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RESEARCH ARTICLE

Materiality Versus Metabolism in the Hybrid World: Towards a Dualist Concept of Materialism as Limit of Post-humanism in the Technical Era

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Abstract
The point of departure of this article is the trend towards hybridisation in new technology development, which makes classical dichotomies between machines, human life and the environment obsolete and leads to the post-human world we live in today. We critically reflect on the post-human concept of the hybrid world. Although we agree with post-humanists that human life can no longer be opposed to machines but appears as a decentralized human-technology relation, alliance or network that constitutes a hybrid world, we ask for a limit to hybridisation. After rejecting the concept of metabolism as such a limit, we explore the concept of the responsive conativity of material entities. The principle of conativity of material entities provides a materialist perspective on metabolism, which enables us to conceive material entities as self-assertive material entities that are differentiated from the environment. The principle of responsivity of material entities provides a materialist perspective on the post-human world in which material entities are responsive to each other and form alliances and networks. We propose to differentiate between the conativity and responsivity of material entities and propose the conativity of matter as a limit to hybridisation in the post-human world.

Keywords Hybridisation · Ontology of Life · Philosophy of Technology · Post-humanism · Technological metabolism

1 Introduction

The ontology of life is heavily under debate in contemporary philosophy of technology and philosophy of the life sciences. Biomimetic technologies are for instance seen as *living machines* that integrate mechanic and organic aspects (Blok

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& Gremmen, 2018), synthetic biology brings forth *cell factories*, i.e. engineered micro-organisms that can produce commodities like animal-free meat and milk (Rijssenbeek et al., 2022), and artificial intelligence converges with human intelligence in hybrid decision support systems. It signifies a trend towards hybridisation in new technology development, in which classical dichotomies between technology and (human) life like mechanic-organic, matter-spirit, non-living-living, nonhuman-human bodies no longer apply and call for philosophical reflection on this new ontological category (Blok, 2023). Hybrids can be defined as an extra, separate, 'third' ontological category of entities transgressing classical classifications like the dichotomy between nature and technology, life and death etc. (Holy-Luczaj & Blok, 2019).

Philosophers of the 20th century like Ernst Jünger experienced this new hybrid reality already in the *organic construction* of human life as intertwined with its technological environment in World War I (Jünger, 1981). More recently, Donna Haraway argues in her *Cyborg Manifesto* from 1985 that there is no fundamental distinction anymore between human life and machines. According to her, the role of technologies is to overcome classical dichotomies like organic life and mechanic machines: "Late twentieth-century machines have made thoroughly ambiguous the difference between natural and artificial, mind and body, self-developing and artificially designed, and many other distinctions that used to apply to organisms and machines. Our machines are disturbingly lively, and we ourselves frighteningly inert" (Haraway, 2000: 293-294). Human life is technologically conditioned, ranging from our internet connection to all kinds of bodily prostheses, while machines perform 'intelligent' behaviour, ranging from chat GPT to all kinds of robots that replace the human workforce.[1] Human life can no longer be opposed to machines but appears as a decentralized human-technology relation, alliance or network that constitutes a hybrid world. Today, this idea is even extended to the natural world as entangled with the social world that forms a hybrid environment of nature-technology-culture (Latour, 2017). For some, this hybridisation goes as far as the identification of the domains of the artificial and the natural. For instance, the *technology* of the quantum computer is understood as the *nature* of the whole universe (Lloyd, 2006), i.e. nature is understood as a large quantum computer.

While philosophers like Jacques Ellul were pessimistic about these developments, as they saw technology mainly as technological *control* of human life and longed for the rehabilitation of the fundamental dichotomy between life and technology (Ellul, 1980), contemporary post-humanists like Haraway and Latour are on the contrary in favour of this hybridisation in which all classical dichotomies become blurred and a symmetry emerges between human life, machines and the natural environment (Haraway, 2000; Latour, 2017).

