Journal of Posthumanism
Fall 2024
Volume: 4, No: 3, pp. 259–271
ISSN: 2634-3576 (Print) | ISSN 2634-3584 (Online)
journals.tplondon.com/jp

TRANSNATIONAL PRESS® LONDON

Received: 9 March 2024 Accepted: 19 September 2024
DOI: https://doi.org/10.33182/joph.v4i3.3288

Digital Milieus: A Posthumanist Media Ecology for a Planetary Computation Era

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Abstract

Media ecology introduced a fresh perspective to media studies, previously dominated by content analysis, effects research, ideologies, and flux studies. This approach allows us to understand media in a non-linear manner, seeing them as constructors of our everyday contexts rather than mere tools for specific purposes. Despite this shift, classical media ecology often views media as information transmitters for discrete human beings, rooted in modern humanist rationalism. This article suggests that a posthumanist approach to media ecology can help overcome modern anthropocentrism by studying the mutual ontogenesis between humans and their media environments. This change offers a fruitful framework for studying contemporary media, characterized by ubiquity, hyperconnection, and planetary-scale computing. The analysis emphasizes the interdependence between humans, technology, and the environment, highlighting the diminishing human agency amid automated systems and ubiquitous computing.

Keywords: *Media Ecology; Digital Media; Posthumanism; Individuation; Planetary-Scale Computation*

Introduction

Media ecology, rooted in Marshall McLuhan's seminal work, has long examined how media shapes human perception, interaction, and societal structures. Initially concerned with understanding the impact of media technologies on human consciousness and culture, this field has expanded to encompass broader socio-cultural and environmental dimensions. Traditional media ecology investigates the intricate relationships between media technologies, human behavior, and cultural formations. It explores how media function as environments that envelop and influence users, shaping their experiences and societal norms. This approach has been pivotal in unveiling the profound effects of media on identity, community dynamics, and the transmission of knowledge.

However, despite the shift from a linear to an encompassing view of media, classical approaches to media ecology still often consider media as representational information transmitters for discrete human beings.

This article embarks on a dual exploration. Firstly, it revisits traditional media ecology's humanist and rationalist foundations, which emphasize human agency and the transmission of information. Secondly, it proposes a posthumanist turn, challenging anthropocentric views and highlighting the agency of non-human actors and the entanglements of technology, culture, and ecology.

* This article was published through an open-access model that charged no article processing fees.
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By embracing a posthumanist framework, this approach promises deeper insights into the transformative impacts of planetary-scale computing. It suggests that understanding media as complex assemblages, involving both human and non-human agencies, is essential for navigating our evolving technological and societal landscapes.

Media ecology and its distresses

In the early sixties, Canadian literary scholar Marshall McLuhan began a theoretical enterprise aimed at understanding human culture and society in light of the technologies they use. From this approach, McLuhan (1962) examined the changes that movable type printing fostered in culture and society during early modernity: by altering the way in which text production is physically produced, movable type printing not only shifted the predominantly aural Western culture into a more visual one, introducing new sensory ratios, but also, by transforming text production from a whole entity into a juxtaposition of discrete types, it prompted a complete overhaul of human cognition. This discretization of text had already commenced with alphabetic writing, but was amplified by print, which, according to McLuhan, "exists by virtue of the static separation of functions and fosters a mentality that gradually resists any but a separative and compartmentalizing or specialist outlook" (126).

Even though *The Gutenberg Galaxy* (1962) primarily focuses on the cultural consequences of the introduction of movable type printing in Western societies, McLuhan clearly states that this analysis is merely a specific case of a general media theory that understands culture and society in relation to the changes in sensory ratios introduced by new technologies. This general media theory is further developed in his subsequent works, especially in *Understanding Media* (2003), whose subtitle posits his general understanding of media as "extensions of man," meaning extensions of human capacities: writing extends memory, film and light bulb extend vision, cars extend legs.

In his examination of these extensions, McLuhan is particularly interested in how new media interact with others:

> Media, as extensions of our senses, institute new ratios, not only among our private senses, but among themselves, when they interact among themselves. Radio changed the form of the news story as much as it altered the film image in the talkies. TV caused drastic changes in radio programming, and in the form of the *thing* or documentary novel (76).

