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Internet of things and automation of imaging: beyond representationalism

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Abstract

It is no doubt that the production of digital imagery invites for the major update of theoretical apparatus: what up until now was perceived solely or primarily as the stable representation of the world gives way to the image understood in terms of "the continuous actualization of networked data"[1] or "networked terminal".[2] In my article I would like to argue that analysis of this new visual environment should not be limited to the procedures of data processing. What also invites serious investigation is acknowledging the reliance of contemporary media ecology on wireless communication which according to Adrian Mackenzie functions as "prepositions ('at,' 'in,' 'with,' by', 'between,' 'near,' etc) in the grammar of contemporary media".[3] It seems especially important in the case of the imagery accompanying some instances of internet of things, where the considerable part of networked imagery is produced in a fully automated and machinic way, as illustrated with my main example, Air Quality Egg.[4] This crowdsourced air pollution monitoring platform consists of networked sensors transmitting signals and data which are then visualized as graphs and maps through the IoT service provider, Xively.

Such examples prompt the need for a major reconfiguration of the theory of digital image beyond the constraints of representationalism[5] and also beyond what has already been named "new aesthetic".[6] In my opinion focusing not so much on the ontology of digital imagery as on its ontogenesis plays a key role in such undertaking. In other words, the main point of interest shifts from image's being in the world to its becoming with and in the world. Hence I would like to propose the processual and relational concept of image as energy exchange, to some extent inspired the philosophy of Gilbert Simondon, yet with a strong posthumanist twist. Such metaphor allows for another step needed to transform how we think about production of digital imagery: shifting the focus from purely human intentionality to the machinic, hybrid and distributed agencies.

[1] R.Marie, I. Hoelzl, *Softimage. Towards a New Theory of the Digital Image*, Intellect, Bristol – Chicago 2015, loc. 146 (Kindle version)

[2] Ibid.

[3] A. Mackenzie, „Wirelessness as the Experience of Transition", „Fibreculture Journal" 13/2008, online: http://thirteen.fibreculturejournal.org/fcj-085-wirelessness-as-experience-of-transition/ Retrieved: December 10, 2015.
[4] http://airqualityegg.com/ Retrieved: December 10, 2015.
[5] The recent critique of representationalism stems from at least a few sources, including performative theory and posthumanism, por. S. Kember, J. Zylinska, *Life After New Media. Mediation as a Vital Process*, MIT Press, Cambridge – London 2012; Ch. Salter, *Entangled. Technology and the Transformation of Performance*, MIT Press, Cambridge – Londyn 2010. See also: N. Thrift, *Non-representational Theory. Space, Politics, Affect*, Routledge, London - New York 2008; B. Anderson, P. Harris, *The Promise of Non-Representationalist Theories* [w:] idem, ed., *Taking-Place: Non-Representational Theories and Geography*, Ashgate, Farnham – Burlington 2010.
[6] D. M. Berry, M. van Dartel, M. Dieter, M. Kasprzak, N. Muller, R. O'Reilly, J.L. De Vincente, *New Aesthetic, New Anxieties*, V2, Amsterdam 2012, http://v2.nl/publishing/new-aesthetic-new-anxieties Retrieved: November 29, 2015; J. Bridle, „#sxaesthetic", 15. 03. 2012, http://booktwo.org/notebook/sxaesthetic/ Retrieved: November 20, 2015; J. Bridle, http://new-aesthetic.tumblr.com/

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Since 2008, when the number of objects connected to the Internet exceeded the number of human Internet users,[1] the vision of an Internet of Things has taken on an increasingly realistic form. As technology becomes increasingly dispersed and connected to the environment, there is a clear departure from traditional concepts that were developed in reference to the world of individual computers immobilized on desktops and connected with wires into a network with relatively stable parameters. The fact that IoT is often based on procedures that entail the automatic exchange of data within sensor networks, where data is collected directly from the environment, means that it diverges significantly from earlier computing technology. Humans constitute just one of the elements in this complex techno-social community.[2] In my article I will argue for the need to re-examine existing frameworks of interpretation when it comes to the visual elements that accompany such data exchanges. Additionally, I would like to propose some ideas for possible innovations in this regard. I am particularly interested in automatically generated maps and visualizations of data provided by environmental sensors (my main example is Usman Haque's IoT platform and the networked Air Quality Egg sensors that evolved within it). Firstly, I want to argue that any interpretation that focuses exclusively or primarily on maps or interfaces, while separating those visual elements from the situation of their production, significantly distorts the contemporary media ecology and its complex relationship with physical and social reality, thereby falling prey to the trap of representationalism. Secondly, I want to propose a new concept and a new metaphor that will fit with more precise interpretations of such imagery. Based on

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[1] See Dave Evans, *The Internet of Things. How the Next Evolution of the Internet is Changing Everything*, Cisco White Papers (Cisco IBSG 2011), accessed March 17, 2016 http://www.cisco.com/c/dam/en_us/about/ac79/docs/innov/IoT_IBSG_0411FINAL.pdf ; Bernard Marr, "17 Internet of Things Facts Everyone Should Read," *Forbes*, October 17, 2015, accessed March 17, 2016 http://www.forbes.com/sites/bernardmarr/2015/10/27/17-mind-blowing-internet-of-things-facts-everyone-should-read/ - 52b4be11a7ab. A critical approach to the concept of the Internet of Things appears in van Kranenburg's report: Robert van Kranenburg, *The Internet of Things. A Critique of Ambient Technology and the All-seeing Network of RFID* (Amsterdam: Institute of Network Cultures, 2008).