Although there are different versions of post-humanism (Miah, 2008), ranging from Fukuyama's idea that the hybridisation of humans and machines might lead to worrisome human enhancement and even replacement of humans (Fukuyama,

[1] We put 'intelligence' between brackets in order to avoid the debate about whether artificial intelligence is or is not comparable with human intelligence. This question is beyond the scope of this article (cf. Blok, 2023).

2002), Pepperell's idea that contemporary technologies undermine the idea of human control and superiority over nature (Pepperell, 1995), or Halberstam and Livingstone's idea that modern technology challenges the coherence of the human body (Halberstam & Livingstone, 1995), a common characteristic can be found in two interdependent characteristics: the blurring of classical boundaries between humans and non-humans due to technological advancements like artificial intelligence and biotechnology (Hayles, 1999), that challenges the humanist ideal of a universal or essential human condition and with this, the hierarchical orientation and anthropocentrism of human exceptionalism (Braidotti, 2019). It results in a (desired) loss of dichotomies that characterizes human versus non-human, organic versus mechanic, life versus death, the dis-integration of the humanist subject in the hybrid world and the convergence of human and non-human actors in symmetric or symbiotic collaborative networks (Haraway, 2018; Latour, 2017).[2]

In this paper, we do not ask whether the post-humanist position itself can be defended. On the one hand, post-humanism is a dominant theory in contemporary philosophy of technology. On the other, we agree with post-humanist philosophers of technology that human life can no longer be opposed to machines but appears as the decentralized human-technology *relation*, alliance or ecosystem that constitutes the post-human world in which there is no room anymore for traditional dichotomies. Contemporary philosophers argue however that we should acknowledge the symmetry of machines, human life and the environment as the 'World' we live in today, but should extend it with a remaining asymmetry that puts a limit to the total symmetry that post-humanism is after. Frederic Neyrath for instance argues that such an asymmetry is needed, because otherwise, there is no humanity that can take political responsibility, and decide and act upon this decision (Neyrat, 2019). I argued elsewhere that the tendency towards total symmetry testifies of *death wish* (Blok, 2021). Human life requires an asymmetry between our experience of the world and the world itself. The reason is that in order to *see* and *hear* ourselves or the environing world, a distance between ourselves as the ones who experience and the environment that we experience is required. If we are completely enmeshed in the hybridisation of machines, human life and the environment, experience is no longer possible, and if we cannot experience anymore, we are dead, i.e., there is no 'I' anymore who can experience. It is in this sense that we need to acknowledge an asymmetry beyond the acknowledgement of the symmetric World in which technology, human life and the environment are interconnected and interdependent.[3]

The problem with post-humanists is that they are often unreflective about the consistency of their position. The question is for instance whether the symmetry

[2] Although it is clear that Haraway has been influential, she rejects the version of post-humanism that focuses on human enhancement and is more interested in the possibility of disrupting hierarchies in human-human, human-machine and human-nature relations and based on this, calling for socio-cultural reform (Miah, 2008).

[3] It remains an open question whether only humans require such an asymmetry, as we argue in this article, or whether also non-human beings require such an asymmetry. In any case, the proposal we develop in this article can theoretically apply to humans in the post-human world, to non-humans in the pre-human world, and to a future world in which no humans are around anymore.

between human life, machines and the natural environment informs the post-humanist philosophy, or that a particular concept of hybrid technology in which no dichotomies remain informs their call for disintegration and convergence towards total symmetry. With this question, we don't want to imply that post-humanists do not acknowledge complexity, fragmentation and difference. But if post-humanists argue that we should acknowledge the symmetry of machines, human life and the environment we live in, then the question is whether and how there is still room for the complexity and difference they argue for. Either we take this fragmentation and difference seriously, but then we have to theoretically acknowledge a limit to the symmetry of machines, human life and the environment. Or we take the symmetry of machines, human life and the environment seriously, but then this implies that any complexity, fragmentation and difference that occur *within* the scope of this symmetric relation, is an asymmetry but only a difference *within* the same, an asymmetry *within* the symmetry of the post-human world.

