson, *Angel's Fear: An Epistemology of the Sacred*, 20.
26 Bateson, "From Versailles to Cybernetics," in *Steps to an Ecology of Mind*, 476.

to him a monumental power with countless failure scenarios in which its virtues can easily turn into traumas with equal resilience.

Wiener, the primary developer of cybernetics as an instrument for machine learning and communication, also articulated the potential destructiveness of this study when involving human society later on in his life. Cybernetics, as a first-order study of how to control entropy through feedback, will crumble within its own restraints when dealing with social action: "It is in the social sciences that the coupling between the observed and the observer is hardest to minimize. The social scientist does not have the advantages of looking down on his subjects from the cold heights of eternity and ubiquity. We are too much in tune with the objects of our investigation to be good probes."[27] Wiener thus turned his attention to propagandizing cybernetics as a science of automated predictability for engineering and mathematical purposes, where he could unambiguously observe the present effectiveness of cybernetics operating as guarantees of managing contingency in the future.[28] Outside of both the first-order ideal of constructing complex systems of communication and control and the second-order ideal of cultivating a recursive position in science, it seems that cybernetics is equipped with actionable measures enough to evade systemic problems of its historical origins and its unchecked meta-level presuppositions that allow applications to propagate in the world. Concerns about logical types in communication, or categories of learning that would hope for a transcendence in a particular way of adaptation, remained imperceptible due to how seemingly effective such adaptations were under a metric of technological advancement and economic growth.

Due to this efficiency in applicability, cybernetics as a theory of recursion poses an epistemological paradox: taking into its own relentless actionability into account, it opens the possibility to interrogate, tacitly or intentionally, how a discipline know what it claims to know when its parameters of knowing are already constructed by its own characterological restraints and validated through its profitable by-products. There is a presupposed violence to *understanding* – what it means to have learned from the experience of learning in the past – when applying cybernetic principles as a formalized attempt to predict, command, and control the future contingencies of the environment in correspondence with a desire to live as efficiently as possible within that environment. Human activity and technology, employed as arsenal of this priority for future management, cannot seamlessly replace nature's tendency towards disorder without disrupting the original contingencies of nature. Modulating the notion of objectivity from fixed definition to mutable possibility, "we" will go in search of the most optimal version of "our" existence – yet the departure never seems to guarantee a stable state such as an arrival. Thus, one cannot talk about the concepts of control and feedback without investigating the *patterns* of control and feedback in the process of delineating those very concepts.

2 Parameters: Epistemological frameworks

The explosion of ever-increasingly minuscule units of information, technological devices, manufacturing, and the huge economic effect of computer technology in the present moment has overshadowed the epistemological curiosity by which cybernetics encountered its most constructive and exciting potential. The long-term adaptive capacity of cybernetics in this contemporary moment depends upon a concerted attempt at remembering its own epistemological standpoints. Epistemological investigation, the experience of learning in recursively encountering how we know what we know and how that affects decision-making on personal, societal, and global scales, seems to be a relevant task for our current moment. If cybernetics contributes to understanding what our beliefs and attitudes are pertaining to a given subject matter, it becomes a matter of referring to the formal bases of cybernetics from a self-reflexive standpoint to provide

27 Wiener, *Cybernetics*, 163–4.

28 Halpern, "Dreams for Our Perceptual Present," 308.

"an entirely new epistemology" that integrates "a new relationship of mind, self, human relationship, and power."[29]

The parameters, as the general framework of relevance from which to view the stakes of the matter, need further clarification. In Ross Ashby's *Introduction to Cybernetics* (1956), the parameters of a system are defined, roughly, as the structural and symbolic bounds that determine what *value* (defined as the axiological governing impetus of an observed and observing system) induces a *transformation* in the basic states of the system – machine or organism. Within a cybernetic paradigm, we are no longer dealing with determinate machines with one-to-one correspondence between cause and effect, but with many correlated, closed, single-valued transformations. The parameters of a mechanical system are its informational input ($P = I$), but this is complicated when we are dealing with biological or social systems, for the parameters involve the organism's environment – the conditions of its life – as an appropriate source of informational input ($P = I[x - y]$). Ashby states: "With an electrical system, the input is usually obvious and restricted to a few terminals. In biological systems, however, the number of parameters is commonly very large and the whole set of them is by no means obvious. It is in fact, co-extensive with the set of 'all variables whose change directly affects the organism.' The parameters thus include the conditions in which the organism lives."[30] In living systems, the one-to-one correspondence between parameter and input is so extensive and complex it cannot be algebraically computed. This is precisely why Wiener correctly claimed that "the human sciences are very poor testing-grounds for a new mathematical technique," and perhaps what von Foerster is cheekily getting at when he states that, *as a scientist*, because he cannot predict the variables that constitute *himself*, he cannot, purely and perfectly, explain and predict the subject matter he is investigating:

