

Sensing the ‘Contemporary Condition’: Chronopolitics of Sensor-Media

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Abstract

Ubiquitous and pervasive micro-technologies of sensing have become one of the dominant yet vastly under-researched media of knowledge production. This article discusses the relevance of conceptualizing sensor-technologies *as* media. Beyond their technical affordances sensor-media act as agents of implementing and activating a more-than-human sensorium within contemporary technoecological assemblages. They actively participate in a comprehensive re-articulation and problematization of what it means ‘to sense’ under current technological conditions. Media-saturated responsive environments operate on their own terms and, for the larger part, on a micro-temporal scale that remains inaccessible to human sense perception. The aim of the article is to delineate the onto-epistemological challenges posed by sensor-media under conditions of intensified global computation, technological interconnectedness, and the ontogenesis of technoecological milieus, their respective temporalities and (an)aesthetics of experienced time.

Keywords

Sensor-media, Technoecologies of sensation, Media environments, Environmental media, Chronopolitics, More-than-human sensing.

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An ecology properly understood can be nothing other than a technology.

(Jean-Luc Nancy, *The Sense of the World*, 41)

Making Sense of Sensors

‘Sensors determine our situation’. What might be construed as a reappropriating reprise of Friedrich Kittler’s provocative opening statement about ‘media’ in the preface to his now classic “Gramophone, Film, Typewriter” (1999; the original book was published in German in 1986), as a matter of fact entails at least two imperatives: First of all, as Kittler decreed in terms of media, any ‘situation’ determined by sensors “in spite or because of it – deserves a description” (Kittler 1999, xxxix). Secondly, this necessary description of the ‘situation’ ought to delineate the point that the explosive increase and expansion of sensing operations and monitoring technologies are more than just another twist in the history of follies of an overly simplistic “technological solutionism” (Morozov 2013).

Rather, this paper will argue, ubiquitous and pervasive micro-technologies of sensing have – subtly but forcefully – become one of the dominant yet vastly under-researched contemporary media of knowledge production. They actively participate in a comprehensive re-articulation and problematization of what it means ‘to sense’ under current technological conditions. As integral parts of an encompassing machinic register of more-than-human perception, sensors urge us to reconsider notions of technological sensing operations and their relation to the human sensorium. Media-saturated responsive environments are created, maintained, and expanded with the aim of complementing the human sensorium in terms of scope and scale.

The extensive equipment of environments with sensors that extract, store, and process data within large-scale networks of information exchange renders such environments increasingly responsive. An intensified entanglement of – seemingly ‘natural’ – environments with and through networked sensing technologies is reflected in an increased academic interest in en-

environmentality and corresponding (media) ecologies. The quality of air and water is not visible to the naked eye, nor are migratory movements of animals around the planet, or biochemical processes of signal transmission between plants. Climate and environmental change are processes too slow to grasp for human perception, yet minimal changes of state can be decisive for environmental processes no matter how detached from any human-scale sensorium they occur. In order to make such processes perceptible – and subsequently manageable – they have to be translated first into data, then processed, cleaned, and structured to make them intelligible as information.

Mediated environments, from this point of view, can no longer be effectually theorized as passive circumjacent spaces in and upon which sensing operations are conducted. In fact, it will be argued, the current environmental situation necessitates opening up an interdisciplinary discussion on the techno-ecological, onto-epistemological, and political implications of intermeshed processes of media becoming environmental and environments becoming media.

In order to instigate such discussion, this article suggests, it is necessary to, first of all, provide a basis for understanding sensors *as* media without falling back into obsolete anthropocentric formations of media theory that follow a logic of tool-based extensions of man (*sensu* McLuhan). Secondly, processes of transduction and translation between technology, environments, data, and human subjects need to be considered regarding their constitutive part in the ongoing technological transformation of the “technoecologies of sensation” (Parisi 2009). It is these technoecologies of sensing operations that sensors at the same time stem from and are constitutive of. Such a perspective on sensors *as* media brings to light (part of) the hidden infrastructures contemporary technoecologies are built on, as well as to the ways in which the latter motivate the development of ever more sensor-media. From this point of view, one of the main onto-epistemological challenges of sensor-cultures becomes virulent, namely the complex temporal relations of media that operate on microtemporal scales in order to locally detect traces of planetary, slow environmental, violence (Nixon 2013) without necessarily taking into account given limitations of the human scale of temporal perception. This temporal and perceptive paradox, lastly, motivates the endeavor to understand the com-

plex chronopolitics of sensor-media which informs ‘the contemporary condition’ and to develop concepts of a mutual becoming of media and environment.

It is a tentative and provisional attempt to realize some of the non-sensual aspects inherent in sensing operations by turning to the temporal relations that define the ‘contemporary condition’ – or what Kittler has dubbed “our situation”. In short, the aim of this article is to delineate (some of) the onto-epistemological challenges posed by sensor-media under conditions of intensified global computation, technological interconnectedness, and the ontogenesis of technoecological milieus, their respective temporalities and concomitant (an)aesthetics of experienced time.