In this article, we take the hybrid world we live in as point of departure to philosophically reflect on the limits to hybridisation in the post-human world. In section two, we explore the difference between living beings and non-living matter. Living beings are traditionally defined as metabolic systems while non-living matter is not metabolic. We will reject these limits to hybridisation as they start with a *difference* – life versus death, organic versus inorganic – and cannot take the phenomenon of hybridity seriously. In sections three and four, we reflect on the conativity and responsiveness of matter, inspired by new materialists. Contrary to new materialists, who see responsiveness as a second commonality that all material entities share and constitute the post-human world, we reject such a symmetry between the conativity and responsivity of material entities. On the one hand, we agree with new materialists that we live in a post-human world in which we are responsive to other material entities and form the alliances, networks and ecosystems in which we live and act. On the other, we reject the extension of the idea of the responsiveness of material entities to the geosphere of planet Earth, as rocks and sand dunes, elements like water and air, and geological phenomena like tectonic plates are in fact conative but not responsive. This difference enables us to disconnect the conativity and the responsivity of material entities and propose the conativity of matter as a limit to hybridisation in the post-human world. In section five, we draw our conclusions.

2 The Difference Between Living Beings and Non-Living Matter and the Metabolism of Life

One traditional dichotomy that is often put forward as a limit to hybridisation is the dichotomy between living beings and non-living matter. This seems to be legitimate, as living beings are traditionally defined as metabolic systems while non-living matter is not. Does such a fundamental dichotomy provide access to the remaining asymmetry in the symmetric world of post-humanism? In *The Phenomenon of Life,* Hans Jonas defines metabolism in terms of the continuous exchange of matter, energy and information between an organism and its environment that sustains life (Hverven & Netland, 2021; Jonas, 1966). Through the consumption of food and

energy, the metabolic system of organisms interiorizes the energy in food to keep their vital processes alive. Metabolism enables organisms to perform two essential aspects of living systems (Capra, 1982). What the interiorisation of matter, energy and information via metabolism achieves, is first of all that it constitutes and maintains the self or identity of the organic agent that is independent from the environment (Godfrey-Smith, 2016). Self-assertion requires the *assimilation* of the energy and matter in food to the structure of the metabolic system, and enables this organism to *dissimilate* from the environment as a self or identity that cannot be reduced to its constituting parts; the self of a cow or a human is metabolically produced from food, grain and cow meat for instance, but the metabolically produced cow *is* not the grass it ate or the cow meat the human has eaten. The self of the organic agent as output of the metabolic process is fundamentally different or a *dissimulation* of the input in the process. Second, metabolism enables this self-asserted autonomous self at the same time to be *integrated* into an exterior milieu, environment or ecosystem of matter, energy and information. This exterior milieu extends beyond the organism. Each and every metabolic system remains embedded in this exterior milieu, on which each and every metabolic system depends as a provider of food and energy; the self-asserted cell is integrated into an organ beyond the sum of the cells, a self-asserted organ is integrated into an organism beyond the sum of the organs, and a self-asserted organism is integrated into an eco-system beyond the sum of the organisms etc. Third, the metabolic process of self-assertion and integration does not produce the self in its environment once and for all, as the self continuously changes due to the flux of matter that is interiorized by the metabolic system. Cells are replaced, organs and organisms grow, develop and evolve while the self is preserved by the process of metabolism (Capra, 1982). Metabolic systems live and act in continuous exchange – eating, communicating, collaborating, adaptation - with the living environment of other metabolic systems and also with the non-living material conditions of the lithosphere, the hydrosphere and the atmosphere. The dynamic balance between the two aspects of the metabolic process – self-assertion and integration – constitutes a metastable organism as living and acting *in relation to* its ecosystem. We have to conceive metabolism at the ontological level, i.e. on the level of metabolic *processes* that constitute this organism in its environment for the first time. This process cannot be conceived from the perspective of the self of the organism as its outcome. Both self-assertion as well as integration have to be conceived from the perspective of the metabolic *process* that constitutes these selves as integrated in their ecosystem. The metabolic process constitutes the self and the environment of metabolic others, that enables the interiorisation of the other in the process of self-assertion (consumption and digestion) and the integration of this self in this exterior milieu of metabolic and non-metabolic others, i.e. the ecosystem in which each and every metabolic system remains embedded.

