Media Ecology and Cognition.

The Humanities and the Digital

BY MARIA TERESA CRUZ

Media Ecology and Cognition. *The Humanities and the Digital*

MARIA TERESA CRUZ
NOVA University of Lisbon, Faculty of Social Sciences and Humanities / ICNOVA – Nova Institute of Communication

Abstract

The long history of human biological and cultural co-evolution has been, in its entirety, a history of the composition between the human and the non-human, a history of interactions and mediations between the physical, biological, technological and symbolic dimensions of existence. The full recognition of this reality dictates the need for an extended ecological thinking that also imposes on the humanities. Their contribution to a general ecology is, in fact, crucial, as the latter cannot do without a critique of the Anthropos's spiritual and cognitive primordiality and his externalization in modes of perceiving, thinking and acting upon the world. Media studies have been central to this critique and to the post-human epistemology that emerged, in particular, through digital culture. Ecological thinking thus requires a cognitive ecology which, in turn, constitutes itself as a critique of mediation, increasingly necessary, as both cognition and existence are now permeated by informationalization, computation and algorithmic governance, forming a planetary scale digital environment[20].

The language of the humanities

For decades now, the digital has been a dominant element in the Humanities, both in terms of the technocultural environment

[20] This paper is dedicated to the doctoral students of the Communication Sciences course 2022, at NOVA University of Lisbon, where most of this research was discussed.

in which they exist and in terms of the forms of mediation that assist in their practice through research, production, publication and sharing of knowledge. Databases, specialized information networks and the world wide web, editorial platforms, data mining, modelling and visualization, automated analysis, image analysis and machine learning—all these processes are shaped by software, algorithms and AI processes and have already transformed, on a significant scale, the practice of the humanities, notably by providing access to and sharing of knowledge with a breadth unmatched at any other phase of human history. At all these levels, the humanities are already digital, to some extent, even though this idea pleases neither proponents of the Digital Humanities, nor their critics. Whatever uncertainty there may be about a paradigm shift does not, however, invalidate the fact that the humanities, too, have launched into the digital transition. The inevitability of that transition can be deduced from the past formation of the humanities—itself shaped by specific technical and medial conditions, including language, writing and print, documentation and archiving systems, and publishing models such as the book. The self-evident relationship between culture and memory transmission, which lies at the core of the humanities, might contribute to the illusion of continuity between old and new information technologies and the illusion that these technologies are neutral and secondary to the true subject of the Humanities. However, the fact that there is no culture or knowledge production without some form of mediation is exactly what makes it necessary to consider the importance of its mutation.

The rapid creation of new habits does not in turn prevent the discomfort of a certain illiteracy in the humanities' relationship with the digital, which has the advantage of bringing into greater awareness their extraordinary expertise in the field of "letters" and the techniques of writing and reading, giving us a better understanding of their relevance to knowledge formation in the humanities. The hermeneutic tradition, which founded the humanities as sciences of the spirit, is inseparable from the

mediation of language, of logocentrism and the grammatological and technological regimes that implemented it, such as those of the alphabet and of typography, of writing and print. Although this was perceived and even documented in humanities research, it did not really become the subject of conscious reflection as to its ultimate meaning until the linguistic and medial shifts of the 20th century.

Derrida's reflection on writing leads, *inter alia*, to a discussion of the phonocentrism that favoured the transparency of language as logos and the ideal self-presence of the spirit (as a kind of inner voice that talks to itself). Derrida criticizes the merely instrumental view of writing as "phonetic writing", to which he opposes the broader notion of a "general writing" or "arche-writing", showing that all Western metaphysics and the epistemology that stems from it are in fact impregnated with its originary technicity, a notion that he interprets based on the work of Leroi-Gourhan[21]. In *Of Grammatology,* he states: "Writing is not an auxiliary means in the service of science – and possibly its object – but first (….) the condition of the possibility of ideal objects and therefore of scientific objectivity. Before being its object, writing is the condition of the episteme" (Derrida 1976 [1967]: 27). The corollary of deconstructionism is therefore the following: "there is no deconstruction which does not … begin by calling again into question the dissociation between thought and technology, especially when it has a hierarchical vocation, however secret, subtle, sublime or denied it may be" (Derrida, 1986: 108). It is worth noting, in this passage, the denegation pointed out by Derrida, suggesting that the relationship between thought and technology is possibly one of the secrets that Western knowledge has best kept from itself. Some years later, Kittler stated that "the world of the symbolic" is

[21] Cf. Timothy Clark "Deconstruction and Technology" (Clark 2000, 238- 257) and Federica Frabetti (2011) "Rethinking the Digital Humanities in the Context of OriginaryTechnicity" (Frabetti 2011, 1-22).

a "world of the machine" (Kittler 1997)[22] and that, "more than any other theorists, philosophers forgot to ask which media support their very practice" (Kittler 2009, 23)

Against this backdrop, the discussion on the adoption of writing by classical culture, presented in *Phaedrus* (Plato, 1972 [370 ac]), cannot but be seen as a moment of particular importance for the foundation of western knowledge and academia. This importance is rightly noted in the famous commentary devoted to the subject by Derrida (1972). Described by Socrates as a kind of *pharmakon*—a kind of remedy or instrument to support memory—, writing is also perceived by him as a risk of erasure or replacement of that same memory, with consequences for the process of anamnesis, which was, for Socrates, central to the discovery of truth. Writing therefore implies a different form of memory and, as such, a potential transformation of the psyche, marked by the technical ambivalence (between remedy and danger) that the *pharmakon* implies.

The long process of literacy teaching and the introduction of book and print technologies were key media transformations for cognition and the formation of modern knowledge, as well as for a first phase of the industrialization of culture that McLuhan named *The Gutenberg Galaxy* (McLuhan 1962). It is in periods of mutation that the mediation of thought becomes apparent in all its artificiality and potentiality, which should prompt an epistemological and political reflection about its virtualities and risks and the designing of strategies for its organization. Bernard Stigler establishes this task as that of a "pharmacology", continuing the discussion of the *pharmakon* in Plato that was initiated by Derrida (Stiegler 2011).

Any epistemic debate in the humanities will thus benefit from a critique of media and their relation to thinking, cognition and knowledge formation. However, such significant moments as the

[22] See the essay by F. Kittler "The World of the Symbolic – A World of the Machine" (1997, 130-146).

Derridean deconstruction of phonocentrism or the Deleuzian reflection about cinema as *"une autre idée de la pensée"* are, despite their undoubtable relevance, fairly isolated endeavours. The emergence of media theory and media studies laid down the possibility for a more systematic critique of the relation between cognition and media but, as we know, the relation between language and thought has deep anthropological roots. It is the relation in which the animal becomes the Anthropos, as symbolic species and begins the long journey towards knowledge and action upon the world, armed with an initially rudimentary set of techniques and, above all, with the technology of language. The specific advantage of this techno-symbolic mediation would manifest itself in the kind of externalization of the mind and the relationship of the cognizing subject with himself and the world around him, ultimately leading to the ecological conditions of existence that we now describe as the Anthropocene. Ecological thinking is, therefore, inseparable from a cognitive ecology which, in turn, calls for a media critique or media ecology in its own right. The invention of a new language and information technology (the digital) and the prospect of a new stage of the externalization of the mind (that of artificial intelligence) require a media ecology whose need has always been dictated by human evolution itself.

Cognitive ecology: origin and challenges of the human

In the last decades, awareness of the ecological crisis and of an increasingly technological future, both implying a loss of human centrality, has caused the end of the modern anthropological narrative. The present is haunted by the difficulty of knowing, or even imagining, what will be our place and our role on the planet that is left and in the world of automation that lies ahead, despite the roadmaps for a green as well as a digital transition. *Staying with the trouble* (Haraway 2016), "learning to be truly present", co-inventing situated practices and discourses, such as through "speculative fabulation", is the proposal of Donna Haraway, who

advises against a "relationship to times called the future", whether they be "apocalyptic or salvific futures" (Haraway 2016, 1-3). However, the prevailing uncertainty of the present also leads to a search for answers in the remote past of the evolution of life and hominization, as if these contained the key to meeting the challenges of the present. The search for the "origin" has always helped the ontological questioning and allowed for some kind of "speculative fabulation" of its own. Above all, it calls upon an *evolutionary narrative* that seems to align with the need to reflect on the transitions of the present: the evolutionary biology from which we have sprung and the biological, technologic and symbolic coevolution that has enabled our existence as sapiens. The return of the evolutionary narrative is, to a large extent, linked to the effort to understand the origin of the human mind, currently complemented by the extensive literature of cognitive sciences and the advances in the computational modelling of the brain. The evolutionary, neurological, and computational theories are thus combined in the thematization of what the contemporary spirit calls "Artificial Intelligence" and onto which it projects the obsolescence or surpassing of the human being.

The coming together of cognitivism and "intelligent machines" was initially based on the conviction that a fundamental isomorphism exists between computation and human cognition as representation and processing of information, and it anticipated, from the outset, that the former would surpass the latter. This isomorphism reduces the human mind to a set of symbolic and logical operations[23], erasing both its embodied dimension and the forms of mediation that those operations entail. This first paradigm of AI (the jargon for which is GOFAI

[23] This initial cognitivist hypothesis is critically described by Varela, Thompson and Rosch as follows: "Cognition (…) defined as computations of symbolic representations", according to "the cognitivist claim that the only way we can account for intelligence and intentionality is to hypothesize that cognition consists of acting on the basis of representations that are physically realized in the form of a symbolic code in the brain or a machine." (Varela, Thompson and Rosch 1991, 40)

— *Good Old-Fashioned Artificial Intelligence*) led to several initial successes (expert systems, the programming language PROLOG, chess programmes that beat world champions of the game, etc.). However, it also quickly showed its limitations regarding basic processes that our brains constantly perform as embodied minds, related in particular to the sensorimotor interaction with the environment. In *The Embodied Mind:* Cognitive Science and *Human Experience* (1991), Varela, Thompson and Rosch describe the capacity for "many cognitive tasks (such as vision and memory)", not as a merely representational function of an external world, "a function of particular symbols", but as the creation of an experience: "even the most hard-nosed biologist (…), would have to admit that there are many ways that the world is—indeed even many different worlds of experience (…) And even if we restrict our attention to human cognition, there are many various ways the world can be taken to be" (Varela, Thompson and Rosch 1991, 9).

