Materialization of Code

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1 Introduction

This article concerns the relation between computer code and theories of materiality. Computer code has often been treated as either a completely immaterial phenomena or something with a ghostly presence that allows language to affect material things. The article asks the question of how the materiality of code can be understood with contemporary theories of materiality and what it is about it that makes it so often perceived as an immaterial phenomena.

What makes the relation between code and materiality an urgent matter today is the developments within computing the latest years which have destabilized the established notions of what a computer can be and thus what its relation to the environment and the human body and thought looks like. This makes it apt to re-investigate the relation between code and materiality. But before that subject is treated the article will do an overview of different theories of materiality.

2 Materiality

2.1 Two Materialities

In recent times there has been a surge of theories of materiality from different disciplines such as philosophy, sociology, literature, informatics and anthropology. Common to all these is an interest in the agency and autonomy of the material outside of its role as passive recipient for human agency and will. There is also an interest from the theories of materiality to dissolve certain dualisms that has pervaded the respective fields and has led to materiality being overlooked. These are among others nature/culture, body/thought, concrete/abstract and object/representation.

However there are differences in between the approaches and for the purpose of this investigation they will be categorized into two different approaches; *empirical materialism* and *epistemological materialism*. This should not be understood as two different schools – often both tendencies are represented within the same authorship – but the two approaches can also be difficult to reconcile.

2.1.1 Empirical materiality

What is studied within the empirical theories of materiality is specific material objects and their impact of different phenomena in the world. Phenomena that previously were understood as being made up of social structures, discourses and representation are shown to be resting on a material ground. Empirical investigations dominates these theories and the researchers access to the material world remains largely unproblematic.

Bruno Latour is to be considered one of the big names within this category. Latours "Science in Action"[1] showed that behind the facts and representations of science were scientists of flesh and blood that *constructed* facts in their daily work – together with their colleagues in the form of instruments, bacterias and note books. In "Where are the Missing Masses"[2] Latour expands this to the whole of society by claiming that the lack of material agency within sociology has forced sociologists to recourse to abstract "social explanations".[3]

Donald MacKenzie has a similar agenda in the book "Material Markets"[4] where he shown that the variables and agents of economy – often understood as neutral measurements and abstract actors – in reality are constructed by rather arbitrary, material, human, and everyday practices. They only appear as a larger scale phenomena after these has been formalized and abstracted as "the market".

- Daniel Miller*. Millers studies of consumption in "Material Culture and Mass Consumerism"[5] shows that contemporary culture is to a large extent made up of peoples relations to different forms of mass-produced objects, something he regards as not studied enough due to its non-linguistic character and the fact that material culture by previous critique have been seen as something coarse. Further, Miller states that there is a rich variation and agency in how consumers relate culturally to mass-produced goods and that it is not something that is brought upon unknowing subjects from above.

Jane Bennet approaches similar questions from a more philosophical perspective. She can be said to be part of a neo-vitalist tendency in contemporary philosophy where the intrinsic morphogenesis and power are bright forth. In the book "Vibrant Matter"[6] Bennett analyses everything from trash to electricity with the purpose of showing that what previously was considered static objects passively waiting to be acted upon by human agency is in fact dynamic actors with their own "thing-power". These should therefor be considered as autonomous actors in the processes that constitute society and should be considered by political theory.

There are some limits to this approach since it leaves the ontological and epistemological questions unanswered. What arises is a situation where the things get agency only be being associated with human actors. Martin Holbraad:

[1] Latour, *Science in Action: How To Follow Scientists and Engineers Through Society.*
[2] Latour, "Where are the missing masses? The sociology of a few mundane artifacts."
[3] Latour, "Tarde Debate," 49.
[4] MacKenzie, *Material Markets:How Economic Agents Are Constructed.*
[5] Miller, *Material Culture and Mass Consumption.*
[6] Bennett, *Vibrant Matter: A Political Ecology of Things.*

> [A]pproaches, which leave the ontological distinction between things and people unmodified, cannot but emancipate things by association. The whole point about the common sense distinction between people and things is that the former are endowed with all the marks of dignity, while the latter are not. So if you want to emancipate the thing while leaving the ontology untouched, then all you can do is find ways to associate it more intimately with the person.[7]

2.1.2 Epistemologic Materiality

The limits of knowledge is in focus within epistemological materiality. The central question is how and under what conditions the conscious subject can approach the materiality and the things-in-themselves. The epistemological materialities often talk about matter, things and objects in an abstract sense, not about any particular things and objects in particular situations.