Can we oppose metabolic systems as living systems and non-metabolic systems as non-living matter? Does the dichotomy between living beings and non-living beings put a limit to the symmetry of machines, human life and the environment in the post-human world we live in today? In the case of engineered bacteria for medical or food production purposes, we can argue that these hybrids are in fact metabolic living systems and that they are metabolically engineered for medical or

agricultural production. On the one hand, if these hybrids are in fact metabolic systems, we shouldn't conceive them as machines, i.e. as cell *factories,* as is common in synthetic biology, but as engineered living beings (Rijssenbeek et al., 2022).[4] On the other hand, if these hybrids are in fact metabolic systems, we can classify them as *living beings* in contrast with non-living beings. Even if the engineer understands the structure of genes that guide metabolic systems, and if he or she engineers the genetic code in metabolically engineered cell factories, the engineer does not *create* life. The same holds for Haraway's concept of the cyborg. She argues that a cyborg is a hybrid of machine and organism, a cybernetic organism (Haraway, 2000). As a cybernetic *organism,* we can argue that the cyborg is still a metabolic system. As such, we can classify them as *living beings* in contrast with non-living beings. Nonetheless the hybrid post-human world we currently live in and in which we encounter rocks and stones, plants and animals, cell factories and cyborgs, a fundamental dichotomy between living entities and non-living matter classifies hybrids as metabolic *living* systems, just as plants and animals, and contrary to rocks and stones as non-living matter. The non-living material conditions of the lithosphere, the hydrosphere and the atmosphere are conditions of the possibility of the emergence of metabolic living systems but are not metabolic themselves. Does this fundamental dichotomy between metabolic living systems and non-metabolic non-living matter provide the limit to hybridisation in the post-human world we are looking for?

We can object that this depiction is too simple, as metabolism can be extended to the social domain of what is traditionally understood as 'non-living matter'. Not only the intake of food by an organism but also the transformation of the natural environment via human labour to make the social and build environment in which we live can be seen as a metabolic process that remains embedded in organic metabolism (Marx, 1974; Swyngedouw, 2005). The economic metabolism of labour produces organic products like agricultural food products and inorganic products like tables, shoes, machines, houses etc., that constitute the technical environment we live in. According to Marx, *human* metabolism guides and controls the *technical* metabolism that constitutes the built environment: "Nature builds no machines, no locomotives, railways, electric telegraphs, selfacting mules, etc. These are products of human industry; natural material transformed into organs of the human will over nature, or of human participation in nature. They are organs of the human brain, created by the human hand" (Marx, 1973: 706). Human-guided technological metabolism culminates in an "automatic system of machinery" that is set in motion by an automaton and in which the human mainly appears as a conscious linkage between "numerous mechanical and intellectual organs" (Marx, 1973: 692). Here, metabolism applies to the production process in which living *and* non-living matter is transformed into natural and artificial products that constitute the built environment in which we live and act.

Although one could argue that Marx originally used the term only as a metaphor, philosophers such as Arendt seem to take it in a more literal sense, as human labour:

[4] This distinction seems to be trivial, but has ethical consequences, as we traditionally give moral status to *living* beings, and not to non-living beings like machines.

"Labor is the activity which corresponds to the biological process of the human body, whose spontaneous growth, metabolism, and eventual decay are bound to the vital necessities produced and fed into the life process by labor. The human condition of labor is life itself" (Arendt, 1989: 7).[5] For this reason, we believe that the extension of biological metabolism to social or economic metabolism is not necessarily at odds with Marx's original intentions.