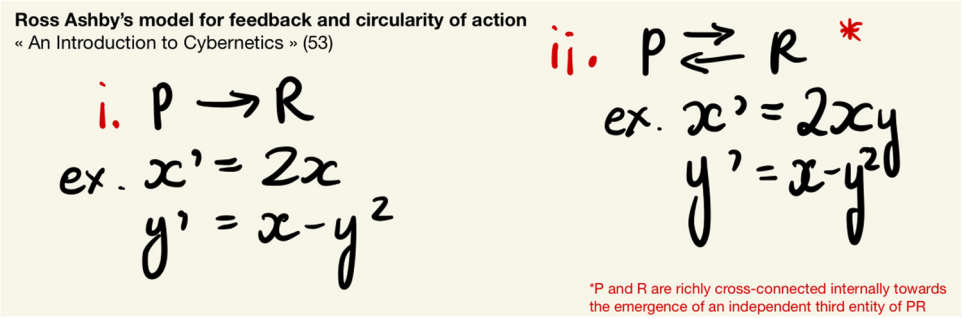
> I repeat: I have no plan, no intentions, I don't understand why I do this or that. And that's probably why I stumble across inexplicability in so many areas, because I can't explain or predict myself. If programs and modules help with this, then let's operate with them.[31]

Ashby offers one certain program or module to operate by in the same text: the notion that the scientist and his concepts constitute a *coupling system* so that when the experimenter runs an experiment he is "coupling himself temporarily to the system that he is studying."[32] Ashby defines a coupling system as "a fundamental property of machines" that allow two or more whole machines to be coupled to form one machine, and any one machine as constitutive of couplings between its substrate parts. Coupling systems, two programs or machines coupling with each other to form a new machine of completely determined behaviour, may be found ubiquitously, from international organizations to ecological habitats to a dyadic relationship. A distinct machine must have a set of its own established parameters that specifies what function these parameters have in the constitution of the *other* machine's variables, and *vice versa*, in order for the coupling to be completed. The parts of "my" given behaviour is often times not sufficient to determine "my" behaviour as a whole, and it is primarily through the details of the coupling itself can the whole of interaction be determined.

Cybernetics as an epistemological endeavour works through coupling systems constituted by scientists and their concepts. These systems attempt to map out the difference between the very logic of coupling systems and the purposiveness towards domination within local instances of coupling. *Forced* couplings, "as two automobiles may be locked together after an accident,"[33] are ubiquitous in science and society, as well as everyday life. We will often see what we would like to see, and we will find entries into entanglement with that which is searched after regardless of the existence of feedback – no matter how potentially violent the process or outcome. Yet what is important to cybernetics is the extent to which the observed behaviour

29 Ibid., 309.
30 Ashby, *An Introduction to Cybernetics*, 46–7.
31 von Foerster, *The Beginning of Heaven and Earth Has No Name*, 147.
32 Ashby, *An Introduction to Cybernetics*, 48.
33 Ibid.

of the coupling system is regular and reproducible, that is, when both sides of the coupling remain relatively undamaged by the process of coupling. This is, however, not particularly useful for organic systems operating within open, ever-expansive, entropic patterns. The difference between a co-constitutive coupling system and a forced coupling in relations of domination is delineated by two equations simplified by Ashby:



In these equations, two machines/programs/organisms, *P* and *R*, undergo modulations of *x* and *y* through the coupling process. In the first equation, *x*'s change does not depend on the *y* value; *x* dominates *y* in a linear, unilateral, irreversible action so that the outcome of *x′* does not factor in *y′*, and *x* can quantitatively multiply in a linear and auto-catalytic (self-inciting) trajectory of growth. Whereas in the second equation, the value of *x* and the value of *y* exist in a circularity of action, mutual arcs of feedback that affect the other accordingly. Both modulations contribute to the trajectory of change so that the outcome of both *x′* and *y′* necessarily implicate each other. Cybernetics is interested in the discrepancy between two modes of coupling *on an epistemological level*, that is, in the complications of relations that emerge from a conception of power that unilaterally perpetuate certain errors in thought that are reinforced by myriad social and cultural details.

