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Mineralising Software: Moving Through Material Processes

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Introducing the notion of 'mineralisation' as a conceptual tool taken from Manuel DeLanda and applied in the context of software, this article investigates the mineral origins of software and how to engage in mapping the vibrancy of software through new material practices.

"Indeed, the exoskeletons of the past everywhere comprise the matter of the present."
(Harris, "Four Exoskeletons and No Funeral" 621)

From automatic doors, ATM terminals, and CCTV security cameras, to schools, hospitals, and even the infrastructure of whole cities, these elements all share one thing in common: they rely upon software to operate. In a sense, most infrastructure nowadays runs on software, to the extent that software becomes, as Lev Manovich states, "the invisible glue that ties it all together" (8). Manovich describes software as 'invisible' for a reason: people tend to accept software as something 'natural,' almost invisible in their daily lives. However, the moment software breaks down, as represented by the well-known "blue screen" in the case of the Windows operational system, the user is made aware of the existence of software, even though software processes still do not necessarily reveal how they operate. The perception of software as invisible and immaterial is not a new phenomenon: since the 19th century, infrastructural technology has demonstrated the tendency to cover its material reality and the effect it has on the environment that surrounds it. In other words, the way software operates makes it difficult to trace and distinguish from the material structures that support it.

This article investigates the way software operates as an unfolding process of material assemblages. The term 'material assemblages' encompasses the way minerals are extracted from the earth to be manufactured into the components of hardware, how these components are later assembled into computers and other computational devices, and how all of these components come together to form the material assembly of software processes. In order to trace the movement of software through material assemblages, I will investigate not the materiality of software, but rather the materials themselves (from minerals to transistors) and the stories they present, situating software not only in objects (as finished products), but providing an alternative account of how software materialism can be mapped in relation to Manuel DeLanda's notion of 'mineralisation.' In his book *One Thousand Years of Non-Linear History*, DeLanda uses the notion of mineralisation to describe how soft tissues turn into bones and how those tissues enable movement, through the mineralisation process. I will incorporate the concept of 'mineralisation' in my analysis to elucidate the material structure that software runs on and how mineralisation can be used as a conceptual tool to provide an example of mapping materials in movement, or minerals in action.

Posing questions about how one is to think about the materials, the rocks and minerals upon which computation is inscribed, I would like to argue for the double-sidedness of software. On the one hand software is often perceived as the sum of its parts, while on the other hand a thing is more than the sum of its parts.[1] Without localising or pinpointing exactly where software dwells, this writing is an exercise of mapping out movement instead of location, since software actualises itself through assemblages, which are quite vibrant and constantly on the move.[2] This movement of software does not finish with the final product, be it a smart phone or a laptop. Nor is it situated solely in the hardware – even though software requires hardware to operate, it is not restricted to it. That is why I want to develop my argument for the movement – the becoming – of software. The main objective of this article is therefore to explore how software can be perceived as a *movement of material practices*, one that is vibrant and in a constant process of revealing itself, both materially and discursively, within a given milieu. This 'revealing' through processes of material formations will be analysed in this article in order to map out what software does *as software*, and how to analyse it as movement through material processes, rather than as still and fixed, in relation to the subject-object divide.

Dematerialisation takes control

There is an outcry for the "death of the material" and the "[d]ematerialization of material culture," according to Bill Brown in his essay "Materiality" (51). Brown introduces the "[d]ematerialization hypothesis," which, according to him, severs the digital or the immaterial from the physical connection that in the past existed between human bodies and technology's tools. To support this hypothesis, Brown quotes archaeologist Colin Renfrew who states, "because 'the electronic impulse is replacing whatever remained of the material element in the images to which we became accustomed,' the 'engagement with the material world where the material object was the repository of meaning is being threatened'" (51). Renfrew sketches a clear separation "between communication and substance," where the image is "electronic and thus no longer tangible" (185-6). This implies that the electronic or digital image is emptied of substance and no longer carries traces of the physical, though relying on Renfrew's presumption that there was previously an existing condition that was engaged with the material world, and that now this condition is challenged by an even less 'material' medium. This sentiment appeals to some sense of nostalgia for a lost experience and perception of the material, or physical. He closes his discussion with the observation that "physical, palpable material reality is disappearing, leaving nothing but the smile on the face of the Cheshire Cat" (185-6).