[2] Mark Weiser, "The Computer for the 21st Century," *Scientific American* 3 (256) 1991, 3-11; Weiser, "The World Is Not a Desktop," *ACM Interactions* 1 (1) 1994, 7-8; Jennifer Gabrys, *Program Earth. Environmental Sensing Technology and the Making of a Computational Planet* (Minneapolis – London: University of Minnesota Press, 2016), Kindle edition.

ideas derived from Adrian Mackenzie and Gilbert Simondon, I offer the concept of the digital image connected to physical reality as a kind of preindividuated continuum that is seen as the nexus of the exchange of energy within such an environment. I aim to displace the familiar notion that the image has a purely representational value, i.e. that it is ontologically separate from reality and set as its counterpart.

A closer look at the conditions in which networked images are generated invites a re-examination of existing approaches to the theory of the image. I agree with Marie and Hoelzl, who emphasize that the image should currently be understood in terms of "the continuous actualization of networked data"[3] or "networked terminal."[4] Yet at the same time I want to argue that interpreting networked imagery in purely computational terms allows only a partial and distorted account of the nature of such imagery, failing to acknowledge its full environmental specificity. Such images are often generated by automated data exchanges, enabled by various modes of wireless communication. As Adrian Mackenzie argues,[5] this is itself a highly hybrid phenomenon, being a compound of digital and analogue signal processing. Human agency and individual authorship is questioned, replaced, and/or coopted within an environment composed of myriads of technical entities (including software) imbued with the capabilities of actants.[6] Additionally, the images generated within distributed sensor networks (comprising the important part of the Internet of Things) become directly related to physical reality—as will be shown in the case of Air Quality Egg. Hence there is a need for a theory of the digital image that will account for the procedures of data exchange, but at the same time recognize the importance of looking at the whole environment of image production (including wireless communication, which is the necessary condition of such exchanges yet rarely gets enough attention, as well as the social activity that often serves as the breeding ground of cybermapping and participatory mapping). This necessary shift in theorizing would involve a departure from the paradigm of representationalism that provides a framework for our current theory of culture that has been shaped in reference to traditional audiovisual media—film, television, and early forms of digital image.

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[3] Remi Marie, Ingrid Hoelzl, *Softimage. Towards a New Theory of the Digital Image* (Bristol – Chicago: Intellect, 2015), loc. 146 (Kindle version).

[4] Ibid.

[5] Adrian Mackenzie, *Wirelessness. Radical Empiricism in Network Cultures* (Cambridge – London: MIT Press, 2010).

[6] According to Bruno Latour, an actant is a human or non-human entity that has the ability to execute actions that produce effects and modify events. Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies* (Cambridge: Harvard University Press, 1999).

Representationalism and its discontents

As I understand it, the representationalist paradigm is a set of views and interpretative approaches based on the premise that the process of representation involves an ontological split between the image and the reality it refers to. This is accompanied by the fetishization of the visual/semiotic, equating it with the intelligible. This often results in treating images as a set of purely symbolic objects, isolated from the reality of their technosocial production. By setting the technical conditions of image production apart from cultural values and meanings, the conditions of production are entirely relegated to the margins or located outside of the process of meaning production, labelled as the "context." Representationalism also means thinking of images as static objects, whereas non-representational theories prefer to focus on the complex process of their emergence. Such assumptions form the basic tenets of those strands of cultural and visual studies that primarily focus on the socially and culturally constructed symbolic order. The relatively recent version of this approach is to be found within the field of visual studies signified by the classic propositions of Nicolas Mirzoeff and W.J.T. Mitchell,[7] despite the continued interest of visual studies in the theory of apparatus which offers the possibility for more materialist understanding of the image. For example, although Mirzoeff proposes the interesting idea of the "visual event," he still thinks of this in terms of "an effect of a network in which subjects operate and which in turn conditions their freedom of action."[8] The point is, such techno-human networks cannot be boiled down to just a discursive "effect." They work primarily on a material level and their operations are neither mechanical nor deterministic.

W.J.T. Mitchell is mostly interested in the phenomenology of the image, yet his theory tends to neglect to frame the media ecology (of which technical images are a part) in any specific way—it is particularly significant that his analysis usually addresses traditional media: photography, film, video and computer generated imagery, leaving digital networked images aside. When Mitchell distinguishes between "picture," "image," and "medium" on the one hand, and on the other discusses three kinds of "metapictures," his theorization continues to echo representationalist thinking. It is grounded in the idea of images ontologically split from reality. Such rapture translates into the division between

[7] William J.T. Mitchell, *What Do Pictures Want? Lives and Loves of the Images* (Chicago and London: University of Chicago Press, 2005).