Bateson, towards the end of *Steps to an Ecology of Mind*, writes that "epistemological error" is how natural circuits are disrupted, for human premises of control and mastery make it too easy to commit the epistemologically erroneous (and materially disastrous) mistake of equating the purposiveness of a system with the description, possession, or perpetuation of normal goals.[34] Scientific and economic normativity participates in an antagonistic dynamic with the natural world. "Normal" here is defined along the trajectory of Georges Canguilhem, Thomas Kuhn, and Michel Foucault as a set of applicable principles by which a universal pattern of explanation can assert itself – simultaneously as it keeps obscured and inaccessible the correlation of this knowledge with social relations of power. Bateson defines power as a myth not because it is an abstracted fantasy but, on the contrary, because the validity of power is a function of belief at a collective scale. In his words: "They say that power corrupts, but this, I suspect, is nonsense. What is true is that the *idea of power* corrupts. Power corrupts most rapidly those who believe in it, and it is they who will want it the most."[35] Furthermore, in myth, as opposed to logic, there are no firm distinctions between symbolic and perceptual abstractions. The individual herself may not be distinguished from her aesthetic-linguistic world. Bateson also refers to the "self" as a myth insofar as it is a network of self-regulatory circuits open to external environments. Within the bounds of such a definition, the notion of "myth" (contra "science") emerges as a unique instance of codification because the *experience* of the self then serves as the epistemological basis for context-specific meaning. Myth, defined as embodied and enacted contextual knowledge woven into the texture of one's everyday life, emerges not just within the psychic life of an individual, but also within the knowability of systemic dynamics on a group-social-ecological scale. Bateson describes this order of knowability as a set of "decision(s) by selective integration,"[36] for myth

34 Bateson, "Pathologies of Epistemology," in *Steps to an Ecology of Mind*, 494.
35 Ibid.
36 Bateson and Ruesch, *Communication,* 183.

complicates notions of voluntary control and power by referring back to its "mythicness" – its constructed, contingent, and indeterminate nature.

That which is consciously known through logical injunction, contra myth, is an *extreme reduction* of the total continuum of psychic and material events. For something to be conscious, it must be selected and then abstracted from the whole of what is going on, and "every such reduction is a transformation or codification in the same sense in which the terms are here used and, as in all other cases of codification, the nature of the transformation is not itself subject to direct introspection or voluntary control."[37] In myth, however, any image or idea can operate simultaneously at many unspecified scales of abstraction. It can encounter the whole of psychic and material events without explicitly affirming the difference between these levels in order to cultivate a variety of associations. This is where the myth of power takes its hold: Bateson posits that power in and of itself does not produce dangerous epiphenomena, but to neglect curbing the possibility of such production is to actually actively reinforce predetermined positive feedback loops that keep power unchecked. In other words, the unmediated growth of one set of rigid codifications will produce a disastrous outcome of an unreflexive disparity in power, manifest in epiphenomena such as ecological disaster, social and political unrest, and economic instability. This inability to see and act upon the unbridled growth of the myth of power produces a context of misplaced associations that muddle epistemological awareness, which Bateson describes as detrimental to scientific and social clarity.

At the same time, Bateson states that power is always an interaction, and not a linear situation. This is because from a cybernetic point of view, there is no such thing as a "unilateral circularity" of information. The circular balances of nature and society are vulnerable to disfigurement when certain errors of our thought become reinforced by the myth of power as a cultural monolith of presuppositions on "power," "progress," "profit," disembodied mind contra matter, and "civilization," and so on. These are epistemological premises that are lived by and through a group that has obtained the technological apparatuses to support their concrete materialization as a given state. As Bateson writes:

> The myth of power is, of course, a very powerful myth and probably most people in this world more or less believe in it. It is a myth, which, if everybody believes in it, *becomes to that extent self-validating*. But it is still epistemological lunacy and leads inevitably to various sorts of disaster.[38]

The subjective experience of encountering one's own parameters of knowability, of coming into conscious awareness of a phenomenon, paradoxically emerges as a territory of unknowability and perhaps mythic ambiguity. Epistemological error about oneself and the world that one inhabits is not an isolatable occurrence in a singular instance of forced coupling. Erroneous beliefs about the self, other, and environment produce historically sedimented material epiphenomena that disclose their own error in ecological scale disruptions to livable order. From this point of view, then, a cybernetic position must first of all ask ethical questions about how technology is implemented in the service of instrumentalizing life, and these questions also include the often double-binding task of first determining a metric of ethics in relation to an hierarchization of life. And finally, this also brings up the question of ecological complexity that may or may not inform how conscious purpose is applied to solutions appropriately scaled to the problems that need to be addressed.