These questions have been inherited from Kant who posited the problem of the subjects access to the world in "Critique of Pure Reason" [@Kant1998]. Kant critiqued both meta-physicians, who wanted to treat issues of the essence of being only with rational arguments following from rational principles, and empiricists, who claimed that knowledge was made up of sense impressions. Instead, Kant meant that experiences are structured by the two faculties *time* and *space* as well as the categories of the subject such as the idea of cause and effect. The subjects perception of the world, and thereby the possibilities of philosophy, are limited to studying the things as they appear *to us*. It is impossible to say anything about the *things-in-themselves*, even though our experiences of them are essential to thought.

Speculative realism is the term for a contemporary philosophical current that tries to overcome the limitation of Kant. The name comes from a title of a seminar with the philosophers Graham Harman, Ray Brassier, Quentin Meillassoux and Ian Hamilton Grant [see Mackay.[8] The four do not have much in common except that they all in their own way reject what Meillassoux have dubbed "correlationism",[9] which he claims sums up the conclusions of Kant all all post-Kantian philosophy the last 200 years. Correlationism means that philosophy can neither speak of thought nor being on their own, but only of the relation between the two – their correlation.

Graham Harman and his "object-oriented philosophy" are here selected among the four to be given a more clear presentation. The way Harman approaches the subjects limited and distorted access to things is not to question the limitation but to extend it to be valid for all relations among all types of objects without giving the relation between humans and things a special treatment.[10] Thus he constructs a philosophy where the essens of every object is withdrawn from other objects and where they can only get indirect access to each other mediated through what Harman calls "sensible objects".

Martin Holbraad. It is not only within philosophy that these issues are considered.

[7] Holbraad, "Can the Thing Speak?."
[8] *Collapse: Philosophical Research and Development. Volume III.*
[9] Meillassoux, *After Finitude: An Essay on the Necessity of Contingency.*
[10] Harman, *The Quadruple Object.*

Martin Holbraad is an anthropologist and for him the concern is the possibilities for interpreting the anthropological objects he encounters in the field. Holbraad calls his approach "thinking through things".[11] Instead of forcing human perceptions upon the interpretation of things, he wants to find a way to make the materiality of the things themselves guide the interpretation and generate their own cathegories by thinging *through* things instead of thinking *about* them. For Holbraad the thingness of things define what we can say about them and do with them.[12]

Hans Ulrich Gumbrecht is a literature scholar of the german school that during the 70's and forwards started to investigate the material conditions of their own discipline. In "The Production of Presence"[13] Gumbrecht presents the theory that we live in a meaning culture. This rests, he claims, on a metaphysical attitude; one that always wants to go beyond the physical and places greater emphasis on the *meaning* of phenomena than their actual *presence*.[14] Its counter-part – a presence culture – has been the dominant attitude in other times and still is today in certain types of activities; aesthetic experiences, music, sex, sport, and driving. Presence is characterized by periods of intense focus. What Gumbrecht is after is not so much to replace a meaning culture with a presence culture, not to merge them in one concept; rather, he wants to keep the tensions between the two attitudes and oscillate between them.

Bill Brown et al. It is not only a question *if* thought can reach things that is central within epistemological materiality, but also *what* it is we encounter once we reach the destination. Those issues are thoroughly treated in the book "Things",[15] edited by Bill Brown. One theme of the book is the tension between the concepts "object" and "thing", which can also be said to be the tension between the manifest and the hidden, between the isolated and the connected, and between theoretical and poetic language. What makes the tension between the two arise is the insight that the closer we get to objects, the further away they seem because the only thing that can be made present is a representation of the thing formed by our subjective faculties. In this tension, theory is on the side of objects and the manifest, while poetry has the ability to make things present without renouncing their abstruseness, and without fixating them and isolating them from the context they arise from. Throughout the book, several examples are given of this power of poetry, for example by the use of riddles.

