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his master's voice: michel serres and the ethics of noise

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> Meddling in the phenomenon, the receiver introduces or produces a certain noise there, his own, for no one can live without noise. The condition of his being a receiver, a subject, an observer, is, precisely, that he make less noise than the noise transmitted by the object observed. If he gives off more noise, it obliterates the object, covers or hides it.[1]

INTRODUCTION

As with most philosophers, the work of Michel Serres is full of normative

judgments. For example, his work can be read as a plea for reviving a "virtue of sensibility"[2] or for a renewed cultivation of our relations with the world.[3] Within his work we also find numerous positive assessments of the work of authors such as Georges Dumézil, Léon Brillouin, or René Girard. In turn, negative assessments are also clearly present, for instance of the work of Gaston Bachelard, Louis Althusser, and as recent posthumous publications have shown, Jules Vuillemin and Michel Foucault.[4] Perhaps the most normative stance found in Serres's work is his "critique of critique"[5] and his broader negative assessment of the academic world and its mores.[6]

In this article, however, I want to focus on another strand of normative judgments found in Serres's work. This concerns negative evaluations of the social world. In his books, Serres often expresses very negative views of society, politics, or language, all of which in their own way distract us from nature, science, and the world. My ambition is to argue that these critiques are not incidental, but a product of his broader philosophical work and its dialogue with information theory. I will call the resulting normativity Serres's *ethics of noise*.

Let me start with some examples of these negative evaluations. The first example comes from *Détachement* (1983). In parts of this book, Serres tells the stories of Diogenes and Francis of Assisi. For Serres, both figures embody a rejection of the social in favor of a return to nature and things. For example, Serres recounts the famous encounter between Diogenes and Alexander the Great as follows:

> Words are interesting, they whirl or rest between us [*inter-esse*]. Diogenes discards the coat, breaks the bowl, remains silent. He abandons interesting objects, and he asks the king to move away from the sun. Who is the king? Or Alexander? The most interesting object, the most interesting person in the world! Power is that much greater in that it intervenes everywhere. And if one becomes the greatest, then there is no place, no time where one does not intervene. Power is therefore what is most interesting. Diogenes forsakes power. He asks the king to allow the rays of the sun to bathe him

> directly with heat and light. Diogenes tries to erase mediation. He bridges intervals. He turns off mediums. He attempts to push aside the parasites, with his hand, with his voice. He is disinterested.[7]

We find a similar rereading by Serres of the anecdote of Diogenes wandering about in the middle of the day with a burning lantern, looking for an honest man. For Serres, it becomes a story about Diogenes "looking for the lost object. Wandering haggardly in the streets with his lighted lantern in his hand, Diogenes is the ancestor of the seeker of science."[8]

A second example can be found in *Les cinq sens* (1985), in which Serres revisits the senses through which we experience the world. In the book, Serres introduces the following anecdote about his visit to the ancient theater of Epidaurus, part of the sanctuary dedicated to the Greek god of medicine, Asclepius: "The silence within the theatre and in the surrounding scrub seeps into my skin, bathes and penetrates it, vibrates and drains it, in the hollow of the empty ear. I give myself to the world which returns me convalescent."[9] But this healing silence is shattered when a group of tourists arrives:

> Horror. Here comes a group. I can hear it in the distance, coming this way. It projects itself across space as filthy noise. [...] What did they really see? They heard: cries, words, echoes. But certainly saw rather little—all the more so as their cameras saw for them. But what did they hear that they did not already know from their language-memory? Did they come to Epidaurus at all? They arrived ill, indisposed by the murmuring of their organs, surrounded by their collective noise, and they departed in that clamorous ship without ever really arriving. [...] Alone on this step, sitting in silence for the last two hours, little by little the world gives me its gods; immersed in the social ship, I would only have picked up stray bits of language from the people around me. The group carries its gods around in bags and walkmans. In its sects and libraries.[10]

A final example is found in Serres's *Le contrat naturel* (1990). In essence, the book asks us to reconceptualize the existing social contract into a "natural contract" in which there is room not only for humans and culture, but also for things and nature. Again, this book is full of critiques of the social, for example in his description of the traditional politician:

> None of his speeches spoke of the world: instead they endlessly discussed men. Once again, publicity, as the rules for forming such a word demand, is defined as the essence of the public: thus, more than anyone else, the politician indulges in no speech or gesture without saturating them in publicity. [...] Closed up in the social collectivity, he could be splendidly ignorant of the things of the world.[11]

More broadly, Serres formulates this as a general critique of modern culture, particularly modern media and television:

> In the evening, at home, television's clamor silences any discussion. An old phonograph ad – 'His Master's Voice' – shows a well-behaved dog sitting with ears pricked up in front of a gramophone horn; we have become obedient puppies, passively listening to our masters' uproar. We never talk any more, that's for sure. To keep us from it, our civilization sets motors and loudspeakers screaming.[12]

By now it is hopefully clear that all these examples share a critique of the social, the political, and language. What is less clear is the basis on which Serres finds these phenomena problematic. What exactly is the argument at work behind these common critiques? The aim of this article is to argue that there is a logic behind these criticisms, which I call an *ethics of noise*. I will attempt to flesh out this ethics of noise in three steps. First, I will show how Serres's philosophy was deeply influenced by information theory, in particular by the opposition between information and noise. Second, I will draw on a number of ways in which information theory has been applied to biology within the work of the French

biologist Henri Atlan. Finally, I will show how this framework can then be applied to a number of social issues in order to demonstrate not only the systematicity, but also the fruitfulness of this ethics of noise.

MICHEL SERRES AND INFORMATION THEORY

The work of Michel Serres was deeply influenced by information theory, although this was until recently not always recognized.[13] This is mainly because Serres is not always so explicit about his sources, especially in his later work. The influence of information theory on his thinking is particularly evident in the early Hermes series, as well as in his recently posthumously published notebooks.[14] Let me therefore outline some of the central ideas of information theory and how they influenced Serres.

Information theory is often traced back to the work of Claude Shannon in the 1940s.[15] In this early work, Shannon proposes a mathematical formalization of communication. Shannon's model has introduced us to the basic elements of communication with which we are now more than familiar: the source of information; a transmitter that translates that message into a signal that can be transmitted; a channel through which the signal is sent; a receiver that translates the signal back into a message; and the receiver. Most importantly, it introduces the notion of noise as a disturbance in this process.