Machine Sensation: Running ‘the Stack’

To refer to sensors as ‘media’ beyond a conventional, demotic, and instrumental use of the term is neither self-evident nor trivial. At the same time, entanglements of sensors with environments and subjectivities emerge within world-spanning infrastructures of connectivity that enable production and extraction in both economic and elemental respects. Due to computation and miniaturization, low-cost production, as well as material and functional differentiation, the versatility of sensor-use has seen a massive boost. As a consequence, sensors by now – whether consciously noticed or not – pervade almost all areas of life. Sensor technology as a defining cross-sectional technology has become relevant for almost all fields of (basic and applied) research, industrial production, consumer cultures – in other words: it is indispensable for an economy that heavily relies on “data as raw material” (Srnicek 2017, 56): “Just like oil, data are a material to be extracted, refined, and used in a variety of ways” (40). However, Srnicek rightfully cautions, it would be naïve to assume that data mining, cleaning, and processing “are frictionless or automated processes” (39) since “[a]s a recorded entity, any datum requires sensors to capture it and a massive storage system to maintain it” (ibid.).

Deviating from Srnicek’s focus on the economic models emerging in and with networked platform capitalism, this article will focus on the “technoecologies of sensation” (Parisi 2009) sensors stem from and at the same time are constitutive of. According to Parisi (and others), shifts and changes within machinic assemblages are inseparably tied to transformations of cognitive and affective capacities of a sensing body. This suggests that, through

current formations of interconnected technological sensing, new relations between human and nonhuman sensory milieus emerge in which media no longer function as mere tools of information transmission and instruments of communication (if they ever did). Rather, media have become part of a technoecological assemblage that includes and intertwines human sense-perception rather than extending the senses, as some strands of traditional media theory would have it.

Sensors are core elements of contemporary media ecologies and infrastructures. They register and process bodies and environments and, by that, produce new forms of knowledge, control, and manageability. Their ubiquitous operational areas span from space (e.g. satellite remote sensing on a planetary scale) via more earthly circumstances (e.g. environmental monitoring, agricultural production) and spatially restricted territories (e.g. social planning, transport, utilities, and re-organizing urban life in so-called ‘smart cities’), commodities and objects of daily use, to the most personal, even intimate, realms (e.g. self-tracking, self-quantification, and subsequent self-conduct). Unobtrusive, frequently networked and automated – despite their unimposing form of appearance, sensors certainly qualify as multifarious *agents* of knowledge production. It is therefore astonishing to note that sensors as *objects* of knowledge have only recently attracted academic attention (beyond technical and engineering matters) – and to quite a limited extent.

In previous decades authors such as philosopher of technology Lewis Mumford described *urban* environments as infrastructures of pipes, electric grids, and coordinated systems of communications – in Mumford’s view an imperceptible, hidden “city within the city that responds to stimuli and forces below the threshold of ordinary observation” (Mumford 1961, 563). In a similar vein, thirty-five years later Friedrich Kittler claims that “a network made up of intersecting networks dissects and connects the city – in particular its fringes, peripheries, and tangents” (Kittler 1996, 718). The city infrastructure for Kittler is a ‘medium’ insofar as it processes, records, and transmits information, regardless of “whether these networks transmit information (telephone, radio, television) or energy (water supply, electricity, highway), they all represent forms of information” (ibid.).

From this initial point of a general informatization and calculability on the level of cities as infrastructural environments, another step has recently been made toward a mode of compu-

tation that spans the entire globe in diffusing and dispersed networks of and for recording, transmitting and processing – a technoecological configuration that Benjamin Bratton has identified as the “Stack” (2016). Computationally interconnected in cybernetic feedback loops, sensors keep ‘the stack’ running, they “form a cloud of machine sensation, each listening or looking or feeling or smelling something about the world or about the *Users* in the world, or both at once” (Bratton 2015, 340; italics original). Users, then, are both subjects and objects of sensing activities in what Bratton defines as “a new architecture of algorithmic governance” (337) through and in which “entire interfacial regimes cohere not just into functional reductions of complex chains of interaction, but also into total images [...] of the world as a whole” (339). Bratton employs the conceptual figure of the ‘Stack’ – “both and idea and a thing” (5) – in order to map the contemporary political geography, and to capture the general logic and emerging rationalities of algorithmic governance. According to Bratton’s account of the different scales and scopes of global computation, exploring their interweavement will allow for a speculative program for “how we might build, dwell within, communicate between, and govern our worlds” (4).