This extension of the notion of metabolism to the transformation of the natural environment in shoes, tables, houses and machines shows that the dichotomy between living beings and non-living beings doesn't necessarily put a limit to the symmetry of machines, human life and the environment in the post-human world. Not only living beings like cell factories and cyborgs are metabolic systems, but also non-living matter like shoes, houses and machines are the product of metabolic transformation; both the traditional domains of living beings and non-living matter are metabolic.

The reference to Marx provides however another dichotomy between human metabolism as primary and technological metabolism as secondary. Although human-guided technological metabolism leads to an automated system of machinery in which the human functions as an organ, the human remains the agent that intervenes, designs and establishes these technical metabolic systems. Marx argues for instance: "The first premise of all human history is, of course, the existence of living human individuals. Thus the first fact to be established is the physical organization of these individuals and their consequent relationship to the rest of nature" (Marx, 1974: 42). For Marx, the economic metabolism that produces 'non-living' artefacts like shoes and steam engines is guided by the 'living' metabolism of human life. The origin of this idea can be found in Aristotle's *Physics,* in which he argues that natural beings have the origin of their emergence in themselves, while artefacts have the origin of their emergence in an external agent, i.e. in human agency (Aristotle, 1980). This means that the symmetry between the metabolism of living beings and non-living matter is only achieved by the involvement of a particular subset of metabolic living beings, namely human beings as metabolic conditions of possibility of the establishment of technological metabolism. This anthropocentric position is the price Marx has to pay for the extension of the metabolism of living beings to economic metabolism. It concerns both human control of natural metabolism via agriculture, food production and health care, as well as the human control of economic metabolism of non-living matter like shoes, houses and machines (Veraart & Blok, 2021).

The dichotomy between human metabolism and economic/technical metabolism is not so much a new dichotomy that potentially limits hybridisation, but rather the

[5] The main purpose of referring to Arendt's work here is to show that labour is not only metaphorically understood as metabolism in philosophy. This idea is irrespective of her criticism of Marx, who didn't distinguish between labour and work. This idea is also irrespective of the context of modern consumer society, in which she discusses the metabolism involved in labour. We don't want to imply that her work endorses the symmetry of the hybrid world and acknowledge that a full understanding of her concept of the metabolism involved in labour requires a dedicated reflection on the other two parts of the human condition: word and action.

traditional Cartesian dichotomy that is precisely challenged by the post-humanist experience of hybrids. On the one hand, Descartes' philosophy is the origin of the humanist subject as *maître et possesseur de la nature*. On the other, it is precisely the hierarchical orientation and anthropocentrism of human exceptionalism that is challenged by post-humanism. How to understand the distinguishing factor of human metabolism if it is especially human life that is subject to hybridisation? It is precisely the fundamental dichotomy between the human subject that controls nature as its object, that is challenged by the experience that "our machines are disturbingly lively, and we ourselves frighteningly inert" (Haraway, 2000: 293-294). In other words, the problem with this dichotomy is that it falls back into the tradition that precedes our new reality of hybridisation and relies on pre-critical dichotomies that are precisely challenged by the experience of hybridisation. The anthropocentric position cannot ask for a limit to hybridisation, because it presupposes a priori already such a dichotomy between humans and the rest of nature and cannot take the phenomenon of hybridisation seriously.

Our reflections so far show a fundamental flaw in our efforts to find a limit to hybridisation. Whether we argue for a dichotomy based on the distinction between living beings and non-living matter or based on human metabolism and the of the rest of nature, in both cases, we start with a difference – life versus death, organic versus inorganic – distinguishing between living human beings and the rest of nature and cannot take the phenomenon of hybridity seriously anymore. If we are interested in a dichotomy that puts a limit to hybridisation while taking the phenomenon of hybridity in the post-human world serious, we shouldn't start with the difference between living matter and non-living matter, but with their commonality, i.e. their materiality. In order to take the phenomenon of hybridity seriously in our search for a limit to hybridisation, in the next section, the point of departure will be found in their materiality. We will ask for the nature of the materiality of both living beings and non-living beings, the materiality of human metabolism and the rest of nature, as a new point of entry to find a limit to hybridisation that takes the phenomenon of hybridity serous at the same time.