Shannon was working at Bell Labs, so he thought mainly in terms of practical problems, such as under what conditions a telephone line could properly carry a signal.[16] Shannon's perspective implies a certain reversal of our common way of thinking about communication. Communication is not so much a matter of breaking silence and beginning to speak. On a telephone line, the main issue is often not silence, but static. The challenge is to make sure that all the irrelevant sounds (the "noise sources") are excluded so that the one relevant source of information could properly convey its signal. This was typically done through the introduction of elements of *redundancy* and *robustness*. Redundancy refers to

how, in order to make sure that the signal comes across, the system transmits the signal in multiple ways (either through different paths or through repetition). Robustness refers to how the system itself must be able to withstand certain perturbations (e.g. the line would not break if it is raining, if you yell very loud, or if you have a very long conversation).

This view of communication was adopted by Serres and became a central point of departure for his early philosophy. In the first volume of the *Hermès* series, not coincidentally called *Hermès I, la communication*, he captures this idea under the label of the 'excluded third'. Communication must be understood not as a struggle between two actors trying to understand each other, but as a struggle between three. There are the two interlocutors, but there is also the third, the noise that is always there and must be kept at bay:

> These interlocutors are not opposed, as in the traditional conception of the dialectical game, they are on the contrary in the same camp, linked by interest: they fight in common against the noise. [...] *To hold a dialogue is to pose a third party and to try to exclude him*; a successful communication *is this excluded third party*. The deepest dialectical problem is not the problem of *the other*, which is only a variety—or a variation—of the same, *it is the problem of the third man*.[17]

Although this is a central idea that Serres takes from Shannon, the latter's influence is more extensive. The impact of Shannon's work is primarily that it provides a formal theorem for conceptualizing the information/noise ratio of a system. The formal details are not our concern here. What is more important is how Shannon understood information in this context, namely as a question of probability: whether something is informative or not has to be understood in relation to all other possible messages. In other words, something is informative to the extent that it is improbable. While noise on the line is a statistical necessity, the transmission of any particular signal is highly improbable (since there are so many different possible signals that could be transmitted through the channel).

Intuitively, the following example might help. Imagine you were not familiar with the work of Serres and I asked you to guess his first name. If you ask for a clue, and I simply say that his first name begins with one of the 26 letters of the alphabet, this clue would be uninformative, since it does not eliminate any possibilities. The probability remains the same: everything is possible. If, instead, I were to say that it starts with the letter M, or that he shares his first name with Foucault or Callon, that clue would be informative because it eliminates many possibilities and thus makes it less probable.

Crucial to the history of information theory, and to Serres's fascination with it, is that this conceptualization of information in terms of probabilities creates an interesting link with physics, in particular statistical mechanics (or statistical thermodynamics) and related concepts such as entropy. Developed by authors such as James C. Maxwell and Ludwig Boltzmann, statistical mechanics was an attempt to conceptualize observed irreversible processes. This is often expressed in popular formulations of the second law of thermodynamics, stating that entropy in an isolated system will never decrease, but will spontaneously evolve to an equilibrium where entropy is highest. Entropy in this context is often understood as a form of disorder or randomness.

Statistical mechanics tries to capture these processes in terms of probabilities: the reason entropy tends to increase is that, within a closed system, states with highly evenly distributed particles are more likely, whereas states with highly uneven distributions—for example, when all the fast particles are concentrated in my warm cup of tea—are unlikely. Isolated systems thus tend to evolve toward their most probable state, which is one of high entropy. So, unless I bring in an external energy source, my hot tea tends to go cold, i.e. it goes towards room temperature and the room heats up a bit, because that is the most likely distribution of particles of that closed-off room.

The connections between statistical mechanics and information theory now become clearer. We have seen how entropy was defined as the most probable

state, whereas information was seen as implying improbability. For this reason, in information theory, information is often understood as "negative entropy" or, as Léon Brillouin calls it, "negentropy".[18] This connection is often illustrated by the infamous Maxwell's Demon thought experiment, which seems to violate the second law of thermodynamics. The thought experiment goes like this: imagine a demon controlling a trapdoor between two gas-filled rooms. If the demon were able to open and close the door in such a way as to allow fast particles to pass through while leaving slow particles behind, the demon would seem to be able to reduce entropy in a closed system. This violates the second law. However, information theory provides an answer to this problem. Originally proposed by Szilard, but elaborated in terms of information theory by Brillouin, the solution is as follows: the thought experiment does not violate the second law because the demon must gain information about the state of the particles (whether they are going fast or slow).[19] This act of measuring requires energy, and so the system is not closed, but brings in energy through the demon—the demon seems to convert energy into information. Since such interaction occurs, the system is not isolated, or must include the demon as part of it. In the latter case, the entropy caused by the measurement offsets the order created by the trapdoor, and the system as a whole still increases in entropy.

The work of Léon Brillouin embodies this crossover between information theory and physics. Like Shannon, he defines information in terms of improbability: "a function of the ratio of the number of possible answers before and after".[20] At the same time, he embeds this definition in a broader physical framework in which our actions are understood along the lines of those of the demon: as expenditures of energy to gain, among other things, information. We can understand living systems, but also our social structures, as 'real' Maxwell's demons. This is, for example, his interpretation of scientific practices in the later chapters of the book. What happens in a scientific laboratory is the expenditure of energy to create information about the physical systems being studied. Local negentropy is thus created at the cost of entropy within the broader system. Brillouin calls this "the

negentropy principle of information, which says that any information resulting from a physical observation must be paid for by an increase in entropy in the laboratory."[21] Or to give some examples of later in the book: "We need a source of light to read a book. The phonograph does not work without a motor to turn the record. [...] In all of these examples, the amount of negentropy taken from the external source can be demonstrated to be larger than the information obtained."[22]

These ideas are central to the work of Serres, who draws heavily on them to flesh out his own philosophy. In his third *Hermès* book he says this about Brillouin:

> It is remarkable, for example, that Brillouin wanted his last book to be called *Science and the Theory of Information*. We find there a complete, descriptive, quantified, normative and foundational epistemology, expressed in the language of physics, of the notion and the fact of experimentation, of laws, of precision and of approximate knowledge, of the limits of what we can know (*que sais-je*?), that is to say, all the classical themes; but also all the 'modern': a theory of code, of language, of writing, of translation. Philosophers do not have to look for or write a manual for the epistemology of experimental knowledge: it is there.[23]

For Serres, Brillouin provides a framework for thinking about information in terms of probability and applying this to all kinds of physical processes. Any existing complexity can be thought of in terms of information: every physical organization can be understood as an improbable state of matter that embodies information to the extent that it is an improbable state. For Serres, this leads to a worldview in which the whole of reality is understood as a vast communicative network exchanging information:

> there is an incessant and continuous dialogue among things, which forms the historical fabric of events and laws, among which my intervention is exceptional [...]. The generalized informational language constitutes the fundamental and continuous relation between the objects. Even before

> deciphering it, the certainty that it exists induces the certainty that the external world exists, in the mode of a communicating network, of which all the networks that I know and can constitute are singular, exceptional cases, approximating to imitating the real world.[24]

Based on information theory, Serres thus develops a philosophy in which the world is understood as a process of information exchange. All objects exchange information, and their differences can be explained by the different kinds of information they exchange and store. This way of thinking has also proved influential among a number of scholars inspired by Serres, in particular Madeleine Akrich, Michel Callon, and Bruno Latour. What they originally called a "sociology of translation"[25], a term borrowed from Serres, would later become known as Actor-Network Theory (ANT). Similar to Serres's philosophy, ANT focuses on a symmetrical analysis of humans and non-humans, where both have agency and constantly 'translate' each other's actions.[26] While this legacy has been the subject of concern elsewhere, the focus of this article is on something specific to Serres, namely his ethics of noise.[27] To understand this ethics, we need to introduce some additional ideas from information theory, and in particular from Henri Atlan's application of information theory to biology.

