

Feedback as Reflexivity as Structure:
A brief theory of unification
A Transcendental Cybernetic Approach

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2009

Feedback is a truly interdisciplinary phenomenon. It appears to be all-pervasive: it occurs in nature, all throughout the cosmos and known time in many different ways, in many different disciplines. The only explanation for the time previous to Planck Time, that fraction of a second after the theorized big bang, and the growth of the cosmos afterwards that physicists across the world are hurrying to grasp, can be understood in terms of a positive feedback cycle. Within the perceivable cosmos, universes, and galaxies, clusters and superclusters maintain their form and structure through *negative-feedback* control through gravitational vortices. Feedback occurs so naturally in our lives and our being-in-the-world that the development of most technology since Babylonian times, have had to incorporate feedback control systems, optimizing instruments by mimicking how nature works. Consciousness itself is also structured through elemental feedback mechanisms inherent in time consciousness, memory, acts of reflection, and self-organization. If one wished to know just how pervasive the phenomenon of feedback is, they would be want of where to begin. The act of looking however is already a feedback process. Early hydrodynamic time devices, biology, neurons, systems of nature, society, and economics, etc., art, computers, automation, life or being-in-the-world, and language are all seemingly structured by or incorporate feedback signals, loops and cycles. If this is the case, and it seems to be, just what exactly is feedback?

Feedback in engineering, biology, chemistry and electronics is when a part of an output is recycled back to a process, mechanism, or organism from which it came, and circularly employs it as an input, creating a loop, like an ouroboros, the snake that feeds on its own tail. The feedback signal then either equalizes a process (which is referred to as *negative feedback*) or amplifies it (*positive feedback*). Fundamentally, we speak of feedback either in terms of control or in terms of information flow. Negative feedback is used in all dynamical systems: in control systems, in such devices as thermostats, computers, satellites, engine governors, etc. In Biology a feedback control system is usually referred to as *homeostasis*, the ability for simple and complex organisms to maintain an internal structure, temperature for example. Across networks feedback maintains structures, coherence and organization towards goals. Synchronization in a flock of birds is an example of feedback working in a system for optimal security.

Negative feedback tends towards stabilization and balance, a governing process. Without the awareness and implementation of negative

feedback by way of mechanical engineering, the industrial revolution would not have had such a huge impact on human society and organization: The steam engine would explode without the intervention of James Watts centrifugal flyball governor for rotation speed control; As the speed of rotation increases the flyball swings out further from the centre hitting a valve and thus stopping the flow of water to the engine.

Positive feedback tends towards amplification or instability and has two orders: explosive or exponential growth (first order) and hyperbolic growth (second order). In a mother's contractions in childbirth or lactation for breast feeding, the growth in population of the human species, as amplification of signals which allows for telecommunications across great distances, in self fulfilling prophecies and bank runs, positive feedback is in play.

The history of feedback in electronics dates back to the industrial revolution and the birth of Leibniz's calculus and the infinitesimal mathematics of Isaac Newton. But in the 19th century, when electronics and dynamical laws were being discovered, the birth of mathematical control theory, differential equations, stability theory and system theory all contributed greatly to feedback control systems. Without the knowledge and understanding of these systems modern society would not have many of its luxuries, from atomic power to cell phones, personal computers to automatic coffee makers.

The 20th century saw a great realization of feedback developed by Harold Black out of Bell Laboratories in August 1927. There was a problem of sending voice signals across the oceans and continents while simultaneously accounting for climate variation and topographical landscape. The amount of amplification required was distorting the signals terribly and spreading them out across frequency waves. One morning Black had realized that if he plugged a portion of the amplifiers output back into the input, he could amplify and simultaneously get rid of oscillation if calibrated properly. For the next seven years, he, Harry Nyquist and Hendrik Bode perfected negative-feedback amplifiers and the information age was given a firm foundation.¹ In this case, 20th century feedback history is tightly linked with the world wars and with weapons deployment and ship control - The atomic bomb is positive feedback in its most explosive and destructive form.

By 1942 Norbert Wiener had nearly perfected the signal-to-noise ratio, through stochastic analysis and coined the term feedback, as a fundamental principle to his theory of *cybernetics*.

¹ Mindell, David, A. *Opening Black's Box: Rethinking Feedback's Myth of Origin*. "Technology and Culture", vol. 41, no. 3, July 2000. The Johns Hopkins University Press. Pp. 405-434.

Cybernetics is the study of complex systems that are directed towards goals in a causal chain or circular way, ie: through feedback loops, relationships, and rules. Its focus is how anything (digital, mechanical or biological) processes information, reacts to information, and changes or can be changed to better accomplish the first two tasks.² The information resulting from cybernetics has led to, amongst other things, the sciences of robotics and artificial intelligence.