Continuing on the path of nostalgia for a lost material reality, Jean Baudrillard, in his most influential book, *Simulacra and Simulation*, observes that the image has come to have "no relation to any reality whatsoever: it is its own pure simulacrum" (6). In the era of the hyperreal, Baudrillard thinks that 'materiality' is the product of a bygone era. However, Brown, Renfrew, and Baudrillard all miss that there has never been any 'real' threat to the material world by the coming of the hyperreal era or the disappearing of material meaning because of digital mediums, represented by 'electronic impulses.'[3] The hyperreal and its relation to digital technologies, such as software, only provide a reflection of the way objects are constructed and the meaning that they carry and create in the

material world. Rather than a newly 'dematerialised' world, the proliferation of digital technologies provides a better look into how materials perform and the symbolic meaning they create. Usually the medium (such as digital technologies) is perceived as one which "prevents some more immediate access to 'things themselves'," which means "media by definition have a dematerializing effect" ("Materiality" 51). This suggests that media are a threat to materiality and that "our human experience of materiality has been compromised" (52).

Brown argues that "dealing with the things themselves" is an impossible task within human experience, since things in their core remain elusive and withdrawn, and, therefore, we can only know the world as it is mediated by perceptual categories (51). One of these perpetual categories is touch; hence, "the immaterial/material distinction often asserts itself (as in Renfrew) as the difference between visible and tangible" (51). The separation of the immaterial and material creates a binary between the phenomenal and the material. Transgressing this binary, software introduces many events that can be labelled as 'immaterial' into the realm of the material. My aim here is to 'unground' the material aspect of software,[4] being careful not to situate it in materiality per se, but to present it as a thing in a process of revealing itself, which moves through materials in the form of computation algorithms that one can label 'discursive'.[5]

The decline of matter and materialism should not be directly linked to the rise of the immaterial, but rather the demise of the *material supporting base* (such as underwater internet cables, data centres, coal mines to power computers and systems, etc.). I would like to focus, now, on how to situate the material presence of software and how to write from a materialist perspective, without defining things and events as passive agents, but rather analysing them in new forms of material assemblages.

The Thingness of Software

So far software has been predominately referred to as an object, as in, for example, Lehmann and Raessens' *Digital Material: Tracing New Media in Everyday Life and Technology*, where there is no clear distinction in framing software as an object or as a thing. But a distinction between the two needs to be made in order to address the vitality (as later discussed by Jane Bennett) of software and to question what is meant by the 'materiality' of software.

The distinction between objects and things is addressed by a specific branch of critical theory, namely 'thing theory,' which focuses on the role of things in literature and culture. The theory borrows from Heidegger's distinction between objects and things, where an object acts as a thing when it is juxtaposed against the backdrop of the world in which it subsists.[6] Brown, who writes extensively on thing theory, asserts that in academia there is a particular return to, and a fascination with, things.

The challenge of thing theory is not 'how to read things,' but how to engage in meaningful dialogues with them (things are already in a dialogue with humans, but we do not necessarily acknowledge this) and eventually to develop sensitivity towards the becoming of things, or, as Heidegger once wrote, the 'thingness of things'.[7] Humans will never leave things alone and things will continue to exist in the human made world.[8] In the words of Brown:

> Is there something perverse, if not archly insistent, about complicating things with theory? Do we really need anything like thing theory the way we need narrative theory or cultural theory, queer theory or discourse theory? Why not let things alone? Let them rest somewhere else – in the balmy elsewhere beyond theory. From there, they might offer us dry ground above those swirling accounts of the subject, some place of origin unmediated by the sign, some stable alternative to the instabilities and uncertainties, the ambiguities and anxieties, forever fetishized by theory. Something warm, then, that relieves us from the chill of dogged ideation, something concrete that relieves us from unnecessary abstraction. ("Thing Theory" 1)