HIERARCHIES OF INFORMATION

In this part, I want to argue that what I call the *ethics of noise* of Serres is mainly a product of a set of ideas that apply information theory to biology, or more exactly, self-organizing systems. These ideas have best been articulated by the French biologist Henri Atlan. Atlan and Serres were both members of the Group of Ten (*Groupe de Dix*), an interdisciplinary group in France who aimed to apply new developments in physics and biology, in particular in relation to self-organizing processes, to contemporary societal challenges.[28] In his work, Serres explicitly mobilized Atlan's oeuvre to understand biological phenomena through an information theoretical lens[29] while, in turn, Atlan saw Serres as an embodiment of a "new natural philosophy"[30] that overcame the opposition between vitalism

and mechanism, together with figures such as Cornelius Castoriadis, Edgar Morin, Jean Piaget, Judith Schlanger and Isabelle Stengers.

Atlan is interested in how Shannon's information theory can help us to understand processes of self-organization in biology. However, he is deeply aware that introducing information theory in the life sciences reveals a number of challenges for information theory. Atlan summarizes the three main challenges as follows:

> 1. Those related to the creation of information: Shannon's second theorem, of the channel with noise, explicitly states that information transmitted in a channel cannot be created, since it can only be destroyed by the effects of noise, or at best, preserved.
>
> 2. Those related to the meaning of the information: Shannon's formula can only be used to quantify the average information per symbol of a message if we neglect the possible meaning of that message.
>
> 3. Finally, those linked to hierarchical forms of organization: of the process of organization, it completely ignores the problems of nesting different levels of organization, more or less integrated, one inside the other.[31]

Returning to Shannon's model of a system in which a message is transmitted by a signal to a receiver, with the risk of interference from noise, we thus see three problems that are particularly pertinent when thinking about living systems. First, it is unclear how such a system is created in the first place, especially if noise is the eternal disruption of order. If, as we have seen, information is equated with negentropy, and systems tend to evolve to higher levels of entropy, how does new information ever arise? Are living systems not inexplicable in a universe governed by thermodynamics? This is a particularly pertinent question for biology, since biology deals with systems that are not created by an engineer, an external source of information and order, but have created themselves and seem to embody elements of genuine novelty.

Second, it is unclear how we can distinguish between *meaningful* improbable organizational states, such as those of organisms, and improbable but meaningless states. To take another intuitive example: a sentence of 22 words can be considered informative because it is improbable. However, many combinations of 22 words on a page can be equally improbable, without therefore necessarily also being considered as equally meaningful. I can write a book the same length as Albert Einstein's that is equally improbable, but that does not mean that both books are equally meaningful. This is where the formal definition of information shows its limits. Shannon defined it in quantitative terms of probability, but living things seem to require a qualitative criterion of meaningfulness.

Third, there is the problem of hierarchy. In Shannon's model, there is only one system in which information is transmitted. It is less clear how different systems can relate to each other, especially if they are related in a hierarchical way with one system being nested in the other (such as molecules, organelles, cells, tissues, organisms, populations, etc.). For Atlan, this question mainly concerns the issue of emergent properties: while it is easier to conceive of the influence of higher-level systems on lower-level ones, for example in the form of environmental constraints on the lower-level system, how can we conceptualize the reverse relationship, where lower-level systems influence the higher levels, such as molecules influencing the ordering of solid objects, or cells influencing the ordering of tissues or organisms? "How can we represent the effect of the molecular level on cells, of cells on organs, of organs on the organism, when this is the daily bread of biological observation?"[32]

To respond to these three challenges, we can draw on two central ideas within Atlan's theory: (a) the *relativity of the information-noise dichotomy* (mainly as a response to the second concern); and (b) the *principle of complexity through noise* (as a response to the first and third concern). Let us have a closer look at both these ideas, since they will prove to be fundamental for Serres's ethics of noise.

The first idea concerns the question of meaning: if we define information in

terms of improbability, is any equal improbable state then equally meaningful? That seems absurd, as the example of writing suggests: though a specific order of words can be equally probable, they are not equally meaningful. To their credit, this is something that information theorists recognize. Brillouin, for example, explicitly states: "we define 'information' as distinct from 'knowledge', for which we have no numerical measure. We make no distinction between useful and useless information, and we choose to ignore completely the value of the information."[33] Similarly, Atlan acknowledges that "the fact that messages have meaning is obvious, but remains implicit since this theory treats problems of coding and transmission efficiency without having to consider the actual meaning of the messages to be coded and transmitted."[34]

For Atlan, however, this must not be seen as a problem, but rather points us to the solution.[35] The issue is not that information theory is unable to think about meaning, but rather that it ignores the issue, because it assumes it already to be solved. "In fact, the problem of meaning and significance is still there, even though we think it has been eliminated."[36] If we revisit Shannon's work, this becomes clear. He does not consider the problem of meaning, because he considers it solved: the meaning is derived from the implicitly assumed sender and receiver, or from the external observer looking at this system. Whether equally improbable signals are meaningful information or useless noise is thus never given in any absolute way, but are relative to the perspective one takes. Serres captures this idea beautifully in an example from *Le Parasite*, which explores the topic of noise:

> At the feast everyone is talking. At the door of the room there is a ringing noise, the telephone. Communication cuts conversation, the noise interrupting the messages. As soon as I start to talk with this new interlocutor, the sounds of the banquet become noise for the new 'us'. The system has shifted. If I approach the table, the noise slowly becomes conversation. In the system, noise and message exchange roles according to the position of the observer and the action of the actor, but they are transformed into one another as well as a function of time and of the

system. They make order or disorder.[37]

Whether something is thus information or noise depends on the frame of reference. This is an insight that is central to Atlan as well:

> The meaning of the message [...] is never intrinsic to the message; the meaning is the relationship of the message to some reference point outside of the information borne by the message. Something or somebody has to 'read' the message. Meaning is referential and contingent.[38]

This is what I call the *relativity of the information-noise dichotomy*: whether something is to be considered information or noise cannot be answered as such, but always depends on one's point of view. Typically, this frame of reference is the observer, the scientist trying to decipher the message or the engineer designing the system.