A staunch evolutionary biologist, like Richard Dawkins, explains that "different species live in different worlds", stating that we humans have evolved as inhabitants of a *"middle world"*, "the medium scale environment" we are capable of grasping and in which we develop the capacity to act, between the microscopic world of the atoms and particles and the macroscopic world of stars and galaxies. However, because our brains are in an "evolutionary apprenticeship", because they are versatile and expandable, they have gradually transformed and trained themselves in new tasks through media that they themselves invented throughout the process of producing and sharing experience and knowledge. In *The Selfish Gene* (1976), Dawkins proposed the notion of "meme" as a cultural unit of imitation, replication and transmission of memory to its descendants, based on forms of mediation that could endure for far longer than the biological material itself, whose fate is to be dissolved into a genetic pool. This hypothesis is taken up by Lumsden and Wilson in *Genes, Mind, and Culture: The Coevolutionary Process* (1981) through the concept of *"culturegene"*, which is used to speak of the evolutionary correspondence between

neural networks and the gradual cultural formation of a first semantic memory, among other aspects[24]. In *Not by Genes Alone* (2005), Richerson and Boyd also posit this biological and cultural coevolution of humans, notably at the neurological level, through feedback loops between genetic evolution, behaviour and environment.

Evolutionary theory has, from the end of the 19th century, already formulated a similar principle—the Baldwin effect—, according to which one of the outcomes of the species' effort of adaptation to the environment is a change in the environment itself, which, in turn, will tend to favour adaptation. In *The Embodied Mind*, the authors underscore that "what is required for evolutionary change is not genetically encoded as opposed to acquired traits" (Varela, Thompson and Rosch 1991, 200). Evolution is therefore a "natural drift", through "self-organizing processes", "under structural coupling with a medium", in a "coimplicative relation, since organism and medium mutually specify each other" (…) Genes are, then, better conceived as elements that specify what in the environment must be fixed for something to operate as a gene" (Varela, Thompson and Rosch 1991,199).

In *A Mind So Rare* (2001), Merlin Donald describes the unique character of the human mind, highlighting four essential aspects: "an expanded executive brain system, extreme cerebral plasticity, a greatly expanded working memory capacity, and especially a process of brain-culture symbiosis" that he also calls "deep enculturation" (Donald 2001, 10). He thus underscores the biological and cultural coevolution of human cognition, including in it the process of the emergence of language:

> ***"Our conscious capacity provides the biological basis for the generation of culture, including symbolic thought and language. Conversely, culture also provides the only explanatory mechanism that can unlock the distinctive***

[24] This research is understood by both authors on the basis of a dialogue between biology and social sciences or what they also call "Socio-biology" in: Lumsden, Promethean Fire: Reflections on the Origin of Mind (1983) and Wilson, Consilience: The Unity of Knowledge (1998)

> *nature of modern human awareness. Without deep enculturation, we are relatively helpless to exploit the potential latent in our enormous brains because the specifics of our modern cognitive structure are not built in. Our brains coevolved with culture and are specifically adapted for living in culture—that is, for assimilating the algorithms and knowledge networks of culture"* (DONALD 2001, 11).

The main difference between our cognitive capacities and those of other animals cannot be dissociated from the fact that we are the only animal that invented the media to externalize and share mental processes, through which the brain is also shaped and transformed. Our cognitive difference lies, therefore, in a process of biocultural coevolution, which opens a large number of possibilities in terms of the relationship with the environment and with other living beings. As stated by Merlin Donald, "cultural mind sharing is our unique trait" (Donald 2001, 12), and it derives from the pressure of evolutionary adaptation itself, giving rise to different stages of "knowledge networks" (Donald 2001, 10)[25].

In *Origins of the Modern Mind* (1991), Donald describes this long process of coevolution (of about 2 000 000 years), pointing out the first evidence of a skilled archaic human, the *homo habilis*. This required control of movement and training, i.e., the emergence of a memory connected with action, and processes of learning and sharing based on repetition, imitation and enacting, that caused the externalization of a notional thought, even before the emergence of language. These aspects are characteristic of the first long stage of cognitive evolution of the archaic human, during

25 "The ultimate irony of human existence is that we are supreme individualists, whose individualism depends almost entirely on culture for its realization. It came at the price of giving up the isolationism, or cognitive solipsism, of all other species and entering into a collectivity of the mind" (Donald 2001, 12).

which the first ritual practices have also developed a first *"cognitive network"* that Donald describes as *"mimetic cognitive governance"*.

The two subsequent stages are marked by the relationship with language: the second stage, by the emergence of speech (between 500 000 and 70 000 years ago), and the third stage (starting around 40 000 years ago), by the invention of notational systems and writing practices (in the last 5000 years). This last stage also comprises the development of new consistent and diversified techniques, among which writing and reading that can be regarded as a superior kind of technical capability. Consequently, despite being the most significant distinctive trait of modern humans, having entailed the largest expansion and transformation of our brain thus far, language must be considered a kind of artefact. The transformation of the brain that accompanied the acquisition of language is dictated by the complexity of the processes associated with it, such as those related to hearing, vocalization and memory: the expansion of executive and metacognitive possibilities associated with the frontal lobes, the development of interactive, procedural and semantic memory systems, and the development of multifocal attention. Although the complexity of these processes might have required a kind of "language instinct", in the words of Pinker (Pinker 1994), or some innate mechanisms for learning it, as Chomsky proposes (Chomsky 1975), they must be understood in the context of their biological and cultural coevolution, as suggested by Darwin's famous statement according to which language is "half art, half instinct"[26].

It is equally relevant that the relationship between cognitive evolution and language takes place in two stages that are clearly differentiated and quite far apart in time. The different forms of mediation involved in a culture of speech and in a culture of

26 "A great stride in the development of the intellect will have followed, as soon as the half-art and half-instinct of language came into use; for the continued use of language will have reacted on the brain and produced an inherited effect; and this again will have reacted on the improvement of language" (Charles Darwin, The Descent of Man, 1871, chap. XXI, 610, https://www.gutenberg.org/files/2300/2300-h/2300-h.htm#link2HCH0003 (accssed 21/02/2022)

writing are thus recognized as crucial and resulting in two different cognitive stages. In conclusion, it is not at all sufficient to define ourselves as a "symbolic species" without acknowledging the different forms of mediation that the *symbolic* entails (Deacon 1997). We should rather refer to the emergence of a "symbolosphere"[27], to use Robert K. Logan's term, a sphere in which fundamentally different media stages must be pointed out. The one that begins with the notational systems and the alphabet leads to an *"exogrammatic culture"* supported by *"new memory media external to brains"* (as opposed to the notion of "engram" as brain memory). This new stage involves the formation of "hybrid distributed cognitive networks", (Donald 2001, 320-324), also described by Logan as "propagation of extra-somatic organization" (Logan 2007, 85).

The externalization and exponential expansion of memory through notational systems and archives entails a different form of access to and management of information, one which enables the great civilizational experiences and the institutionalized forms of government and law that brought us to modern societies. The invention of notational systems also triggers the emergence of analytical reasoning and mathematical ideation, which should not be seen as innate capabilities. Regarding the coevolution of the forms of symbolic mediation and the brain, Donald also refers to a neuronal reorganization, usually termed the "cultural recycling hypothesis", which stems from the practices of writing and reading, and the gradual imposition of literacy with increasingly longer periods of formal education. This kind of neuronal reorganization is currently attested by the neurosciences.

These studies show that when we acquire (alphabetical, mathematical or musical) reading skills, new functional architectures are formed in our brain, cortical maps aimed at serving new functions, something that does not happen in people who have

[27] "In the same way", Logan continues, "that biology cannot be reduced to physics it is also the case that the symbolic conceptual aspects of human behavior, namely, language and culture cannot be reduced to, derived from or predicted from human biology. Nor can the future evolution of language and culture (the symbolosphere) be finitely prestated" (Logan 2007, 86).

not learned to read. Katherine Hayles underscores that "learning to read has been shown to result in significant changes in brain functioning"; and "so has learning to read differently, for example by performing Google searches" (Hayles 2012, 2; Carr 2011). Studies on neurobiology have attested with growing consistency this type of phenomena of functional or even structural adaptation—referred to as neuroplasticity. This adaptation can result from specific accidents, but also from the ordinary experience of learning and memory creation in response to changes in attention, cognitive challenges and adaptation to new tasks. Therefore, it is necessary to study cognition in light of its biocultural evolution, its interaction with the environment, and its specific forms of mediation.