Thus, McLuhan's media theory is not merely a theory to study any specific medium and its relationships with human societies, but one oriented toward studying media in relation to other media and how these new relationships affect human societies, by altering human environments and creating entirely new ones. [2]

Building on the concept of technology shaping human environments, a few years later, McLuhan's disciple, Neil Postman (1970), coined a name for this new approach: "media ecology." According to Postman, media ecology

> looks into the matter of how media of communication affect human perception, understanding, feeling and value, and how our interaction with media facilitates or impedes

[2] I find interesting to note that, in the introduction of later reprints of *The Gutenberg Galaxy* (the earliest I found is the 1969 reprint, which is not a new edition, but has a two-paragraph addition), McLuhan states that the word "environment" would have been a more advantageous choice than "galaxy".

> our chances of survival. The word ecology implies the study of environments: their structure, content and impact on people.
>
> An environment is, after all, a complex message system which imposes on human beings certain ways of thinking, feeling, and behaving. It structures what we can see and say and, therefore, do. It assigns roles to us and insists on our playing them. It specifies what we are permitted to do and what we are not (161).

In subsequent years, this media ecology was further developed by other media scholars. Naming just a few: Walter Ong (2002), another disciple of McLuhan, studied writing as a technology and its effects on culture; J. T. Mitchell (2005) expanded the role of the extensions, stating that "McLuhan's notion of media as 'sensory ratios' needs to be supplemented with a concept of 'semiotic ratios', specific mixtures of sign functions that make a medium what it is" (261); and, Henry Jenkins (2003, 2006) analyzed how, with digital media, different media converge, reshaping culture and favoring different ways of transmedia storytelling.

The ecological approach to media brought a fresh perspective to a context of media studies dominated by content analysis, effects research, ideologies, and flux studies. This approach enables us to understand media in a less linear manner, not merely as instruments for specific purposes nor just as tools for domination[3] but as constructors of our everyday contexts. However, despite the departure from the somewhat linear approach of the effects and ideology studies and the excessive interest in semantics and pragmatics of content analysis and the embrace of an encompassing view of media, classical approaches to media ecology maintain certain aspects of the rationalistic and anthropocentric modern tradition.

Even when media ecology proposes that media constitute the environments where humans are, the idea of media as extensions of man posits humans as the center of the environments, with media being just technologies attached to him, [4] as mere prosthetic add-ons. Additionally, traditional media ecology often considers media as representational information transmitters for discrete human beings and disregards other kinds of beings and their key role in the conformation of media environments as well as their entanglement with humans.

In this way, classical media ecology remains anthropocentric, representational, instrumental, and transmissional, firmly anchored in the modern rationalistic, and liberal intellectual tradition (Moreira Alonso, 2021). Nevertheless, the general approach of media ecology and concept of media environments remain valuable for any media theory aspiring to move beyond the modern humanist tradition of rationalism. It simply needs to get rid of its representational and transmissional background, which, I believe, can be achieved by embracing a posthuman approach.

Posthumanism and media studies

Posthumanism emerged at the end of the past century as a new way to understand human beings and their relationships with other beings (non-human animals, technological objects, the planet Earth, to name just a few), as well as a deconstruction of the concept of the human itself. This new understanding is rooted in the anti-humanism of Marx and the critique of any human essentialism in psychoanalysis and post-structuralism, rejecting the dichotomies around which modern philosophy revolved, especially the Cartesian dichotomy of res cogitans and res extensa, or, in other

[3] However, they may be very good at this.
[4] McLuhan writes "man", so, it seems to be a him. The man to whom media are extensions is an able western man.

words, mind and body, as well as other neural dichotomies of modernity, such as self/other, truth/illusion, civilized/primitive, man/woman, culture/nature (Haraway, 1991).

Posthumanism states that the modern idea of the human is not synonymous with homo sapiens, a general category that encompasses all human beings, nor even a statistical average, but rather "a systematized standard of recognizability – of Sameness – by which all others can be assessed, regulated, and allotted to a designated social location" (Braidotti, 2013, 26). The human is a white, able, Western heterosexual cis man, the standard, the proper way to be human. In that way, rocks and cats are not human, but neither are those homo sapiens who deviate from this standard, who are, in the best-case scenario, flawed humans. This human is also a rational and reflexive being, the Cartesian subject, autonomous, aware of his own essential nature, and capable of understanding the world around him, which is clearly separated from himself (Hayles, 1999).