The significance of framing things and processes as objects is that, according to Brown, objects are tied to subjects. When one works theoretically through objects, those objects will always be tied to the subject-object divide, which brings exclusion and privileges the dominance of humans over objects.[8] At the core of the subject-object divide is a division in language, where the subject is the one who is the active agent, and the object is the one whom the agent is acting upon. Objects receive, while subjects give and move. In this scenario, objects are experienced as empty vessels, awaiting meaning to be prescribed to them by the subjects, as opposed to things, which do not stand still and do not await affirmation or the granting of agency.

While the focus here will mainly be upon the 'thingness of things' in relation to software as a thing, nevertheless, things will not be treated with a special privilege, since, as Tim Ingold observes in "Bringing Things Back To Life," objects become things and things turn into objects. Thus, I will try to trace the movement of things in relation to objects and consider how they exchange roles continuously.

Life is filled with things and this frightens most people. This is because things are vital on their own, separate from human perception, and they do not wait to be granted meaning and liveliness. That is why people like to align themselves with objects (consciously or not), which appear safer and remain at a proper distance, rather than things, which appear too alive, almost bursting from their material shell. The vitality of things is almost threatening and excessive in its proximity, compared to the calm and orderly existence of objects. Things do not stand still and they do not wait to be pushed around.[10] This is what vital materialism is about: the recognition that "vitality is shared by all things" and not limited to humans alone (*Vital Materialism* 89).

Software is more of a thing than an object, it is not fixed in one form like hardware or other network structures; rather, with its thingness, software constantly reveals itself as a process in the making of. If one opens up a phone or computer, the software components, such as microchips and other hardware elements will be there, but software itself escapes being confined to these configurations alone. Ingold writes about this distinction between objects and argues for a model that favours an ontology "that assigns primacy to processes of formation as against their final products" ("Bringing Things Back to Life" 2). He states that form is death, while form-giving is life (2). What Ingold means is that one should not focus on forms, such as the final products/objects, which appear polished and finished, but on processes, which makes objects look always unfinished, always in a state of forming, without ever being complete. Borrowing from Heidegger's celebrated essay on "The

Thing," Ingold asserts, "the object stands before us as a fait accompli, presenting its congealed, outer surfaces to our inspection. It is defined by its very 'over-againstness' in relation to the setting in which it is placed" (4). In contrast, a thing is always "going on," and if one wishes to observe a thing, it "is not to be locked out but to be invited to the gathering" (4). In other words, people participate, as Heidegger puts it, in the thing "thinging" in a "worlding" world (4). Ingold suggests that we look at the thing as a "parliament of lines, "since it is always in the process of revealing itself to the world, not as an "externally bounded entity, set over and against the world," but rather as a "knot whose constituent threads, far from being contained within it, trail beyond, only to become caught with other threads in other knots" (4).[11] In other words: all entities exist in an interwoven network of relations and 'knots,' and there is constant exchange between one assemblage and another. All human beings are invited to participate with software in its thinging. It is not only about experiencing software, but participating with software in its revealing of fibre knots through interconnected tunnels of unfolding matter.

While Ingold is arguing for the usage of 'things' rather than 'objects,' he makes it clear that one should not be privileged over the other. He states that, "any artifact could in principle be regarded as either a thing or an object. But these alternatives are not mutually exclusive, nor is one right and the other wrong" (*Redrawing Anthropology Materials* 5). Following Ingold's description, I want to point out how *working with things* elucidates the flow of materials in the process of making, rather than their final form, as objects, which are perceived as fixed. Therefore, I argue that software is a software-thing, which is always in the process of becoming software, and it is not bound to only one fixed form: "Zooming in, up close, we see the meshwork of things; zooming out, from a distance, we see the network of objects" (5).