3 Methodology: Recursivity as scientific position

Bateson concluded at the end of his life that this problem of power in relation to the confines of our own epistemological parameters must be postponed as being beyond the scope of scientific experimentation in his time. The problem of knowledge and actionability in the present moment requires a partial movement

37 Ibid.

38 Bateson, "Pathologies of Epistemology," in *Steps to an Ecology of Mind*, 495. My emphasis.

beyond the frame of epistemology itself, towards an investigation of the emergent paradoxes within the very codification processes that produce it. A meta-level turn towards second-order application by theoretically inclined scientists participating in the Macy conferences marked the beginnings of questioning the role of recursion as it is experienced. Recursion attempts to explain how an observer-participant is implicated in the dynamics of the system in question, but also introduces a set of paradoxes in actionability and learning. Increasing talk about the concept of recursivity propelled individuals such as Bateson, Ashby, Gordon Pask, and Heinz von Foerster to look inwards, so that their conceptualizations would stem from and end with an understanding of the self. Von Foerster, speaking about this branch of cybernetics dealing with the "soft" sciences of information exchange, describes this turn towards self-recursion as a scientific necessity. In his words: "They [cyberneticists] began to see themselves more and more as being included in a larger circularity; maybe within the circularity of their family; or that of their society and culture; or even being included in a circularity of larger proportions."[39] Cybernetics, according to Humberto Maturana, takes as epistemological necessity the fact that "human beings can talk about things because they generate the things they talk about by talking about them."[40] A cybernetic position emerges from a domain in which a radically constructivist understanding of distinctions and their descriptions informs both the internal states *and* external interactions of the entities in question, at myriad scales. Yet this process requires a recognition that although such a method may provide the scientific symbolism as well as various calculus of reasoning for such understanding, it necessarily evades questions of what it is to be "conscious" or "human," what it means to share the planet with other strange programs, and perhaps most importantly, *how* we are going to communicate with each other. This set of ethical and aesthetic questions (ethics defined not as deeds but guidelines for acting, and aesthetics defined as perceptual awareness of complex systemicities) contain questions of self-recursion. This is the notion that one's propositions – which validity is function of belief – are produced only within the scientist's particular set of interestedness: the parameters of their questioning that radically calibrate the definitions and outcomes of their scientific work.

One of the mechanical games cybernetics is equipped to play is war, and it is through a position of radical recursivity that war can be rejected as an option. War, the application of game-like laws to every facet of a system, becomes a great game where "life" outside of war gets reduced to rule-sets and differences are reduced to comparative ratings. The "self" is, of course, free to play the game, but cybernetics at its best may advise against it – for recursive process operates in a domain where encountering silence (beyond the random activity of noise) is a possibility, and beyond that, where – perhaps through the silence – the prospect of a totally unforeseen change of orientation may emerge. And furthermore, the "self" becomes not a hinderment to a myth of scientific objectivity but what von Foerster calls "a folded up recursive operator of infinite depths,"[41] an integrated receptor *and* effector of phenomena in the external world. The cyberneticist, in this sense, orients herself to an anticipatory futurity that aims to invent not objects of mass application, but the epistemological meta-context – the preliminary groundwork – for the conditions of that very invention.

The recursive turn of cybernetics begins when cybernetics branches off from a theory of observed information to a theory of the observer. A "cybernetics of cybernetics," moving away from viewing the behaviour of a system in terms of purposiveness and control, feedback, and stability or instability, is characterized by a recognition that all propositions – and the cognitive processes that form them – stem from an inability to recognize one's own blind spot. The blind spot that one is not aware of one's blind spot is, in the language of an engineer, akin to recognizing that the computational algorithms that bring about knowledge are in turn being computed: they are composed of computations that compute computations.[42]

39 von Foerster, *Understanding Understanding*, 288.