To this essentialist and fixed humanity, posthumanism opposes a different mode of existence, one which is fluid, undetermined, hybrid. As Rosi Braidotti (2013) puts it,

> the posthuman condition introduces a qualitative shift in our thinking about what exactly is the basic unit of common reference for our species, our polity and our relationship to the other inhabitants of this planet. This issue raises serious questions as to the very structures of our shared identity – as humans – amidst the complexity of contemporary science, politics and international relations. Discourses and representations of the non-human, the inhuman, the antihuman, the inhumane and the posthuman proliferate and overlap in our globalized, technologically mediated societies (1–2).

Unlike the natural self of modern rationalism, a whole and permanent being, discrete and clearly separated from his environment and other humans, but also from the informational posthuman of classical cybernetics (which maintains the core elements of the rationalistic and liberal conceptualization), we must understand the posthuman as an "amalgam, a collection of heterogeneous components, a material-informational entity whose boundaries undergo continuous construction and reconstruction" (Hayles, 1999, 3).

The special regard of posthumanism towards technology and media (especially digital media) makes it a fruitful framework for media studies, enabling media scholars to study media beyond semantic and representational meanings, favoring the analysis of the ways in which media entangle with people and in which both media and people construct each other. It also allows us to consider all the non-human agents in communication processes as well as, as proposed by Sarah Choukah and Philipe Theophanidis (2016), the possibility of communication without agency.

Incorporating the posthumanist approach into traditional media ecology, we may be able to overcome the centrality of the human in the idea of media as extensions of man, understanding media not as prosthetic attachments that merely enhance already existing capacities, but embedding into them, in a process in which both the human and the medium come into being, or, even better, emerge. A posthumanist turn in media ecology could also account for all the non-human entities that have agency in a given media environment and all the situations in which humans do not, and, at the same time, recognize the myriad of human-machine, human-human, and machine-machine amalgams emerging in a specific environment. Finally, it allows us to drop the understanding of media as exclusively information transmitters and, instead, consider them as elements of individual and collective ontogenesis (Hayles, 1999; Simondon, 2005).

Extensions and embodiment

Opposed to what they called the "rationalist tradition" (where they group, among others, part of analytical philosophy, decision and rational action theory, a big part of cognitive sciences, and, more broadly, the Cartesian rationalist dualist tradition) and to the established practices in computer systems design, which presupposes a user in complete control and an interface that works as a direct translator of the system's internal functions to the user, Terry Winograd and Fernando Flores (1987) developed a new approach to the analysis and design of interfaces by rejecting the conception of computational systems as a mere set of technical processes and interfaces as input and output systems and embraced a conceptualization of computers and their interfaces as functional processes with which humans have cognitive and hermeneutic involvement. Taking the concept of readiness-to-hand (*Zuhandenheit*) from Martin Heidegger (1996), by grasping how to use any given interface, the user does not rationally learn a set of discrete and specific pieces of knowledge and internalize clear and distinct representations of the internal functioning of the system; on the contrary, they acquire new cognitive processes of their own. But, those processes do not correspond to the technical interface but to their previous uses, interests, and their physical and cognitive interaction with the computational system. According to Winograd and Flores (1987), in the use of the system, the user embodies the interface, entangling it with their body as an organic-hermeneutic entity.

N. Katherine Hayles (1999, 2012) takes the concept of embodied cognition from Francisco Varela, Evan Thompson, and Eleanor Rosch (1993), [5] integrating it into her posthumanist theory, making it a basis for her desubstantialization of the body and the human.

> In contrast to the body, embodiment is contextual, enmeshed within the specifics of place, time, physiology, and culture, which together compose enactment. Embodiment never coincides exactly with "the body," however that normalized concept is understood. Whereas the body is an idealized form that gestures toward a Platonic reality, embodiment is the specific instantiation generated from the noise of difference. Relative to the body, embodiment is other and elsewhere, at once excessive and deficient in its infinite variations, particularities, and abnormalities (1999, 196–197).