However, the evolutionary narrative tends to overlook cultural transformations that happened more recently and at a more accelerated pace, such as those related to modern media, evidencing, instead, the big leaps in evolution, like the one regarding language. Nevertheless, as discussed above, it acknowledges the different media stages of symbolic thought itself. More interestingly, it consistently points to the present digital transition as a leap as relevant as the one concerning the invention of language and notational systems of calculus and writing. The view that we might be on the verge of a new "leap" in cultural evolution, a leap with extraordinary implications for our cognitive capabilities and the neuronal organization of our brain, is now more or less explicitly widespread, and consistently points to the same set of aspects of contemporary technological experience: the continuous growth of artificial memory systems and information networks, the increasing capacity and autonomy of computational and algorithmic processes, the significant changes in our modes of attention and literacies, the constant immersion in a digital media environment and, in particular, the new stage of artificial intelligence. On the one hand, our brains are increasingly interconnected with the information networks, as if they formed a single hybrid and distributed system, and the aim of each individual life was merely to add a few more traits to it before disappearing.

On the other hand, the level of complexity, diversification and autonomy that computational applications have reached in the last few years, especially with the recent exploration of neuronal models, has once again rekindled expectations around Artificial Intelligence or an effective simulation of human intelligence.

These expectations are based on the implementation of Machine Learning systems capable of learning by themselves to perform certain operations, instead of fully programmed systems. These are operations associated, inter alia, with "non-conscious" or "primary" dimensions of cognition (Hayles 2017, Damásio 2021), many of which have been in a process of consolidation ever since our neurological system was formed, including operations associated with the sensorimotor system of our embodied mind. Such operations, which have become basic tasks for our mind, are nevertheless difficult to model and programme by artificial systems[28]. The implementation of some of them, however, has become possible in the past years: voice recognition, image analysis and machine vision, are increasingly used in "intelligent systems". These systems use automated learning processes based on neural architectures, which train them to extract patterns, through trial and error, from massive databases on which they operate. The paradigm of machine learning comprises, therefore, a dimension of blindness, or black box, which compensates for the difficulty in modelling those systems. In fact, the operations of the human brain remains largely unknown, and despite some extremely important advances, the challenge of its effective computational simulation continues to be, as described by the *Blue Brain Project*

[28] Hayles includes this"mode of awareness", mentioned by various neuroscience specialists, in the concept of "non-conscious-cognition", explaining that it "operates at a level of neuronal processing inaccessible to the modes of awareness but nevertheless performing functions essential to consciousness". Perhaps its most important function is to keep consciousness, with its slow uptake and limited processing ability, from being overwhelmed with the floods of interior and exterior information streaming into the brain every millisecond." (Hayles 2017, 10)

(2013-2024)[29], like "finishing a trillion-piece puzzle when you only have a few piece to start with". Consequently, machine learning systems are shaped by the current state of the art in computation and by the data culture and economy that feeds it, constituting, to that extent, a specific stage of the digital cognitive ecology.

Speculations concerning an ultraintelligent machine (Good 1965) anticipated early on the possibility of a machine that is *"able to learn from experience"*, based on an *"artificial neural network"*, and the idea that such a machine "will need embodiment", i.e., to be "adequately integrated with its *sensorium* and *motorium* (input and output)" (Good 1965, 31-32). The horizon of this speculation is that such a machine might itself produce other machines, whose principles will be unknown to us, thus reaching autonomy and "singularity" at a level close to general intelligence and consciousness, a prospect that some view as a *"pernicious fantasy"*[30]. This is, however, the horizon of a transhumanist ideology that actively seeks the *enhancement* of the human being and the acceleration of that process by way of corporate research and investment. Thus, the narrative according to which our destiny is to be surpassed by forms of artificial intelligence that are evolved versions of ourselves presents technology as the final stage of biological evolutionism and of the process of selection of the fittest.

Evolutionary theory, however, aims to explain the variety of life as being the result of the organisms' adaptative response to the environment *"in its infinitely complex relations"* (Darwin 1859, 60–6), contradicting, to that extent, both the idea of a purely genetic specification and the idea of an original design or

[29] "It is not feasible to map every detail of the brain experimentally because, there are too many parts (over 20,000 genes, more than 100,000 different types of proteins, more than a trillion organic molecules in a single cell, nearly 100 billion neurons, up to 1,000 trillion synapses and over 800 different brain regions in the human brain), too many complex relationships between all these parts, and then too many variations of the brain; across individuals, genders, age, and species." (The Blue Brain Project - https://www.epfl.ch/research/domains/bluebrain/blue-brain/about/)

[30] Cf. Dennett in the debate "On the Evolution of the Mind, Consciousness and AI", London, 13/03/2017, https://www.youtube.com/watch?v=o86W0DgrmRc&ab_channel=IntelligenceSquared (accessed 21/02/2021)

intentionality. Biological evolutionism, according to the "blind watchmaker" model (Dawkins 1986), implies that nothing takes precedence over the process of interaction with the environment and its complex interdependencies and contingencies. The view of Varela and Thompson accentuates this idea, with respect to the biological evolution of the mind: "to situate cognition as embodied action within the context of evolution as natural drift provides a view of cognitive capacities as inextricably linked to histories that are lived, much like paths that exist only as they are laid down in walking." And they add: "It should be noted that such histories of coupling are not optimal; they are, rather, simply viable", thereby ensuring the integrity of the system. On the contrary, for a dimension "to be optimal, the interactions of the system would have to be (more or less) prescribed", which could then compromise its viability (Varela, Thompson and Rosch 1991, 205). Fully in line with this idea, Hayles herself emphasizes the embodied condition of our mind and the fact that it possesses "an evolutionary history that intelligent machines do not share" (Hayles 1999, 284)[31].

In conclusion, the optimization of evolution by design, just as the idea of the natural selection of the fittest, has no parallel to the actual evolutionary process. In *From Bacteria to Bach and Back* (2017), Dennet warns that the introduction of "Intelligent Design" also re-introduces the logic of *memes*, i.e., the replication of strains without the necessary outcome in terms of diversity, contrary to the processes of biological and cultural co-evolution we entered millions of years ago. This assessment becomes

[31] Cf. How We Became Posthuman: "As I have repeatedly argued, human being is first of all an embodied being, and the complexities of this embodiment mean that human awareness unfolds in ways very different from those of intelligence embodied in cybernetic machines (…). The body itself is a congealed metaphor, a physical structure whose constraints and possibilities have been formed by an evolutionary history that intelligent machines do not share. (…) There is a limit to how seamlessly humans can be articulated with intelligent machines, which remain distinctively different from humans in their embodiments. The terror, then, though it does not disappear in this view, tends away from the apocalyptic and toward a more moderate view of seriated social, technological, political, and cultural changes." (Hayles 1999, 283-285)

particularly relevant in the age we seem to be entering now, fuelled by evolutionary imagination —the "age of evolutionary design. An era of creationist processes, evolutionary computing and algorithms, deep machine learning and experiments with artificial life and artificial intelligence.

The notion of "intelligence" is itself symptomatic of yet other aspects at stake within this imagination. As Malabou points out, the notion of "intelligence is one of the key stakes for (…) eugenics"; it appeared in 1883 by the hand of Francis Galton, "Darwin's cousin and an avid reader of On the Origin of Species", who decided to apply "the concept of survival of the fittest", which "in Darwin's work was distinct from any value judgement or intention, (…) to a potential improvement of the species (...) developing a process of artificial selection in order to favour the appearance of certain characteristics while eliminating others, such as hereditary illnesses and mental degeneration" (Malabou 2017, 38-39). After the shock of Darwin's discoveries, the 20th century needed a constant pedagogy to counter the creationist narrative of an omniscient design of human beings and life. Paradoxically, the 21st century may need a similar pedagogy to unmask the alleged evolutionary basis of transhumanist creationism.[32]

Consequently, we must reflect upon the feeling of the Obsolescence of the Human Being (Anders, 1956) shared by both discouraged humanists as well as empowered transhumanists and develop a posthumanist critique long proposed by Hayles, Haraway and others, namely in the now more explicit condition of the Anthropocene. Today, as before, this posthumanist critique remains a critique of the liberal subject because, as Hayles stated already in 1999, "what is lethal, is not the posthuman as such but the grafting of the posthuman onto a liberal humanist view of the

[32] Cf. Nick Bostrom (2005), founding director of the Future of Humanity Institute (Oxford University), explaining that many of humanity's problems are a result of us not having explored all our capacities yet. "To fix this problem", we need to explore "the space of possible modes of being", https://www.ted.com/talks/nick_bostrom_a_philosophical_quest_for_our_biggest_problems#t-7750 (accessed 21/02/2022)

self", or "of that part of humanity who had the wealth, power, and leisure to conceptualize themselves as autonomous beings exercising their will through individual agency and choice" (Hayles 1999, 285-287). This power, which perceives itself to be an expression of the exceptionality of the human being, stems from the legitimizing view that "humans are the dominant species on the earth because of their cognitive abilities", a view that calls for a "new planetary cognitive ecology" in as much as the conditions of general ecology directly depend on it (Hayles 2017, 3). That is why the task of an "affirmative" ethical and political thinking is to create the conditions for "posthuman knowledge production" and the "Critical Post-Humanities", as proposed by Rosi Braidotti. Therefore, "a change of perspective is needed": "repositioning terrestrial, planetary, cosmic concerns, the naturalized others like animals and plants, and the technological apparatus, as serious agents and co-constructors of transversal thinking and knowledge" (Braidotti 2019, 111). This change is already taking place, through new forms of knowledge and practices and a new interdisciplinarity between human sciences, environmental and earth sciences, biology, palaeontology, neurosciences, computational sciences, among others.