The layered configuration of a hardware/software/network ‘stack’ integrates and arranges “different technologies vertically within a modular, interdependent order” (ibid.). In other words: “These technologies align, layer by layer, into something like a vast, if also incomplete, pervasive if also irregular, software and hardware *Stack*” (5; italics original). The definition Bratton ultimately provides has been eagerly appropriated by academic and artistic discourse: “The Stack is an accidental megastructure, one that we are building both deliberately and unwittingly and is in turn building us in its own image.” (ibid.) As useful as this global and comprehensive image of an “accidental megastructure” might be, in its totalizing tendency it necessarily has to omit closer inspection of operative elements within this multi-layered configuration of the material and the discursive, the numeric and the symbolic – their becoming, their ‘objecthood’ and processuality, their materialities and genealogies, in short: the material-discursive agencies within contemporary “technoecologies of sensation” (cf. Parisi 2009). Nevertheless, the technology - or rather media - dependent form of the “perception of a totality” opens up to devising a novel “synthetic ontology” (Bratton 2015, 339) defined by a multiplicity of entangled totalities which can hardly be grasped in terms of inher-

ited notions of what media ‘are’ and ‘do’: e.g. media differentiated along the lines of their material appearance, designated use for definable purposes, or determinable sensual relation to a (group of) user subject(s).

Consider the Sensor

As the articulated joints that link different zones of action and spawn the stack, sensor technologies have become one of the dominant forms of knowledge production, indispensable not only when it comes to what has been called ‘making objects smart’, but also regarding environmental research and environmentalist intervention and citizen initiatives. Now a key technology in this respect, sensors help to create, shape, and sustain media ecologies and thus underpin contemporary cultural and technological formations. Sensors come in an abundance of shapes, sizes, and material manifestations, from satellite systems and large-scale WSN’s (Wireless Sensors Networks; cf. Nanda/Singh 2016) to nano-scale ‘smart dust’ sensors (cf. Bishop 2015); they populate space as well as the most mundane electronic devices, ‘smart homes’ and cities – but any ‘dumb home or city’ as well –, industrial and other production sites, modern weaponry, scientific laboratories, but also environments such as agricultural areas, woods, water systems. They can be attached to animals or other companion species to study behavior and migratory activities with the promise of non-invasively observing at a distance¹.

Some technical specifications, albeit not sufficient to grasp their complexity and implications, are due: The sensor itself is a module, a technical component or subsystem that basically and essentially detects any event of change in the environment it is part of. Its form of appearance, technical construction, and intended purpose, however, is far too diverse to further confine its functionality beyond this most basic characteristic. Sensors have been used in everyday objects long before any fantasies or actualization of the so-called ‘Internet of Things’ had been in place. Thermostat-controlled heating, dimmable lamps, touch-sensitive buttons in household appliances, are uses of sensors most users hardly ever consciously notice – unless any malfunction occurs. Applications in manufacturing and robotics, traffic and mobility, medicine, scientific research practice, in the military, as well as in the entertainment complex, are legion. The development of minute microsensors has further expanded the realm of uses, the measurable timescale and level of sensitivity, while at the same time pro-

duction costs have been lowered to an extent that even disposable sensors – cheap, easy to handle, designed for short-term use – are available on a mass scale. Not unlike other forms of technological innovation throughout media history, the development of miniaturized, portable, useable low-cost sensors discursively seems to trigger hopes of democratization, participation, and empowerment regarding the access to knowledge, as it “enables mining of critical analytical information by anyone, anywhere and at any time, without worrying about contamination and recalibration” (Dincer/Bruch et al. 2019, 1).

In order to process detected changes of state a sensor is usually used in combination with other electronic components necessary, for instance, to convert an analogue signal into a digital one within a material assemblage of processing and transmission. What is referred to as the ‘resolution’ of a sensor, i.e. the smallest change a sensor can detect within its environment, therefore not only depends on the sensitivity (signal-to-noise ratio) of the sensing element itself, but is limited by the possibilities of the (digital) output it is connected to. Next to monitoring physical properties of an environment such as light, motion, gravity, humidity temperature, magnetic or electrical fields, to name but a few of the most basic fields of operation, optical bio- and electrochemical sensors can be applied to detect organic, inorganic, or biological contamination of air, water and soil. An emerging method within this scope of environmental application to detect pollution “is to use microbes themselves as disposable sensors which can both recognize toxins and transduce their presence into measurable signals” (Dincer/Bruch et al. 2019, 22), hence expanding the scope of the potentially ‘sensible’ beyond the technological into the more-than-human realm of bioengineering and ‘biosensing’.

The ‘actuator’ is an element of the machinic ensemble that responds to a (often electric, sometimes also hydraulic or pneumatic or other) signal from a control system by transducing it into motion, i.e. any mode of required action the sensor signal indicates within the sensor environment is executed through an actuator: “Sensors are small and static devices with limited power, computation, and communication capabilities responsible for observing the physical world. On the other hand, actuators are equipped with richer resources, able to move and perform appropriate actions.” (Ngai et al. 2006,1). Only if sensor and actuator are coupled and efficiently cooperating does the system perform what is commonly understood as sens-