This move from a definite body toward a contextual embodiment has profound implications for media theories, especially for the study of the interaction between humans and media. Hayles (2012) states that

> our interactions with digital media are embodied, and they have bodily effects at the physical level. Similarly, the actions of computers are also embodied, although in a very different manner than with humans. The more one works with digital technologies, the more one comes to appreciate the capacity of networked and programmable machines to carry out sophisticated cognitive tasks, and the more the keyboard comes to seem an extension of one's thoughts rather than an external device on which one types. Embodiment then takes the form of extended cognition, in which human agency and thought are enmeshed within larger networks that extend beyond the desktop computer into the environment (3).[6]

[5] Hayles does not directly cite Winograd and Flores, so it is not clear if she read them. But, by taking the concept of embodied cognition from Varela, Thompson and Rosch, (who read them, indeed; actually, Flores and Varela were longtime friends and co-authors), she roots her ideas in the propositions of Winograd and Flores.

[6] She took the concept of extended cognition from Andy Clark and David Chalmers (1998).

In Hayles's works, embodiment is explicitly associated with McLuhan's idea of media as extensions of man. This is notable in the next fragment:

> When we say that someone knows how to type, we do not mean that the person can cognitively map the location of the keys or can understand the mechanism producing the marks. Rather, we mean that this person has repeatedly performed certain actions until the keys seem to be extensions of his or her fingers (1999, 199).

It is easy to understand the McLuhan reference at the end of the quotation; however, I may point out a difference between the usage of the word "extensions" in McLuhan and in the previous quote by Hayles. When explaining how media are extensions of man, McLuhan always focuses on an extension of a previously existing capacity: the wheel is an extension of feet; the phonograph is an extension of voice; radio of hearing, and television of touching; clothing is an extension of skin and housing an extension of the bodily heat-control mechanisms; machine is an extension of human process, and art is an extension of "human awareness in contrived and conventional patterns"; "the arrow is an extension of the hand and the arm, the rifle is an extension of the eye and teeth"; and, in general, orality, scripture, and mass media are extensions of the human central nervous system. [7] If media and technology are extensions of already existing capacities, the human remains as a thing-in-itself which, in certain circumstances, gets attachments that expand some of his properties.

I would assert that, in the example of Hayles, the keys as extensions of the fingers work less as an extension of the already existing abilities of the human and more as the emergence of a new one; the fingers (or the user of the keyboard) weren't able to type before the first time they did. Actually, as Hayles posits and everyone who had ever been in front of a keyboard may concur, the whole experience of typing for the first time is a very frustrating one, a lot of time looking for a key that is right there, several spelling mistakes, and the necessity of looking at the keyboard for the whole time. It is in the use that the capacity emerges; in this way, the human as a part of their environment is never a thing-in-itself but rather an impermanent entity, always becoming into being.

Furthermore, where each of them chose to locate the extension may be taken as another evidence of the distinction I make. In the chapter dedicated to the typewriter (of all the technologies he analyzes in *Understanding Media*, the one that can be easily related to the typing of Hayles example), McLuhan writes about poetry, fashion, industry, print, and its specialization and fragmentation impacts, orthography, and grammar, but never about the fingers. And this is understandable; at the end of the day, with extensions of man, McLuhan means extensions of the capacities of man, and the fingers are not a capacity.

Whereas McLuhan's conceptualization of extensions is reified in anthropocentric traditions, the use of the term by Hayles entails an entanglement between the human user and the technical environment. Therefore, even when I understand and completely agree with the outline of the typing learning process that Hayles does, I wouldn't agree with her use of the word "extension" and the rooting of the process in McLuhan's conception of media as extensions of man.

In this way, by displacing the idea of media as extensions and embracing the relationship between humans and media as an embodiment engagement, media theory can focus on the mutual ontogenesis occurring between humans and media in a way that does not prioritize the human.

[7] This list of extensions may seem unnecessary long, but I wanted to show how, even in the variety and complexity of the concept of extension of man, McLuhan is always talking about extensions of already existing capacities.

The individuation of technical objects

In order to understand how the ontogenesis of humans and media occurs, Hayles refers to Gilbert Simondon. According to Simondon (1989), the ontogenesis of technical objects is a continuous process of concretization (the transition from an analytical structure to a functional one) in which conflicts between the object and the environment in which it operates, its milieu, are resolved.

