Introducing Four Regimes of Entropy: Notes for a Biomorphic Media Theory

Matteo Pasquinelli

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Humboldt University Berlin
Institut für Medienwissenschaft

> It is by avoiding the rapid decay into the inert state of 'equilibrium' that an organism appears so enigmatic.
> —Erwin Schrödinger, *What is Life?* 1944

Introduction. My contribution moves from underlining some uses and misuses of the notion of entropy across the history of science—especially in biology, ecology, psychoanalysis, cybernetics, economics and today's media theory. My proposal is about starting to distinguish different densities of energy and regimes of entropy, namely: mineral, biological, mechanical, informational. According to this modest 'geology' of energetic regimes, we will be able to understand better the circulation of the notions of energy and entropy across different disciplines—and to recover a role for its twin concept: the notion of *negative entropy* introduced by Erwin Schrödinger. In general, this text intends to focus again the forms of *positive* energy accumulation instead of just dissipation of energy. Moreover, this outline can be useful to understand the shift from the age of industrial machines to the age of digital machines.

I start with three examples to show how the notion of entropy and more generally the laws of thermodynamics have inspired different disciplines across the last century, but first a basic definition of entropy is needed.

What is entropy in fact? Entropy is a measure of disorder within a given system: that is, of how much energy is 'disorganized' or in a chaotic form. For example, the entropy of a room is said to increase if furniture is put on fire and the energy enclosed in the materials is transformed into heat and dispersed by combustion. Entropy is the measure of the second law of thermodynamics—which states that the energy disorder of any closed system tends to increase and points to an uniform equilibrium. More generally, it says that everything decays and especially that heat tends to irradiate and dissipate. From the sun to violent geological events, the inorganic world shows a clear positive entropy: it appears to burn energy and, eventually, to increase the chaos of the universe. According to general physics, entropy is the destiny of inorganic matter.

1. Freud: entropy applied to desire. The foundation of psychoanalysis happened to be influenced by the 'hard science' of thermodynamics too. The concept of *psychodynamics* was proposed in 1874 by the German physiologist Wilhelm von Brücke (Sigmund Freud's supervisor at University of Vienna) and rooted on the very physical principles of thermodynamics. Together with Hermann von Helmholtz (one of the formulators of the first law of thermodynamics), Brücke supposed that all living organisms were systems governed by the law of energy conservation. In those days, it was strongly believed that if human body follows the laws of physics, so mind has to do. Such a 'thermodynamic' psychology based psychic life on a conservative equilibrium of energy. This approach surfaces also later in Freud's essay *Beyond the Pleasure Principle* (1920), where an ancestral link between mind and matter was found in the life cycle and the energy metabolism of the monocellular organism *protista*. Fatally, Freud described death drive as the *intention* of organic matter to go back to its previous state, that is the state of inorganic matter, following the ancestral dissipation of energy, in fact following the entropy arrow. The notion of entropy is here the model for the life of the mind itself.

2. Shannon: entropy applied to information. In the 1940s Claude Shannon and Warren Weaver defined information as the opposite of noise. In quantitative terms Shannon decided to measure the quality of communication as a negative value against the background noise of a given channel. The lower the noise on the channel or 'information entropy', the higher the quality of communication. Information was described then as a sort of 'negative entropy'. The application of the term entropy to information was, by the way, suggested to Shannon by John van Neumann:

> Von Neumann told me, 'You should call it entropy, for two reasons. In the first place your uncertainty function has been used in statistical mechanics under that name, so it already has a name. In the second place, and more important, nobody knows what entropy really is, so in a debate you will always have the advantage.[1]

The term created confusion suggesting that information processes negate the second law of thermodynamics: 'information order' in fact does not accumulate energy out of chaos. A database, to give a surreal example, cannot burn. A hard disk full of data contains the same energy of an empty one. Digital impulses can be perfectly transmitted today via a very noisy medium. Shannon's homology of information and entropy was quite audacious and its consequences are still visible today in academic media theory and the economics of the digital. Informational negative entropy and thermodynamic negative entropy refer to two completely different scale of the being and cannot be confused or considered homologous.