ing action, i.e. “[w]hile sensors perform sensing, actuators make decisions and react to the environment with the right actions” (ibid.). Thereby the sensor-system’s genuine problems of ‘timing’ become apparent, as one of the main tasks for developers and engineers is to deal with the question of how to minimize transmission delays between sensor and actuator which requires experimentation with “different network architectures, frameworks and algorithms” in order to “achieve delay estimation, data priority, reliable routing, energy efficient clustering, real-time communication and latency” (Vikram et al. 2015, 19). Put simply, the actuator is part of a process of transducing energy, i.e. converting one form of energy into a different one, be it the transduction from electric signals to other forms of energy or vice versa. Conversion between physical signals and electrical signals obviously has always been the basic principle of technical media (be it the use of electromagnetic waves in telegraphy, transmitting and receiving radio signals, or processing and sequential transmission in computers). In technical terms, a sensor can, most basically, be described as a transducer that responds to external stimuli and that produces a signal that can be processed as information representing a change of state within the system. Environmental sensor-media detect changes of state and location, monitor measurable aspects of environments, and produce large amounts of data which, ultimately and ideally, by database-registration and comparison, allow for specific responses to measured conditions. Yet, it is by no means self-explanatory to address them as ‘media’.

The Becoming of ‘Sensor-Media’

Significantly, in their comprehensive introduction to the so-called “Internet of Things”, Mercedes Bunz and Graham Meikle (Bunz/Meikle 2018) start from the assumption that ‘things’ have become media since ‘things’ now are “able both to generate and communicate information” (9) and any given object or device “can now be linked to digital communication networks – your phone, your watch, your car, yes, but also beehives and basketballs, razors and rocks, stoves and sex toys” (ibid.). The equipment with sensors, the network connectivity, and access to data turn things into media, according to their account, because: “Once networked, things have become able to record and process, to store and circulate information” (10). It is for this communicative reason that sensors which “detect and record change, and circulate information and messages” (11) can be addressed as ‘media of communication’.

While it is evident that once connected and able to communicate the status of objects fundamentally changes, the focus on the communicative function of sending, receiving, and meaning-making, may be (deliberately and for the sake of their argument) chosen too narrowly to explain the process of becoming-media in a full, emphatic sense. Some supplementary remarks might be expedient to support the aforementioned idea of a mutual becoming of media and environments.

As noted above, the idea of a preformed, passive environment that is awaiting the deployment of a sensor to have its features detected will not do justice to the dynamics and complexities of establishing environmental relations ‘with and through technologies’. Conversely, the notion of ‘media’ is not an unproblematic one either.

Technical objects inserted into environments do not necessarily turn into media immediately if one takes into account that, as media philosopher Joseph Vogl has argued, the concept of media “cannot be adequately explained by reference to the material bases or the forms of communication, to symbolic systems or to distribution techniques.” (Vogl 2007, 15) What media are and what they do, their role and function as cultural technologies, hence, cannot be reduced to a simplistic definition. This shift of perspective rejects any essentialist, a-historical or merely instrumental definition of media in favor of perpetual renegotiation of what can ‘become media’ – under which conditions and to what cultural effects: “Media theory might thus axiomatically claim that no such thing as a medium exists, at least not in a stable generic, disciplinary, substantial, or historical sense.” (15) ‘Becoming media’ thus remains ambiguous, non-predetermined, and multi-causal. In each case of becoming a “transformation of apparatuses, symbolic orders, or institutions comes about through a specific assemblage of diverse conditions, factors, and elements” (23).

Therefore, I would like to suggest, in the mutual process of ‘becoming environmental of media’ and ‘becoming media of environments’ one cannot restrain theorization by exclusively focusing on communications or devices. It seems more promising to widen the conceptual scope to include events of becoming media, i.e. to the specific constellations in which heterogeneous elements, technical objects, infrastructures, symbolic systems, practices, and certain forms of knowledge concur and concreate.

It, then, becomes apparent that what applies to media or media-functions applies to sensor-systems as well: like all media they “make things readable, audible, visible, perceptible, but in doing so they also have a tendency to erase themselves and their constitutive sensory function, making themselves imperceptible and ‘anesthetic’” (16).

An approach such as Vogl’s discards strands of media theory that refer to media as an anthropocentric, intentional, and instrumental ‘extension of the senses’. While the specific configuration of a global ‘stack’, the mutual becoming of media and environments, and the temporal paradox of the ‘contemporary condition’, may be different from previous constellations, at least one underlying characteristic of the ‘media-function’ persists: like the early seventeenth-century telescope Vogl discusses, the sensor is “not just an extension of the senses nor an auxiliary device to improve or correct the senses” (17). It rather “creates the senses anew: it defines the meaning of vision and sensory perception, turning any and all visible facts into constructed and calculated data” (ibid.).

Implications of ‘creating the senses anew’ in the case of sensor-media are beginning to show most evidently when the temporal condition is taken into account. Such implications – by no means exclusively, but nevertheless to a great extent – pertain to questions of temporality and entanglement that deserve particular attention in order to conceptualize sensing technologies and practices as more than merely functional technical units which simply detect given external stimuli, and process and transpose them into manageable data content. The ways media co-produce environments, infrastructures, modes of circulation and distribution, as well as various and diversified human/nonhuman-relations, hint at the pre-eminent political dimension and epistemological challenge of what I refer to as the ‘chronopolitics of sensor-media’.

