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Heinz von Foerster's Demons
The Emergence of Second-Order Systems Theory
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34 The discourse of cybernetics centred on the cluster of topics given by the initial title of the famed Macy Conferences, ten of which occurred between 1946 through 1953, „Circular Causality and Feedback Mechanisms in Biological and Social Systems". The interdisciplinary group here assembled brought together philosophically minded scientific polymaths and pioneers of electronic computation and information theory. The Macy Conferences represented the high point of the first interdisciplinary synthesis through which cybernetics came forward as a metadiscipline, bringing physical, mathematical, and engineering concepts of entropy, information, and feedback towards an integrated study of complex mechanical, computational, biological, psychic, and social systems.
However, in the years after the Macy Conferences closed up shop, this cybernetic synthesis gradually splintered into non-communicating specialisations. Broadly considered, it diverged sharply back into subject/object dicotomy and Cartesian dualism. The former monopolised its resources, hoarded its grants, and redirected the mathematical and engineering sides of cybernetic's toward Artificial Intelligence (AI), robotics, computer science, and command-control-communications technologies. The latter camp, often loosely identified with the work of Gregory Bateson, gradually gathered up the cognitive and philosophical insides of cybernetic's towards matters of managerial and social systems, psychotherapy and epistemology.

Twenty years after the lapse of the Macy Conferences Heinz von Foerster would consolidate these alternative cybernetic trends with the turn towards what he called „**second-order cybernetics**". In a cluster of papers written by the mid-1970s – „Notes on an Epistemology", „On Constructing a Reality", and „Objects: Tokens for (Eigen)Behaviors" – von Foerster catalyzed new thinking about the deeper cognitive implications of „**circular causality**". Essentially, von Foerster tweaked the engineering discourse of positive and negative feedback towards **the recognition of self reference as a form of operation in systems in general**. The crucial conceptual shift was a movement from **first order cybernetics** (homeostasis as a mode of autonomous self-regulation in mechanical and informatics systems) to **concepts of self-organisation** (the apparent self-ordering and self-regulation of bodies and minds) – and to **self reference and autology** - the abstract logical counterparts of **recursive operations** in concrete and worldly systems. **With this second-order turn, matters of circular form and operation break out of philosophical and literary treatment (as reflexivity) and to scientific discussion (as recursion). One discovers that circularity is death (by infinite regress) to** *structures*, **it is life (by autonomous self-regulation) to** *systems*. **Von Foerster's work renders paradoxical propositions, recursive forms, and self-referential operations available at once to rational and aesthetic, scientific and literary view.**

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45   We still have a hard time **taking for real that all knowledge of the environment depends upon the specific realities of the systems that observe it**. The systemic reality of the environment is to be both the precondition and the product of an observing system. **This is the self reference bound up in any presentation of something beyond the self**. This conveys an ironic message to those who would affirm that when they observe the world and state their truths about it, they are *not* a part of the reality they are describing, that they are not embedded within their own descriptions. This denial would be the sort of reverse solipsism of the epistemological positivist that posits a contextless context of knowledge - as if the world could be known without the existence of local and embodied knowers to carry out the knowing.

46 The message is that the reality one can know depends on the communication of reality from one observer to another, which depends on „a consistent reference frame" within which „at least two observers"are embedded so as to construct a conversation about that reality.

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51 Neocybernetics of Social Systems Theory

„We may take it that the world undoubtedly is itself (i.e., is indistinct from itself), but, in any attempt to see itself as an object, it must, equally undoubtedly, act so as to make itself distinct from, and therefore false to, itself. In this condition it will always partially elude itself". George Spencer Brown

(We can) perhaps the most accessible and broadly disseminated rendering of von Foerster's insights into **recursive and neural computation** and what Maturana and Varela would soon call the „**organisational closure of autopoietic systems**", the 1973 paper „On Constructing a Reality". It begins with a humorous and erudite literary allusion, then segues to a series of perceptual puzzles eliciting „blind spots" in the sensorium before settling into its central argument regarding neuronal computation and the „double closure" of cognitive systems.