40 Maturana, "Biology of Language," 15.

41 von Foerster, *The Beginning of Heaven and Earth Has No Name,* 133. "All these people [scientists] just didn't want to deal with people being allowed to speak about themselves. For me, "I" is a folded up recursive operator of infinite depths, but one can operate with it, one can operate with it without any trouble… By letting ourselves in for paradoxes we find ourselves in a dynamic game in which the one creates the other – and *vice versa*."

42 Ibid., 283–6.

Second-order cybernetics recognizes that recursive computation into a depth of arbitrary circular regress occurs in both animal and machine at the moment the second-order deficiency of "not seeing that we do not see" is revealed to oneself. In Heinz von Foerster's words:

> [...] a brain is required to write a theory of a brain. From this follows that a theory of the brain, that has any aspirations for completeness, has to account for the writing of this theory. And even more fascinating, the writer of this theory has to account for her or himself. Translated into the domain of cybernetics; the cybernetician, by entering his own domain, has to account for his or her own activity. Cybernetics then becomes cybernetics of cybernetics, or *second-order cybernetics*.[43]

Walking into the paradox of self-reference, the task of learning how to learn entails an aspirational transcendence of the properties of the observer incorporated into their observations. A recursive cybernetics must view the invention of a science of feedback and communication as situated in the infinite regress of its own processes of invention, explanation, and interpretation. Defined as the "self-awareness" of a circular system, recursivity in cybernetic consciousness is the epistemological awareness of self-referentiality. Second-order cybernetics thereby once posed a radical break in basic principles in scientific discourse that asserted the separation of the observer with the observed, namely, the axiom of objectivity. Moreover, experimental epistemologists like Bateson, von Foerster, and Maturana are well aware that people are receptive to parabolic, metaphorical models of myth. One likes to live in a story, which one understands in a certain way, and which can then serve as a basis of understanding another story. What occurs in myth is an *aesthetic* recognition, an internal perceptiveness to the nature of contingency and complexity implicating "our" own being as such, which "we" then recognize as having been disturbed through personal and cultural milieu. Cyberneticists delight in such paradoxes that retain the capacity to resolve themselves in a relatively stable and ordered circulation of information – for whenever time is incorporated into a static formulation of a paradox, an circular movement of thought arises and may enact a paradoxical form of change.

However, the material contexts of cybernetics already ossified into technologies for socio-political regimes constructing linear history of scientific progress, self-validating contradictory premises persistently appear in the repetition of acquired habits. A theory of the observer crumbles under the repetitive confusions of one's own self-recursions. A circularity of self-awareness can easily repeat to a point of self-sabotage, where one cannot arrive anywhere else but one's own blind spot. Thus the aporia of a brain having to write a theory of the brain, the scientist having to inductively establish the laws of induction, cannot be resolved in terms of recursion. Likewise, what is made actionable in order to produce probabilistic claims of unknowable future outcomes may allow the observer to change her present object of inquiry – but this can easily get stuck at a level of learning, which would mean that it can only recursively return to remembering a position of ignorance. A field of actionability, then, will only reproduce what problematized the observer in the first place: their inability to change as a subject in the present. At a level of learning, this logic corresponds to what Bateson, following Whitehead and Russell, would classify as an error in logical types: when we think we know how to model the phenomena, we cannot know the phenomena, and therefore a paradox of referentiality and actionability emerges.

This condition, however, may not have to unfold as a Sisyphean infinity loop – for the condition of being inextricably tied to one's own ends and outcomes provides a sense of the systemic determinism that is at stake. Destabilizing the original conditions of paradox through another paradox of learning precluded by actionability allows for the possibility of a meta-level self-referentiality: "I" must encounter myself encountering the world if I am to resolve the logical tangle of contingency that I find myself in. If the self is implicated in the progressive patterns of growth of its larger ecological system, it becomes a literal matter of life and death to understand the patterns at hand in order to control certain trajectories of growth for survival. This recognition of systemicity may be framed as a cybernetic process: any sort of "arrival" within circular activity could be, paradoxically, always somewhere unexpected and incongruous to the self. The

43 Ibid., 289.

conventions of history and scientific normativity in a macroscopic scale, therefore, exist as direction posts and not necessarily as outcomes.