> This milieu, both technical and natural, can be called associated milieu. It is that by which the technical being conditions itself in its functioning. This milieu is not manufactured, or at least not entirely manufactured; it is a certain regime of the natural elements surrounding the technical being, linked to a certain regime of the elements constituting the technical being. The associated milieu is mediator of the relationship between the manufactured technical elements and the natural elements between which the technical being functions (57).[8]

According to Simondon, the milieu is not the physical or historical context in which the technical object is situated; it encompasses a dynamic and relational framework that influences the development and organization of individuals and systems, being a crucial aspect of the ontogenesis of the technical objects, which establish a relationship of recurrent causality (*causalité récurrente*). This type of recurrent causality is identical to the one humans establish with their own milieu, resolving potentialities by, as well as being modified by, modifying the milieu and themselves through the development of abilities that allow them to continue their individuation, as happens in Hayles' example, where the user has to develop new abilities by embodying the keyboard.

As Haraway, Braidotti, and Hayles concur, the human is not a definite and immutable substance but an entity in continuous process. Simondon would agree with this, but would have expanded it to include any kind of individuals, natural, technical, and living. For him (2005), any individual is an emergent result of the resolution of potentialities present in the milieu and, hence, does not exist in a state of stability but of metastability, prone to change, as tensions inside the individual or between the individual and its milieu ignite new processes of dedifferentiation (*dédifférenciation*).

> The individual would then be understood as a relative reality, a certain phase of being that supposes before it a pre-individual reality, and which, even after individuation, does not exist completely alone, because individuation does not exhaust all at once the potentials of pre-individual reality, and, on the other hand, what individuation brings forth is not only the individual but the individual-milieu couple. The individual is thus relative in two senses: because it is not all of being, and because it results from a state of being in which it did not exist either as an individual or as a principle of individuation (24–25).[9]

The relation between individuals and their associated milieus seems much denser and more complex than the environment of McLuhan, Postman, and most traditional media ecologists. That is why I

[8] My own translation from the French original: "Ce milieu à la fois technique et naturel peut être nommé milieu associé. Il est ce par quoi l'être technique se conditionne lui-même dans son fonctionnement. Ce milieu n'est pas fabriqué, ou tout au moins pas fabriqué en totalité; il est un certain régime des éléments naturels entourant l'être technique, lié à un certain régime des éléments constituant l'être technique. Le milieu associé est médiateur de la relation entre les éléments techniques fabriqués et les éléments naturels au sein desquels fonctionne l'être technique".

[9] My own translation from the French original: "L'individu serait alors saisi comme une réalité relative, une certaine phase de l'être qui suppose avant elle une réalité préindividuelle, et qui, même après l'individuation, n'existe pas toute seule, car l'individuation n'épuise pas d'un seul coup les potentiels de la réalité préindividuelle, et d'autre part, ce que l'individuation fait apparaître n'est pas seulement l'individu mais le couple individu-milieu'. L'individu est ainsi relatif en deux sens: parce qu'il n'est pas tout l'être, et parce qu'il résulte d'un état de l'être en lequel il n'existait ni comme individu ni comme principe d'individuation".

would rather use the term milieu than environment to refer to the complex ensembles of humans, machines, non-human living beings, and geological, geographical, atmospheric, and extraplanetary beings involved in contemporary media processes. This change stresses the move from a conception in which any given medium establishes relationships with other media but maintains an essential individuality, to one in which media are profoundly related in an ontological way, not just between themselves, but with the entire milieu, which would not be only the immediate physical context, but all the functional relationships that make them be.