Vibrant Matter and the Thing-Power of Software

Moving on, another useful concept that can be employed to elucidate the way software is always in the process of making, or to put it differently – software is always in the process of becoming software (its being is its becoming), is the idea of vibrant matter and vibrant materialism. The concept of 'vibrant matter' comes from Jane Bennett and her 2010 book of the same title. In it, Bennett focuses on vital materialism, stating that the flow of energy through matter should not be perceived as passive and fixed, but rather as vibrant matter, always in connection with other actants, and having thing-power.[12] By thing-power, Bennett aims to provide a theoretical framework for "a vitality intrinsic to materiality" (*Vibrant Matter* 10). According to Bennett, when things actualise this "thing-power" they make a certain "call": "Stuff exhibited its thing-power: it issued a call, even if I did not quite understand what it was saying" (4). This call manifests itself in the form of a reminder of its existence through different practices, even though people do not understand what this call means and how to interpret it. Given this, one might ask: what 'call' does software produce and can humans understand it?

To focus on software as a thing that is in constant state of becoming, the notion of thing-power comes in quite handy. In "The Force of Things," Bennett extrapolates the concept of 'thing-power,' in order to give an account "of the thingness of things that might enable me to feel it more intensely" (349). To be more precise, thing-power is another form of materialism which:

> ... figures materiality as a protean flow of matter-energy and figures the thing as a relatively composed form of that flow. It hazards an account of materiality even though materiality is both too alien and too close for humans to see clearly. It seeks to promote acknowledgment, respect, and sometimes fear of the materiality of the thing and to articulate ways in which human beings and thinghood overlap. It emphasizes those occasions in ordinary life when the us and the it slipslide into each other, for one moral of this materialist tale is that we are also nonhuman and that things too are vital players in the world. (349)

By this description of thing-power, the thing in focus is elucidated as a material in the making, and not as a fixed object that can be studied as an end product. When things are seen operating as materials connecting to other materials, or as assemblages that connect to other assemblages, objects start to appear more vividly as things, as "entities not entirely reducible to the contexts in which (human) subjects set them, never entirely exhausted by their semiotics" (351). Thus, even as people *try* to control software, pushing it in different directions, there is always something *unexpected* happening, like a small glitch in the code or some other anomaly (although software does not reveal its thingness only in cases when it breaks down), that elucidates that software is not merely an application running on somebody's mobile phone, but operates as a thing, connecting to other actants in the network in which it exists, and it cannot be reduced to the object that operates within the given network.

Artists take this opportunity to experiment with software as a thing, creating glitch art and other 'unstable' media pieces, showing how the culture of things is irreducible to the culture of objects (351).[13] Thinking through the framework of thing-power, Bennett states that "a material body always resides within some assemblage or other, and its thing-power is a function of that grouping. A thing has power by virtue of its operating in conjunction with other things" (354). This does not conflict with previous claims that objects can manifest as 'things' without human intervention, since things have power on their own. Deleuze and Guattari in a similar way, locate the process of unfolding of things within a single cosmic flow of "matter-movement" (407). This autopoetic flow signifies a wide multiplicity of mobile configurations that are "matter in variation that enter assemblages and leaves them" (407). Bennett states: "this is not a world, in the first instance, of subjects and objects, but of various materialities constantly engaged in a network of relations" ("The Force of Things" 254). In connection to this quote, the role of software, as I argue here, is to constantly engage in a variety of networks of relations, to enter and exit different assortment of assemblages, to "shift or vibrate between different states of beings" (254).

Mineralising Software, Enabling Movement

In the preceding discussion I look at the question of how to map out the vibrant materialism of software, by analysing it as a thing in the process of making and see how the thinging of software comes to being, through the notion of mineralisation. Mineralisation is chosen here as a conceptual tool, for several reasons: a) it helps to work conceptually through the notion of unstable material, much more material in its core than simply using notions such as materialisation, since b) mineralisation signifies in a quite coherent way the enabling of movement of materials, which is what

my work is all about – the movement of software and how to analyse it. Most importantly, the process of mineralisation serves well for pointing out the material façade of software that I want to accentuate–software literally *runs on minerals*, hence making the concept of mineralisation productive both in a material and metaphorical way. The idea of the 'mineralisation of software' will help to focus on the movement of the materials in software and elucidate the material grid that operates with software.