Recursion as a methodology introduces paradoxes of description as they are experienced. To occupy a recursive position propagates iterations of the Epimenides' paradox in the process of introducing a fundamental self-referentiality in the notion of "self." The recursivity immanent in such paradoxes create descriptive potentialities that will be chaotic for the uninformed observer, but may create eventful lateral movements between pre-existing structural couplings that may generate new couplings from which to encounter independent systems yet again. The Ouroboros explored in the beginning of the article is a mythical reminder of the overarching thesis in Bateson's work: "The more we believe in our 'power' over an enemy environment, the more 'power' we seem to have and the more spiteful the environment seems to be … The unit of survival is organism plus environment. We are learning by bitter experience that the organism which destroys its environment destroys itself."[44] Technocratic activity and its empirical demonstrations define its "progress" in terms of human adaptation often at the cost of ecological contingency – yet if the larger systemicity is destroyed, so are the conditions for "our" survival. The circular patterns of purpose that we wilfully return to often take form as self-promoting returns: there will always be a more apex form of ecology, an unknowability or complexity that we must gain control over so as to make it applicable for our ends. The second-order cybernetic ideal of ecological-scale recursion attempts, at best, to transform this circular pattern at a scale of human activity so that a *flexibility of human thought or purposiveness* can begin to match up to that of the environment through constant recursive feedback with it. Instead of a circular return to one's belief in adaptation, there can perhaps be a return to the adaptive contingencies within the larger system in question. What would perhaps emerge is a complex system open for slow change at the level of the entire epistemology (the environment *plus* the organism's "hard-programmed" characteristics).

Applications of theory, even an experimental epistemology, can however quickly devolve into a repetitive method of torturing an other to give an answer and solution in the pre-determined terms of "your" epistemology – not their terms or even the terms of some ideal of universal metric of justice and equity. Abstract principles of justice and equity cannot be completely secure or perceived as unfailingly applicable until they and their limitations have been determined in practice. It seems paramount to acknowledge that the ideals of cybernetics must remain to some extent *as an ideal* rather than an accomplishment of the past or present. This is not a pessimistic abandon of its possibility – on the contrary, to posit something as an ideal is to at once acknowledge that *failing* to follow in the trajectory of the ideal, the system in question will descend into chaos or worse: a barren purgatory in which the most barren individuals uphold the premises that allow existing parameters to perpetually continue. This could perhaps be articulated as an enclosure of privilege, the possibility of choosing *not* to undergo painful epistemological shifts.

At best, then, a recursive position will allow for a systemic (aesthetic) recognition that the logic of technocratic adaptation is divergent from, and perhaps incompatible with, that of the logic of ecological survival and evolution. What is necessary for such a position to be viable is a sustained re-evaluation of the self, other, and the shared environment entangled in loops of contingent feedback – but beginning most extensively with the self. With its commitment towards a notion of indefinite (infinite?) circularity, an Ouroboros of cybernetic recursion articulates the need for this attempt at slow change to be carried forward without fear – yet wary of the forces of cultishness, fundamentalism, and groupthink that would break the circularity in to a linear conscious purpose. It needs to be carried through and beyond the fire of our immediate political and moral disagreements, beyond the dishonest brokerage of power at the interstices of law and politics, medicine, and economics. By willingly and knowingly walking into circular epistemology that cybernetics offers, I believe to be true that no amount of demonstration can ever "prove" that living process is subject to infallible law, and no amount of application or experimentation can demonstrate that difference can be processed as a tool of control. At the scale of one's own body, a context that remains free to toil in recursive paradoxes of attempted description may constitute the very islands of decreasing entropy that Wiener proclaimed as constitutive in turn of "you" and "I." Such attempted confluence

44 Bateson, "Pathologies of Epistemology," in *Steps to an Ecology of Mind*, 491.

between application and epistemology, at whatever scale, may circle back to where we began: perhaps however at a transformation, no matter how slight, from which to begin the process once again.

Acknowledgments: Early drafts of this paper were work-shopped in HISC203B Writing Seminar led by Dr. Carla Freccero in the Spring of 2021, along with colleagues Robin Jones, Jen Ham, Antwan Herron, and Keegan Quiroz. Thank you all for your valuable feedback and support. Special thanks to Dr. Colin J. Campbell, an early teacher of Gregory Bateson during my undergraduate degree and frequent interlocutor providing inspiration for this paper, and Adrian Drummond-Cole, for thoughtfully sending along the CFP.

Funding information: The publication of this research has been financially supported by the History of Consciousness department and The Humanities Institute at UC Santa Cruz.

Conflict of interest: Author states no conflict of interest.

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