This, for example, is the basic point of a novel like *His Master's Voice* by Stanislaw Lem. The book deals with the subject of first contact, in which humanity receives an apparently intelligent message from the cosmos. But at the heart of the novel is the question of whether the signal contains real information or is just noise. As is typical of Lem's novels, the answer remains unclear, as Lem often aims to show how it is our own frame of reference that shapes our expectations about aliens.[39] As Lem states it pessimistically, "receiving the message from the stars, we did with it no more than a savage who, warming himself by a fire of burning books, the writings of the wisest men, believes that he has drawn tremendous benefit from his find!"[40] Deciphering the information of a received message cannot be solved by itself, but is always related to the frame of reference from which one approaches it.

Similarly, in one of his texts, Serres mobilizes this framework to reconceptualize the 'unconscious', not in terms of the subject, but in terms of information and noise:

> All of information theory, and therefore all of noise theory, only makes sense in relation to an observer who happens to be connected to it. Who is this observer? The simplest answer would be to say that for our own organic system we are the observer(s) in question. And so we should perceive this noise.[41]

But, and this is Serres's fascination, we often do not perceive this noise from the world. If we did, we would be constantly bombarded with it, inundated. "Leibniz already said it in his language: the cloud of small perceptions, external and internal, should make us feel uneasy and dizzy, it should be unbearable. Yet, except in extraordinary circumstances, we see almost nothing of this intense chaos, which nevertheless exists and, as we have discovered, is experimentally proven to work."[42]

Serres finds the answer in an image proposed by François Jacob[43], namely that of Russian dolls or nested objects: where a system produces information and noise, according to its own criterion, the next level integrates both information and noise in a novel way. "The next level, in the nested series, receives and manipulates, and generally integrates, the pair of information and background noise emitted by the previous level. How does this work? Some recent studies have shed some light on the answer to this question."[44] In fact, Serres is referring with these "recent studies" to the work of Atlan. The latter, for example, uses this framework to think about how new forms of order can emerge in evolutionary history. While mutations are to be considered as sources of noise, perfectly in line with Shannon's framework when thinking at the level of the cell, they can become sources of novelty at higher levels:

> From the point of view of the organ or physiological apparatus, this same noise has the effect of creating variety and heterogeneity among cells, which allows them to be more adaptable. Therefore, up to a certain point, and provided that the redundancy of the cell is great enough so that these false proteins do not interfere with the function of the cell, the same

> effects of noise on the channel within the cell that are considered harmful by the cell itself can be considered beneficial by the organ.[45]

Similarly, as Serres summarizes, the information-noise dichotomy "changes its meaning when the observer changes location: when he is immersed in the level under consideration or when he examines the whole from the next level up. In a sense, the latter functions as a rectifier, and in particular a noise rectifier. What was an obstacle to any message on the track is reversed and added to the information."[46]

We thus end with a reinterpretation of the role of the observer and the relativity of the information-noise dichotomy. The observer can be understood as a *higher level* analyzing a lower system in terms of its own criterion of noise and information. Or, in Atlan's words:

> *This observer, external* to the system, *is in fact, in a hierarchical system, the higher* (encompassing) *level of organization* in relation to the component systems that constitute it; it is the organ in relation to the cell, the organism in relation to the organ, etc. It is in relation to it that the effects of noise on a track within the system can, under certain conditions, be positive. [47]

This ultimately, leads to Serres's reinterpretation of the unconscious: it is not so much a deeper layer, hidden beneath consciousness. Rather, it is to be understood as this noise of the world, that would otherwise bombard us, but filtered through many layers of information-noise distinctions. "It's no longer a single black box, but it's a series of nesting boxes, and this series is the whole organism, the body. Each level of information functions as an unconscious for the global level that encompasses it."[48] While the top level is that of language and culture, the lower levels are undefined, but all share a similar pattern:

> I know who is the last observer, the receiver at the end of the chain: precisely, the one who emits language. But I don't know who is the first sender at the other end. It's indefinitely a black box. A box of boxes, and

> so on. I can go as far as I want, down to the cells, down to the molecules, provided, of course, that I change the observed object. All I know for sure is that they are all structured by the copula information-noise, chance-program, or entropy-negentropy.[49]

We have now seen how to think about the relativity of information and noise, and how this can help us think about if and when information is meaningful. The answer is relative: it is always in relation to the perspective of the system and its criteria of relevance that something can be seen as meaningful. The reason why Einstein's book is more meaningful than my own, which is equally improbable, can only be understood by taking into account the broader culture that values Einstein's theories. Moreover, these systems can often be understood hierarchically, in the sense that they are nested: the noise from a lower level may turn out to be a source of information from a higher level. Again, we can understand this intuitively. Consider examples where we are trying to evaluate something, such as whether our written software code works, or whether a student has learned their lesson. How do we judge that? We observe their actions and see where they go wrong. But these errors, this "noise", are evaluated differently by the evaluator and the performer. While for the program or the student errors are annoying and to be forgotten or ignored, for the evaluator they become informative: the "noise" of errors "informs" their action to introduce new corrections to the system they are observing, be it a computer program or a student.

We see how this line of thought also helps us think about the third issue, namely that of hierarchy. But what remains unclear is this third problem in light of the first: how is novel information created, and how can lower levels produce new information for higher levels, especially in biological systems? For this, it is helpful to turn to Atlan's second central idea, namely that of *complexity through noise*. This idea mainly concerns the following tension between information theory and biology, namely that of the different story of how order is created. Whereas in the case of Shannon the creation of order was derived from the engineer who built the system, it is much less clear how in evolutionary history such complexity as

we see in the living world can arise spontaneously.

Atlan tries to capture the creation of information in biology, leading to new forms of self-organization, through what he calls the principle of complexity through noise. Atlan builds on the work of the cyberneticist Heinz von Foerster, who introduced the principle of *order* through noise. Von Foerster was dissatisfied with the fact that within Shannon's information theory, noise was only thought of in a negative way, i.e. as something to be avoided, since it can only destroy order, never create it. Von Foerster disagreed, since "in my restaurant self-organizing systems do not only feed upon order, they will also find noise on the menu."[50] To illustrate the idea, Von Foerster introduces the following thought experiment. Imagine that "I get myself a large sheet of permanent magnetic material which is strongly magnetized perpendicular to the surface, and I cut from this sheet a large number of little squares".[51] These squares are then glued to cubes, for example so that three sides are positive and three sides are negative. If you then put them in a box and shake the box, these cubes will "self-organize" into predictable figures when you open the box. Von Foerster concludes that "the entropy of the system has gone down, hence we have more order after the shaking than before."[52] In this sense, a system can seemingly gain order through noise.