[8] Nicolas Mirzoeff, "The Subject of Visual Culture" in *The Visual Culture Reader* ed. Mirzoeff (New York – London: Routledge, 2002) 6.

picture and image. Here, image is a kind of mental, "phantasmatic appearance"[9] without particular material support, whereas picture is always materialized, and translatable into different media (yet, again, little attention is paid to the media specificity of the process). Mitchell uses the concept of media to link both categories (picture and image), but he formulates it in a way that is too static. It is an entity that, following Luhmann, is situated on both sides of the system/environment division, reframed by Mitchell in different terms (faces and places on the one hand, places and spaces on the other). Although he proposes the idea of the agency of pictures (framed as a matter of their "desire"), he outlines this in a somewhat esoteric way, almost completely overlooking the technosocial conditions of their production. What's more, he models such agency in an anthropomorphic, subject-centered way. To some extent, even the recent "new aesthetic," formulated by James Bridle for the purpose of researching the very nature of networked images, bears representationalist traces. Performed mainly through the visual field, his analysis pays most attention to visual aspects (including interfaces), although he does emphasize the networked nature of the phenomena he researches, and often mentions infrastructural conditions.[10] Yet still on several occasions, Bridle does not pay enough attention to the conditions of production and circulation of the imagery he analyses.

In my critique of representationalism I follow Joanna Żylinska and Sarah Kember,[11] who propose to replace the notion of media with that of mediation, thereby emphasizing the processual and vital character of media representation. Also, it is important to note how, within representationalist approaches, the visual form is often seen as a single, discreet, separated phenomenon that is generated primarily within human culture, and whose "authors" are clearly indicated by a signature (their individual name or a brand name). The critique of representationalism comes from various sources, including human geography, performative theory, and posthumanism. For the purpose of my undertaking, I leave aside the well known philosophical critique of representationalism, as it approaches the matter from a different angle and presents a different set of problems.

Nigel Thrift produced one of the earliest critiques of representationalist approaches in the study of culture and social theory. Since at least the early 1990s,

[9] Mitchell, *What Do Pictures Want?*, 85.
[10] James Bridle, "#sxaesthetic," March 15, 2012, accessed September 12, 2015 http://booktwo.org/notebook/sxaesthetic/.
[11] Sarah Kember, Joanna Zylinska, *Life After New Media. Mediation as a Vital Process* (Cambridge – London: MIT Press, 2012).

he has been developing a non-representational theory[12] that is clearly meant to counteract approaches that focus almost entirely on representations of the various practices of everyday life. This is usually modelled as a set of frozen states where ongoing life processes, and their media counterparts, are separated by deep cuts. To Thrift, cultural studies based on such approaches privilege a subject-centered understanding of life processes. This is mostly limited to the symbolic content produced by conscious humans, with all affective, habitual, pre-cognitive, pre-individual, and non-human activity relegated to the margins or entirely forgotten. Non-representational theory is—according to Thrift—interested in the processuality of the phenomena being researched, also including the energy of transformation and the reality of ongoing change. In Thrift's formulation of his non-representational theory, importance is attached to performative aspects, and to things themselves, particularly "the energy of the sense-catching forms of things."[13] This is also why this theory proves valuable for my endeavor. Its basic tenet calls for a theory of the digital image that also comprises the general environment of its production, including the conditions of wireless communication as well as the dispersed nature of distributed sensor networks. In this way I am in agreement with ideas postulated by Ben Anderson and Paul Harrison, who see the endeavor of non-representational theory as locating "the making of meaning and signification in the manifold of actions and interactions rather than in a supplementary dimension such as discourse, ideology, or symbolic order."[14]

The re-examination I am proposing calls for different conceptualizations. Imaging in media networks is "nested" in reality since it is often generated by data collected directly from the environment. It also forms part of the stream, and is an element of a hybrid "ontological coalition"[15] that combines the physical and digital domains. This concept refers to the intertwining of the sphere of

[12] Nigel Thrift, *Spatial Formations* (London – Thousand Oaks – New Delhi: Sage, 1996); Thrift, *Knowing Capitalism* (London – New Delhi: Sage, 2005); Thrift, *Non-Representational Theory. Space, Politics, Affect* (London and New York: Routledge, 2008).

[13] Thrift, *Non-Representational Theory*, 9.

[14] Ben Anderson, Paul Harrison, "The Promise of Non-Representational Theories" in *Taking Place. Non-representational Theories and Geography*, eds. Anderson, Harrison (Surrey – Burlington: Ashgate, 2010), 2.