The notion of mineralisation is taken from Manuel DeLanda, who is considered a neo-materialist working within the philosophical tradition of Deleuze and Guattari, focusing on geophilosophy and the philosophy of immanence. The term mineralisation has multiple significations and thus its meaning is not static, but rather performative. Using the concept of mineralisation both as a metaphor for a process and as an actual happening, DeLanda asserts that reality might be perceived as constituted by a flow of matter-energy, which is animated within by self-organisation processes. In *One Thousand Years of Non-linear History*, DeLanda offers a definition of mineralisation:

> In the organic world, soft tissue (gels and aerosols, muscle and nerve) reigned supreme until 500 million years ago. At that point, some of the conglomerations of fleshy-matter energy that made up life under-went a sudden mineralization, a new material for constructing living creatures emerged: bone. It is almost as if the mineral world that had served as a substratum for the emergence of biological creatures was reasserting itself, confirming that geology, far from having been left behind as a primitive stage of the earth's evolution, fully co-existed with the soft, gelatinous newcomers. Primitive bone, a stiff calcified rod that would later become the vertebral column, made new forms of movement control possible... and yet bone never forgot its mineral origins: it is the living material that most easily petrifies, that most readily crosses the threshold back to the world of rocks. (26-7)

Essentially, the process of mineralization comes down to actualising the soft tissue into bone, thus enabling movement. This bone, as DeLanda points out, "never forgot its mineral origins," since, even as a bone, it is still constituted of soft tissues at its core (26-7). From bone emerging out of soft tissue to the development and decay of urban centres, everything is in the process of fossilisation. Mineralisation enables the movement of matter into other forms, creating bones, cities, and other material structures to emerge along the way. That is to say, mineralisation can be understood as taking part in the process of the production of things, of the material production of 'reality', enabling the movement of matter and producing the building stones of civilisation:

> For that reason, much of the geological record is written with bone fossil. About 8000 years ago, human populations began mineralizing again when they developed an urban exoskeleton, bricks of sun-dried clay became building materials, stone monuments and defensive walls. This exoskeleton served a purpose similar to its internal counterpart, to control the movement of human flesh in and out of the town walls. (26-7)

In much the same way, mineralisation enables the movement of software and gives it a 'flesh'. Because of the minerals that are extracted for building the hardware upon which software functions, software

is in its core constituted of *minerals in action*. People may perceive software as a finished product/object, but the minerals inside continue to change and enable the movement of software, although not directly perceptible in the final polished form.

Once the minerals are ungrounded as objects, they enable the movement of software as being in the world. When software is situated within an object, the mineral façade is often forgotten, but it nevertheless exists. As the bone does not forget its mineral origins, neither does software—even when perceived as a dematerialised or dematerialising agent, software, at its core, is still made of minerals. Shaking and vibrating, software serves as a mineralised event set in motion.

There is much to say about the complex relationship between Earth's minerals and software, since they are intrinsically linked to each other. Without the first, there cannot be the second. Software is fundamentally linked to the Earth and its minerals, as much as any form of media or even cloud computation. It may sound like it resides 'in the clouds,' but it is still grounded in the core of the Earth. With the appearance of the digital as software, the human imagination entered the realm of the immaterial, although, as pointed out before, software continues to depend upon the extraction of minerals and their conversion into material media assemblages. With the help of software to render the whole world visible, through mapping with satellites and other methods, what was once considered remote and detached from human contact now appears closer than ever.