Atlan wants to build on this example, but is still unhappy with the details. For Atlan, this does not really create a new order, since it simply relies on the magnetic forces at work. The result is not surprising, once we take these forces into account: "The whole point of von Foerster's examples of cubes lies in the assumption that we don't know anything about their magnetization."[53] The example is closer, not so much to life, but to the growth of a crystal: the creation of order, yes, but an order that is predictable and repetitive. Living systems, on the other hand, are characterized by the creation of truly novel and surprising results that were not given at the beginning.

This is what Altan tries to capture with this principle of complexity through noise, which "represents, let us say, a normal principle of organization for any natural

system endowed with the capacity for self-organization and adaptation through undirected learning."[54] To understand this principle, it is important to keep in mind that complexity has a specific meaning here. Something is *complicated* when it requires many known elements and interactions. Something is *complex* when the presupposed elements or the principle behind their ordering remain unknown to the observer. Although one typically knows the constituents of the lower level—for example, that an organism is composed of cells—the specific principles by which they are ordered remain unknown to the observer. "In other words, *complexity is an apparent disorder where we have reason to suspect a hidden order; or complexity is an order whose code we don't know*."[55] The principle of complexity through noise thus refers to a process of self-organization that uses the noise of a lower level, but without it being clear to the outside observer what the exact rules are by which it redraws the distinction between information and noise. This code remains accessible only from within the system.

The formal treatment of this principle by Atlan does not concern us here. Rather, let me illustrate the logic by quoting two other authors that Atlan often cites in this context: Cornelius Castoriadis and Jean-Pierre Dupuy, two philosophers who are similarly fascinated by self-organization. Castoriadis captures the core ideas of this principle as follows:

> What [...] characterizes an automaton—and living things in general—is that it establishes a system of partitions in the physical world which applies only to itself [...] and which, being only one of an infinite number of such possible systems, is completely arbitrary from a physical point of view. For example, the rigor of the reasoning contained in the *Principia Mathematica* is of no interest to the moths of the Bibliothèque nationale. Ambient lighting is irrelevant to the operation of a computer. [...] Obviously, it is only this system of partitions [...] that makes it possible to define, in each case, what is information for the automaton and what is noise or nothing; it is also this system that makes it possible to define, for the automaton, what is relevant information, the weight of an item of information, its

> value, its operational 'meaning' and, finally, its meaning altogether. These different dimensions of information [...] ultimately show that the automaton, in the sense that matters, can only ever be thought of from within, that it constitutes its framework of existence and meaning, that it is its own a priori, in short, that to be alive is "to be for itself", as certain philosophers have long maintained.[56]

Dupuy offers another intuitive way to distinguish between von Foerster's principle of order through noise and Atlan's principle of complexity through noise. He illustrates the distinction through an imaginary game: let one player leave the room while the others agree on a certain story that they want to tell. But instead of telling the player this story when he re-enters the room, they let the player guess the story through yes-or-no questions. However, Dupuy continues, there are actually two versions of this game: one in which the others actually agreed on a predetermined story, and another in which they merely agree on a rule to follow in their answers to the player's questions (e.g., "answer yes if the question starts with a vowel"). While in both cases a story will be the end product of the game, only in the second version there is a real novelty in the sense of Altan's principle:

> In the first case, between the beginning and the end of the game, the range of possible stories narrows down on an 'order' that was always present: the story to be discovered. For the players who have chosen the story, there is a reduction of surprise as the game unfolds. In the second case, the same players go from surprise to surprise. For them, there is a real increase in complexity, even though the player who asks the questions thinks he is approaching a present and fixed form.[57]

The key point of this example is that in Atlan's principle of complexity through noise, there is no set of rules accessible to the outside observer. Order emerges through a combination of variation and a set of simple rules, accessible only from within the system. In the case of Dupuy's game, it is a variation of questions and the rules to follow to answer yes or no. In biology, the equivalent could be genetic

or environmental variation and the rules of selection (survival, sexual, or other).

At the same time, and this is crucial, this also points to two fundamental conditions for this to work, according to Atlan. We have already encountered these two elements in Shannon's information theory, namely redundancy and robustness. Complexity through noise always requires, first, "sufficient initial redundancy" that can serve "as a reservoir, or potential for self-organization" and second, a degree of "inertia, i.e. its reliability or resilience must suffice to prevent small perturbations from immediately destroying it."[58]

As we have seen, redundancy refers to the existence of repetition: the signal is not transmitted once, but (in) multiple ways. This guarantees that the original signal is still received despite noise. This is necessary because the original systems, which gain new functions through new sources of noise (e.g. mutations), already had relevant information to transmit. If there is no redundancy, and each signal is transmitted in only one way, there is simply no room for new variation, unless it is at the expense of existing information being transmitted. Similarly, robustness is needed to ensure that noise perturbations do not immediately destroy the system. Without some level of robustness and resilience, the system would not be able to incorporate and live with the noise that creates the new complexity.

Returning to our examples, we can see how they relied on redundancy and robustness. In the case of Dupuy's game, redundancy was present in the form of the player's ability to interpret the yes/no answers in multiple ways. When redundancy is removed, there is no room to connect and interpret the different answers in novel ways. This would mean that either the story is closed (everything is clear) or that it has led to clear contradictions. Similarly, the game needs a certain level of robustness, in the sense that the sometimes surprising answers to the questions must be able to be incorporated into the story or the game without rendering the story nonsensical, or without making it clear that there is in fact no agreed-upon story. Turning to biology, we see similar needs. Self-organization in biology requires that the living system has a certain amount of redundancy, in

the form of genes or cells that can take over functions that have been disrupted by noise. If there is no room for further mutations, there is no room for novelty. At the same time, the cell typically needs some robustness: it needs to be able to survive with new mutations or in new environments. So biological systems cannot be pure flux and change. They also need stability. Hence, the title of Atlan's most famous book: between crystal and smoke (*entre le cristal et la fumée*). For Atlan, this is how life is defined: "the two forms of existence between which living beings navigate, crystal and smoke."[59]

SERRES'S ETHICS OF NOISE

Now that we have a better idea of how Serres's philosophy is inspired by information theory, we can return to Serres's negative evaluation of the social with which we began. The framework articulated above will allow us to better understand what is going on in these judgments. Throughout this article we have learned a number of things. We have seen how information theory can reinterpret the world as a network of objects that exchange information with each other. We also learned that this information-noise dichotomy must always be understood relative to a frame of reference. We are often confronted with a hierarchy of systems (such as cells, tissues, organs, bodies, ...) where at a higher level the distinction between information and noise can be redrawn in such a way that what is noise at a lower level can become information. This principle of complexity through noise is characteristic of living systems, but it always depends on the existing redundancy and robustness of the lower systems.