3 The principle of conativity as a common characteristic of both living beings and non-living matter.

The starting point for our argument is found in an early philosophical insight that is nowadays increasingly accepted in science: the idea that not only humans, but all things, have agency (Latour, 1993; Bennett, 2010). Based on the work of quantum physicist Niels Bohr, Karen Barad for example develops a theory of agential realism, i.e. the idea that entities are made of entanglements of intra-acting social and natural agencies (Barad, 2007). One of the origins of this idea can be found in the work of Spinoza. According to Spinoza, "each thing, as far as it can by its own power, strives [conatur] to persevere in its own being" (Spinoza, 1992: part 3, proposition

6).[6] Building on the work of Spinoza, new Materialist philosophers like Jane Bennett (2010) argue that all material entities, not only living beings but also non-living matter, are characterized by agency. Everything is conative, ranging from rocks and sand dunes, plants and animals, to cell factories and cyborgs.

If the starting point of our reflection on the limit to hybridisation should be found in de *commonality* of organic and inorganic material entities, the principle of conativity of all beings enables us to move beyond a position that starts its reflection on hybridity with a difference, without being able to take the phenomenon of hybridity in the post-human world serious.

Conativity is not to be understood as an ontic will or impulse of material entities to preserve themselves, but as an ontological principle that constitutes the being of these beings. Spinoza argues that the conativity to preserve oneself is the *essence* of material entities (Spinoza, 1992: par 3, proposition 7; Blok, 2019). It concerns a principle that establishes the *identity* of these material entities, a principle of *self*-assertion of material entities. We take conativity therefore not as the will of material entities, but as the principle of becoming *present* of material entities as a self that is differentiated from the environment and can subsequently produce effects on this environment.

The principle of conativity enables us to conceive the metabolism of living systems at the material level. The self-assertion of metabolic systems that we encountered in the previous section can be understood out of their being conative as material entities; *all* material entities are conative, i.e. self-assertive. The self-assertion of metabolic systems is just a special case of the conativity of matter that constitutes the self of material entities. While the conativity of living beings constitutes the self via metabolism, the self of non-metabolic entities is constituted via the conative differentiation of material entities that maintain themselves as differentiated from the material entities of which they are made, like a gulf in the ocean or a tornado of wind (Schneider & Sagan, 2005). The principle of conativity of material beings enables the self to assimilate and dissimilate the environment in the process of self-assertion – it constitutes the self or identity of a gulf or ripple as differentiated from the ocean in which they are embedded - and metabolism is just a special case of this general process of self-assertion that characterizes all material beings. This allows us to criticize Jonas, who argues that life breaks free from matter and becomes free (Jonas, 1966); not only life but all material entities are 'free', i.e. conative. It also enables us to criticize philosophers like Grosz, who tend to connect the superabundance and excess of new possibilities of existence with organic life (Grosz, 2005). The principle of the conativity of matter shows that all material entities are excessive. With the introduction of conativity as the principle of all material entities, we are able to move beyond the strict dichotomy of living entities and non-living matter; not only plants and animals, cell factories and cyborgs are conative, but also rocks and sand dunes.

[6] The introduction of the concept of responsive conativity in this section is derived from an earlier contribution (Blok, 2019).