The Contemporary Condition: Media Environments and Environmental Media

Sensors matter not only in terms of their materiality, connectivity, and functionality, but just as urgently call for a reconsideration of the convoluted temporal relations they bring about. It has therefore been essential that researchers have started to re-consider the ‘so-called nature’, i.e. “the environment as conditioned by the technological condition, as well as itself conditioning the existence of technology by becoming resource for advanced technological

culture” (Parikka 2016a, 197). New materialist, and particularly media archaeological, research over the last years has multiplied notions of materiality (cf. Goddard 2015; Cubitt 2017), redefined the relation of materialities to ontology and temporality, as well as “successfully expanded the definition of media beyond mass media to practices of technology that both condition formations of knowledge and serve as historical ontology for current investigation” (Parikka, 2016a, 201). Considering the “the material continuum between the environment and technology” (203), Jussi Parikka, for example, has on various occasions broadened the agenda of what counts as media object and operation in media studies - and even further “toward the nonmediatic basis of technical media: from minerals to scientific development of synthetic materials, and to the afterlife of media technological waste” (204). What is found there are alternative materialities and temporalities of media.

Jennifer Gabrys, in her pioneering work on sensors, has insightfully analyzed cases of environmental sensing and the ways in which sensors in wildlife, sensors for air and water pollution, and urban sensing practices (including subversive or empowering counter-practices), are being implemented and put to use. These not only produce knowledge about the environment but actively contribute to creating the sensor-saturated environments which allow for what Gabrys calls the “programmability of planet earth” (Gabrys 2016). Located in specific infrastructures and environments, sensors operate in a way, and with an intensity, which paves the way to a (media) ecology that approaches entities “not as detached objects for our subjective sensing and contemplation, but rather as *processes* in and through which experience, environments, and subjects individuate, relate, and gain consistency” (9; emphasis by author).

The aesthetic, epistemological, or media epistemological issues brought up by the implementation of sensors on a large, planetary scale, as well as the intimate, private, local micro-scale that constitutes what could playfully and tentatively be called ‘contemporary sensor-media culture’, still need to be mapped out. More attention ought to be directed to the sensor as a more-than-technical entity that keeps current modes of algorithmic culture, knowledge production, and global connectivity afloat, which informs and formats perception and experience while itself remaining vastly imperceptible for the larger part. Expanding existing critical frameworks by paying closer attention to the entanglement of all components within the

constellation at hand, calls for analyses of the temporal, or rather: processual material-discursive logic of the sensor and its surrounding assemblages.

It is against this backdrop that sensor-media can be seen as part of, and at the same time a gateway into, recent conceptual debates symptomatic of an academic and artistic interest in not only specifically “Program Earth”, but the planetary condition in a broader sense (cf. Elias/Moraru 2015). This general interest is accompanied by renewed attention to the different aspects and conceptions of time (cf. Burges/Elias 2016; Avanesian 2018; Avanesian/Malik 2016) or meditations on an alleged disappearance of time by means of a unification of all temporalities in an “absolute present” (cf. Quent 2016). Technological and temporal aspects thus forgather in reflections on ‘the contemporary condition’. This strand of thinking is exemplified by a series of essays published by Sternberg Press since 2016, assembled under that same denominator. The essays serve as a starting point for inquiries regarding the constitution of “the *present* present or the *contemporary* contemporary” (9; emphasis original). Contemporaneity, the preface suggests, “refers to the temporal complexity that follows from the coming together in the same cultural space of heterogeneous clusters generated along different historical trajectories, across different scales, and in different localities.” (ibid.).

Sensors as media technologies may originate from the desire to manage and technically control the aforementioned heterogeneities across different scales, and in different localities. However, and at the same time, sensors themselves originate entangled and complex temporal constellations which pose momentous onto-epistemological, political, and aesthetic challenges. ‘The contemporary’, thence, is not predominantly a category of historical periodization, it rather constitutes modes of temporal experience which engage human sense perception in a fundamentally more-than-human configuration. Relation to time is always “constituted or ‘mediated’ by the technical means through which it is apprehended”, the authors assert, consequently “our conception of contemporaneity builds upon an understanding of media not merely as a means of communication and as narrowly technical entities, but also as environments within which forms of life are developed” (27).

The ‘becoming-media’ of environments and simultaneous ‘becoming-environmental’ of media increase the intricacy of said condition when for example sensor-media are used in moni-

toring the “slow violence” of environmental change (Nixon 2013), i.e. “a violence that occurs gradually and out of sight, a violence of delayed destruction that is dispersed across time and space [...] a violence that is neither spectacular nor instantaneous, but rather incremental and accretive, its calamitous repercussions playing out across a range of temporal scales” (Nixon 2013, 2).