I think that it has become apparent just how all-encompassing feedback is in our lives and our history, in our external observations, how much we are controlled by and in control of feedback as a modern society, how much we depend on it. What is interesting at this point though is to ask a difficult question: Is it possible that these structural elements from nature that we utilize for increased innovation and rationalization in society are merely projections of our own consciousness onto the observable world? Is it that we understand feedback as pervasive because it is inherent and fundamental to our selves as conscious sentient beings, an occurrence fundamental to perception itself? David Levins asks, "Perhaps feedback is no more than an artifact of our mode of representation of systems- that it is not an objective property of the systems themselves?"³ But how is feedback imminent in consciousness, where is it apparent in perception, how and why is this representation occurring?

Through the development of existential phenomenology originating from Edmund Husserl, Jean-Paul Sartre and Maurice Merleau-Ponty, transcendental analysis or the investigation of the conditions for the possibility of knowledge, issuing from Immanuel Kant, leads to a comprehensive and complex investigation of the conditions for the possibility of experience, of consciousness itself.

The parenthesizing of the *natural attitude* or *the belief in the world as factually existing*, the bracketing of this rampant belief, is what Husserl termed: the *epoché*. From this perspective, one can reflect on facts and truths *as appearances*, as phenomena. In dissecting consciousness from this position Husserl showed how all consciousness is consciousness *of* something, or is *intentional*. This correspondence immediately sets up a synthesis of internal and external: some output from the world becomes an input to a conscious observer or perceiver, who then reorganizes, reflects on and reacts to the input. A feedback loop is therefore fundamental within a perceived environment or within the dialectic of being-in-the-world

² Beer, Stafford. *Designing Freedom*. John Wiley: London and New York, 1975.

³ Wimsat, William, C. *Some Problems with the Concept of 'Feedback'*. PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association, Vol. 1970 (1970). P. 252.

according to this philosophy.

Perhaps more substantially to an argument of consciousness as a feedback system is the three-fold structure of *time consciousness* that Husserl posits as fundamental to all consciousness. Time consciousness allows for perceivers to unify and make coherent experiences across time. Without time consciousness and its organizational principles, everything would be a mass of chaotic confusion with no links from moment to moment: there would be no linearity necessary for being as we are in this world.

The three-fold structure of time consciousness consists of a unity between retention (the just past), immediate impression (the now) and protention (the anticipated future). Each moment in time is held simultaneously in consciousness in this fundamental and co-relational form. There is in the *now* an immediate knowledge of what has just passed being fed back to our awareness of our situation. Consciousness is itself folding time to a point of immediacy, by feeding back outputs, the just past, into our immediate senses, enforcing our expectations for the future. Time consciousness is absolutely fundamental to consciousness, to the unity of perception and experience necessary for a 'self'. Similarly, *every phase of perception has this three-fold structure*. Recollection and reflection are using feedback cycles to structure conscious thought and self-awareness.

This may seem rather obscure, but an analysis of the phenomenological problem of solipsism that was present in Husserl and taken up by Sartre, but not satiated, was finally overcome in Merleau-Ponty's *Phenomenology of Perception*. Self and Other, he argues are immediately already apparent in the subject by example of the sense of touch. This sense initiates an understanding of what it is to be touched *and* to touch; we can sense ourselves being touched by or touching our own hand. We are always already aware of the other in this way: there is an expectation of touch in us because we can touch ourselves. This overlap of sense and expectation can be understood as an open feedback loop.

In so many ways consciousness is a loop into and onto itself. It self-organizes in this way. It is constantly related to itself. This structural aspect of consciousness is inherently reflexive: feedback is synonymous with reflexivity. Each is structural and constituting. Reflexivity too refers to circular relationships. It is the act of taking an output and reinterpreting it; it is being aware of ones self in action and emotion. It is the stepping back from the appearances and the analyses of the perceptual processes and analyzing them for new insight. The act of reflection is necessary for memory and knowledge and is structural to all consciousness. How could there be otherwise without an ability to cycle experiences back to ourselves? Or consider the optical feedback loop: the camera sees its own capture and, near the speed of light, sees it seeing itself, producing a plethora of intense visual effects. The same is true of aural feedback: the

microphone that hears itself hearing: a media specific device recognizing its own use and potential.

Reflection is one of the simplest and yet more complex feedback signals. In the science of optics, lasers have two curved mirrors facing and create the simplest feedback amplification, resulting in a laser beam. Lasers and optical feedback as a topic open up a whole new and complex subject of fractals. Fractal geometry occurs in lasers, but also in more complex types of optical feedback generally. A fractal pattern refers to emergence, *self-similarity* or *recursive geometry* and was coined in 1975 by Benoît Mandelbrot. A fractal is generally "a rough or fragmented geometric shape that can be split into parts, each of which is (at least approximately) a reduced-size copy of the whole".⁴ The Fractal geometry of Madelbrot has taken over Euclidean geometry as the 'geometry of nature'. Fractals are found in cloud formation, galaxy formation, tree formation, in crystals and lightning, broccoli, river networks, the human nervous system, etc. These geometric and mathematical patternings and packings are also, interestingly enough, found in the art works of Jackson Pollock's drip paintings.⁵ This geometry opens up issues of complexity theory, instability, chaos, astronomy and astrophysics. But what is important for our considerations is to remember that fractals are created through feedback mechanisms.