„On Constructing a Reality" is a seminal annunciation of second-order cybernetics, precisely as **a constructivist theory of cognition**. As one now says in the vocabulary of George Spencer Brown, „On Constructing a Reality" *re-enters* **the form of cybernetic observation into its own form.** Von Foerster later coins the slogan „the observation of observation", and „On Constructing a Reality" prefigures the slogan with its logical derivation of **cognition as recursive computation.**

Cognition as recursive computation
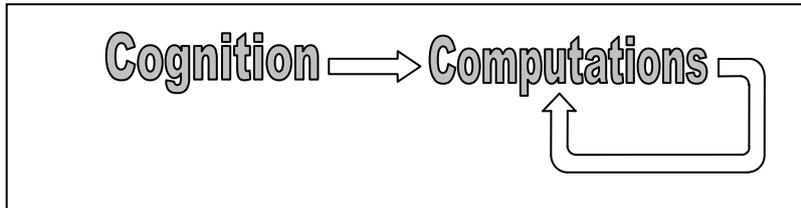
Computation is generalised to mean any process or algorithm that transforms or recodes stimuli or data presented to it: "**Computing (from com- putare) literally means to reflect, to contemplate (putare) things in concert (com), without any explicit reference to numerical properties. Indeed, I shall use this term in this most general sense to indicate any operation (not necessarily numerical) that transforms, modifies, re-arranges, orders, and so on, observed physical entities (objects) or their representations (symbols)**" (H.v.Foerster On Constructing a Reality, pg.216.).
Although the term „autopoiesis" does not appear in it, several of Maturana's works are cited in it, and the form of the concept of autopoiesis - self-referential recursion bounded by operational closure – is limned throughout the essay.
Using recursion as a skeleton key to unlock a range of complex self-referential systems, von Foerster's second order cybernetics arrived at the general discourse of operational circularity by turning cybernetic thinking upon itself. Luhmann has written about cybernetics in general that „the first innovation was the rediscovery of the circle as, at the same moment, a natural and technical form". When viewed in this wider context, much of Luhmann's social systems theory extends directly from von Foerster's contributions to the recuperation of selfreference. In „Notes on an Epistemology for Living Things" von Foerster sketches the ways that, for most of the century, hard scientific thought has been forced to acknowledge the paradoxes of observation. Forcing the epistemological issue of second-order cybernetics, Luhmann puts the paradox point-blank in „The Cognitive Program of Constructivism": „It is only non-knowing systems that can know; or, one can only see

because one cannot see". However, how can a discourse of knowledge founded on the concept of self reference, which implies the operational closure of subjects of knowledge reconceptualised as „observing systems" cut out from the surrounding environments, result in anything but a short-circuit or an infinite regress?

52 To **shift epistemology to an explicitly recursive system/environment paradigm** forces a cascade of repercussions. This cognitive regime **bars any traditional form of empirical or realist representationalism, any simplistic notion of knowledge as the mechanics of linear inputs and outputs**.
Redescribed as the production of an observing system, **cognition is rendered as a contingent operational effect rather than assumed as a free-floating or even disembodied agency**.
The boundary between „subject" and „object" is re-cognized as both an ongoing product of and an impassable limit to the operation of the system. A sytem boundary never just is, ontologically, but is always coming into being as part of the systems autopoiesis.

As a self-referential product of the system's operational enclosure, the boundary guarantees that the system is autonomous, or „information tight". The environment as „object" cannot enter into the system in the mode of its own being, cannot dictate to the system. What it can do is perturb its observer in such a way that the system reorganises its own elements to compensate, which compensation must then count for the system's cognition of the object. One of the more scandalous ways to express this situation appears as Proposition 11 in von Foerster's „Notes on an Epistemology for Living Things": „The environment contains no information; the environment is as it is".
That is to say, it is only self-referential observing systems that can construct environments in the mode of information; the construction of these descriptions is so only the system's affair."The environment is as it is". However, there is always more than one observing system; or again, **cognition is always a social affair**. Observing systems in communication may be observed to arrive at **eigenbehaviors** - mutually to stabilise and reinforce perceptions autonomously achieved.