3. Georgescu-Roegen: entropy applied to economy. With its 1971 book *The Entropy Law and the Economic Process*, Nicholas Georgescu-Roegen tried to apply the notion of entropy to the field of economics. Indeed, he believed that "political economy was an extension of biology". We could say that Georgescu-Roegen believed in a clear parallel and symmetrical relation between economy and the laws of thermodynamics, exactly like Freud put a *continuum* between the laws of inorganic matter and desire. Georgescu-Roegen's hypothesis is that humankind has a limited entropy budget and that human activity is simply increasing the entropy of the whole planet, thus devouring the entropy budget of future generations. Despite it looks like a critical and progressive view, his *bioeconomy* is paradoxically a *naturalization* of capitalism and a fatalist attitude that perceive capitalism just as an irregular cycle to be regulated and redesigned. Also the school of degrowth, that was inspired by Georgescu-Roegen, we may say polemically, believed unconsciously in a similar *naturalism of capital*. The conceptual problem here is to understand that—aside the *entropy* of production—there are gigantic processes of value *accumulation*. In fact, the fatalistic application of the notion of entropy to economics conceals the form of *capital* itself, that is a form of (value) accumulation and not just of (energy) dissipation.

It was Karl Marx to see clearly the problem of capitalistic accumulation. In economics, the other side of the problem of entropy is indeed the problem of surplus and its accumulation. Marx perceived clearly the problem of scale, when the accumulation of surplus produces something different and breaks through another ontological scale—he

[1] Quoted in: Myron Tribus and Edward C. McIrvine, "Energy and information". Scientific American, n. 224, 1971.

saw when surplus becomes capital. This vision of scale is precisely what is missing in the current economic and political debate on energy and entropy.

4. Schrödinger: the negative entropy of life. So far, we have seen the attempts to translate the notion of entropy to the dynamics of the mind, the dynamics of economy and the dynamics of information. It is time now to show that the notion of entropy is not an universal dogma. This is clear in the famous notion of negative entropy.

In his 1944 book *What is Life?* Erwin Schrödinger, observing cellular metabolism and its exchanges of energy between the inside and outside of the cellular membrane, concluded that life does not follow the second law of thermodynamics—the law of entropy. On the opposite, aside from consuming energy, cell metabolism is also able to accumulate it. He writes:

> Every process, event, happening call it what you will; in a word, everything that is going on in Nature means an increase of the entropy of the part of the world where it is going on. Thus a living organism continually increases its entropy or, as you may say, produces positive entropy and thus tends to approach the dangerous state of maximum entropy, which is death. It can only keep aloof from it, i.e. alive, by continually drawing from its environment negative entropy which is something very positive as we shall immediately see. What an organism feeds upon is negative entropy. Or, to put it less paradoxically, the essential thing in metabolism is that the organism succeeds in freeing itself from all the entropy it cannot help producing while alive.

The renowned reaction of photosynthesis transforms solar energy and storages it into the carbon rings of sugar and cellulose. This flow of energy feeds the whole ecosystem till predatory animals and the civilization of machines too ('fossil fuel' was indeed living matter once). Going *upstream*, this flow of energy challenges continuously the law of entropy, which is the tendency of mineral world to dissipate energy. Schrödinger freezes the enigma of life itself in the formula of *negative entropy*. Despite entropy can be measured in physical and mathematical terms, Schrödinger recognizes here one of the limits of science. Schrödinger is important to recognize life as a *positive accumulation* process and not just as a *negative resistance* to entropy.

5. Four regimes of entropy. Following Schrödinger inorganic and organic worlds can be distinguished as affected respectively by positive and negative entropy. Following then the innervations of the energy flows from nature into human civilization, also industrial revolution and information revolution can be described according to their different entropy regime. I propose here a very basic scheme and periodization of different regimes of entropy.

