Some Remarks on the Philosophical Significance of Complexity Theory

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Elementary Terminology

SYSTEMS: Three forms of systems: closed (determined), open (random or self-organizing).

1. Closed systems have constant matter and energy. They were models for classical modern physics. I stress the "model" aspect. Newtonian physics proposes a model that allows approximations good enough for (military) technology. E.g., the center of gravity is only part of a model, a thought-entity, that allows for calculation: it doesn't exist in the same way atoms and molecules exist. (excusing myself from quantum mechanics stuff about existence of electrons.) Closed systems provide the classical image of nature as determinate system, as figured in the story of LaPlace's demon {Note 1}. Reversibility of time's arrow: predict and retrodict. Or better, destruction of time and achievement of God's eye view. Problem of articulating human freedom with deterministic nature. Various dualisms: Cartesian, Kantian.

2. Open systems have flow of matter and energy through them.

A. Open random systems, like laminar flow of fluids or diffusion of gases. No models for predictability, but statistical probabilities. Classic image of "chaos."

B. Open self-organizing: studied by "chaos/complexity theory." Short-term predictability, long-term unpredictability. New image of "chaos."

We have thus broached the question of a reduction of Newtonian physics from ontology to epistemology. All we ever encounter, all that exist, are open systems, but treating some of them as closed, modeling their behavior by closed model and linear equations, can be technologically helpful.

PHASE SPACE: Idea developed by Henri Poincare in late 19th century. Improved computer technology (material support of mathematics) allowed new uses. Five steps in constructing a phase space portrait of a system. 1) Identify important aspects of a system's behavior, which are called its "degrees of freedom." 2) Imagine or model a space with as many dimensions as the degrees of freedom of the system to be studied. 3) Each state of the system can then be represented as a single point, with as many values as there are dimensions. In other words, it only takes one measurement, one value, one number, to identify the state of a system with one degree of freedom: the temperature of a human being, for instance. The phase space here (instantiated in a thermometer) is only a line, while more complex phase spaces have more dimensions (temperature and pulse and blood pressure, for instance, would need three values to locate the point.) 4) The changing states of the system then trace a line, a trajectory, through phase space. In our thermometer example, the line follows only one dimension, but in more complex phase spaces the trajectory can (when random systems are studied) zoom about throughout the space, "exploring" all the permutations. 5) We can then try to solve the equations and pin down the system's behavior (closed deterministic). Sometimes we can't solve the equations, and no patterns emerge (open random). Sometimes though, in studying the system we can't solve the equations, BUT we can identify the evolution of some patterns (open self-organizing). These patterns have various features, some of which are named: attractor, repellor, bifurcator. More on these terms later.

I. Complexity Theory

In the late 60s, Gilles Deleuze began to formulate some of the philosophical significances of what is now sometimes referred to as "chaos/complexity theory," the study of "open" matter/energy systems which move from simple to complex patterning and from complex to simple patterning. Though not a term used by contemporary scientists in everyday work, it can be a useful term for a collection of studies of phenomena whose complexity is such that Laplacean determinism no longer holds beyond a limited time and space scale. Thus the formula of chaos/complexity might be "short-term predictability, long-term unpredicability." (I leave it at "predictable," an epistemological term, because people get nervous with "indeterminate," an ontological term. Thus we're only talking epistemology, or at best heuristic ontology.)

The groundbreaking works in identifying Deleuze's (and Deleuze & Guattari's) interest in this field are Brian Massumi's *A User's Guide to Capitalism and Schizophrenia* and Manuel De Landa's "Non-organic Life" in

Incorporations: Zone 6. Although post-modern appropriations of science--to say nothing of critiques--have been the focus of much negative attention lately, due to the notorious Sokal hoax, there does seem to be good cause to take seriously the work of Deleuze and Deleuze & Guattari {Note 2}.

Briefly, as De Landa explains, the actual/virtual distinction Deleuze appropriates from Bergson is put to use to distinguish between the (actual) traits of a physical system (its long-term tendencies) and the (virtual) thresholds at which it either adopts or changes those traits. Thus an actual system might, say, oscillate at one frequency within a certain range of parameters, and at another within another range. The actual behavior of the system, its oscillation at frequency #1 or #2, would be a trait, while oscillation frequencies #1 and #2 would be virtual "attractors," and the transition between #1 and #2 would be a virtual "bifurcator." "Attractors" receive their name by capturing the behavior of systems within a range of values of parameters -- their "basin of attraction" -- while "bifurcators" are named because they are the events by which a system moves from one attractor to another.

DeLanda isolates three types of attractors: point, loop, and chaotic. They correspond to three states: steady state, oscillation, and turbulence.

Deleuze's terminology in *Logic of Sense* is that of trait, singularity and Event ("emission of singularities), which line up roughly with that of trait, attractor and bifurcator. The terms adopted in the collaboration with Guattari is slightly different, with "black hole" naming "attractor" and "line of flight" naming "bifurcator."

The virtual / actual distinction enables D and D/G to account for unpredictability in physical systems while still maintaining a consistent materialism; the virtual is "real but abstract." (Deleuze/Guattari are bold enough to do ontology. They don't want just a heuristic materialism, which everyone knows is how scientists work; they want to make ontological claims.) Attractors are forms of self-organization of matter; physical systems of matter/energy flow CAN BECOME organized, even if currently random or laminar. (thus the current interest in Lucretius and Democritus: the *clinamen*, or "swerve" is the least deviation from the laminar. Thus ancient Greek atomistic physics was a fluent dynamics, not a solid one. See Michel Serres, *Naissance de la physique*.)