The long history of human biological and cultural coevolution is, in its entirety, a history of composition between the human and the non-human, a history of the interaction between biological, technological and symbolic life. Hayles further points out that "human involvement with technology did not happen at a late stage of this co-evolution but was there from the very beginning of homo sapiens" (Hayles 2014, 102) and that is why "we have always been posthuman" (Hayles 1999, 279, 291). The process by which "we invent things and things invent us" can be summed up by the concept of "technogenesis" (Hayles 2014, 102). The interactions and mutual implications between the biological, technological and sociocultural dimensions of human life should especially be acknowledged today, given the growing penetration of these various systems by computational technologies and the formation

of a cognitive ecology with ever- shortening cycles of epigenetic change. Now is the time to fully acknowledge the links between "biological life", "symbolic life", and "artificial life" because, in fact, "there is but one life" (Malabou 2019 [2017], xvi). Vitalism, mechanicism, materialism and animism have all been partial anticipations and symptoms of the posthuman epistemology. This new epistemology will require *"a nature-culture and medium-nature-culture continuum*", as described by Rosi Braidotti (Braidotti 2019, 111). Indeed, the dichotomy and passage between nature and culture, "biological life" and "symbolic life", which have always been at the center of Anthropology, imply a division and, at the same time, a Gordian knot that the question of mediation has sought to untie and rearticulate without resorting to an ontology of technique nor, conversely, to a negation of technology. Such an endeavour is vital for a contemporary cognitive ecology.

Media ecology and post-human epistemology

In *How We Think* (2012), K. Hayles begins her reflection by noting that "we think through, with, and alongside media" (Hayles 2012, 1). She recognizes in this manner the centrality of media to cognition and thinking in general and, consequently, the contribution of Media Studies both to cognitive sciences and to the epistemology of the humanities, paying homage to several of its authors: "This, of course, is not a new idea. Marshall McLuhan, Friedrich Kittler, Lev Manovich, Mark Hansen, and a host of others have made similar claims." (Hayles 2012, 1). Indeed, media studies have produced a significant body of work that has become vital to the understanding of cognition and its relation to culture: evidence that oral cultures differed fundamentally from the experience of the "typographic man" (McLuhan 1962), which was mediated by the techniques of writing and reading, by books and the printing press; or, further yet, evidence that cinema, the gramophone, radio, television and other modern media transformed a predominantly literary culture into a culture of image and sound,

with new forms of representation, perception and attention. In the last decades, computation and digital media have, in turn, so radically changed the way we produce and disseminate knowledge, and the way we interact with information in general, that human culture seems to be undergoing a process of deep change within just a few generations. Consequently, according to Hayles, to understand the human condition and experience, one cannot forgo the contribution of the Comparative Media Studies, which "with its foregrounding of media technologies in comparative contexts, provides theoretical, conceptual, and practical frameworks for critically assessing technogenetic changes and devising strategies to help guide them in socially constructive ways" (Hayles 2012, 14). At the heart of the theory and study of media lies particular attention to the technical dimension of human experience, not just at the level of the relationship with nature but also at the level of the human being's own resources as a sentient, cognizing and social being. In conclusion, modern and contemporary media have brought to the foreground what the narrative about the long process of hominization and emergence of culture had already told us —"that human beings have always depended on and co-evolved with technologies", as Hansen points out in an essay about new media (Hansen 2003). This reality, however, has often been neglected by the humanities, which tend to oppose culture to technique more frequently than to seek a deeper understanding of this relationship.

In *La Technique et le Temps* (1985), Bernard Stiegler returns to the question of technology through the narrative of Prometheus, pointing out that it comprises, first and foremost, the acknowledgement of a fault— Epimetheus's fault (which Prometheus seeks to repair), as he left humans deprived of various qualities. He thus notes that technique makes up for this fundamental incompleteness of the human being, permeating, therefore, his very constitution. In this way, he returns to the idea of an originary technicity, which he describes as an "originary prostheticity" (Stiegler 1985, 98-100) or a process supplementing the organic

with the non-organic, a means "to pursue life through means other than life" (Stiegler 1985, 17). At the heart of this process lies the externalization of the mind, through means of retention and transmission of experience, which he terms "mnemotechnics". The originary role of technique lies, therefore, in a supplementation of memory that enables a different relationship with time. In the absence of this *time-binding* relationship, we would have a merely immediate relationship with life, without any sense of a past nor the prospect of a future, i.e., without culture. Mnemotechnics supplements both our genetic memory and secondary retentions (our lived experience and interactions with the environment) with a third memory that Stiegler names as "epiphylogenetic" - a fully externalized memory composed of "tertiary retentions" through technical and symbolic forms of mediation. "Mnemotechniques" are, in this sense, "technologies of the spirit" and the basis for all our knowledge: from "theoretical knowledge" (*"savoir théorique"*) and "know-how" (*"savoir faire"*) to "know how to act" (*"savoir agir"*) and "know how to live" (*"savoir vivre"*) (Stiegler 2011, 294-309). This view finds support in notions such as the "associated milieu" of Gilbert Simondon, (2017 [1958]), the "technical milieu" (of Leroi-Gourhan) that much like the natural environment, surrounds the human being (*"entoure l'homme"*) and "contains all the means of material action" (Leroi-Gourhan 1945, 333, 348), or "the new technical milieu" (of Jacques Ellul), in the sense that "technique has become the new and specific milieu in which man is required to exist, one which has supplanted the old milieu, viz., that of nature" (Ellul 1962, 394). For Simondon, too, "technicity" is a central aspect of the "mode of existence of the whole constituted by man and the world" (Simondon 2017 [1958], 173), to the extent that a psychic and social individuation of the human being entails his externalization (Simondon 2005) and this externalization, in turn, entails the formation of a technical and symbolic environment. In Stiegler's own account of these anthropological theses, "the individuation of the human being occurs in the environment, between the externalization

of the organs and the internalization of the prostheses"[33]. The connection between the human and the non-human is what is truly proper to the human being, implying processes of "exosomatization" and mediation that must be addressed by a general "organology", comprising the description of artificial organs or technical prostheses. (Stiegler 2004).

Media Studies can be understood as the descriptive analysis of these artificial organs of the human being that externalize and shape his cognitive, perceptual and affective dimensions. The differentiation and implementation of some of these apparatuses in modern times prevented the illusion of their naturalization and produced the mnemotechnical inscription of experience in the form of photography, phonography, telegraphy, cinematography, and videography. The material and technical encoding and decoding of these sensitive flows reveal the technicity of the script and remove any illusion about language as a natural feature of human beings, still associated with verbal language. The materiality of the analogical inscription uncovers the irreducibility of meaning to form, exposes the phantasmagorical aspects that exceed grammatization and fills the stream of consciousness with the sensorial flows and temporal objects of this new media aesthetics. This enormous historical rupture has often been perceived as a retreat of the symbolic and associated with the larger theme of the industrialization of culture as "aesthetic barbarism", according to the influential formulation of Adorno and Horkheimer (Adorno e Horkheimer 2002 [1947], 104). In contrast with the first stage of the industrialization of culture—that of typography—controlled by the leading institutions of knowledge (the church and the university), "the apparatuses of symbol production, which had pertained thus far to the artistic, theological, legal and political spheres (…), are now completely absorbed by the world trade and industry organization" that tye together the spheres of

[33] Cf. "Milieu", Ars Industrialis, https://arsindustrialis.org/milieu (accessed 21/02/2022)

communication, cultural production and entertainment. (Stiegler 2001, 4).

In the 20th-century view of the humanities, media appear as the background of industrialized and massified culture and, therefore, as the diffuse object of critical thinking. The enormous relevance and influence of the cultural industry theme have not impeded, however, the further reflection on the relationship between culture and technique, which has, in turn, transformed into a critique of the humanities. This new critical assessment has called for a "medial turn" in cultural studies, countering dominant humanistic views, such as the ones of hermeneutics and semiotics. Materialism and technological determinism, which were frequently associated with the authors of this "medial turn", are not the only relevant aspects of this epistemic change. This shift also includes a relevant anthropological and ecological dimension. As the relationship between culture and media describes how media shape a technical and symbolic environment as the very condition of human existence and culture.

The revolutionary enterprise of *Understanding Media* (1964) as prostheses relates them to the challenges posed by the human condition, which, in McLuhan's view, are mainly linked to changes in the scale and pace of experience. Media enable response and adaptation to those changes in the cultural and social environment, ensuring the continuation of human existence: "man in his normal use of technology (or his variously extended body) is perpetually modified by it and in turn finds ever new ways of modifying his technology" (McLuhan 1994 [1964]. The notion of prosthesis implies, however, a fundamental ambivalence, for there is no prosthesis (even as "extension" or enhancement) without "self-amputation" (McLuhan 1994 [1964], 42). McLuhan gives yet another warning regarding the ambivalence of media by pointing out that the co-evolution of human and technique potentiates media themselves as much as humans, because "we must, to use them at all, serve (…) these extensions of ourselves, as gods or minor religions" of contemporary civilization. The

following image clearly describes media as tools for environmental coping, as well as the political implications of media ecology: "By continuously embracing technologies, we relate ourselves to them as servo-mechanisms (…) as the bee of the plant world, enabling it to fecundate and to evolve ever new forms" (McLuhan 1994 [1964], 46). The vision of a prosthetic being presents a clear parallel to the post-structuralist crisis of the human but also an interesting contrast to its no less famous image of the vanishing of man—*"comme à la limite de la mer un visage de sable"* (Foucault 1966, 398) — anticipating instead the posthuman metaphor of an essentially changed human being, namely the metaphor of the cyborg that will emerge later on.