Software's relation to organic matter shows how people are increasingly dependent on the earth's resources, and what is perceived as immaterial and ephemeral is intrinsically material at its core. Minerals manage to re-assert themselves into the flow of modern computational machines and to actualise their presence in the hardening softness of software. Since hardware is used to describe the 'hard' physical part and software, the 'soft' intangible, the hardening softness of software implies that the soft part of software is not that soft at all and it is intrinsically linked with the 'hard' portion. Therefore, we need to harden the softness, to show how software operates on and through the Earth's resources, such as minerals. Starting with the movement of organisms, minerals now enable the movement of global infrastructure. Even though this movement is not immediately perceived through daily life, it certainly plays a pivotal role in shaping how the global infrastructure functions.

To conclude, mineralisation helps to elucidate the process-oriented direction of software. It becomes a mineral exoskeleton, which enables software to swirl up and down in different material assemblages and to connect with other flows of matter. Jonathan Harris remarks that, "the exoskeletons of the past everywhere comprise the matter of the present" ("Four Exoskeletons and No Funeral" 621). The exoskeleton gives a sense of fixed structure, as is the case of the hardware of software, but this is just one form among many, since matter never sits still, and can enter and exit different exoskeleton formations. Mineralisation as a conceptual tool can be useful in shaping and re-shaping the constantly changing and vibrant concepts and approaches of how to deal with the material practices of the digital, how to question the way software materialises, and how to create and co-create new methods of analysing the geo-socio-political aspects of software and new digital technologies in general. Work still is need to be done upon sharpening the concept of mineralisation in relation to software, and this article attempts to adjust the human ears towards the call of the software. Hearing this call is the first step towards inter-action.

Notes

[1] This links to Graham Harman and his claim that no matter how much you dig to find what constitutes a thing, either by looking at it as a whole or at each individual element, the thing will still remain imperceptible to human experience ("Concerning Stephen Hawking's Claim that Philosophy is Dead" 11-22).

[2] The notion of vibrancy is read in the context of Jane Bennett and her book *Vibrant Matter: A Political Ecology of Things*, where she discusses matter not as passive and stable, but rather being 'vibrant,' undergoing transformations, and being able "to act, to produce effects dramatic and subtle" (6).

[3] Baudrillard defines the hyperreal as that which is more real than reality itself and obliterates any boundaries between what is solid (material) and what is not. As he states: "It is the generation by models of a real without origin or reality: a hyperreal" (*Simulacra and Simulation* 1).

[4] The notion of 'unground' is used in relation to Jussi Parikka and his writing on how, through different practices of elucidation, the 'ungrounding' of the material infrastructure of things can take place, showing that things function in a material domain (*The Geology of Media).*

[5] Discursive here is used in the context of Karen Barad and her book *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning.*

[6] For Heidegger, the world is merely a backdrop against which things appear.

[7] What Heidegger means is that each thing represents a gathering of other things, thus a thing is always composed of other things in itself. Therefore, the thingness of things is what constitutes things. Heidegger writes that the 'thingness of things' remains distant from humans as long as things are conceived as objects: "the thingly character of the thing does not consist in its being a represented object, nor can it be defined in any way in terms of objectness, the over-againstness, of the object" ("The Thing" 167).

[8] What a thing is depends upon who is asking. Humans are things, trees are things, everything manifest itself as things, and at the same time a 'thing' is something different from an object, as it becomes clear in this article. A thing may be represented as gathering of elements. There is no one thing, but rather gatherings of things in the thing itself.

[9] The privileged position of humans over objects and the dilemma following why the subject-object divide is problematic is articulated in an article titled "Can the Thing Speak?" (Holbraad).

[10] What is implied with this is that things are not alive, in an amphomorphic way, but rather that things exert agency and operate at times in different ways then normally attended.

[11] Ingold borrows from Bruno Latour's concept of a 'parliament of things' (*We Have Never Been Modern* 144-5).

[12] Actants as Latour defines them are anything that "[...] modifies other actors through a series of actions" (*Politics of Nature* 65).

[13] A list of glitch artists can be found at: http://gli.tc/h/wiki/index.php/Glitch_Artists

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