[15] Lambros Malafouris, *How Things Shape the Mind. A Theory of Material Engagement* (Cambridge: MIT Press, 2013), 5. See also a collection of works on agency and relations between humans and objects from a posthumanist and anthropological perspective, inspired by the ANT theory: *Material Agency. Towards a Non-Anthropocentric Approach*, eds. Carl Knappett, Lambros Malafouris (New York: Springer Science & Business Media, 2008).

representation with the physical world. The term "ontological coalition" indicates a mutual permeation of the physical, object domain with mental and imaginary phenomena, and the situation of distributed cognition. It highlights the complexity of the category of agency when it is perceived as a quality of the environment more than of the individual, and the problem of viewing cognition exclusively as an operation on symbols. The concept of "ontological coalition" emphasizes the embodiment of perception and the processing of data. So far, the physical and digital have often been perceived as disjunctive, contradictory domains. The images I am writing about—in the first place, networked cybermaps of the Internet of Things, the example of which is Pachube and its succeeding incarnations—are situated at the intersection of the two domains and are generated through automated procedures, often bypassing human actors. Also, they are images "on the edge," playing a somewhat functional role, and are not located at the center of the entire communication exchange (the postvisual Internet of Things, IoT, requires practically no complex graphic interfaces). Such an approach to images accompanying the Internet of Things complements the proposals of non-representationalist theories. However, I believe that apart from describing reality in computational and programming terms, these theories have yet another very important feature: they enable hybrid, transversal combinations of different ontological realms—material, discursive, and social.

The first basic conclusion is that networked media, and especially postdesktop computing technology (ubicomp), is a hybrid environment. This quality is a consequence of wireless connectivity, whose diverse forms are based on a range of protocols and technical parameters. This includes satellite communications, WiFi, 3G, LTE, RFID, Bluetooth, and other standards based on radio waves, which, in the case of ubicomp, determine the aforementioned, material-discursive "ontological coalitions." For this reason, focusing exclusively on "digitality" is insufficient. Another important assumption is that they are based on wireless connectivity, which lends this new environment a postmedia quality.[16]

[16] For me, the key quality of the postmedia condition lies not in the aesthetics of the digital metamedium, but in the ontological instability of the media basis; its networked nature, dispersion, and incoherence, which also imply different forms of socialization. Here, I am more inclined to follow the early reflections of Rosalind Krauss, and the proposals of Felix Guattari, rather than the overview of postmedia aesthetics offered by Lev Manovich, Andreas Broeckmann, or Peter Weibel. Work by the latter group is dominated by the digital domain, and features a thesis about the disappearance of the medium. By contrast, in my opinion, we are dealing with the problematization of the medium, rather than its disappearance. Cf. Rosalind Krauss, *A Voyage on Art in the Age of the North Sea. Post-Medium Condition* (New York: Thames & Hudson, 1999); Krauss, "Reinventing the Medium," *Critical Inquiry*, 25 (2) 1999, 289-305, and Felix Guattari, "Vers une ère post-média*"* (initially an unpublished article from October,

Here, I would like to refer to a project that originated in the field of artistic practice: the Pachube platform and its related device, called the Air Quality Egg. A forerunner of the Internet of Things, this platform is marked by civic and grassroots data exchanges. Its associated device provides small-scale air quality monitoring for individual users, visualized in the form of an automatically updated map on the Pachube platform (now, Xively). It is also an example of a citizen-sensing practice based on distributed networks of sensors.[17]

Mapping of communicating objects

Founded by the British artist Usman Haque in 2007, the Pachube platform provides an interesting insight not only into civic activities related to environmental protection, but also into ways of saturating everyday life with objects that have the capacity to communicate. Back then, it was not the only project utilizing communicating objects in environmental actions. In 2009, the MIT SENSEable City Lab launched Trash Track, a widely publicized project carried out in collaboration with the Architectural League of New York among others. With GPS-enabled tags attached to nearly 3,000 waste items, the project provided information on the journey of waste collected in New York and Seattle.[18] Apart from its research element, the project was also presented at several exhibitions, for example, as *Sentient City* at the Science Museum in London, and at Prix Ars Electronica 2009 in Linz. In 2014, environmental

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1990, published later in *Chimères* no. 28, 1996). Here I refer to Guattari, *Towards A Post-Media Era*, trans. A. Sebti, C. Apprich, in *Provocative Alloys: A Post-media Anthology*, eds. Clemens Apprich et al. (Lueneburg: Post-Media Lab & Mute Books, 2013), 26-8. See also, Lev Manovich, *Post-media Aesthetics*, 2001, accessed September 20, 2015 http://manovich.net/index.php/projects/post-media-aesthetics; Andreas Broeckmann, "Postmedia Discourses. A Working Paper", accessed September 21, 2015 http://www.mikro.in-berlin.de/wiki/tiki-index.php?page=Postmedia+Discourses; Peter Weibel, "Post-media Condition", *Mute*, March 19, 2012, accessed September 21, 2015 http://www.metamute.org/editorial/lab/post-media-condition.

[17] Gabrys, *Program Earth*. The author describes such networks as follows: "activities that use computational sensing technologies in the form of smartphones, as well as mobile and low-cost electronic devices such as Arduino and Raspberry Pi, and online platforms to monitor and potentially act on environmental events through the collection of environmental data." (loc. 546, Kindle edition).