To what extent can we consider conativity to be *essential* for the *identity* of material entities? If all material entities are conative and assert themselves, each material entity is resistant to everything that can take its existence away. This resistance is precisely the conativity or striving to assert oneself. All differentiated material entities that compose our reality are conative, self-assertive. As such self-assertive entities, each material entity is resistant to everything that can take its existence away. This resistance is precisely the conativity or striving to preserve oneself in the midst of the environment of material entities that strive to persevere in their own existence as well. In Spinoza's view, only one common substance—*Deus sive Natura*—constitutes the universe. All separated material entities that compose our reality are *modes* or *modifications* of this one substance. As such a mode, each material entity is resistant to everything that can take its existence away, and this resistance is precisely the conativity or striving to assert oneself as such a mode of the common substance (Spinoza, part 3, proposition 6). Conativity is essential then because it *differentiates* the identity of material entities from the environment's common but undifferentiated materiality, articulates and establishes the self or identity of these material entities *as* differentiated materiality (*self*-assertion), and resists at the same time efforts by this environment to overpower, digest and dissolve it again (self-*assertion).* Conativity is a process of self-assertion that differentiates the self of material entities like stones and sand dunes, trees and animals, cell factories and cyborgs from the environment and prevents their dissolution into this environment.

The self-assertion of conativity enables us to conceive the metabolic process at the material level. Not only metabolic systems like plants and animals, cell factories and cyborgs are characterized by self-assertion, but also rocks and sand dunes. On the one hand, the conativity of material entities provides a further specification of the self-assertion at stake in metabolic systems. Self-assertion is not a neutral process, as the assimilation of the energy and matter in food involves the annihilation of other metabolic systems that try to persevere in their own existence as well. Self-assertion therefore emerges in the context of resistance and headwind and comes at the expense of other metabolic systems. On the other hand, the principle of conativity of material entities provides the condition of possibility of each and every metabolic system. Metabolic systems are dependent on a fundamental difference between the inside and the outside of the system, i.e. the energy and matter in exterior food that the metabolic system interiorizes (consumption, digestion) in the process of self-assertion. This holds not only for heterotrophic organisms that consume organic nutrients in the external environment in order to live. It also holds for autotrophic organisms that produce their own nutrients. Also in this case, the energy to produce their own nutrients is absorbed from the external environment, like the energy of the sun in the case of photosynthesis. We call this the exterior milieu that constitutes the input in the metabolic process of interiorization that enables the assertion and maintenance of the self in the case of plants, cyborgs and living machines as output. While metabolic systems *presuppose* such a differentiation between the interiority of the self and the exteriority of the environment in order to live as metabolic systems, and metabolic systems are dependent on the exteriority of the environment of material entities that can be interiorized in the metabolic process in order to survive, the principle of conativity of material entities constitutes this differentiation of

the self of material entities from the other of this self, the exterior milieu on which each and every metabolic system depends. Why? The principle of conativity *differentiates* the identity of material entities from the environment of common but undifferentiated materiality as we have seen, differentiates the interior milieu of the self from the exterior milieu of the environment (food, energy) on which each and every metabolic system depends.

With this, the self-assertion of metabolic systems turns out to be not only a special case of the conativity of material entities. The self-assertion of metabolic systems is not only embedded in the self-assertion of the conativity of material entities – both metabolic and non-metabolic entities – but the conativity of material entities is also the condition of possibility of metabolic systems, as it provides the necessary exteriorization of the self from the other of the self that enables the interiorisation of this other in the metabolic process.[7]

The principle of conativity exteriorizes the identity of material entities as differentiated materiality (self-assertion) from the environment – a gulf in the ocean, a tree in a forest, an animal in the ecosystem - and constitutes the exterior milieu of differentiated material entities on which each and every interiorisation in the metabolic process depends. This doesn't imply that all material entities are metabolic. All material entities are conative but not yet metabolic. The principle of conativity constitutes a milieu of differentiated material entities that persevere in their existence (assimilation of the other in the process of *self*-assertion, which holds for both a 'growing' tornado and a growing child) and resists their dissolution by this exterior milieu of other differentiated material entities (dissimilation of the other in the process of self-*assertion,* which also holds for the mature tornado and the grownup child). In case of metabolic material entities, this self-assertion of conativity is achieved via the interiorization of the food and energy in the exterior milieu. The existence of this exterior milieu of material entities is the condition of possibility for the metabolic interiorisation that enables the assertion of the self (*self*-perseverance) and the resistance against the environment of other metabolic systems to interiorize and dissolve this self (self-*perseverance*).