What has been presented is two sometimes entangled, sometimes mutually exclusive perspectives on materiality. On the one hand a perspective thrust is on cataloging the agency of material objects in the construction of social phenomena and on the other hand a perspective that remains only *carefully* optimistic that thought can speak about objects on their own terms at all and if that was the case remains doubtful whether or not these entities would be things and objects at all. The next section will try to reconcile these perspective within materialist media theory. What is sought after is a perspective that both is able to speak about specific material ob-

[11] Holbraad, "Can the Thing Speak?."
[12] Ibid.
[13] Gumbrecht, *Production of Presence: What Meaning Cannot Convey.*
[14] Ibid., p. xiv.
[15] Brown, *Things.*

jects and their meaning in specific situations at the same time as it cares for the concerns about the limits of thought and its access to the world.

2.2 One Media Materialism

When I here talk about *one* mediamateiralism it is to reduce to a single perspective the multiplicity of a lively theoretical development the last decades that include numerous writers and perspectives with unreconcilable points of departure.[16]

One name that often occurs when talking about this kind of media theory is Friedrich Kittler. Kittler was a literary scholar and was influenced by French poststructuralism. His maneuver consisted of *materialising* poststructuralists such as Derrida, Lacan and Foucault.

In Derrida he finds that "Of Grammatology"[17] seems to point to a possibility of reading history as a history of different writing systems of cultures.[18] For Derrida, the structure of writing is "the hidden premise of the concept formation of western philosophy".[19] Kittler historicises and conreticises this insight to concern different "writing systems", a term Kittler uses for a given epochs ability to store, process and transmit information.

Going further, Kittler shows that Lacan already externalized the human psyche by letting the unconscious in Freud be equated with the language of "the other", which Lacan claims is discusive.[20] The unconscious becomes an external system, rather than being located within the subject. The only thing Kittler has to do now is to technologize this external system to make it consist of a certain writing systems, which in the case of Lacan was the writing system 1900 consisting of grammaphone, film cameras and typewriters.

Foucault gets a similar treatment of his concept of the discourse. Just like with Derrida and Lacan, Kittler find a point where Foucault seems to point towards a technologization of discourse. For Foucault, this concept is *the archive*.[21] Kittler claims that it's not a coincidence that Foucaults investigations always ends at the time when the dominance of writing is challenged by the technological media of the 1900s such as gramophone and film, since they are not possible to investigate with his archival methods. Thereby, Foucaults ahistorial notion of of the archive as the material base of discourse has been historicized and technologized so to be concerning a specific writing system subject to historical change.

It is precisely in this technologization of the material base of thought that media theory open up for a reconciliation of the empirical and the epistemologic theories of materiality. It fulfills the criteria that was postulated in the last section; it takes seriously the problems of the subjects access to being, but also escapes the dead end of Kants categories by externalizing, technologizing and historicizing the relation of the

[16] For example Ernst, *Sorlet Fr\ran Arkiven: Ordning Ur Oordning*; Hansen, *Embodying Technesis: Technology Beyond Writing*; Winthrop-Young, *Kittler and the Media*; Drucker, *The Visible Word: Experimental Typography and Modern Art, 1909-1923*; Parikka, *Insect Media: an Archaeology of Animals and Technology.*

[17] Derrida, *Of Grammatology.*

[18] Kittler, *Gramophone, Film, Typewriter*, 33.

[19] Kittler, *Maskinskrifter: Essäer Om Medier Och Litteratur*, 24.

[20] Kittler, *Literature, Media, Information Systems: Essays*, p.130.

[21] Kittler, *Gramophone, Film, Typewriter*, 5.

subject to the world. Thereby, the question of the subjects access to objects becomes a question of mediahistorical examinations, albeit paradoxical ones because the historian is examining from within the contemporary writing system, which according to Kittler should be named *writing system 2000* since the advent of computers.