[18] See the project's website: "Sentient City", http://senseable.mit.edu/trashtrack/index.php accessed September 20, 2015, and the Sentient City exhibition website: http://www.sentientcity.net/exhibit/ accessed September 20, 2015. See also, Mark Shepherd, *Sentient City. Ubiquitous Computing, Architecture and the Future of Urban Space* (Cambridge: MIT Press, 2011).

activists in St. Petersburg, Russia employed a similar concept: they dropped waterproofed GPS transmitters into home toilets. The signals from the devices confirmed their hypothesis that untreated waste was being dumped straight into the Neva River, eventually finding its way into the Baltic Sea.[19] The project involved a visualization in the form of a map that presented the route of the transmitters as they flowed with the wastewater. Termed "climate art"[20] by Roger Malina, many other artistic projects are worth mentioning here. These include Natalie Jeremijenko's *Feral Robotic Dogs* (2005), *AIR Project Preemptive Media* (2006), and a series of projects by Marko Peljhan: *Makro Lab* (1997–2007), and *Arctic Initiative Perspective* (2009, with Matthew Biederman).

Certain aspects of these projects that relate to hardware and its materiality are worth mentioning here. The Russian environmentalists' project is relatively recent, but the tools used were the result of adjusting available technology to the local context and the project's requirements. The activists had to modify Chinese-made GPS modules to ensure that they would initially sink, then later float to the surface to enable signal reception. So they enclosed the devices in containers along with a mixture of salt. The gradual evaporation of the salt would eventually bring the container to the surface. This apparently minor detail constitutes one of many arguments supporting an approach that sees automated images not as objects separated from reality by representation (understood as a drastic split), but as elements of an internally dynamic and hybrid environment, as some of the bonding agents in the construction of an "ontological coalition."

The idea of a platform that would constitute an open-source communication network for environmental sensors emerged in the form of the Pachube platform. As previously mentioned, it was conceived by Usman Haque, an architect and artist renowned for designing interactive environments like *Scents of Space* (2002), *Haunt* (2004–2005), and *Evolving Sonic Environment* (2005–2007). In July 2011, the service was bought by the company LogMeIn, and renamed Cosm. This was a slightly misleading name, since it could be confused with the open software and protocol solutions developed by a different company, Mithral Inc. Perhaps this is why, in May 2013, the service was renamed again. It became Xively.com,[21] a provider of subscription-based complex business

[19] Kevin Rothrock, "Activists Discover Evidence of St. Petersburg's Poop," *Global Voices*, November 17, 2014, accessed September 20, 2015, https://globalvoices.org/2014/11/17/russia-sewers-poop-river-petersburg-gps/.

[20] Roger Malina, *What is a Climate Artist?* in *Deep North. Transmediale parcours 2*, eds. Stephen Kovacs, Thomas Munz (Berlin: Revolver, 2009), 99; online edition: http://www.diatrope.com/rfm/docs/Transmedialen_2009.pdf accessed February 20, 2016.

[21] "Xively" https://xively.com/ accessed November 11, 2013.

solutions for companies seeking development opportunities in the Internet of Things. Xively is a platform that facilitates the collection and sharing of data, and its real-time management. The data—particularly about the environment, including environmental pollution—is provided by devices, sensors, and buildings. Xively also enables the remote control of devices, as well as communication between data-exchanging objects, and may be used for developing proprietary devices and applications. At present, this is primarily a commercial platform, offering paid services in object management and the development of applications for entire systems of sensors. Yet, until recently (March 2016) the company still included Air Quality Egg among its "success stories," even though it was initially an open-source community project.

The strength of the Pachube service was a result of its openness, community character, and the fact that it enabled users to make specific, contextual use of data provided by sensors. Information on energy consumption, humidity, room temperature, or pollution levels usually remains within a closed cycle that is accessible only to administrators. Since Pachube used the EEML standard (Extended Environments Markup Language, not to be confused with the Extended Enterprise Modelling Language), users could build their own applications or other objects with the use of, for example, the popular Arduino platform. It is worth noting here that the EEML serves streams of data and metadata collected both from the physical environment (for example, so-called intelligent architectural components) and the virtual one (for example, from Second Life). This allows the building of transversal connections between virtual worlds and real objects and devices. Haque himself called his service a "Twitter for machines."[22] In fact, many of the sensors connected to the platform did indeed publish automatic Twitter updates, with data on their functioning or status. This circulation of information was accompanied by a real-time updated map of the tweeting Pachube objects.

The platform's main goal was to regain control over data that describes the spaces of everyday human existence, primarily environmental data on the consumption of electrical energy, air pollution, and so on. This is best illustrated by the example of the above-mentioned Air Quality Egg, a device created with the help of the well-known crowdsourcing platform Kickstarter. The Air Quality Egg was a small appliance with sensors that enabled a range of air quality measurements: initially, the concentration of nitrogen dioxide (NO_2) and carbon monoxide (CO), and later, also dust/particulate matter (PM), ozone (O_3), gamma

[22] Pete Swabey, "Pachube opens the Internet of things to end users," *Information Age*, December 9, 2011, accessed July 15, 2015, http://www.information-age.com/industry/start-ups/1678543/pachube-opens-the-internet-of-things-to-end-users.

and beta radiation, volatile organic compounds, and hydrocarbonates. Compared to traditional monitoring stations, the data provided by the device was more local and more compatible with users' everyday activities. This data was shared by the platform (Pachube had by then become Cosm), which also incorporated it into a network. A real-time interactive map of communication exchanges was an important element of the project, helping to track network-connected components and their data streams. The Air Quality Egg, currently a product offered by the Wicked Device company, is an example of a phenomenon that the platform's creators called Distributed Citizen Sensing.[23] As is the case with grassroots participatory mapping projects, this involves data of a very local character that is easily obtained and always shared in an open way (a similar motivation drives the activists associated with the Grassroots Mapping network who focus on creating maps with the help of kites and microscale GPS units).[24] Hence, the images (and the above-mentioned maps in particular) generated by such a network of sensors seem to be "nested" in a reality that consists of the automated exchange of data between objects (enabled by programming languages and data exchange protocols), the objects themselves (sensors), the platform structure that supports open access to the circulating data, and the work of community activists (or, sometimes, single users).