It is this framework that can help us see what is normatively at stake for Serres. The three examples I have given, but it is a common pattern throughout Serres's oeuvre, are cases in which the higher level reaches such a level of complexity that it threatens to overrun the lower level on which it depends. Or, in more technical terms, the higher level is in danger of completely consuming (and even exceeding) the available redundancy of the lower level. Metaphorically, the higher-level system is in danger of sawing off the branch on which it sits.

Let me illustrate this with a simple example. When people communicate, especially in a foreign language, they tend to do so with an accent. If we look at this form of communication through a frame of reference that, analogous to Shannon's, is primarily interested in the content of what is said, then the accent will be a form of noise. It would be similar to the grammatical errors you might find in this paper: something that is not informative, but rather a distraction from the content. However, if we shift our frame of reference to a higher level, say as an anthropologist interested in cultural differences, the accent can become a source of information. At that level, what was noise suddenly becomes informative about the speaker's nationality, class, or status. But as Atlan pointed out, this higher-level game of status can only be played within certain limits. The problem Serres is concerned with would be tantamount to having an accent so strong that the content is lost to outsiders, or a text written with so many errors that it becomes unreadable.

My argument is that the same issue is at play in the examples I cited *from Détachement*, *Le Cinq sens*, and *Le Contrat naturel*. The concern in these examples is that higher-level systems of communication, such as social prestige, politics, or language games, tend to overrun the lower levels on which they depend: science, nature, the world. In Diogenes's example, it was the problem of science: scientific research risks being overrun by systems of complexity built on its own noise, such as prestige, power, or financial incentives. Of course, these higher levels of complexity are inevitable, since every system produces noise that can produce forms of complexity at a higher level. The problem is when the scale of this noise complexity tends to overwhelm the original lower-level distinction between noise and information. This would lead to a complete lack of concern for scientific truth, but only for career or money.

In the case of the ancient theater of Epidaurus, the danger was similar but more general: the higher-level system of language threatened to overrun the world that was its original object. While at a lower level of complexity language served the purpose of describing and understanding the world, the noise generated in

that system served as the basis for new levels of complexity focused on social interactions for their own sake. We see a similar dynamic in the examples of the politician and the media in *Le Contrat naturel*. While politics served to find pragmatic solutions to coordination problems between people, its noise served as a basis for political careers, personal gain, or media spectacle. Again, the problem is not that these higher levels of complexity exist—they are inevitable—but that they threaten to exhaust the redundancy of the lower level: a science that can no longer make real discoveries, a discourse that forgets the world, a political game that is only about who gets in the newspaper.

Rather than delve deeper into some of Serres's texts, I would like to briefly build on some of these examples to highlight the power of this framework. As a first example, we can think of the way in which consumer goods tend to become *cultural signifiers* of prestige. This is a well-known phenomenon that has been extensively described by social theorists such as Jean Baudrillard or Pierre Bourdieu.[60] It is often associated with concepts such as reification or fetishism: while we adopt a technology as a means, it tends to become an end in itself. Andrew Feenberg illustrates this with the example of the automobile:

> Automobile ownership involves far more than transportation. It symbolizes the owner's status. In poor countries, it has an even greater symbolic charge than in rich ones, signifying the achievement of modernity and its vision of a rich and fulfilling life. It cannot be said in such cases that the means are separate from the ends. Possession of the means is already an end in itself because identity is at stake in the relation to technology.[61]

Whereas a car was introduced as a means to an end, to go places, it tends to become an end in itself: I buy a car for the prestige of driving it. We can analyze these cases in terms of information theory. We can approach a car from different frames of reference: either in terms of utility or in terms of cultural signifier. But we also see how these levels are nested: cultural prestige could only build on the information-noise dichotomy of the lower level, and it can surprisingly redraw

this dichotomy. For example, the loudness of the engine or the size of the wheels, once a source of noise, can now become information about identity. Moreover, we can see how the same concern of Serres is at play here, namely when this system of cultural signifiers risks becoming so extensive that it erodes all the redundancy of the lower levels. The size and loudness of the car can only be a cultural signifier as long as it does not completely undermine the lower system, as when cars no longer fit into parking spaces or narrow streets, or keep residents awake at night.

A second example could be *political polarization,* in particular the current wave of populism in politics. Again, populist rhetoric can be analyzed on different levels. When we look at the actual content of populist rhetoric, we often see clichés or empty phrases ('the elite', 'Brussels', 'I hear you'). However, a more meaningful analysis takes place at a higher level, where populist rhetoric is analyzed not in terms of its actual practical content, but in terms of the signals it sends to the electorate. At this level, the making of certain political statements plays out according to a different information-noise dichotomy. Again, this is inevitable, but it risks becoming a real problem if the fixation on this level is at the expense of the lower level, where there is no redundancy left to actually come to practical political decisions.[62]

A third example is ecology, a subject close to Serres's heart, not only in *Le Contrat naturel*, but also in *La Guerre mondiale* and *Le mal propre*.[63] Here we come closer to a case where it is not so much two different social systems being nested within one another, but more generally of how social systems are nested within natural systems, on which they depend. Often certain sources of noise in nature – such as natural landscapes, specific climates or ancient ruins – can become signifiers of information at higher levels. But the ecological crisis raises the question of whether we are not approaching tipping points for some of these elements, and risk putting too much pressure on the lower levels, where no redundancy is left. That is why Serres argues for rethinking the social contract in terms of a natural contract. We need to impose constraints on these higher levels in order to preserve the lower ones, we need to master our mastery:

> Because, unregulated, exceeding its purpose, counterproductive, pure mastery is turning back on itself. Thus former parasites have to become symbionts; the excesses they committed against their hosts put the parasites in mortal danger, for dead hosts can no longer feed or house them. When the epidemic ends, even the microbes disappear, for lack of carriers for their proliferation.[64]

In other words, Serres's ecological thought draws on his inspiration from information theory. This is particularly evident in his famous opening example of Francisco Goya's painting, *Fight with Cudgels*. "A pair of enemies brandishing sticks is fighting in the midst of a patch of quicksand. Attentive to the other's tactics, each answers blow for blow, counterattacking and dodging. Outside the painting's frame, we spectators observe the symmetry of their gestures over time: what a magnificent spectacle-and how banal!"[65] The first part of the book is a long analysis of this painting in terms of information theory: two interlocutors in conflict against the background of an excluded third, nature, a subordinate system on whose redundancy they rely.