In this way, the milieu of moveable type printing and of the typographic man is extended to more than literate culture, previous printing technology, paper, mining, wood carving, weaving, rocks, forests, agriculture, the Mediterranean Sea, lead poisoning, and also Martin Luther and the nation-state. But, more importantly, the moveable types print and the typographic man are not just intertwined with each other and their milieus, but are collectively individuated by their becoming process in which the tensions present in the codex are resolved in a more efficient way than with the pecia system and woodcut printing.[10]

Digital milieus

Yuk Hui (2016) initiates his inquiry into the ontogenesis of digital objects by analyzing the digital milieus in which these objects come into being. Hui discerns the differences between digital objects (composed of code) and technical objects studied by Simondon (which are ultimately apparatuses physically in contact with the rest of the world), and therefore, suggests that their concretization processes must be understood differently. To do so, he focuses on the systems of relations and ontologies instituted by markup languages, the semantic web, and, I would add, machine learning models. He proposes that the milieu in which digital objects come into being, what he calls the digital milieu,[11] is constituted by "the multiple networks, which are connected together by protocols and standards" (26). By acquiring new metadata labels (whether human or machine-made, situated in external files such as XML or RDF, or in the header of the file) or new relations (links, parentings, embeddings), objects are individuated through the increase of information that makes them more concrete and more interwoven with their milieus.

At the electronic level, I mean, in the mere piece of hardware, there are only continuous electric charges, or the absence of them. It is because of the existence of these standards and protocols that digital objects become computable (the continuous charges are translated into discrete zeros and ones), processable (the zeros and ones are transformed into low-level programming functions), and phenomenologically available (the functions are turned into things that users can interact with). It is only within a specific digital milieu that the pre-individual voltages in a silicon plaque, binary operations made by the assembler, and code fragments processed by the operating system resolve their tensions and become individual plain text files, videos with external subtitles, or entire websites. Moreover, as Agustín Berti and Javier Blanco (2013) point out, the mode of existence of contemporary digital objects, in which they are collaboratively created, cloud-distributed, and massively consumed/used (their socio-historical milieu), is only possible because of the massification of the standards and protocols developed by the computing industry and standardization organizations (such as the W3C, DCMI, and DDEX).

[10] On the different book production technologies in the late middle age and early modernity, see Kirwan and Mullins (2015).

[11] It is important to note that, in his study on digital milieus, Hui expands the theory of Simondon incorporating Martin Heidegger's concept of *Umwelt* (usually translated as "surrounding world", but translated as "milieu" by Hui), a move that includes not just the physical and functional context, but also the socio-historical and hermeneutic in the ontogenesis of digital objects.

Simondon (1989) considers that, in their evolution, technical objects can develop hypertely (*hypertélie*), an exaggerated specialization to a certain milieu which maladapts it to any change (even a minor one) in its conditions, like a tire made for cold climates or a glider that requires a carrier plane to fly. In the case of digital objects, there are different levels of hypertely, but it is always present: there are programs with strict software and hardware requirements, file formats that wouldn't work without specific codecs, and low-level languages that only work for specific hardware, not to mention the precariousness of most data storage methods and the error sensitivity of systems based on low redundancy separation of form and content such as HTML and most video and audio processing software. This functional overadaptability poses a threat to a digital-based culture because digital objects are very susceptible to compatibility problems, obsolescence, licensing, and bugs related to metadata and file addressing.

Hui's perspective on digital milieus originates from his inquiry about digital objects, so it is understandable that the conceptualization is mostly software-related. However, even when software can seem to be somewhat functionally autonomous at a certain level of complexity, it is a mistake to disregard that modern computation requires both hardware and software, and that we should avoid what Blanco and Berti (2016) call "digital dualism," an actualization of the core dualism of modern humanism, Cartesian *res cogitans–res extensa*. Consequently, I prefer to expand the concept of digital milieus from the milieu of digital objects to the milieu of digital media, complex metaobjects that assemble components of different natures: electric, electronic, thermodynamic, mechanical, coding, and since they are fully integrated into culture, visual, aural, narrative, instrumental, and much more.

Additionally, building on Hui's ideas of the objectification of data and the datafication of objects, I can include in this digital milieu not just classical computers, but also any other device integrated into the networks of standards and protocols, such as the engine of an airplane that continuously checks for malfunctions in order to inform the manufacturer when service is needed, or a home with automated appliances controlled by a computer system or the homeowner via a smartphone app.

Digital milieus for planetary computation

Which would be the individual in a study of the genesis of digital media? The first intuitive answer may perfectly be each compound device, including its computation and interface hardware and software, that may be considered components, and which may conform with other connected devices (printers, microphones and webcams, other computers connected in local networks) an assemblage (what Simondon calls *ensemble*). Following this, the digital milieus of digital media may be composed of the electric grids, the computer-oriented furniture and also (adopting the expanding of Simondonian milieu adding Heidegger's *Umwelt*, as Hui proposes) the different aspects of social and cultural life that affect technical development and usage practices.