Thus far in this excursion, it has become possible to speak about actual material objects without renouncing the challenge of Kant, but only as long as these objects are of a specific class called media; that is, the class that thought have been externalised, technologized and historicized to. But this still leaves a large part of the multiplicity of objects in the world and their "thing-power" to themselves, only reachable through media. So far, the subject is circulating in a rather closed space between media and thought. One way of getting out of this loop is to also problematize the status of media as subject-generating material objects and show that they in their turn are insecure and fleeting phenomena that only arise as the result of a number of constructions. To continue on this track, this investigation will now move closer to the field that in the beginning was states as the motivation for this whole excursion – that is digital technologies and the materiality of code.

3 Code

3.1 Code and Materiality

Computer code and its materiality can be seen as an especially suitable object of investigation because their immateriality is often highlighted as a defining characteristic. This immateriality is often compared to the "old" medias weight, slowness and material extension. This includes comparissions of books and paper prints with digital text; between records, cassettes and film rolls with their digital counterparts; and between sending letters or transporting people compared to the data transfer capabilities of digital networks. Nowadays another level of immateriality is introduced where even storing digital files locally on the computer is considered "heavy" compared to storage located in "the cloud". A short history of immaterialization of digital technologies will here be presented in three levels; human-computer interaction, cyberspace and the new economy.

1) The first level concerns the human-computer interaction itself. Since the computer mouse was invented at XEROX PARC in the early 80's the development of the physical interaction between man and computer stood mostly still for almost two decades; keyboard and mouse became the de facto standard.[22] The interaction itself was also static. The computer and the screen was just as immobile as the body of the computer user; sitting still in a chair, eyes glued to the screen, the only detectable movement is in the fingers and wrists. The major changes during these years instead happen in software with the arrival of graphical user interfaces and the computers increasing ability to show advanced moving graphics what makes the user ever more subsumed into the experiential world of the screen, forgetting tome, space and body.[23]

[22] Moggridge, *Designing Interactions*, 27–47.
[23] Ibid., 19–58.

In focus for human-computer interaction is the ability of the human cognitive system to recognize, process and memorize information.

2) The digital technologies have also been the subject of (now highly criticized) speculative vision of the future about a time when the material world have outplayed its role, if not completely dissolves. This second level of analysis is mostly associated with the concept of *cyberspace* as the idea that the internet would one day bring about a new world where the characteristics of ones body and place would not matter, only ones intellect. Perhaps one day, the visionaries though, we would completely leave the bodies behind. This was a common perception on the American west coast in the 90's. Ester Dyson wrote in "Releast 2.0: A Design for Living in the Digital Age"[24] that the internet would erase hierarchies and inequalities on the market place and turn individuals and corporations into equally powerful information packets. The most famous expression of this perspective is John Perry Barlows "Declaration of Independence of Cyberspace" where he proclaims that "We will create a civilization of the Mind in Cyberspace".[25]

3) The third and final level concerns not only digital technologies but they are an essential prerequisite for it and are developed in parallel with this development that went by the name of "The New Economy". In many countries this meant a period with a decrease share of the economy consisting of industrial production of goods and in increased share consisting of service economy and immaterial goods. This lead to these economies stressing innovation, creativity and other "light" aspects of economy.[26] The new economy can be said to have reached its peak during the dotcom bubble in the early 2000's. Globally, "the new economy" implied friction-free flows of information, goods and capital.[27] In "New Rules for the New Economy", Kevin Kelly postulated that "the world of the soft—the world of intangibles, of media, of software, and of services—will soon command the world of the hard—the world of reality, of atoms, of objects, of steel and oil, and the hard work done by the sweat of brows".[28]

Now over to the critique of the dematerialization on the same three levels. The critique have in all three cases grown out as a result of both new theoretical frameoworks and sociotechnical developments. At the first level I focus on developments within design theory that has put emphasis on embodied interaction. At the third level I highlight critique of the supposed immateriality of the new economy from critical geography. Finally on the middle level I will highlight theoreticians who come out of the material media theory that was presented earlier in the article. This middle level will later become the main focus of the continuation of the article.