Computational sensing networks are a prime example of a conjunction of mutual becoming at which environments (not necessarily ‘natural’ environments) spawn the development and distribution of sensor technologies while, at the same time, the implementation of sensors generate and condition new environments in distinct but profoundly entangled ways that propel nature-cultural ecological thought: “The becoming environmental of computation then signals that environments are not fixed backdrops for the implementation of sensor devices, but rather are involved in processes of becoming along with these technologies” (Gabrys 2016, 9). Neither passive nor pre-existing, environment “develops with and through sensor technologies as they take hold and concreate in these contexts” (ibid.). Notably, Gabrys borrows Alfred North Whitehead’s notion of ‘concreation’ to bring forward the argument that mutual becoming is more than an accretion or “a simple adding together of preformed subjects and objects into an assemblage, but rather articulates the very processes by which entities are parsed, are able to conjoin (or not), and persist in environments” (10). It therefore involves the production of relations as much as of entities and environments.

The emergence of environments and environmental relations “with and through these technologies” (ibid.) substantiates two distinct yet interrelated claims: first of all, that environments cannot be understood as passive material spaces ‘waiting for’ and subjected to a sensing operation – no matter whether human or more-than-human. Secondly, and as importantly, the repudiation of a notion of sensing operations “as merely detecting preformed environmental data as though there is a world of substantialist phenomena to be processed by a cognitive device” (ibid.).

Sensors, thus, “harness energies and materials, transforming their own configurations and the environments they would tap into” (13). They figure as “exchangers between earthly processes, modified electric cosmos, human and nonhuman individuals” (ibid.). Sensors and their environments thus are emerging, co-evolving agents within ever-transforming material

contexts, including, as Nicole Starosielski argues in her impressive study of undersea cable networks, “not only cultural practices and political formations but also atmospheric, thermodynamic, geological, and biological processes” (Starosielski 2015, 14). Starosielski convincingly argues that any “creation of a stable circuit of transmission (more than simply the exchange of a single message) is always an environmental process” (21) within complex and multidirectional circulatory practices. . The unstable ‘fluid environments’ emerging from these practices, then, enable ‘turbulent ecologies’ that cannot be limited to environmentalist issues (as if those existed outside of other contexts) but must be critically extended to encompass ecologies “which consist of social practices, built architectures, and natural environments” (ibid.) – or rather ‘medianatural environments’.

The reliance on sensor-generated data and the material-discursive processes necessary for making data extractable, legible, and usable for all sorts of interventions (be it as decision-making tools, in order to legitimate political initiatives, or even with the aim of in-forming strategic long-term planning for the future of the planet), can thus be understood as part of a larger gradual and reciprocal development within the so-called ‘techno-sphere’: a shift in which environments become more and more mediated whilst media tend to become strongly environmental. Increasingly, visible and invisible entanglements of extraction economies and respective technologies with media of knowledge production and circulation have incited reconceptualizations of ‘emergent naturecultures’ (cf. Haraway 2003) as well as ‘medianatures’ (cf. Parikka 2011) which aim to acknowledge the constitutive role media have in processes of in-forming ecological rationalities. This diagnosis, one could add, obviously resonates with Gaston Bachelard’s famous allusion to the dynamic, conceptual, and historically changing order of nature as “the order we put into it [nature]with the technical means at our disposal” (Bachelard 1984, 108; originally published in 1934).

Chronopoetics of Media

What characterizes and complicates both planetary environmental, as well as intimate, personal technological sensing, is, I would like to argue, a seemingly unresolvable temporal paradox: Sensed changes of state that are transduced into transmittable currents have to submit to the temporal logic of a radical ‘presentness’, a persistent condition of being (spatio-temporally) present, and in the presence of an impregnable ‘always now’, time and time

again. Detecting, for instance, ecological damage and climate change which unfolds on an imperceptibly slow and large scale is carried out by deploying micro-temporal media technologies that measure actual states, comparing state A to state B to state C, and so on. Interpreting the cascade of successive states allows the detection of change, but in a mode of perception that radically evades human sense experience in several ways: Neither the local state itself nor the change from state to state, neither the process of translation (into currents, into data) nor that of transmitting, neither the micro-temporal measurement nor the hyperphenomenal global change, can be apprehended or sensualized except for ‘downstream’, secondary representations of the process. This fact does not render the latter obsolete, in fact, quite the contrary, it confers even greater strategic significance to representations of those “hyperobjects” (Morton 2013) that define ‘our contemporary condition’.

Having to delineate a condition that can only be understood through a *modus operandi* of continuous re-iterations of actual states captured by sensor-media, ephemeral, imperceptible, local, and always ‘now’ – ‘now’ – ‘now’ – and ‘now’ again in order to extrapolate models of ‘before and after’ that fuel narratives of reconstructable pasts and projections of possible futures (manageable, catastrophic or else), poses an exigent onto-epistemological challenge that we find ourselves confronted with.