If we say that nature is structured by fractal geometry, a particular set of feedback equations, and we say that consciousness is inherently structured by feedback, and we argue that feedback is all pervasively structural of the known universe . . . just what are we saying? What is structure? Structure in the sense being employed throughout this paper is referring to the fundamental elements necessary for these very things: Feedback is the foundation of thought, self, knowledge, language, societal organization, computers, the economy, nature, tides, clouds, rotation through space, time, etc. Without feedback or reflexivity we are not self aware, we have no science, no civilization, no language. It is thus structurally first, primal and pervasive to our existence. There has not been a substantially relevant analysis of feedback as a unified theory of systems, action, or organization. "This...feedback and the examples we have given . . . are only particular cases of what is a very complicated theory, and a theory as yet imperfectly studied".⁶ There is more than semantics at stake in the argument. But it seems that it is okay to avoid any definite *meaning*, it seems mysterious and exciting to simply have this realization and to

⁴ Mandelbrot, B.B. (1982). *The Fractal Geometry of Nature*. W.H. Freeman and Company: USA. 1982.

⁵ Richard Taylor, Adam P. Micolich and David Jonas. *Fractal Expressionism: Can Science Be Used To Further Our Understanding Of Art?* "Physics World". October 1999.

⁶ Wiener, N. "Cybernetics: or Control and Communication in the Animal and the Machine". MIT Press:1965. p.114.

experience it as one pleases.

I find it tremendously interesting how feedback tends towards recognition of itself, or how it tends towards being recognized. It shows up everywhere, it follows its own rules. It seems apparent to so many processes that there is never a moment where it cannot be present. In structural analysis and art, for example the films of Stan Brakhage illustrate the very technologies at play in cinema, mainly light and film, but also camera and projector. In the 1960's Marshall McLuhan, with his groundbreaking book *Understanding Media: the Extensions of Man*, had inspired a generation of artists to become reflexive of their media, to analyze the structural elements of the very things they were working with. Works from Michael Snow and Stan Brakhage in the Fifties and Sixties began to unearth the many potentials of film and the moving image. Time based media such as music was deeply scrutinized by the likes of La Monte Young, John Cage, and Max Neuhaus to reveal the inherent aspects and qualities of the instruments and ideas themselves. Structuralism is being reflexive of the media and presenting the investigation or the findings in the same media, further enriching the system, loop or cycle.

Nam June Paik, considered the father of video art, has used optical feedback most notably in contemporary art. In his experimental pieces of 1967, it is apt that he worked at Bell Laboratories - as earlier we learned that the application of feedback circuits in communications was developed there (His *Bell Labs* video use simple visual feedback at the place that negative feedback controllers were developed 40 years earlier). In popular music, the Beatles were the first to intentionally use acoustic feedback on a recording, though it is argued that Link Ray had been the first to perform guitar feedback intentionally. Bands throughout the Sixties's and Seventies were constantly looking for new sounds and pushing the limits of their ear drums by squealing the gain on their amplifiers and feeding back their instruments by merely facing the input mechanism to the output mechanism. In the 1980's bands such as Sonic Youth who grew out of the New York art music no-wave scene of Glenn Branca, et al. began to reincorporate feedback in new and interesting ways.

But perhaps this discussion of feedback has become too obvious, too known. Another shift of gears leads us to the current act, the now: The act of recording, of either writing, videotaping or sound recording, is motivated towards a feedback loop. Here I am, writing an observant yet dense and complicated theory of how I perceive the world with the intention that someone will read it. I am taking my experiences and perceptions, encoding them in language, which is created overtime through feedback negotiations, writing them out; and here you are, the reader, closing the loop, reading what I have recorded: a sort of intersubjective feedback loop of communication, motivated from a need for expression and aiming towards mutual understanding. Language theory as understood and explained by Jürgen Habermas in his two volume opus *The Theory of Communicative*

Action discusses the ability to communicate and the processes of language as a feedback loop, as inspired by John Austin's language theory.

Interaction in any system is a feedback cycle: in language, in societal organization, in the market economy, in governmental organization. The increased rationalization and technocratization of modern society seems to be built on a developmental understanding of feedback processes. The growth of agriculture depends on feedback in terms of language, but also in terms of conscious reflection, observation and communication. The role of feedback is so pervasive that one can neither exhaust the topic nor do it great justice...

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