It would be impossible to analyze such a map without referring to the processes that enable its existence in the form of an interface. Indeed, the interface is just a small part of the "ontological coalition" that is comprised of diverse forms of wireless communications, from microscale RFID and mesoscale WiFi, to the most spectacular satellite communications on which maps are based, both Google Maps and OpenStreet Map. The Air Quality Egg was an experimental project with a relatively narrow group of recipients and prosumers. Yet we can now observe a growing number of such "hybrid products" defined by "their interplay of digital and physical materials, and a fundamental connection between a physical device and digital networks."[25] Collectively termed "smart technology," they comprise a wide range of products, from household appliances (for example, intelligent electricity meters) to biometric equipment used in

[23] Ed Borden, "You can build an open air quality sensor network," accessed March 15, 2013, no longer available, http://blog.cosm.com/2011/12/you-can-help-build-open-air-quality.html#more.

[24] "Grassroots Mapping" http://grassrootsmapping.org/, accessed October 18, 2014.

[25] Joern Knutsen et al. "Investigating and <Internet of Hybrid Products>: Assembling Products, Interactions, Services, and Networks Through Design," *Computers and Composition* 28 (2011), 195-204, 198, accessed July 15, 2015, doi: 10.1016/j.compcom.2011.07.002

medical care, sports, and fitness training. All of them generate unique image forms—graphs, maps, and charts.

Beyond representationalism – an image "nested" in the world

Let us take a look at the "networking" of the environment in which sensors, as well as the condition of the environment they monitor, are visible as an automatically generated map. The popular opinion that we live in an era with an overabundance of images results from the limitations of the representationist paradigm. This paradigm involves an (often subconscious) belief that the process of representation performs a profound split between reality and the image that attempts to capture or present reality. It usually goes hand in hand with an excessive focus on the image at the expense of the entire complex process of image generation. As I have already noted, such an approach may be misleading, and often results in overlooking the technosocial conditions of imaging. This particularly applies to data visualization which, by the way, increasingly becomes one of the most fetishized image forms. Here, what often disappears from view is, for example, the fact that such a proliferation of images is only possible owing to the distinctive properties of an environment made up of networked media; media that are wirelessly connected, forming an apparently incoherent conglomerate. This, in turn, constantly generates questions about connection procedures, the interoperativeness of applications, methods of intensive data stream generation and, last but not least, the status of image forms in this complex system. Here, it again worth reiterating that wireless communications encompass a wide array of diverse solutions, from close range Bluetooth standard, to data transfer in different forms of enhanced cellular telephony (3G, 4G and LTE), to the longest range satellite communications, plus the RFID system on which the industrial Internet relies. So we are talking about a spectrum that is non-homogenous and internally diversified. In addition, the most popular standard, known as WiFi, is a brand name patented by the Wi-Fi Alliance, carrying a trademark and usually involving a technical certification process.[26]

My reason for paying particular attention to these diverse forms of wireless communication is grounded in the fact that wireless communications uniquely bind together the automatically generated visualizations of the Internet of Things. As Adrian Mackenzie writes, "It might not be going too far to say that wireless networks are the very substrate of network media convergence today. We could think of wireless networks as prepositions ('at,' 'in,' 'with,' by,' 'between,' 'near,' etc.) in the grammar of contemporary media. Because of their pre-positional power to connect subjects and actions, wireless networks act

[26] Mackenzie, *Wirelessness*.

conjunctively, they conjoin circumstances, events, persons and things."[27] In organic terms, wireless communications today play the role of connective tissue for such "hybrid products" as Air Quality Egg. Their hybrid quality results from, among other things, the fact that they are simultaneously an object and, due to their communication capacity, a service and a terminal in data circulation. The borders between a single object, the environment in which it is immersed, and the image forms resulting from it, are very unstable. All of this constitutes very complex systems that may be called "quasi-organisms with digital nervous systems."[28] Moreover, the "connectivity" of ubicomp (the nearly omnipresent wireless communications) is linked with a very interesting feature: the fact that ubicomp is based on unstable and provisional protocols for wireless communications. However, at the same time, more and more areas of reality, experienced and sensed, are being transformed into data streams. So we are dealing with two simultaneous, overlapping processes with opposite vectors: the growing entropy of the entire communication environment, and an unprecedented intensification of the discursivization of actions that until recently often went unnoticed. The former is the outcome of wireless communications based on different scales and protocols, offering data access of diverse extent and on different levels. The latter involves actions that, when they are mediated by a network platform or communication protocol, leave a "digital trace."[29]