In his post-phenomenological account of the “feed-forward loops” of “twenty-first-century media”, Mark B. Hansen characterizes the challenge as follows: “Human experience is currently undergoing a fundamental transformation caused by the complex entanglement of humans within networks of media technologies that operate predominantly, if not almost entirely, outside the scope of human modes of awareness (consciousness, attention, sense perception, etc.)” (Hansen 2015, 5). What Hansen calls ‘twenty-first-century media’ is not limited to any set of (digital) objects or processes, but rather refers to a specific tendency, namely, “the tendency for media to operate at microtemporal scales without any necessary – let alone any direct – connection to human sense perception” (37). Where nineteenth and twentieth-century recording media (like photography and cinema) at least strived for synchronization of media system and human sense perception, according to Hansen, “twenty-first-century media not only resist any form of direct synchronization but question the viability of a model of media premised on a simple and direct coupling of human and media system” (ibid.).

Former models of recording as inscriptions of physical traces are being replaced by a mode of recording that operates primarily subexperientially.

For Hansen, these “complexifications” introduced by networks that link machines with machines, humans with networked machines, and humans with humans in different ways and often in ‘real-time’, “nonetheless impact our sensory lives in significant ways” (38). Indeed they “directly shape the sensory continuum out of which perception and memory arise” (ibid.), albeit being constitutively “hybrid in their address” (ibid.).

As contemporary digital media no longer are mediating experience as content, what they actually mediate is “the technical condition of mediation itself” (43). Whatever becomes perceptible to human perception will always already have happened as a micro-scalar process. The temporalities of human perception and micro-scalar processes are disjoint and can only be synchronized later by adding another layer of mediation, in Hansen’s words: “their operability belongs to a different level of temporalization than any ensuing and retrospectively constructed perceptual interface” (ibid.). This primordial coexistence (peaceful or not) of different, disjunctive levels of temporalization not only signifies the aforementioned temporal paradox, but is one of the defining aspects of what has been referred to as the ‘contemporary condition’. Adding levels of temporalization to the micro-temporal, the human sensorium, and the supplementary layer of mediating aimed at merging both levels, the contemporary condition is decidedly multi-temporal. It “expands to a multitude of times that overlap and that cannot be resolved into one, simple designation such as ‘new’ or ‘old’” (Parikka 2016, 9). Sensing extremely slow environmental processes by use of micro-temporally operating sensor-media is utterly paradigmatic in this context of an asynchronous onto-epistemology of time.

The entanglement of sensor-media and environments, molded by micro-temporal or, more generally speaking, time-critical media technologies, is infused with their respective ‘proper tempor(e)alities’ or ‘Eigenzeit’ (Ernst 2016). According to Wolfgang Ernst technological media always ‘take place’ in the temporal dimension, operative as actualizations, regardless of whether they are understood through epistemological reflection or not: “The signal-technical discovery of time-critical processes *through* measuring media (like chronophotography) revealed for the first time a corresponding epistemological sensitization.” (Ernst

2016, 3). Time-critical processes *sensu* Ernst thus literally “determine the overall process and success of systems in electronics and informatics” (4). It is, according to Ernst, ‘technical intensification’ that has shifted ontological questions to the realm of the micro-temporal and transfigured the concept of time: “The trivial machine of the clock is reified time. In contrast, the world of electromagnetism, electronics, and computers introduced a way of processing time that developed its own temporal cosmos or chronosphere.” (9). Within this chronosphere, the acceleration of calculation technologies “culminate in this one message: the intensification of the temporal moment” (12).

Those intensified yet imperceptible temporal moments have to be retroactively synchronized (in yet another time-critical process) with the horizon of human perception in order to draw conclusions or build up narratives that deal with the hyperphenomenality of super-slow processes, like, for instance, climate change. Hence, in sensing procedures – as well as in other events of assembling data that feed into the ‘programmability of planet earth’ – the contemporary becomes detached from exclusively human time-scales even if, or rather, especially when it is directed at the current moment of ‘now’. The layering and merging of a multiplicity of data, due to the very condition of technologically extracting and processing them, inevitably involves at first a disjunction, then a layering and merging of temporalities. One can think of ‘the contemporary’, Jussi Parikka suggests, “as a way to open up the complex entanglement of the temporal determinations of what constitutes *the now* as a stretch between multiple time horizons” (2016, 10; *emphasis by author*).

Conclusion: towards an Ecology of Sensors

What has been argued up to this point allows us to describe the current period in time as the first to be ‘genuinely environmental’ in a broad sense. According to media philosopher Erich Hörl, due to an ongoing re-distribution of agency by environmental media technologies that range from sensorial to algorithmic environments, from bio- to nano- and geotechnologies, the current historical configuration “renders environmentality visible and prioritizes it like never before” (Hörl 2017, 9).