I think this may have been a good answer twenty or fifteen years ago, when internet connection was still mainly a human-driven activity and cloud and ubiquitous computing were little more than an idea. But in contemporary computation, this results in an excessively reductionist conception that ignores the high level of integration of computers and the interdependency between them. Nowadays, almost all of the computers we use every day (from my phone and laptop to the air conditioner in my living room connected to Google Home that starts cooling automatically when I am reaching home in a hot summer afternoon) depend on other systems that, in turn, depend on other systems, and so on. Additionally, a growing number of the functions of those computers at

any level (not just logical calculus and programming instruction resolve, but also highly symbolized and socially relevant activities) are becoming more and more automatically controlled by some of those other systems which automatically feed on data from those computers.

On that premise, Benjamin Bratton (2016) proposes that:

> Planetary-scale computation takes different forms at different scales — energy and mineral sourcing and grids; subterranean cloud infrastructure; urban software and public service privatization; massive universal addressing systems; interfaces drawn by the augmentation of the hand, of the eye, or dissolved into objects; users both over-outlined by self-quantification and also exploded by the arrival of legions of sensors, algorithms, and robots. Instead of seeing all of these as a hodgepodge of different species of computing, spinning out on their own at different scales and tempos, we should see them as forming a coherent and interdependent whole (4–5).

The current development of long-scale computer networks has reached a state in which the different devices have lost their individuality and become part of an emergent megastructure, [12] a megastructure that Bratton names "The Stack". This Stack is not composed only of devices and the cable, antennae, and satellites that connect them; it also comprises, among others, the raw minerals extracted to create components; the rivers, winds, fissile materials, and other sources of energy for its functioning; the new geographical landscapes it produces, as well as the urban ones; the new political formations and sovereignty claims it enables; the semiotic, symbolic, and hermeneutic configurations that institute; and the final users (of both kinds, humans and non-humans) that engage with them and, at the same time, feed it with data for its algorithmic governance.

The Stack operates at a planetary scale but does not institute a geography but a topology; it is composed of superimposed and interconnected layers. Those layers are, from the phenomenological to the geochemical:

> At the top of any column, a *User* (animal, vegetable, or mineral) would occupy its own unique position and from there activate an *Interface* to manipulate things with particular *Addresses*, which are embedded in the land, sea, and air of urban surfaces on the *City* layer, all of which can process, store, and deliver data according to the computational capacity and legal dictates of a *Cloud* platform, which itself drinks from the *Earth* layer's energy reserves drawn into its data centers. Paths between layers are sutured by specific protocols for sending and receiving information to each other, up and down, that do the work of translating between unlike technologies gathered at each plateau (Bratton, 2016, 67–68).

The interdependency of all the devices in contemporary planetary computing takes us from multiple ensembles in a network-based milieu to one huge individual that involves more than just apparatuses, protocols, and interfaces. Humans are, as much as rocks and data centers, also part (at least, partially) of this huge megastructural individual; they are individuated by it and, at the same time, contribute to its individuation. Humans as part of the user layer have some degree of agency, but two things have to be pointed out. First, humans are not the only thing in the user layer; a traceable cow, an ore extracted and processed by an automated mining system, a crop field supervised by semi-automatic means, a submarine beacon, all these things are generating inputs that make The Stack work, and some are also receiving outputs that instruct or suggest how to behave.

[12] Bratton writes "accidental megastructure", but I prefer to use "emergent," which still recognizes the non-volitional nature that Bratton attributes to change, but I place emphasis on it as ontogenetic.

Secondly, humans, like any other element of the *User* layer, have significantly less agency and awareness of their involvement than is commonly thought. This is not only due to the growing number of decisions made by automated systems in other layers, but also because human users generate inputs and receive outputs that they are unaware of and cannot control.