Around the same time, cybernetics and electronic computers were paving the way into a new media condition, which McLuhan has also anticipated and coined as the "Electric Age", where the empty medium of electricity would allow the pure processing of information (McLuhan , 1994 [1964]: 9). This in turn would lead to a radical spatiotemporal contraction of experience and to a retribalization of society, condensed into yet another famous image - that of a "global village" (McLuhan , 1989). However, the age of electric media is also characterized as the one that has produced a *"model of the central nervous system itself"* and, "to the degree that this is so, it is a development that suggests a desperate and suicidal autoamputation" (McLuhan 1994 [1964], 43). Thus, since McLuhan, media theory is the study of artificial organs or technological supplementation for coping with changing conditions of human existence. It proposes a new dimension of ecological thought - media ecology – that describes the balance between human and technological modes of being and the social, cultural and political environment they co-evolved.To a large extent, this

media ecology is an ecology of the mind,[34] since media extend (and amputate) human perceptual, affective, and cognitive capabilities.

The designation of Media Ecology would emerge shortly after, with Neil Postman, who called for the inclusion of the techno-symbolic environment study in ecological thought besides that of the biophysical environment. Thinking of the profound transformation of modern societies, which he referred to as the triumph of the "technopolis" (Postmann 1993), he particularly noted the collapse of institutions and their replacement with technological forms of organization. In the "mediology" of Regis Debray, the notion of "media spheres" points to the equally inescapable conditions of a technically constituted existence. In the words of Debray, "reality has become a category of techno-culture", which, once again, bears an important political warning: "the machines of today are like the politics of yesterday. We may choose not to concern ourselves with them, but in that case, they will be the ones to concern themselves with us". (Debray 1992, 389). More recently, in *Media Ecology: An Approach to Understanding the Human* (2017), Lance Strate describes media ecology as "the conditions that shape us as human beings, drive human history, and determine the prospects for our survival as a species" (Strate 2017, 1). Media theory is inherently an ecological critique of culture through an ecology of the spirit. It is a fundamental contribution to general ecology since the latter cannot do away with a critique of the Anthropos' spiritual or cognitive

[34] Gregory Baetson proposed the expression "ecology of the mind" in a work from 1972 to aggregate interdisciplinary research studies that shared a systemic and holistic epistemology with special attention to cybernetics. In a chapter on "the role of consciousness in the ongoing process of human adaptation", the following is stated: "Three cybernetic or homeostatic systems will be considered: the individual human organism, the human society, and the larger ecosystem. Consciousness will be considered as an important component in the coupling of these systems. A question of great scientific interest and perhaps grave importance is whether the information processed through consciousness is adequate and appropriate for the task of human adaptation. It may well be that consciousness contains systematic distortions of view which, when implemented by modern technology, become destructive of the balances between man, his society and his ecosystem" (Baetson 1972, 447).

priority and how its externalization determines modes of thinking about and acting upon the world. By revealing the intrinsically technological dimension of culture, it shows that it is insufficient to undertake a critique of modern technoscientific reason while attempting to preserve a vision of culture as an idealized space of unalienated spirituality and originary *poiesis*.

Media theory opened the way for the taking up again, on a new base (anthropological and ecological, more than ontological), of "the question concerning technology" (Heidegger 1977 [1954], 26-28), an inquiry unexplainably rare in a century already profoundly transformed by the power of technology. Nevertheless, as Bernard Stiegler pointed out at the beginning of the rather unique project of *Technics and Time* (3 volumes: 1994, 1996, 2001), the question of technology remains largely "unthought" (Stiegler, 1994: 9) for most of philosophy and the humanities and, as such, also the most significant "danger", to go back to Heidegger's note (Heidegger [1954]). Referring to media studies, Sybille Krämer repeats the same kind of diagnosis: "the media debate reached philosophy late", and the "orientation towards questions of media certainly originated at the margins of academic philosophy (…) and core areas like the philosophy of spirit and language, epistemology, and the theory of science, not to mention ontology and metaphysics, that remain largely unaffected by the issues in media theory". The explanation for this, she adds, is the fact that the idea of mediation disturbs the "unimpeded view" of that which is seen as "the 'actual' objects of humanistic work, like 'sense', 'meaning', 'spirit', 'form', and 'content' – an assumption that had previously been taken for granted by the humanities" (Kämer 2015 [2008], 28). Possibly no one has been more effective than Friedrich Kittler in drawing all implications from the" media turn" and in exorcising, through it, the ideality of the sciences of the spirit. Against the persisting view of philosophy that "teaches of an original' familiarity with ourselves'" (Kittler 1997, 132), Kittler points to the relevant questioning that began with psychoanalysis, emphasising not only the notion of the unconscious but also

Freud's description of consciousness as a "psychic apparatus" (cf. Kittler idem). Its functionalities, Kittler says, are externalised in each historical realisation of a "media system". The humanities' tendency, however, has been to cover up this uncanny (unheimlich) dimension of the human, i.e., the media that make our very spiritual existence viable or the set of "technological standards" in which it materialises itself historically (Kittler 1997, 132), as he explains in this famous provocative passage:

> ***"so-called Man is not determined by attributes which philosophers confer on or suggest to people in order that they may better understand themselves; rather, He is determined by technological standards. Presumably then, every psychology or anthropology only subsequently spells out which functions of the general data processing are controlled by machines, that is, implemented in the real"***
>
> (KITTLER 1997, 133).

Therefore, media theory is also a continuation of the critique of reason. It occupies the space left vacant by the universals or the *"a priori"* of the transcendental subject (Siegert 2015, 1), which it replaces with media technology, expressing an often assumed determinism or constructivism[35]. The same (transcendental) space has also been occupied, with different nuances, by other variations of the critique of reason, such as the apparatuses theory (that runs through Foucault, Deleuze, Agamben, and others), frequently avoiding, in its turn, a direct reflection on the question of technology. Other developments of media theory, although continuing

[35] «In The *Philosophy of Symbolic Forms*, Ernst Cassirer claimed that 'the critique of reason is turning into the critique of culture'. With the rise of so- called German media theory, an alternate formula has emerged: the critique of reason is turning into the critique of media. (…). A war is waging that pits "culture" against "media." (…) Both combatants are striving to inherit nothing less than the throne of the transcendental that has remained vacant since the abdication of the "critique of reason." (Siegert 2015, 1)

to emphasize the technicity of mediation processes, seek to avoid the correlationism of that transcendental space. Through the lens of new materialism and object-oriented theory, they extend the critical value of the notions of "mediation" or "mediality" to counter the ontological and anthropocentric beliefs of the humanities, a critique that continues to lay at the heart of media theory itself. In "Technical Mediation" (1994), Latour criticizes the exclusion of objects and technologies from the scope of agency and in "Towards an Ontology of Media" (2009), Kittler criticizes the "exclusion of physical and technical media from questions of ontology" (Kittler 2009, 23). For Latour, mediation is a "translation" process, "the blind spot where society and matter exchange properties": technical objects are themselves "full of engineers, chancellors and legislators, connecting their wills and storylines" with matter. As such, in "artefacts and technologies we do not find the efficiency and obscurancy of matter, imprinting chains of cause and effect onto malleable humans" but "actors in their own right", says Latour (Latour 1994, 62). For Kittler, in turn, ontological enquiry must transform into mediological questioning, because we now understand that "'in the middle' of absence and presence there exists no nothing anymore, but a mediatic relation". And he adds: if "the connections of media and ontology are to be formulated in more precise terms", we must then understand "the connections of mathematics and media" (Kittler 2009, 23). Hence the notion of "media of mathematics" which will frame his discussion.

The mathematical root of media technology expresses itself fully in the emergence of the computer, whose logical and calculation operations are rooted in a long genealogy of Western reason. Kittler's view of Western technology has common aspects with that of Heidegger, but the framework developed by each of them is quite different: for Heidegger, a history of being; for Kittler, an archaeology of media, with an emphasis on the notational systems of alphabets and numbers, the media of western reason's ideation and abstraction. The abstraction of reason is made possible through

cultural techniques, materialities and embodied practices, such as writing, reading, counting or making music. Consequently, the information age should not be understood as that of a new metaphysics but rather as a new age of code and notational systems (digital and software), a new technology of the symbolic (that of computation) and new materialities (transistors, interfaces, etc.). This view helps to clarify the "Postmedia" debate, which Kittler himself launched (as early as in the 80s) - the discussion of the possible culmination, or even end, of the epistemology of media, due to their current non-differentiation status or "convergence".[36] By looking at the computer as a symbolic machine, it emerges as an apparatus able to codify and program any other media, i.e., the media version of the universal Turing's machine. Later on, Manovich will name this the "meta-media paradigm" and describe the computer as "a simulation machine for old media" (Manovich 2005, n.p.). The computer thus combines all the functionalities of the media system (storage, reproduction and transmission) and all the sensory diversity of analogue media, but its genealogy goes back to a similar "monopoly" situation, held for a long time by language and writing (Kittler 1999 [1986], 4)[37]. This provides the grounds for a parallel between the digital and language, implied by most views about the computer, with several important implications. Firstly, it causes a non-linear narrative of the history of media, moving from the domination or "monopoly" of language to the explosion and differentiation of analogue media, and then, once again, to the implosion and "monopoly", triggered by the digital: "what will soon end in the monopoly of bits and fibre

[36] In *Gramophone, Film, Typewriter* (1986), Kittler expressed it as follows: "a total media link on a digital base will erase the very concept of medium" and "writing functioned as a universal medium—in times when there was no concept of medium" (Kittler 1986, 5-6).

[37] Kittler speaks of language as a supra-sensory entity that allows for the various sensuous qualities of the world around us to be "hallucinated" (Kittler 1999 [1986], 80). The same happens with the digital: "Inside the computers themselves everything becomes a number: quantity without image, sound, or voice" (Kittler 1999 [1986], 80). Hence the comparison: "In the Greek alphabet our senses were present – and thanks to Turing they
are so once again". (Kittler 2006, 59)

optics began with the monopoly of writing", Kittler states (1986, 4). Secondly, to include language in the history of media dissolves a distinction that the humanities have tenaciously protected, even after the "media turn". To think of the digital as a language makes language, in turn, appear as information technology. And, if the techno-symbolic emergence of language represented a leap with such enormous implications in the history of mankind, we should expect that digitization and the widespread use of computation will trigger equally decisive and unpredictable changes.