Even turbulent fluids, for instance, which were classic symbols of "chaotic" matter, are embodiments or actualizations of virtual attractors, albeit "fractal" or "strange" ones. There's no real chaos in turbulence, rather fiendishly complex interactions of matter. However, laminar flows (paradoxically, "calm" fluids) or gases come close to the original sense of chaos.

In the phenomena of self-organizing systems, we find creativity, novelty, etc., but this is in matter itself: bifurcators, Events, lines of flight, are changes triggered unpredictably when sensitive systems pick up slight cues that move them onto another basin of attraction, or keep them moving about within a zone of unpredictability: in Stuart Kauffman's terms, "poised on the edge of chaos."

D/G critique hylomorphism, following Gilbert Simondon. Self-organizing matter does not need the imposition of a transcendent form to organize its putative chaos. The forced choice or exclusive disjunction: chaos or state-form, for instance, is the root of fascism. *Après nous, le déluge.* By overthrowing long-term determinism in locating innovation, novelty, creativity in matter (albeit in its virtual thresholds), chaos/complexity disrupts the materialism = determinism equation and its concomitant forced choice of monistic materialist determinism or spiritualist dualist freedom. Common sense dictates (literally): since monistic materialism is determinism, and since we must preserve the phenomena of freedom, then we must pay the price of a spiritualist dualism.

It's important (as Gross & Levitt abjure), to specify Deleuze and D/G's "speculation." Chaos/complexity is well-established in physical chemistry (Prigogine) and an interesting avenue in evolutionary biology (Kauffman). Thus Deleuze was a "sensitive" who picked up currents in the air and thought through, with Guattari, what a chaos/complexity approach to econo-psycho-politics might look like. Hints and sketches of chaos/complexity used to jazz up Marx, Freud, Nietzsche, in other words. A fancy materialism.

Now it's also important to recognize that Deleuze operates above and below the level of the individual: molecular and global, rather than exclusively molar. The universal (form of personality: responsible, gendered, indebted) does not explain (the formulation of works like *Anti-Oedipus*, say), but must be explained. The question is: how are we organized, that is, how are social/familial parameters adjusted so we fall into the black hole of our "selves" and how are social/political parameters adjusted so that societies fall into the black hole of fascist paranoia?

The schizophrenic, and its "body w/o organs" (BwO) is D/G's clue to organ-ization of the body as a process. Unfortunately, I must remind you, as too many repeat the canard, that D/G do not "advocate" clinical schizophrenia as

a model for political action. Instead, they look at psychoanalysis' befuddlement in the case of psychosis, and its focus on neurosis instead. The BwO (the set of potentials for bodily organization, the virtual realm of the body) is experienced by schizos as the breakdown of body functioning (catatonia in clinical cases). The BwO teaches us that the body is organ-ized over time (thus the BwO is the testimony to the Bildungsroman we all undergo in the literal constructivist sense of being built). The body is organ-ized by assigning free floating affects accruing to machines (mouth - breast, e.g., but not privileged, except Oedipally) to persons instead: teaching you what your desire was: "so it's me! so that's what I wanted!" "It was Mommy after all I wanted!" Thus we all have a "body politic": different social machines organize the body differently. This is move from molecular to molar; it's the molarization of the body to produce a person.

Similarly, societies have thresholds at which they adopt or change behavioral traits. The body politic of feudalism is organ-ized differently than the body politic of capitalism. Fascism is a particular inflection, a black hole or attractor, within capitalism. What is the fascist threshold? D/G suggest a process of resonance of micro-fascisms until crystallization into great black hole of totalitarian state. Technically, they distinguish fascism as cancerous body politic, as a molecular process, from the totalitarian state (molar) that it sometimes eventuates in.

The process of organ-ization, although self-organization of a matter/energy system at a threshold, carries a "transcendental illusion": it creates the appearance of a transcendent organizing agent coming down from on high to organize a chaotic matter. This is particularly effective in fascism: it looks like Hitler swoops down to save the masses from chaos or impurity: this is what Hitler wanted it to look like, what he himself probably thought was the case, and how many have approached it: how did he fool the masses?

Note 1. For Laplace, or more precisely, the "demon" of his thought experiment, precise knowledge of initial conditions and universal laws would yield precise knowledge of past and future conditions. The problem with some systems is their "sensitivity" to slight deviations in our reckoning of their initial conditions. Even the slightest mistake then yields overwhelming discrepancies fairly quickly. {Return to text}

Note 2. About DeLanda's "Non-Organic Life," no less severe critics than Paul Gross and Norman Levitt say in their *Higher Superstition: The Academic Left and Its Quarrels with Science* (Baltimore: Johns Hopkins University Press, 1994), p. 267-68n17: "[although] there is some muddle ... [it is] pretty clear and straightforward ... a good and honest job, although one might wish for a more careful delineation of how much of this is really speculative." As readers of Higher Superstition will attest, this is praise indeed from Gross & Levitt. Since DeLanda explicitly links his account with Deleuze & Guattari, and since Gross & Levitt somewhat approve of De Landa - although admittedly without mentioning Deleuze & Guattari by name (they do contempuously dismiss Deleuze's treatment of Riemann in his Cinema series, although they do not mention the similar treatment in Mille Plateaux) - I assume the connection of Deleuze & Guattari and complexity is at least an avenue worth pursuing. {Return to text}