At the same time, communication protocols form a distinctive layer that help us to observe the emergence of the above-mentioned "ontological coalitions." Automatically generated images are just one of many elements in these "coalitions." While Renfrew and Malafouris analyze such nexuses of agency in relation to traditional tools (a blind person's cane is a telling example, used by these scholars in the introduction to a book they edited in 2008), in the case of wireless communications it is easy to see what they call "a gray zone of material engagement,"[30] or a zone where "brains, bodies, and things conflate, mutually catalyzing and constituting one another."[31] It is interesting to take a look at, for example, the technical parameters alone. These provide a basis for such

[27] Mackenzie, "Wirelessness as the Experience of Transition," *Fibreculture Journal* 13, 2008, accessed November 26, 2015, http://thirteen.fibreculturejournal.org/fcj-085-wirelessness-as-experience-of-transition/.

[28] Simon Penny, "Trying to Be Calm. Ubiquity, Cognitivism, and Embodiment" in *Throughout. Art and Culture Emerging with Ubiquitous Computing*, ed. Ulrik Ekman (Cambridge – London: MIT Press, 2013), 263-277, 266.

[29] Rob Kitchin, Martin Dodge, *Code/Space. Software and Everyday Life* (Cambridge: MIT Press, 2011).

[30] Malafouris, *How Things Shape The Mind*, 5.

[31] Ibid.

processes, enabling massive data transfers. Data is then translated into geolocatable tags on the map, and into charts presenting the time-variable parameters of the immediate environment of IoT devices.

Inspired by the radical empiricism of William James and his relational understanding of the category of experience, for Adrian Mackenzie the algorithms that determine data transfer in physical space are something more than just a process of computing. Their significance goes beyond being a subject or object; they're not a relation, either. Mackenzie sees them primarily as "relational situations concerned with transitions between states,"[32] and emphasizes that they operate on the physical plane. As he puts it, they act as agents or intermediaries between institutions, markets, public spaces, and transport. They stimulate the movement that initiates the flow of data, so they connect different modes of conversations, text, and graphic data, emitted by sensors and monitoring devices. For Mackenzie, these algorithms constitute "unstable movement between [...] thing and thought."[33] So, in the transductive understanding of French philosopher Gilbert Simondon, they transgress the borders between ontologically different phenomena. Inspired by James and Simondon,[34] Mackenzie focuses his attention on the methods and modes of connection. At the same time, he emphasizes the significance of the materiality of phenomena that are too often treated as the primary face of a "dematerialized" Internet, making particular reference to the so-called "air interface," or all the aspects of signal processing between the transmitter and a mobile device antenna. In reality, wireless communication is only a "kludge" that functions just well enough; well enough to sustain our illusions of instant data transfers. The name applied by Mackenzie is taken from hacker culture, where "kludge" means a clumsy but temporarily effective programming solution.[35] As he explains, this results from the fact that WiFi comprises a series of processes which, rather than being separate sequential procedures constituting an arranged act of data communication, are more of a set of overlaying orders: "The juxtaposition of different components constructs a signal envelope or composite waveform that is open in certain ways and heavily closed in other ways. Information is coded in a sequence of steps, but these steps take account of each other. Information is encoded a number of times to allow different relations to be entwined with other."[36] Two moments are of particular

[32] Mackenzie, *Wirelessness,* 67.
[33] Ibid.
[34] He does so in his book published before *Wirelessness.* See Mackenzie, *Transdutions. Machines and Bodies at Speed* (London: Bloomsbury, 2002).
[35] Mackenzie, "Untangling the Unwired. WiFi and the Cultural Inversion of Infrastructure," *Space and Culture* 8 (3) 2005, 269-285.
[36] Mackenzie, *Wirelessness,* 70.

importance: data transfer and data reception. In fact, data transmission is enabled not by the precise splitting of information into a sequence of packets, but by the relations of connection between individual portions of signal. The algorithm used here, the fast Fourier transform, divides the transmitted information into a series of separate signals that differ slightly in frequency, so that they can be sent in the crowded electromagnetic spectrum. The moment of signal reception, on the other hand, is determined by the Viterbi algorithm, which is used in dynamic programming to determine the source of data transfer, the addressee, and the sequence in which portions of data are to be received, so that data can be compiled into a single whole (let us remember that all of this is occurring in an environment densely packed with electromagnetic signals). This algorithm uses a reverse logic of functioning (hence, it is called convolutional): it is able to recreate the portion of data received on the basis of an earlier segment of sequence, using the sequence information included in each packet. However, this is not a completely determined process; according to Mackenzie, there are also elements that possess a stochastic quality, which means partially random. This is a general overview of what I have called the instability of wireless communication protocols. It is a situation where digital signal processing combines with the analogue conditions of the radio wave (or the electromagnetic spectrum in general), and with computing. This last element is not entirely determined or purely mechanistic, and takes into account emergent factors.