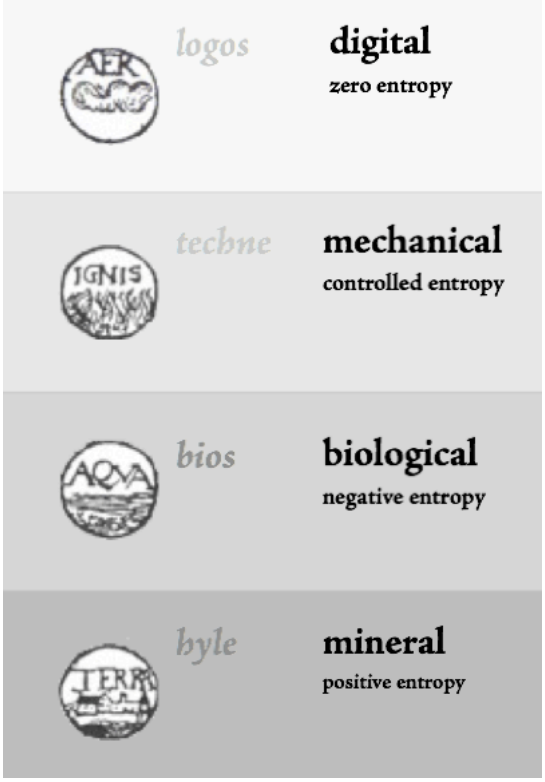

Diagram of four regimes of entropy (in metaphorical relation with the four elements doctrine of ancient thought).

The first 'violation' into the domain of natural entropy occurred in the 18th century with the introduction of the heat engine that launched the industrial revolution. A heat engine is a device that converts thermal energy to a mechanical output, nevertheless burning and dissipating more energy than what is actually transformed. Industrial machinery is designed to execute work and release energy in a constant and controlled flow—indeed, *techne* is a sort of domesticated entropy. Regarding their energy balance, heat engines are closer to the inorganic world than to the living matter: they are just able to consume those carbon compounds, such as coal, in which natural metabolism has condensed energy. Thermal engines devour far more energy compared to natural metabolism and devour nature itself: after few centuries industrial by-products have visibly altered biosphere everywhere.

In the 20th century the information revolution introduced a further entropic regime. Computers consume very few energy in comparison to mechanical engines and they have obviously a lower environmental impact. More precisely, a Turing machine, being an *abstract machine* counting binary digits, does not refer to any material

substratum and consumes almost zero: it runs on an ideal and virtual space at zero entropy. From the angle of abstraction, digital networks are purely mathematical spaces: with no gravity, no friction, no entropy whatsoever. The ethics and aesthetics of the digital, the abyss of the infinite reproduction of copies, are possible thanks to such a virtually zero-entropy engine. Also postmodern thought can be see as the cultural reaction to the abyssal nature of a digital *logos* running at (almost) zero-entropy. These four different regimes of entropy are then summarized so:

- Inorganic and mineral stratum: regime of *positive entropy*.
- Organic and biological stratum: regime of *negative entropy*.
- Industrial and mechanical stratum: regime of *controlled entropy*.
- Informational and digital stratum: regime of *zero entropy*.

This 'geology' of entropy is inspired by Deleuze and Guattari's multi-stratum ontology (and specifically by the chapter "A Geology of Moral" in *A Thousand Plateaus*), but unlike Deleuze and Guattari here strata are not sliding over each other, 'things' are not confused with 'signs', nature is not confused with culture, industrialism is not confused with informationalism, here movements are more viscous. Each stratum produces specific phenomena of friction, energy dissipation and energy accumulation. In this viscous space, phenomena of surplus accumulation and not just entropic tendencies can finally be explained.

6. From techno-determinism to energo-determinism? This geology of different regimes of entropy and regimes of production was introduced to show first that we do not live in an energetic *continuum*. Specifically, this diagram was introduced in order to show how a specific energy regime cannot be translated and used as a model for another stratum. Along the recent history of thought and cultural forms, we can recognize these examples of circulation and contamination of paradigms:

- *The technological as a model of the biological:*	Mechanicism
- *The technological as a model of the economical:*	Techno-determinism
- *The informational as a model of the biological:*	Genetic reductionism
- *The biological as a model of the informational:*	Memetics, Artificial Life
- *The biological as a model of the economical:*	Bioeconomy
- *The informational as a model of the economical:*	Digital idealism
- *The physical as a model of the economical:*	Energo-determinism

In the debate on entropy, it is clear that the mineral and physical level of energy is taken as universal model and applied to all the other strata. This can be the source of a dangerous misunderstanding. After the year of techno-determinism, I am wondering if we enter the age of *energo-determinism*: that is just another way to naturalize the dystopia of capitalism under the new moralistic motto "Consume less".

To conclude I suggest briefly that the one-dimensional paradigm of entropy should be contested with other readings, focusing precisely on the notion of *negative entropy*, i.e. on the forces that accumulate energy against its dissipation. Natural forces but also the forces of social struggles fight against the entropy of value constantly governed by capitalism. We should not forget that social autonomy is the *first* form of resistance against economic 'entropy'.

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