At the beginning of the 21st century, Hansen described the nature of this challenge and the new media age, once again, in anthropological and ecological terms: "what are the consequences for our understanding of the future prospects for human beings and for the life of our planet? Such are the stakes bound up in the issue of the 'newness' of new media" (Hansen 2010, 172)[38]. However, the dominant reception of the new media has mainly reflected a comparison with the familiar condition of modern media and mass culture and the well-known dialectics between euphoric and dysphoric expectations around media. The first moment pointed to such aspects as the creative and participatory possibilities arising from the virtuality, interactivity and connectivity of information systems and networks, but this view has been quickly surpassed by other much less positive and equally widespread themes: the datification and plataformization of most cultural, social and economic activity, new forms of exploitation and surveillance, and a set of dysfunctional phenomena such as ideological bubbles, fake news, hate speech, etc. Critical thinking repeats, in this way, the kind of dialectic that has locked us in

[38] Above all, it is essential to consider this process as a transformation of the media ecology and, as such, as a technological and cultural transformation that affects the conditions of existence of the human being and his general relationship with life. It was this perspective that created, early on, a link between cyberculture and the problem of the posthuman in the work of such significant authors as Donna Haraway or Katheleen Hayles. Their prefigurations, while admittedly within the realm of the metaphor or of the fable, represent an effort to create an epistemology and a policy for the digital ecology.

a specific view of media technology and the industrialization of culture and, at the same time, has made it difficult to respond to it. The generative power of media places them at the centre of a phenomenology of "suspicion", in its most essential form, as Boris Groys points out: "the suspicion that behind the medial surface" lay "the manipulative, deceptive, and dangerous" power that shape the culture economy, leaving no alternative other than "protesting against it, accusing it, holding it accountable, and combatting it" (Groys 2000, 178). Media becomes the "scapegoat" (Stiegler 2011, 296) of all alienation, leaving nothing we might turn to other than the split-off institution of art.

Without denying the process of industrialization of culture, which, on the contrary, he describes and criticizes in-depth, Bernard Stiegler speaks of the need for new avenues for critical thinking, capable of framing this technical and industrial dimension of culture that takes place through the media, as "pharmaka". This vision acknowledges the central link between the human and technique, as well as the constitutive ambivalence of media: the danger of their toxicity, as well as the possibilities opened by each new media condition. Media innovation, therefore, implies responsibility and care for the forms of life and conditions of existence that we want to promote. Media analysis is thus also a "pharmacology", both critical and curative (Stiegler 2011). This pharmacology is even more urgent in the present time, characterized by the hyper-industrialization of culture and the risk of a general proletarianization of the spirit (Stiegler 2014 [2004], 1-13). Knowledge and information have become the main assets of "cultural capitalism" (Jeremy Rifkin 2000) or "cognitive capitalism" (Moulier-Boutang 2007), and they are currently based on the collection, analysis and exploitation of data about the psychic and affective resources of the subjects. By replacing the very experience of desire, will and

expectation[39], the data economy extends the power of capitalism as a psycho-power. But, most of all, the grammaticalization of cognitive, affective, symbolic and behavioural processes causes the alienation of knowledge, especially the knowledge of how to live (Stiegler 2014 [2004], 1-13). This process constitutes, according to Stiegler, the deepest aspect of the "disruption" caused by the new digital ecosystem, insofar as it "short-circuits" the processes of psychic and collective individuation and our ability to invent new modes of organizing our existence, accentuating the path towards entropy (Cf. Stiegler 2019 [2016], 8).

According to Stiegler, countering this fate implies understanding the technical exteriorization forms of the human spirit, rather than its mere denial or diabolization, and recognizing the potential of the new digital ecology. In fact, never before has humanity been able to produce and share such an amount of knowledge, nor has it had the possibilities of organization and dialogue with itself as those within its reach today, on a planetary scale. Stiegler, therefore advises developing a "cultural policy of the technologies of the spirit" (Stiegler 2004b, 25) and fostering an "economy of contribution" (Stiegler 2019, 25). The task of critique is that of a positive engagement with the current technological experience, refusing some possibilities, promoting the regulation of others[40], but also fostering experimentalism, participation in the design of processes and systems, educational innovation, and reinvention

---

39 "Desires, expectations, volitions, will and so on: everything that for individuals forms the horizon of their future, constituted by their protentions, is outstripped, overtaken and progressively replaced by automatic protentions that are produced by intensive computing systems operating between one and four million times quicker than the nervous systems of psychic individuals" (Stiegler 2019 [2016], 8).

40 Em *Information and Biological Revolutions: Global Governance Challenges* (2000), Francis Fukuyama addresses the liberal myth that technological revolutions are not susceptible to regulation, a myth that is mainly rooted in the information technology revolution because of its scale and speed. However, he points out that various technologies have been the subject of reflection, regulation, and even, sometimes, abandonment after their emergence.

of institutions[41]. A critical reason endowed with a new technical ethos[42], in short, pharmacology, as a new context for critical thinking. The opposition between culture and technique that largely shaped the humanities and the arts of the 20th century will be an insufficient framework for the critical reception of the industrialization of knowledge unleashed by the digital. However, the first shock of the industrialization of culture and the arts provides, a century later, fundamental material for the reflection we now need to undertake and for the decisions on the kind of institutions and knowledge formation we need to promote in the 21st century. This reflection requires the university and a transversal deepening of digital studies. Even because, in what concerns the digital revolution, a lot will have started with an academic researcher's proposal and a PhD dissertation[43].

A policy for the technologies of the spirit needs to start by recognizing the integration between human and non-human cognitive processes, i.e., the integration of biological, physical and technical systems in the formation of knowledge. Katherine Hayles describes this integration as "cognitive assemblages" or "distributed cognitive systems", "with well-defined interfaces and communication circuits between sensors, actuators, processors, storage media, and distribution networks, and which include

---

[41] Bernard Stiegler's intellectual path reflected a commitment to these various aspects: the co-founding of the Ars Industrialis association (2005), including the promotion of public seminars *"Trouver de Nouvelles Armes"* and the creation of *Pharmakon - École de Philosophy*; the foundation of the IRI - Institut de Recherche et Innovation (2006) the co-foundation of the Internationes project (2020), and the activity in French public organizations (IRCAM - Institut de Recherche et Coordination Acoustique/Musique and CNNum - Conseil National du Numérique).

[42] In *"Qu'est-ce que Les Lumières?"* (1984), Foucault takes up Kant's critical project, understanding it, not as a formal requirement of universal reason, but as a task of cosmopolitan reason, as an "attitude" or "ethos" capable of extracting and inhabiting the actuality of the present. If the modern ethos was, to a large extent, an aesthetic one (at least in Foucault's Baudelairean reading of the modern), the new critical ethos needs to be a technical one or, as in the Yuc Hui's proposal, "cosmotechnical" (Hui 2017).

[43] This reminder is from Friedrich Kittler, who repeatedly refers to Alain Turing's role in ushering in the computer age.

human, biological, technical, and material components. They have the possibility to maximize cognition, precisely because they function as systems and because they include "non-conscious cognitive processes" that extend to modes of sensing and information processing of technical entities as well as different biological life forms, conscious and unconscious modes of human cognition "(Hayles 2017, 2-5). According to the neurosciences' state of the art, our own human cognitive processes happen in reality outside our modes of awareness, and they contribute to a kind of "core or primary consciousness" (Damásio 2000), inaccessible to any introspection or psyche analysis but essential for consciousness to function. On the one hand, the formation of knowledge implies a process of exomatization that increasingly involves establishing a network of connections between the human and the non-human: a cognitive ecology where the participation of other cognitive agents grows and, also, the opacity and knowledge automation. Many sectors (financial markets, urban and environmental management, air traffic, satellite and war equipment activities, Etc.) include sensing, monitoring, automatic analysis, and supported or autonomous decision-making systems. The scale of the information involved, and the complexity and speed of its processing are inaccessible to human consciousness, although they are somehow comparable to the complexity of specific non-conscious processes of our mind. On the other hand, this cognitive ecology is shaping our own cognitive and neurological processes, with epigenetic implications that we are beginning to detect within just a few generations. Katherine Hayles points that: "As digital media, (…) and other computational media embedded in the environment, become more pervasive, they push us in the direction of faster communication, more intense and varied information streams, more integration of humans and intelligent machines, and more interactions of language with code. These environmental changes have significant neurological consequences, many of which are now becoming evident in young people and to a lesser degree in almost everyone who interacts

with digital media on a regular basis" [44]. They "become part of the cultural inheritance of a species, laid on top of and interacting with their genetic inheritance" (Hayles 2012, 11).

We are now reaching a significant feedback loop stage: the more information, the more we need distributed cognition and automation, and the more systems and automation, the better we can handle the information we have, which leads to more data, and more technical interaction, and more significant neurological impact. Many of these interactions occur daily, through tools for collecting, archiving, sampling, analyzing and modelling content and data (including natural language processing, machine vision and image analysis, extraction of patterns and automatic generation of content), and also outside the scope of HCI, through the interoperability of different types of physical, biological and technical systems, intelligent agents, robots, Etc. In this regard, David Berry notes that the processes in question can no longer be described solely as processes of exomatization. Instead, these technologies differ from all previously externalized techniques insofar as they penetrate and control, through datification, automation and embedded methods, all instances of thought, rationality and action, transforming themselves into a kind of infrastructure or what Berry proposes to address as "infrasomatizations" (Berry, 2018).