Acknowledging both the material and the cultural side of sensor-culture might be one way of defining ‘the contemporary’ not as a historical period within a linear historical narrative, but as constructed, multiple and temporally asymmetrical, as part of an emerging and expanding

techno-ecology. Consequently, and this constitutes the vanishing point of the paper at hand, the onto-epistemological question of understanding the ‘contemporary condition’ in terms of human entanglement in a more-than-human configuration may open radically new avenues for arriving at timely ecological rationalities –or to what has recently been called the radical “ecologization of thinking” (Hörl 2017). Conceptually and discursively, “the concept of ecology designated primarily the other side of technics and of mind, [...] has now begun to switch sides within the nature/technics divide, undoing the sutures that bound it to nature” (Hörl 2017, 2).

Sensors have become part of any media ecology, it has been argued. That is to say: Sensors *as* media have become environmental in the most literal sense of the notion. By means of concrescence of media, and environments-specific milieus, specific ‘medianatures’ are produced which are part of fluid ecologies of technological amplification and intensification. At the same time, sensory perception is diverted through technological assemblages that do not comply with any simplistic, naturalized or direct form of phenomenological apprehension. After the dichotomy of ‘nature’ and ‘culture’ has long been dissolved and conceptually transformed into concepts of material-discursive agency, diffractions and entanglement in ‘naturecultures’ (cf. Barad 2007), the concept of ‘ecology’ has only recently commenced undergoing conceptual reformulations that successively help to denaturalize it in favor of an “ecology without nature” (to appropriate Timothy Morton’s term, cf. 2009). It is a process of pluralizing and disseminating the concept of ecology towards versions of non-natural ecologies or technoecologies. That way, ‘ecology’ will be a key concept and a “signal of the non-modern deterritorialization of the relationship between technics and nature” (Hörl 2017, 2). Ecology, then, designates collaborative constellations of multiple human and nonhuman agents and might, hence, expedite a “radically relational onto-epistemological renewal” (3).

It therefore seems imperative to problematize the material and time-critical elements inherent in efforts of constantly, but necessarily punctually and momentarily, detecting and regulating imperceptibly slow ecological processes that unfold on a large scale, by deploying micro-technologies which locally measure momentary states and transmit them in the form of data in imperceptibly fast processes of electro-technical transmission. The imbalanced and asynchronous temporal dimensions involved in processes of ‘sensing slow violence’ vault the

very limited range of human sense-perception even though they initially have been plugged in to one another precisely with the aim of securing – or at least increasing the probability of – the human species’ survival on a severely damaged planet.

Consequently, the question at stake is *if* and *in what ways* human perception is joined up in circuit when, strictly technologically speaking, for the functioning of the contemporary system of gathering and processing data – for the ‘stack’ – there is no reason whatsoever to be considerate of this particular ‘wetware’-related time scale. Therefore, and maybe somewhat counter-intuitively given its ‘secondary role’, the ‘supplementary layer’ of retrospective mediation for human perception is of particular political importance. Even though expendable for the technical process of sensing itself, or any technical process of mediation for that matter, it will be crucial to make considerate aesthetic choices when it comes to comprehending, and critically reflecting upon, information acquired and processed through sensor-media.

An onto-epistemological ‘re-calibration’ of sensor-mediated re-iterations of measured states on the imperceptible level of micro-temporality, and the planetary scale of imperceptibly slow temporalities of environmental change, seems indispensable for any ethical, political, scientific, social, and economic negotiation regarding how to address now unmanageable pasts and uncertain potential futures (or the possible lack thereof).

As has been outlined, the ‘chronopolitics’ of the sensor have to be situated in an encompassing perspective of reflecting on the possibility of an alternative ‘general ecology of thinking’. Sensor-media which ceaselessly monitor, measure, collect, compare, and quantify are integral to contemporary ‘media ecologies’ and call for corresponding media onto-epistemologies to be developed. Such media onto-epistemologies may, ultimately, allow for rethinking our ways of addressing ‘the contemporary condition’. The merging and layering of data, the multiple materialities and temporalities, the entanglements of media and environments, medianatures and technoecologies, the complex more-than-human configurations touched upon in this article – all deserve increased attention not only from within media studies, but from a wide range of theoretical backgrounds and disciplines. Any program – academic, artistic, or activist – grappling with ‘the contemporary condition’ will necessarily have to be as complex, entangled, turbulent, confusing, and at times paradoxical as the cur-

rent situation itself. Making sense of sensor-media and their environments will be an essential part of this program.

Notes

1] The Icarus-Initiative (International Cooperation for Animal Research Using Space) associated with the Max-Planck-Gesellschaft, for instance, has developed a satellite-based system to observe animal migration, including small animals such as birds and bats which are equipped with lightweight mini-sensors. Obtained data is sent to a space-based receiver from where it gets distributed to receivers on earth. The project promises findings on a planetary scale that not only will aid species protection, but might “even help to predict ecological changes and natural disasters.” In an attempt to generate even more data and information beyond the mere position of an animal, the project reaches out to non-professional “citizen scientists” who may use the animal-tracking app developed for this purpose: “Anyone watching a transmitting animal in nature can report their observations and thus help provide a better understanding of the movement data of animals.” (cf. <https://www.icarus.mpg.de>).

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Biography

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