On the other extreme of The Stack, at the *Earth* layer, this emergent megastructure is draining the planet of its resources in order to expand and maintain its functioning. It depends on the wind, solar, tidal, nuclear, biochemical, geothermal, and fossil power to function, on the lithium, silicon, and rare-earth materials to incorporate new components, on water, air, and ice to cool the processors, and, at the same time, it generates tons of greenhouse gases, electronic waste, and metallic dust that poison the air, the soil, and the water streams. As stated by Jussi Parikka (2015), contemporary media are a core part of the Anthropocene and are rooted in the long stories of colonialism, extractivist capitalism, environmental devastation, and workforce exploitation.

Just as, following McLuhan (2003), the wheel and the printing press played significant roles in the consolidation of urban centers and nation-states respectively, this emergent megastructure of planetary computation shapes a new scale and form for human associations. It introduces a new regime of superimposed sovereignty claims, leading to new geopolitical dynamics (Bratton, 2016). New actors arise and dispute with nation-states, as evidenced by the conflict between China and Google and, more recently, between ByteDance and the United States. This shift also changes the socio-political role and agency of individuals, who are still citizens but also platform clients and sources of raw data to be harvested. It weakens the social bond within nations while simultaneously strengthening transnational communities based on commonalities other than nationality, thereby challenging some of the main foundations upon which modern philosophical anthropology was built.

Rethinking media ecology

Changes in media over the last decades compel media scholars to revise their understanding of media. With the emergence of planetary-scale computation, highly interconnected to the extent of forming a single megastructure, and where human agency is diluted amidst algorithms, data crawlers, ubiquitous computing, and myriad other non-human agencies, contemporary media ecology must move beyond classical approaches and embrace this new complexity. Studies across various media-related fields, from internet culture and sociality to media semiotics and hermeneutics, should expand their understanding of contemporary networked culture. This involves addressing new logics of locality and identity, superimposed jurisdictions of diverse kinds, the continually evolving order of legitimacies, and the involvement of various non-human agencies in the contemporary world.

Moreover, posthumanism provides a framework to rethink media ecology, acknowledging the interweaving of technology, culture, humans and non-human living beings, minerals, and extraplanetary objects. This framework helps comprehend the changes introduced at every scale by planetary computation and move beyond the modern humanism entrenched in traditional media ecology. It encourages the study of humans as non-essential beings in complex processes of transindividuation, and the assessment of instances of non-human agency, along with the often-unconscious interactions humans engage in with all kinds of computers daily.

Some of these changes have been explored by influential authors in the accelerationist movement, such as Nick Srnicek (2017) in his study on platform capitalism and Tiziana Terranova (2014) in her

techno-autonomist call to action. Grounded in Benjamin Bratton's ideas about The Stack, Srnicek and Terranova analyze global connectivity and interdependence in contemporary societies through a planetary computation complex, emphasizing the central role of algorithms and automation. This new media ecology offers a more comprehensive understanding of our social, political, and economic realities compared to traditional analyses based solely on institutions or local movements.

This evolving approach to media ecology contributes to understanding our sociality, which is increasingly intertwined with the multiple layers of The Stack. Algorithms shape our social interactions and how we inform ourselves about social and political events, the gig economy introduces platformization into everyday life, cloud computing disperses our digital assets across data centers around the world instead of local hard drives, and as-a-service models redefine access and ownership dynamics. The planetary media ecology may contribute to understanding the overlapping of these problems, while the posthuman view could deconstruct their common root in the modern paradigm of centralization and control on which systems analysis and design are based, and adopt an approach that acknowledges the collective ontogenesis of users and their milieus.

A posthumanist media ecology also prompts engagement with the Anthropocene and critiques colonial and capitalist extractivism. Building on Siegfried Zielinski's (2008) concept of deep time of media, Jussi Parikka (2015) suggests studying media in a geological manner, focusing on raw materials, energy generation, and global change as integral aspects of contemporary media practices. Thus, this media ecology is not just a metaphorical concept but a proper ecological study.

The emergence of media ecology in the 1960s introduced a fruitful approach to media studies, expanding its scope and fostering new methodologies and research fields. However, traditional media ecology retained core principles of modern humanist rationalism, such as the centrality of humans, their separation from context, and a transmissional view of media. A posthumanist approach to media studies can preserve the valuable contributions of media ecology while simultaneously overcoming this anthropocentrism and addressing more effectively the radical changes in communication technologies that have occurred in recent decades

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