1) As was described in the previous section, on the first level the establishment of the interface duo of computer and mouse led to two decades of realtive stillness in the material interaction between human and computer. But the latest 15 years, things have started moving. Lucy Suchman was ground-breaking is using ethnological methods to study the everyday, embodied interactions that was behind what was

[24]Dyson, *Release 2.0: a Design for Living in the Digital Age.*
[25]Barlow, "A Declaration of the Independence of Cyberspace."
[26]Thrift, *Knowing Capitalism.*
[27]Harvey, *The Condition of Postmodernity: An Enquiry Into the Origins of Cultural Change.*
[28]Kelly, *New Rules for the New Economy: 10 Radical Strategies for a Connected World*, 2.

previously thought of as abstract infomration processing.[29] Focus shifts from the cognition-based study of how technology is *used* to the embodied, performative and ecological study of how people *live with* technology.[30] This have spawned a drive to move computeruse away from the office environment and its static place to make it mobile and embedded in dynamic environments, so called "ubuquitous computing",[31] which is turn have been driven by a material development of means of production where the same computing power has been possible to package in ever smaller and energy-efficient devices.

At the technical level, the first thing that breaks with the static computer is the laptop that makes the user at least periodically mobile between sission of sitting or laying down computing. There is no longer a given space for the computer where it stays form installment to recycling. Parallell to the laptop, the popularity of the mobile phones and other pocket devices such as the mp3-player grows. With these, the user is mobile also in use and can very well be located in dynamc and eventful environments such as in the middle of urban areas. These devices later merge in so called smartphones with the "pads" as mediator between phone and computer. In computer games there has also been a re-focus on embodiement with interfaces such as Nintendo Wii and Microsoft Kinect that rests of interaction throough full body movement.

3) Critical geography has launched a heafty critique targeting the top level where it has emphasized the local, situated and material prerequisited for the dematerialization of (some parts of) the new economy.

David Harvey describes in "The Condition of Postmodernity"[32] how the apparently immaterial character of global capitalism with its service dominated economies and unhindered global flows of goods and capital is in fact the result of a number of material restructurings. For Harvey the increased flexibility in production and logistics to rapidly transform to meet new needs, the ability of capital to refolcalize production and mor powerful infomration processing has made the economy seem global, immaterial and without friction.

Nigel Thrift shown in "Knowing Capitalism"[33] how the talk about "the new economy" has created new organisation practices that in turn creates new embodied subjects what constantly have to keep themselves flexible, innovative, communicative and alert.

2) The middle level is the one that has gathered most critique form the social sciences. Perhaps not surprising since it treats interpersonal communication and social living. An overview of the critique is presented here while the next section will investigate a few version of it in greater detail.

The purpose of the critique on this level is to show that what has been perceived as immaterial, or purely social, phenomena in fact rests on localized and material ground. Even if it does not always include direct references, this critique could be said to rest on the same foundations as the material mediethеory presented earlier.

[29] Suchman et al., "Reconstructing Technologies as Social Practice."
[30] Redström, "Designing Everyday Computational Things," 2.
[31] Weiser, "The computer for the 21st century."
[32] Harvey, *The Condition of Postmodernity: An Enquiry Into the Origins of Cultural Change.*
[33] Thrift, *Knowing Capitalism*, 130.

Instead of treating concepts such as the internet or cyberspace as abstract phenomena, this critique exposes the actual mediatechnologies that sustain such notions. This critque is often based on a close reading of the protocols and power structures that makes the existence of the internet possible. This includes both critique from legal perspectives such as from Tim Wu[34] who shows the political structures that has power over the networks and Alexander Galloway who influnced by critical theory show how technical protocols can exercise control in distributed networks.[35]

By doing close readings of the function of specific softwares the analysis can both be more concrete than sweeping ideas based on the concept of cyberspace, but also more encompassing since software and computer code is what lies behind mediatic surface effects such as image, sound, virtual reality, etc.