Hence, knowledge formation occurs through increasingly distributed infrastructures and processes, becoming more and more opaque, mainly because of the scale and acceleration of data processing, which vastly surpass our thinking capacities. This scenario, which has already been associated to the "end of theory" (Anderson 2008), is also that of a particular end of science, as

[44] The phenomenon of brain plasticity is, according to specialists, particularly effective in children. Current studies show that "an infant's brain undergoes synaptogenesis, in which synaptic networks stimulated by the environment strengthen and spread, whereas those less stimulated shrink and diminish" (Hayles and Pötzsch 2014, 102). These studies point, in particular, to "a technologically enhanced rewiring of children's brains toward hyper attention at an age characterised by high degrees of neural plasticity. This might help them adapt even better to the socio-technical systems we are currently shaping, but it might come at a significant cost, the consequences of which we do not fully understand at present" (idem, 98).

practised throughout most of the 20th century, as well as that of a particular end of criticism, as a form of reason capable of accessing the foundations of its own exercise. In short, instead of representing the specificity and exceptionality of the human, justifying his unique position of mastery and control over the environment, cognition is precisely the instance where the post-human condition is now revealed. Hence the need to frame this new type of knowledge and layout a new task for thinking. In 1964, in "The end of philosophy and the task of thinking", Heidegger already pointed to cybernetics as the culmination of modern technoscience: "no prophecy is necessary to recognize that the sciences now establishing themselves will soon be determined and steered by the new fundamental science which is called cybernetics". At the same time, he also foresees the "dissolution of philosophy into the technicized sciences", insofar as they share the same Western metaphysical roots and dispositions Heidegger 2002 [1964], 58-59). According to Heidegger, it will then be necessary to organize the end of Philosophy and "bring us to the path which leads us to a determination of the task of thinking at the end of philosophy" (Heidegger 2002 [1964], 64).

In "Philosophy After Automation" (2021), Yuc Hui returns to this issue, pointing out some of the reasons that led Western thought to this cybernetic destiny, in particular, the fact that "modern western philosophy is fundamentally the pursuit of the universal through different means" (Hui 2021, 391) and that this universalization is carried out today through the planetarization of computing. Furthermore, the opposition between organism and mechanism on which (at least since Kant) the autonomy and self-determination of the subject are founded has been rendered obsolete by cybernetics, as shown by Norbert Wiener in *Cybernetics: Communication and Control in Man and Animals* (1948/1962). The algorithmic revolution, in turn, makes cybernetics increasingly effective as a science of control and recursivity and a new form of governance, undermining even more deeply the sovereignty of the human. The spread of computerization and

algorithmization will soon allow generalized automation, which will advance not only in the field of work but also in services, liberal activities and knowledge in general. As Stiegler says, "today automatization serves the autonomization of technics more than noetic autonomy" (Stiegler 2021, 241). In response to this scenario, it will be necessary to actively seek out possibilities for deautomatization, but, at the same time, "autonomy and automatism must be reconceived as a composition rather than an opposition", says Stiegler (Stiegler 2021, 241).

At the beginning of the 21st century, automation and the ecological crisis are, as Frase says, the two new "spectres haunting earth" (Frase 2016, 1), and it is crucial to understand the relationship between them. Despite the expectation that the digital transition can facilitate the ecological transition, computerization is, at the same time, the main factor in technological acceleration. In fact, as Yuc Hui says, we can understand "the real problem of the Anthropocene as that of a gigantic cybernetic system in the process of realization, a 'metaphysics without finality'", as he also points out, recalling the words of J.-F. Lyotard (Hui 2017, 2-3). This metaphysics, which implies a particular type of relationship to nature, is culminating in the present "monotechnologism", and that is why "a specific type of technology and rationality are transforming the earth into an artificial earth" (Hui 2021, 396). Yuc Hui, who repeats Heidegger's view in this regard, proposes the reintroduction of other cosmogonies, which must include, as Viveiros de Castro says, other forms of relationship to nature or "multinaturalisms" (and not just multiculturalisms), in order to "negotiate" the type of technology that is becoming universal. However, according to Yuk Hui, the solution can hardly emerge as some form of "strategic primitivism" or a return to "indigenous ontologies" (Hui 2021, 397). Thinking about other beginnings requires, in any case, aknowledging the "incontestable contingency of nature", against the belief in a "necessary triumph of technology over nature" (Hui 2021, 397) which is supposed by the Anthropocene itself.

The ubiquity and planetarization of computation are producing themselves a kind of "accidental megastructure" (in the words of Benjamin Bratton) which, to a certain extent, reintroduces a kind of contingent dimension and subverts the very idea of a (world where humans imprint their domination and their project). Bratton names this accidental megastructure "the stack" and describes it as a coherent but discontinuous planetary-scale infrastructure., that merges the social, the institutional and the technical, is composed of several layers ("Cloud", "city", "address", "interface", "user"), and "produces new territories in its own image", distorting our traditional models of experience. This kind of accidental "technological totality" does not focus on "computation in the service of governance, or in resistance to governance", but rather on "computation as governance". That is is why, according to Bratton, any political negotiation of "the stack", any possibility to "work through this schema, across their nonsense scales and toward different futures", entails "thinking with tools", asking ourselves not only "What can we do with it ?", but "What does it want from us?" and, at best, "what do we have to design better" (Bratton 2016, xvii-xviii).

Thus, the present technological system contains, in itself, factors of culmination and rupture with the very logic of the Anthropocene. Insofar as it deprives the human of a primordial place, it rather provokes a kind of second Copernican revolution, that of the post-human. This condition requires the recognition and adoption of what Simondon already called the "technical mentality": "It is not a question here of the rape of nature or of the victory of the Human Being over the elements, because in fact it is the natural structures themselves that serve as the attachment point for the network that is being developed". As an example, Simondon refers to the relay points of the Hertzian cables that "rejoin with the high sites of ancient sacredness above the valleys and the seas". Simondon speaks of this "technical mentality" as a form of intelligence that "successfully completes itself and rejoins nature by turning itself into a thought-network", a "material and

conceptual synthesis" whose "mazes are woven together with those of the world, in the concrete and the particular" (Simondon 2009, 22).

With the emergence of computation at every scale of reality there is an intensive dynamics of sensing and data gathering including the activity of satellites that encircle the earth, of probes that penetrate the oceans' floor or monitor the terrestrial critical zone, and of systems that produce a clinical, social and economic mapping of our bodies and behaviours. Cybernetics as a new form of intelligibility forces a new general ecology, which encompasses both technical and social processes as well as geo-biochemical processes, at various scales, infra and superhuman, from the world of bacteria to cosmic events, passing through the processes of globalization and those of climate change.

In the cybernetic age, we no longer inhabit a "middle world" (Dawkins), organized according to our perception and will. Instead, we experience an ecology of systems of different natures, organic and non-organic, which, like ourselves, are capable of receiving, storing, and processing information, opened to "circular causal and feedback mechanisms", which are also "governors", i.e., governing mechanisms or mechanisms of "control and communication (..) wether in the machine or in the animal" (Wiener 1985 [1961], 10-12). Cybernetic governance is a science of creating "equilibria in a world of possibilities and constraints" (Glasersfeld 2000, 95), balances that constitute a kind of "teleological mechanisms", says Margaret Mead (Mead 1968, 2), an apparent poor substitute taking the place of our old teleological systems. Our goals and ideals have now to be negotiated with the technical systems - the "minor gods" of our era, as McLuhan has called them - if we are not to be transformed into their "servomechanisms". This negotiation (or a politics of technics) is, therefore, of crucial importance and should not be viewed as a poor substitute for politics, quite the contrary. As we now know, we can no longer aspire to impose on nature the greater goals and ideals of humanity, those we have formerly negotiated with also greater

gods, who awaited us at the end of history, and in the name of whom ideology has made its share of victims, at least as many as technology itself. In a world that is now capable of self-governing, we urgently need to concern ourselves with technology, understand how to deal with it, as much as how it deals with us, and cooperate to achieve the balances that sustains us both.

Translation

ADRIANA BARREIROS

References

Adorno, T. and Horkheimer, M. (2002 [1947]) "The Culture Industry: Enlightenment as Mass Deception" in Dialectic of Enlightenment, Stanford University Press, 94-136.

Anderson, Chris (2008) «The End of Theory: The Data Deluge Makes the Scientific Method Obsolete», Wired, June 23, 2008, n.p.

Baetson, Gregory (1972) *Steps to an Ecology of Mind. Collected Essays in Anthropology, Psychiatry, Evolution, and Epistemology,* Northvale, New Jersey: Jason Aronson Inc.

Berry, David M. (2018) "Encoding Cultures: Automating Thought", Interdisciplinary symposium: Encoding Cultures. Living Amongst Intelligent Machines, ZKM, 27-28 april 2018.

Boutang, Yann Moulier (2008) *Le Capitalisme Cognitif,* Editions Amsterdam.

Braidotti, Rosi (2019) *Posthuman Knowledge,* Medford, Cambridge: Polity Press.

Bratton, Benjamin (2016) *The Stack. On Software and Sovereignty,* Cambridge, Mass.: MIT Press.

Carr, Nicholas (2011) *The Shallows: What the Internet Is Doing to Our Brains*, W. W. Norton & Company.
Chomsky, Noam (1975) *Reflections on Language,* London: Fontana.

Clark, Timothy (2000) 'Deconstruction and Technology', in N. Royle (ed.) *Deconstructions. A User's Guide,* Basingstoke: Palgrave, 238- 257.