53 The **virtual boundaries of social and psychic systems** are produced and reproduced by the forms of distinction those same systems construct in the **medium of meaning** - say, between self and other, between inclusion and exclusion - that render those systems operable at any given moment. Luhmann writes: „**Boundaries** can be differentiated as specific mechanisms with the specific purpose of separating yet connecting. They assume this function via particular performances of selection".

Psychic and social identities coalesce around the systems probable reiteration of the same selections from a given repertoire of possible distinctions and may be transformed when different selections ramify into a new norm or new options enter the repertoire of possible distinctions. But because the inevitable effect of the systems history of self-bounding through cognitive selections is to have excluded, at least for the time being, other forms of possibility, Luhmann goes on to note that „a contact mediated by boundaries cannot convey to any system the full complexity of another, even if its capacity for processing information would otherwise be sufficient".

Re-entry: the operation of re-entry as a model of recursive cognition in the second-order cybernetic description of observing systems.

Re-entry as a model of recursive Cognition

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        B
      b   B
    s e   S  E
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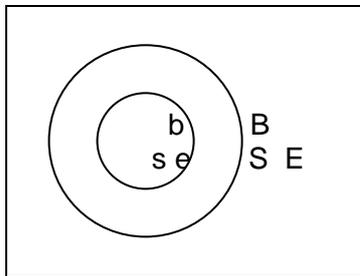
This is how one construct a reality: an observing system **S**, and necessarily self-referential form, creates epistemological space for itself by re-entering the virtual form of its own bounded distinction from the environment **B/E** into itself as the virtual border **b/e**, which it can then use to make distinctions between self and other. It can then, at any given moment, construct its selective knowledge **e** as a reduction of the complexity of the environment **E** rendered through its own repertoire of distinctions. We see that our knowledge of **E** will always be a somewhat lesser version, **e**. But that's still saying something, and **S** can also proceed to test its knowledge, its internal model **e**, against other versions constructed at other moments. In this way we see that **e** is not a static production but an ongoing, recursively refreshed computation. And recursive processes, like rolling hoops or gyroscopes, are self-stabilising - they tend to find their own balance.

54 According to"the postulate of homeostasis", our self-referential constructions of the world rendered relatively stable (and not merely arbitrary) because as a result of its own recursive self corrections, „The nervous system is organized (or organizes itself) so that it computes a stable reality". But still, how does this **self-referential construction** of a **epistemological constructivism** differ from traditional notions of **idealism**, in which the world of objects was also presented as a product of the minds own activities? As Luhmann observed at the outset of „The cognitive program of Constructivism", „It is only **in our century that the name idealism has been replaced by constructivism**…Insofar as constructivism maintains nothing more than the inapproachability of the external world „in itself" and the closure of knowing - without yielding, at any rate, to the old sceptical or **„solipsistic" doubt that an external world exists at all** - there is nothing you to be found in it".To earn its epistemological spurs as a tool in pivotal the description of **our knowledge of knowledge**, that is, **neo-cybernetic constructivism must demonstrate its actual operationality**, its social productivity beyond any singular mind's phenomenonality.

56 Second-order cybernetics sees instead a world so constructed that any single observer's observation may be rendered stable from moment to moment by the structural couplings and recursive conversations of *its* multiple observers. Just as all nervous systems and all organisms that possess them within themselves are virtual **consortiums of multiple autopoietic systems**, so are **all observers bound into (what Varela calls) „observer-communities"** within which (**what Luhmann calls) social autopoiesis - the ongoing self-production of and self-maintenance of communication - produces (what von Foerster calls) eigenvalues** - that is, stable yet mobile and multiple recursive concensuses about sharing environments.