So we see a similar pattern in all these examples. But what is the normative principle at work here? If all these examples show problematic cases of higher systems overwhelming lower ones, what is the alternative? Here Serres seems to rely on the model of symbiosis: instead of the parasite killing the host, we need an interaction in which host and guest can live side by side. More specifically, Serres's proposal seems to be that all levels in the hierarchy of information are worth preserving, since the higher levels will inevitably emerge from the noise, and the lower ones are needed by the higher ones, or else they will perish. In this sense, information theory for Serres leads to what I have called an ethics of noise.

CONCLUSION

In this article we have seen how Michel Serres derives a normative framework, which I have called an ethics of noise, from reflections on information theory.

From this perspective, the world must be understood in terms of a series of nested levels that distinguish between information and noise, typically relying on the noise of the lower levels. However, there is a danger that they may exhaust the redundancy of that lower level. This is where the ethics of noise comes in, requiring that sufficient redundancy be maintained at all levels, or else the higher-level systems will undermine the lower-level systems, and thus themselves.

We have seen, through a number of examples, how this framework is at work in many of Serres's normative judgments about the social, the political, and language in general. These tend to be higher-level systems that rely on lower-level systems, but run the risk of overwhelming them: science, nature, the world. A further elaboration of this framework could therefore also help in the interpretation of Serres's other works and claims. For example, it could help make sense of his infamous 'critique of critique':

> Criticism is never fertile, and evaluation of the sciences is not even possible, since they fluctuate so rapidly. Although it is valued in academia, criticism is easy, temporary, fugitive, quickly out of style. If yesterday's truth is tomorrow's error, then in the sciences it likewise happens that the error condemned today will sooner or later find itself in the treasure house of great discoveries.[66]

This critique of critique can be read as another example of how a higher-level system, critique that relies on the lower level it seeks to critique, exhausts the redundancy of the lower level. If all one sees in literature or science is ideology, capitalism, or patriarchy, then there is no longer any redundancy in the lower level to create truly new literature or science in the first place.

Another important question is the extent to which this ethics of noise is unique to Serres. There is good evidence that many other scholars who were fascinated by self-organization in the 1970s and 1980s had similar thoughts, such as Cornelius Castoriadis or Jean-Pierre Dupuy, and especially those who were part of the Group

of Ten (*Group des Dix*), such as Henri Atlan or Edgar Morin. Atlan, for example, applied his information theory to the analysis of social crises. For Atlan, a crisis implies a kind of inversion of the principle of complexity through noise, where complexity produces noise for the lower level: "It is as if the different levels of organization within the same system no longer understand each other. What is information at one level is perceived as noise at another".[67] Or to quote him more fully:

> In the social organization in crisis, the individual's code would be incomprehensible and untranslatable to the social code, and vice versa. The variety and absence of constraints observed at the global level would be a source of noise for the system itself at the individual level. In this case, the differences between individuals, instead of constituting a regulatory and adaptive capacity for the system, could only be disruptions—in other words, noise—in the communication between the individuals that make up the system. For the observer, it would be as if the information (complexity) contained in the system were transformed into noise, preventing communication within the system and thus only contributing to its destruction.[68]

Other examples could be Castoriadis's analysis of the "imaginary institution of society"[69] or the fascination of Serres, Dupuy, Atlan and others with the work of René Girard and his scapegoat mechanisms.[70] Castoriadis' political philosophy is based on what he himself calls an ontology of magma, mapping how local islands of determinacy (information) are situated in a sea of indeterminacy (noise). This translates into a political project that aims to map the creative ways in which societies are instituted by imaginaries, echoing the theme of complexity out of noise. Similarly, Girard's rereading of history through a logic of mimetic violence (noise) that leads to a new social order through a mechanism of complexity out of noise (the scapegoat mechanism) has many similarities to the analysis proposed above. This initial mapping of Serres's ethics of noise could therefore be a further invitation to explore the way how within French philosophy information theory

and cybernetics have been translated into broader research programs with clear political and ethical stakes.[71]

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NOTES

1. Michel Serres, *Genesis* (Ann Arbor: University of Michigan Press, 1995), 61.
2. David Webb, "The Virtue of Sensibility," in *Michel Serres and the Crises of the Contemporary*, ed. Rick Dolphijn. (London: Bloomsbury, 2018), 11–29.
3. Massimiliano Simons, *Michel Serres and French Philosophy of Science: Materiality, Ecology, and Quasi-Objects* (London: Bloomsbury Press, 2022).
4. Michel Serres, *Cahiers de formation: pages choisies* (Paris: Le Pommier, 2022). For remarks on Vuillemin, see 480–2; for Foucault, see 1003; 1009.
5. Bruno Latour, "The Enlightenment without the Critique: A Word on Michel Serres' Philosophy," *Royal Institute of Philosophy Lecture Series* 21(1987): 83–97.
6. This 'critique of critique' is not particular to Serres, but also found in the work of authors often associated with his work, such as Isabelle Stengers and Bruno Latour. See Ilya Prigogine and Isabelle Stengers, "Postface: Dynamics from Leibniz to Lucretius," In Michel Serres, *Hermes: Literature, Science, Philosophy*, eds. Josué V. Harari and David F. Bell (Baltimore: The Johns Hopkins University Press, 1982), 135–58; Bruno Latour, "Why Has Critique Run out of Steam? From Matters of Fact to Matters of Concern," *Critical inquiry* 30, no. 2 (2004): 225–48.
7. Michel Serres, *Detachement* (Athens: Ohio University Press, 1989), 73.
8. Ibid., 69.
9. Michel Serres, *The Five Senses: A Philosophy of Mingled Bodies* (London: Continuum, 2008), 85.
10. Ibid., 85-86.
11. Michel Serres, *The Natural Contract* (Ann Arbor: University of Michigan Press, 1990), 43.
12. Ibid., 8.
13. Though see N. Katherine Hayles, "Two Voices, One Channel: Equivocation in Michel Serres," *SubStance* 17, no. 3 (1988): 3–12; Massimiliano Simons, "The Parliament of Things and the Anthropocene: How to Listen to 'Quasi-Objects," *Techné: Research in Philosophy and Technology* 21, no. 2 (2017): 150–74; Vera Bühlmann, *Mathematics and Information in the Philosophy of Michel Serres* (London: Bloomsbury, 2020). Massimiliano Simons, "Self-Organizing Life: Michel Serres and the Problem of Meaning," in *Canguilhem and Continental Philosophy of Biology*, eds. Giuseppe Bianco, Charles Wolfe, Gertrudis Van de Vijver (Cham: Springer, 2023), 209–32; Lilian Kroth, "Entropy and Entropic Differences in the Work of Michel Serres," *Theory, culture & society* 41, no. 2 (2023): 21–35. In June 2024, there was also a workshop on 'Michel Serres, la cybernétique et l'ifnormation comme grandeur physique' at the ENS in Paris, organized by Bernadette Bensaude-Vincent and Roland Schaer.
14. See Michel Serres, *Hermès I, La communication* (Paris: Éditions de Minuit, 1969); *Hermès II, L'interférence*. (Paris: Éditions de Minuit, 1972); *Hermès III, La traduction* (Paris: Éditions de Minuit, 1974); *Hermès IV, La distribution* (Paris: Éditions de Minuit, 1977); *Hermès V: Le passage du*

nord-ouest (Paris: Editions de Minuit, 1980). For the posthumous manuscripts, see Serres, *Cahiers de formation.*

15. See Claude E. Shannon, "A Mathematical Theory of Communication," *Bell System Technical Journal*, 27 (1948): 379–423; 623–56; Claude E. Shannon and Warren Weaver, *The Mathematical Theory of Communication* (Urbana: The University of Illinois Press, 1949).