Damásio, A. (2000) *The Feeling of What Happens: Body and Emotion in the Making of Consciousness,* New York: Mariner Books.

Damásio, António (2021) *Feeling & Knowing. Making Minds Conscious*, New York: Pantheon.

Darwin, Charles (1859) *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life,* London: John Murray, Darwin online - http://darwin-online.org.uk/content/frameset?itemID=F373&viewtype=text&pageseq=1 (accessed 21/02/2022).

Dannett, Daniel (2017) *From Bacteria to Bach and Back: The Evolution of Minds,* New York: W. W. Norton & Company.

Dawkins, Richard (1976) *The Selfish Gene,* Oxford, New York: Oxford University Press.

Dawkins, Richard (1986) *The Blind Watchmaker: Why the Evidence of Evolution Reveals a Universe without Design*, New York: W. W. Norton & Company, Inc.

Deacon, Terrence W. (1997) *The Symbolic Species: The Co-Evolution of Language and the Brain,* New York: W. W. Norton & Company, Inc.

Debray, Régis (1992) *Vie et Mort de l' Image. Une Histoire du Regard en Occident,* Paris: Gallimard.

Derrida J. (1972) "La pharmacie de Platon" in *La dissémination*, Paris: Seuil, 77–213.

Derrida, Jacques (1986) *Mémoires: for Paul de Man*, New York: Columbia University Press.

Derrida, Jacques (1976 [1967]) *Of Grammatology*, Maryland: Johns Hopkins University Press.

Donald, Merlin (1991) *Origins of the Modern Mind: Three Stages in the Evolution of Culture and Cognition,* Harvard University Press.

Donald, Merlin (2001) *A Mind So Rare: The Evolution of Human Consciousness,* New York: W. W. Norton.

Ellul, Jacques (1962) "Ideas of Technology" in *Technology and Culture. Proceedings of the Encyclopaedia Britannica Conference on the Technological Order* 3, no. 4 (Autumn), 394-421.

Frabetti, Federica (2011) "Rethinking the Digital Humanities in the Context of Originary Technicity", Culture Machine, vol.12, 1-22

Foucault, Michel (1966) *Les Mots et les Choses. Une Archéologie des Sciences Humaines*, Paris: Gallimard.

Foucault, Michel ([1984]) "What is Enlightenment?" in Rabinow, P. (Ed.), *The Foucault Reader,* New York, Pantheon Books, 32-50.

Frase, Peter (2016) *Four Futures: Life After Capitalism*, New York, London: Verso.

Fukuyama, Francis (2000) *Information and Biological Revolutions: Global Governance Challenges*, Santa Monica: Rand Publishing.

Glasersfeld, Ernst von (2000) «Reflections on Cybernetics», Cybernetics and Human Knowing 7(1), pp. 93–95.

Groys, Boris (2000) *Under Suspicion. A Phenomenology of Media*. Columbia University Press.

Hansen, Mark B. (2003) "'Realtime Synthesis' and the Différance of the Body: Technocultural Studies in the Wake of Deconstruction", Culture Machine 5: n.p.

Hansen, Mark B. N. (2010) "New Media" in *Critical Terms for Media Studies* Edited by W. J. T. Mitchell and Mark B. N. Hansen, Chicago, London: The University of Chicago Press, 172-185.

Haraway, Donna (2016) *Staying with the trouble. Making Kin in the Chthulucene.* Durham, London: Duke University Press.

Hayles, N. Katherine (1999) *How we became posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics,* Chicago: The University of Chicago Press.

Hayles, N. Katherine (2012) *How We Think: Digital Media and Contemporary Technogenesis.* University of Chicago Press.

Hayles, N. Katherine and Pötzsch, Holger (2014) "Posthumanism, Technogenesis, and Digital Technologies: A Conversation with N. Katherine Hayles", The Fibreculture Journal, Issue 23 (General Issue 2014), 95-107.

Hayles, N. Katherine (2017) *Unthought. The Power of the Cognitive Nonconscious*, Chicago, London: The University of Chicago Press.

Heidegger, Martin (1977 [1954]) *The Question Concerning Technology and other essays*, London, New York: Garland Publishing House.

Heidegger, Martin (2002 [1969]) "The End of Philosophy and the Task of Thinking" in Stambaugh, Joan (Ed.) *Martin Heidegger: on Time and Being*, University of Chicago Press, 55-73.

Hui, Yuc (2017) "On Cosmotechnics: For a Renewed Relation between Technology and Nature in the Anthropocene", Techné: Research in Philosophy and Technology, 21, 1–23.

Hui, Yuc (Editor) (2017) Philosophy Today - Special Issue: "Philosophy after Automation", Volume 65, Issue 2, Spring.

Kittler, Friedrich (1997) «The world of the Symbolic – A World of the machine» in *Literature, Media, Information Systems*, Ed. John Johnston, Amsterdam: G+B Arts International, 130-146.

Kittler, F. (1999 [1986]) *Gramophone, Film, Typewriter,* Stanford University Press.

Kittler, Friedrich (2006) "Number and Numeral", Theory, Culture & Society, London, Thousand Oaks and New Delhi: SAGE, Vol. 23 (7–8), 51–61

Kittler, Friedrich (2009) «Towards an Ontology of Media» Theory, Culture & Society, Sage, Vol. 26 (2–3): 23–31.

Krämer, Sybille (2015 [2008]) *Medium, Messenger, Transmission. An Approach to Media Philosophy,* Amsterdam: Amsterdam University Press.

Latour, Bruno (1994) «On Technical Mediation. Philosophy, Sociology, Genealogy», Common Knowledge, Fall, Vol. 3, N.2, 29-63.

Leroi-Gourhan, André (1945) *Milieu et techniques.* Paris: Albin Michel.

Logan, Robert K. (2007) *The Extended Mind: The Emergence of Language, the Human Mind, and Culture,* Toronto: University of Toronto Press.

Lumsden, Charles J. and Wilson, Edward O. (1981) *Genes, Mind, and Culture: The Coevolutionary* Process, Harvard University Press.

Malabou, Catherine (2019 [2017]) *Morphing Intelligence. From IQ Measurement to Artificial Brains,* New York: Columbia University Press.

Manovich, Lev (2005) "Understanding Metamedia", CTheory - International Journal of Theory, Technology, and Culture, n.p.

McLuhan, Marshall (1962) *The Gutenberg Galaxy: the making of typographic man*, Toronto, Toronto University Press.

McLuhan, Marshall (1994 [1964]) *Understanding Media. The Extensions of Man,* Cambridge, Mass.: MIT Press.

McLuhan, Marshall and Bruce R. Powers (1989) *The Global Village: Transformations in World Life and Media in the 21st Century,* Oxford: Oxford University Press.

Mead, Margaret (1968) "Cybernetics of cybernetics" in H. von Foerster, J.D. White, L.J.

Peter son, & J. K. Russell (Eds.) *Purposive systems*, New York/Washington: Spartan Books, 1-11.

Pinker, Steven (1994) *The Language Instinct,* New York, William Morrow and Company.

Postman, Neil (1993) *Technopoly: The Surrender of Culture to Technology*, New York: Vintage.

Plato (1972) *Phaedrus* (370 ac), Edited by R. Hackforth, Cambridge University Press.

Rifkin, Jeremy (2014) *The Age of Access: The New Culture of Hypercapitalism,* New York: Jeremy P. Tarcher / Putnam.

Richerson, Peter J. and Boyd, Robert (2005) *Not By Genes Alone. How Culture Transformed Human Evolution*, Chicago: The University of Chicago Press.

Siegert, Bernhard (2015) *Cultural Techniques: Grids, Filters, Doors, and Other Articulations of the Real,* Fordham University Press.

Simondon, Gilbert (2017 [1958] *On the Mode of Existence of Technical Objects*, Minneapolis: Univocal Publishing.

Simondon, Gilbert (2005 [1964/1989]) *L'individuation à la lumière des notions de forme et d'information,* Ed. Jérôme Millon.

Simondon, Gilbert. (2009) "Technical Mentality'. Parrhesia, 7, 17–27.

Stiegler, Bernard (1985) *La Technique et le Temps.* Vol 1. *La Faute d'Épimethé.* Paris: Galilée

Stiegler, Bernard (1996) *La Technique et le Temps.* Vol 2. *La désorientation.* Paris: Galilée

Stiegler, Bernard (2001) *La Technique et le Temps.* Vol 3. Le temps du cinéma et la question du mal-être. Paris: Galilée.

Stiegler, Bernard (2004) Elements Pour Une Organologie Generale, Paris: Galilée.

Stiegler, Bernard (2011) "Pharmacology of the Spirit. And that which makes life worth living" in Jane Elliott and Derek Attridge (eds), *Theory After 'Theory'*. London, NY: Routledge, Chap. 20, 294-309

Stiegler, Bernard (2014 [2004]) *Symbolic Misery, Volume 1: The Hyper-Industrial Epoch*. Cambridge, Malden: Polity Press.

Stiegler, Bernard (2019 [2016]) *The Age of Disruption: Technology and Madness in Computational Capitalism*. Cambridge: Polity Press.

Strate, Lance (2017). *Media Ecology: An Approach to Understanding the Human Condition*. Peter Lang Inc., International Academic Publishers.

Varela, Francisco J., Thompson, Evan and Rosch, Eleanor (1991). *The embodied mind: Cognitive science and human experience*. Cambridge, Mass.: MIT Press.

Wiener, Norbert (1985 [1961]) *Cybernetics: Communication and Control in Man and Animals*, Cambridge, Mass.: MIT Press.

This work is funded by national funds through FCT – Fundação para a Ciência e a Tecnologia under the project UIDB/05021/2020.