> [N]ew media may look like old media, but this is only the surface . . . to understand the logic of new media, we need to turn to computer science. It is there that we may expect to find the new terms, categories, and operations that characterize media that become programmable. From media studies, we move to something which can be called software studies; from media theory — to software theory.[36]

3.2 Inscription & Discipline

Even if this can be seen as a concretization of abstract notion of the internet as a cyberspace, this perspective can too be criticized for immaterializing since it takes the function of computer code and its functions as givens. A critique following from this will now be presented throught Katherine Hayles and Wendy Chun.

Katherine N. Hayles traces the immaterialization of computer code to what she calls "a postmodern orthodoxy that the body is primarily, if not entirely, a linguistic and discursive construction"[37] that she finds in authors like Baudrillard. She claims that this is particularly common in disciplines like the humanities and informatics who, due to their research objects, have special reasons to treat embodied matter as discourse and information. Despite efforts to try to materialize discourses to media governing their execution, they still become accomplices in a general ideology of de-materialization.

Instead, Hayles wants to emphasize "the material, technological, economic, and social structures that make the information age possible".[38] In this she includes all the three levels mentioned in the last section – from capitalist accumulation, via specific configurations of hard- and software, to the special gestures and postures that humans have developed in union with information technology.

She also criticizes Foucault panopticon-concept since it makes surveillance discursive and totalitarian by only analyzing surveillence on a structural level and on

[34] Goldsmith and Wu, *Who Controls the Internet?: Illusions of a Borderless World.*
[35] Galloway, *Protocol: How Control Exists After Decentralization.*
[36] Manovich, *The Language of New Media*, 65.
[37] Hayles, "The materiality of informatics."
[38] Ibid.

abstract bodies, but not on a concrete embodied level. According to her, this disregards how in practice actual bodies resist the surveillance systems when they are implemented.

> [I]t diverts attention away from how actual bodies, in their cultural and physical specificities, impose, incorporate and resist incorporation of the material practices he describes.[39]

Hayles emphasizes the materiality by distinguishing between Foucaults abstract bodies and *embodiment* that always happen in a specific body. Further, she relates this to another binary distinction, that between *inscription* and *incorporation*. For Hayles, incorporation is impossible to separate from the medium where it takes place (literally) and is about the expression of a specific body, such as a gesture or a smile. An inscription on the other hand is a sign that functions *as if* it could be separated from its medium, such as alpha-numerical symbols on paper. Hayles stresses that it is about a tension between the two; a struggle between the situated character of incorporation and practices that turn incorporation into inscription. In the relation to every materiality there is a struggle between inscription that makes it appear in all its interpretive clarity and the incorporation that clouds its appearance and makes it ambiguous; a struggle between signal and noise.[40] Due to this constant tension between inscription and incorporation the embodiment of discourses is never completely algorithmic; never completely formalizable into code. Even if Foucault sketches the structure for the *function* of surveillance, it does not mean that the outcome in eveyr instance follow this structure.

Hayles connects this to technological developments since it is the incorporate that creates the link between technological systems and discursive practices that in turn structure thought.

> When changes in incorporating practices take place, they are often linked with new technologies that affect how people use their bodies and experience space and time.[41]

Note here that Hayles does not proceed directly from new media to new forms of discursive knowledge but claims that new media first and foremost structure new ways of using the body, which should include the brains and the sensual organs through new mnemonic technologies and technological ways of perceiving the world. Hayles means that this turns the premise of Decartes – that the only sure thing is thought and all else follows from that – upside-down. Instead it is the preceeding material incorporation that makes the cognitive mind reach its "security":

> the body exists in space and time and through its interaction with the environment defines the parameters within which the cogitating mind can arrive at its "certainties".[42]

[39] Ibid.
[40] Compare Brown, *Things*.
[41] Hayles, "The materiality of informatics."
[42] Ibid.

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Wendy Hui Kyong Chun*.

Barlow, J. P. "A Declaration of the Independence of Cyberspace," 1996. Retrieved from https://projects.eff.org/~barlow/Declaration-Final.html.