16. Bell Labs, originally called Bell Telephone Laboratories, is an American industrial research and scientific development company in New York. The lab has been credited with many inventions and developments throughout the century, including radio astronomy, the development of the transistor, the laser and the photovoltaic cell. Work at the lab has resulted in ten Nobel Prizes and five Turing Awards.

17. Serres, *Hermès I,* 41. All citations from French sources are translated by the author.

18. Léon Brillouin, *Science and Information Theory* (New York: Academic Press, 1956), vii.

19. See Leo Szilard, "Uber die Entropieverminderung in einem thermodynamischen System bei Eingriffen intelligenter Wesen," *Zeitschrift für Physik*, 65 (1929): 840–66; Brillouin, *Science and Information Theory.*

20. Brilllouin, *Science and Information Theory*, x.

21. Ibid., 229.

22. Ibid., 261.

23. Serres, *Hermès III*, 45.

24. Serres, *Hermès II,* 110.

25. See Madeleine Akrich, Michel Callon, and Bruno Latour, *Sociologie de la traduction: textes fondateurs* (Paris: Presses des Mines, 2006).

26. Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network Theory* (Oxford: Oxford University Press, 2005).

27. See Simons, *Michel Serres and French Philosophy of Science*; Simons, "Self-Organizing Life".

28. See Brigitte Chamak, *Le Groupe Des Dix, ou les avatars des rapports entre science et politique* (Paris: Éditions du Rocher, 1997); Edgar Morin, René Passet, Franck-Dominique Vivien and Henry Dicks, "Edgar Morin et René Passet: Les passeurs du Groupe des Dix," *Natures Sciences Sociétés* 27, no. 2 (2019), 225–37; Simons, *Michel Serres and French Philosophy of Science,* 152–4.

29. Serres, *Hermès IV*, 265.

30. Henri Atlan, *Entre le cristal et la fumée: Essai sur l'organisation du vivant* (Paris: Seuil, 1979), 26.

31. Ibid., 65.

32. Ibid., 68–9.

33. Brillouin, *Science and Information Theory,* 9.

34. Henri Atlan, "Self-Creation of Meaning, " *Physica Scripta* 36, no.3 (1987), 563.

35. See Simons, "Self-Organizing Life".

36. Atlan, *Entre le cristal et la fumée*, 73.

37. Michel Serres, *The Parasite* (Baltimore: The John Hopkins University Press, 2007), 66.
38. Henri Atlan and Irun Cohen, "Immune Information, Self-Organization and Meaning," *International Immunology* 10, no. 6 (1998), 713.
39. See Massimiliano Simons, "A Philosophy of First Contact: Stanislaw Lem and the Myth of Cognitive Universality," *Pro-Fil – An Internet Journal of Philosophy, Special Issue* (2022) 65–77.
40. Stanislaw Lem, *His Master's Voice* (Evanston: Northwestern University Press, 1999), 26–7.
41. Serres, *Hermès IV,* 264.
42. Ibid., 264-265.
43. François Jacob, *La logique du vivant: une histoire de l'hérédité* (Paris: Gallimard, 1970).
44. Serres, *Hermès IV,* 265.
45. Atlan, *Entre le cristal et la fumée*, 179.
46. Serres, *Hermès IV,* 266.
47. Atlan, *Entre le cristal et la fumée*, 70.
48. Serres, *Hermès IV,* 268.
49. Ibid., 270.
50. Heinz Von Foerster, "On Self-Organizing Systems and their Environments," in *Self-Organizing Systems,* eds.. Marshall C. Yovits, Scott Cameron (Oxford: Pergamon Press, 1960), 31.
51. Ibid.
52. Ibid., 32.
53. Atlan, *Entre le cristal et la fumée*, 85.
54. Ibid., 91.
55. Ibid., 78.
56. Cornelius Castoriadis, *Les carrefours du labyrinthe* (Paris: Seuil, 1978), 181.
57. Jean-Pierre Dupuy, "Mimésis et morphogénèse," in *René Girard et le problème du mal,* eds. Michel Deguy, Jean-Pierre Dupuy (Paris: Grasset, 1982), 115.
58. Atlan, "Self-Creation of Meaning," 565.
59. Atlan, *Entre le cristal et la fumée*, 9.
60. See Jean Baudrillard, *The Consumer Society: Myths and Structures* (London: SAGE Publications Ltd, 1998); and Pierre Bourdieu, *Distinction: A Social Critique of the Judgement of Taste* (Cambridge: Harvard University Press, 2007).
61. Andrew Feenberg, "Ten Paradoxes of Technology," *Techné* 14, no.1 (2010), 10).
62. See Ernesto Laclau, *On populist reason* (London: Verso, 2005); and Cas Mudde and Cristóbal Rovira Kaltwasser, *Populism: a very short introduction* (New York, NY: Oxford University Press, 2017).
63. Michel Serres, *La Guerre mondiale* (Paris: Le Pommier, 2008); *Le mal propre: Polluer pour s'approprier?* (Paris: Le Pommier, 2008).
64. Serres, *Natural Contract*, 34.

65. Ibid. 1.
66. Michel Serres, and Bruno Latour, *Conversations on Science, Culture and Time* (Ann Arbor: Michigan University Press, 1995), 52–3.
67. Atlan, *Entre le cristal et la fumée*, 91.
68. Ibid., 92.
69. Cornelius Castoriadis, *L'institution imaginaire de la société* (Paris: Seuil, 1975).
70. René Girard, *La violence et le sacré* (Paris: Bernard Grasset, 1972). See also Simons, "Self-Organizing Life," 224–6.
71. This would concern the way how French philosophers use information theory and cybernetics in their political philosophies. There is a separate question of how information theory and cybernetics itself were inscribed into broader political projects. For a good first attempt to map this, see Bernard Dionysius Geoghegan, *Code: From Information Theory to French Theory* (Durham: Duke University Press, 2023).