Images as exchange of energy

Thus, for studies of imaging accompanying automated data exchange, the application of the representationalist paradigm seems inadequate. Such a paradigm ignores the unique properties of the wider environment of network media—networking conditions, signal transfer, responsiveness to transformation, social interventions or interventions by activists, and corporate data management policies. It also sustains the illusion of the "smoothness" of computing processes, and of an information network that operates instantly, with no obstacles, in a mechanistic way. So I would propose to view such images (like the maps on the Pachube platform) as forms of an exchange of energy with the world, treating the visual form (mapping interface and the dynamic map itself), and the reality in which it emerges, as a certain type of continuum. This constitutes a metastable system (in reference to its Simondonian traces[37]) that contains different potentials

[37] See Gilbert Simondon, *L'individuation psychique et collective* (Paris: Editions Aubier, 1989); Mackenzie, *Transdutions*.; Muriel Combes, *Gilbert Simondon and the Philosophy of the Transindividual*, trans. T. LaMarre (Cambridge: MIT Press, 2013).

and hence forms a starting point for change (individuation) on the edge of the "event." This also involves an understanding of the entire processuality of networked images; events and places entwined in a complex process, a process that they form as much as they are formed by it.

Hence, Pachube-generated maps would be something more than just a graphic interface visualizing data; our view of them would also include the social processes involved in civic-sensing practices, and the subsequent transformations of a platform that was initially social in nature. From this perspective, the image becomes a process: the exchange of energy between different actors. It would be an example of distributed agency, of which hybrid satellite and other wireless communications are an important component. The cartographic image automatically generated on the basis of the data collected would also be a zone of transition, and an articulation of different domains—material (hardware, sensed environment), discursive (coding procedures), and social (civic activity). So the process of image emergence would be a form of transduction described by Simondon using the example of the process of crystallization, in which "different realities have been transduced or mediated."[38] This implies a connection between realities from domains that are heterogeneous, incoherent, and mutually incompatible (thus enabling the emergence of hybrid, material-discursive subjects). In this way, in studies of imaging, the focus shifts from the ontology of the image to its ontogenesis: its emergence along with the world in which it was born, from collecting data from reality to algorithmic procedures and/or human activity, combined in different proportions, to the final phase of image crystallization.

The Simondonian terminology encourages a more serious approach to the relation between the emerging digital (network) image and the effects it generates. And so, coming back to images accompanying the Internet of Things, it helps explain the relation, for example, between the act of community mapping of environmental conditions registered by sensors, the protocols and technical standards that make this possible, and social activities in environmental protection. Most importantly, however, it helps reflect on the process from an entirely different viewpoint, one that goes beyond the illusion of "image" and its social "effect." This is exactly the core of representationalism as a conceptual framework in which the entire process disappears from view. Process is replaced by frozen, static moments situated on two sides of the boundary set by the classical concept of representation: the image, its "source," and, next, its "effect" in the world. So, the emergence of image-beings would be subject to the process of individuation, occurring, for example, in the complex processes of collecting,

[38] Mackenzie, *Transductions*, 46.

processing, and transferring data in an environment of wireless communications that is unstable, open to transformation, and based on continuous negotiations between repetition and difference. This would entail a view of individuation as movement perceived in the Bergsonian way, as continuous fluctuation, rather than as a transition through individual stages (which freezes individual phases).[39] The networked (not just digital) image understood in this way is not so much an object with clearly defined borders determined by the logic of representationalism, as it is a form of participation in a range of operations and events, owing to which it emerges from the environment due to the varied intensity of energy exchange. For an image that involves coexistence with the world based on the principle of metastability, each individual instance of it (rooted in the actual exchange of data) would mean a subsequent phase of structuring, of the articulation of potentials belonging to different ontological orders (material, software, social, and cultural).

This article has paid more attention to the conditions of wireless communication than to the graphic design of the automated maps associated with the civic IoT platform Pachube. This is because I see the various forms of wireless communication as the important factor enabling the very functioning of the Internet of Things, something which rarely gets enough attention in research focusing on networked imagery. I argue that this deserves far more attention in studies of digital culture, since wireless communication serves as the breeding ground for the current shift to the postmedia condition. The reason for this neglect is grounded in approaches I have described as the paradigm of representationalism, which means introducing a sharp split between image and reality, while at the same time privileging visual and symbolic content over social and cultural practices (civic activism), as well as technical conditions (data processing procedures and forms of communication). These factors form the proper milieu of image production and circulation. In other words, representationalism relies on isolating imagery from its wider environment, often relegating the latter to the margins by framing it as merely the "context" of the process of visualization. In this regard, it is important to note that wireless networks present a hybrid quality that combines the digital with the analogue, merging the physical space and the procedures of data processing, and bridging the various components of the continuum (material, discursive, and social) where the cybermaps are produced and circulated. Hence it enables the "ontological coalition" that links human and non-human actors imbued with different modes and scales of agency—the networked imagery made available with Air Quality Egg sensors and the Pachube platform can be seen as one of its examples. To counter the representationalist tendency of equating the visual with the intelligible, and separating imagery from its environment, I have offered the idea

[39] See Kember, Zylinska, *Life After New Media*.

of framing the networked imagery of ubicomp and IoT as an energy exchange that coexists with the world, not just its description or point of reference.

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