Bennett, Jane. *Vibrant Matter: A Political Ecology of Things*. Durham: Duke University Press, 2009.

Brown, Bill. *Things*. Chicago: University Of Chicago Press, 2004.

Derrida, Jacques. *Of Grammatology*. Baltimore: Johns Hopkins University Press, 1997.

Drucker, Johanna. *The Visible Word: Experimental Typography and Modern Art, 1909-1923*. Chicago: University of Chicago Press, 1997.

Dyson, Esther. *Release 2.0: a Design for Living in the Digital Age*. New York: Broadway Books, 1997.

Ernst, Wolfgang. *Sorlet Fr\ran Arkiven: Ordning Ur Oordning*. Göteborg: Glänta, 2008.

Galloway, Alexander R. *Protocol: How Control Exists After Decentralization*. Cambridge, Mass.: MIT Press, 2004.

Goldsmith, Jack L., and Tim Wu. *Who Controls the Internet?: Illusions of a Borderless World*. New York: Oxford University Press, 2006.

Gumbrecht, Hans Ulrich. *Production of Presence: What Meaning Cannot Convey*. Stanford, Calif.: Stanford University Press, 2004.

Hansen, Mark B. N. *Embodying Technesis: Technology Beyond Writing*. Ann Arbor: University of Michigan Press, 2000.

Harman, Graham. *The Quadruple Object*. Winchester, U.K.; Washington [D.C.]: Zero Books, 2011.

Harvey, David. *The Condition of Postmodernity: An Enquiry Into the Origins of Cultural Change*. Oxford [England]; Cambridge, Mass., USA: Blackwell, 1990.

Hayles, N. K. "The materiality of informatics." *Configurations* 1: 147–170.

Holbraad, M. "Can the Thing Speak?." *OAP Press, Working Paper Series*.

Kelly, Kevin. *New Rules for the New Economy: 10 Radical Strategies for a Connected World*. New York: Viking, 1998.

Kittler, Friedrich A. *Gramophone, Film, Typewriter*. Stanford, Calif.: Stanford University Press, 1999.

———. *Literature, Media, Information Systems: Essays*. Amsterdam: GB Arts International, 1997.

———. *Maskinskrifter: Essäer Om Medier Och Litteratur*. Gr\rabo: Anthropos, 2003.

Latour, Bruno. *Science in Action: How To Follow Scientists and Engineers Through Society*. Cambridge, Mass.: Harvard University Press, 1987.

———. "Tarde Debate," 2009.

———. "Where are the missing masses? The sociology of a few mundane artifacts." *Shaping Technology/building Society: Studies in Sociotechnical Change*: 225–258.

MacKenzie, Donald. *Material Markets:How Economic Agents Are Constructed*. Oxford; New York: Oxford University Press, 2008.

Mackay, Robin, ed. *Collapse: Philosophical Research and Development. Volume III*. Falmouth, UK: Urbanomic, 2007.

Manovich, Lev. *The Language of New Media*. Cambridge, Mass.: MIT Press, 2001.

Meillassoux, Quentin. *After Finitude: An Essay on the Necessity of Contingency.* London: Continuum, 2009.

Miller, Daniel. *Material Culture and Mass Consumption.* Oxford: Basil Blackwell, 1995.

Moggridge, Bill. *Designing Interactions.* Cambridge, Mass.: MIT Press, 2007.

Parikka, Jussi. *Insect Media: an Archaeology of Animals and Technology.* Minneapolis: University of Minnesota Press, 2010.

Redström, Johan. "Designing Everyday Computational Things." 2001.

Suchman, L., J. Blomberg, J. E. Orr, and R. Trigg. "Reconstructing Technologies as Social Practice." *American Behavioral Scientist* 43: 392–408.

Thrift, Nigel. *Knowing Capitalism.* London: SAGE Publications, 2005.

Weiser, M. "The computer for the 21st century." *Scientific American* 265: 94–104.

Winthrop-Young, Geoffrey. *Kittler and the Media.* Cambridge, UK; Malden, MA: Polity Press, 2011.