With this materialist understanding of metabolism as a special case of the conativity of material entities, we can extend Jonas's idea that life not only breaks free from matter but is also dependent on this matter as food and energy. Each and every metabolic system is dependent on matter, but not only dependent on the availability of food and energy in the exterior milieu. It is primarily dependent on the exteriorization of this exterior milieu as a condition of possibility for each and every interiorization of this environment (food, energy) in the metabolic process. This

[7] We tend to think about this exteriorization and interiorisation at an ontic level, i.e. on the level of the entities as an outcome of the conativity of material entities. But just like in the case of metabolism (see section 2), we have to conceive the exteriorization and interiorization on the ontological level, at the level of the process of exteriorization of the external milieu and interiorization of this milieu that constitutes and maintains the self in this milieu. Not the material entity engage in the process of exteriorization and interiorization, but the process of exteriorization and interiorisation constitutes the self of material entities as persevering in the exterior milieu.

exteriorisation is performed by the principle of conativity that characterizes all material entities.

4 The Difference Between Conative and Responsive Conative Material Entities as a Limit to The Hybrid Post-Human World

So far, we have seen the commonality of all material entities. It enables us to conceive the difference between metabolic and non-metabolic material entities as secondary, as they are both characterized by the principle of conativity. This principle can therefore not provide a limit to the post-human world we live in. Can we, based on this commonality of the conativity of all material entities, also find a difference that enables us to articulate a limit to hybridisation?

According to Spinoza, material entities are not only conative but also *associative*; this means not only that the principle of conativity establishes the identity of material entities as differentiated from other material entities in the environment that can *affect* these other entities, but also that these differentiated material entities are always already *affected* by other entities, which are, in their turn, also performatively constituted by the principle of conativity. From a Spinozian perspective, each mode of Earth's materiality has to be seen as a composition of simple modes that affect and are affected by one another, that is, they are primarily *responsive* to one another and form the relatively stable bodies that we encounter in the environment, ranging from simple bodies like stones and bacteria to complex bodies like human beings and to complex networks and alliances of bodies like Earth's ecosystems. Or as Jane Bennett puts it:

> "Because each mode suffers the actions on it by other modes, actions that disrupt the relation of movement and rest characterizing each mode, every mode, if it is to persist, must seek new encounters to creatively compensate for the alterations or affections it suffers. What it means to be a 'mode', then, is to form alliances and enter assemblages: it is to mod(e)ify and be modified by others" (Bennett, 2010: 22).

Responsiveness means that a material entity does not only affect (i.e. shape and modify) other material entities in the environment but is at the same time itself affected (i.e. shaped and modified) by these other material entities.

If we conceptualize this responsiveness of material entities at an ontological level, that is, at the level of the articulation and establishment of the identity of material entities, we can conclude that the identity of material entities is not only performatively constituted by the conativity of material entities because this identity of material entities is at the same time constituted by their responsiveness to other material entities that are performatively constituted by the principle of conativity. In the differentiation of material entities by the principle of conativity, these entities are at the same time constituted by their responsiveness to the conativity of (other) material entities and build the complex ecosystems of planet Earth and the world in which these entities are interconnected and interdependent. Because of the principle of responsive conativity, the identity of material entities is interconnected

and interdependent with other material entities and builds the ecosystems of planet Earth, up to the world in which we are always already intentionally involved. This means that responsiveness is a second commonality that all material entities share and constitute the post-human world in which each and every material entity is conative and responsive to each other. We can even argue that the principle of responsive conativity legitimizes the post-humanist claim of the symmetry between human life, machines and the environment.

And yet, we can question the convergence of all material entities. We agree with new materialists that 'we' are not a subject in front of the world as an object. 'we' are always responsive to thousands of microorganisms as intestinal flora, just as 'we' am interconnected with and form alliances with other organisms that co-constitute our 'self' as embedded in these alliances and networks. 'We' form assemblages, alliances and ecosystems in which we are responsive to other material entities, dependent as we are on the continuous exchange, collaboration and communication between microorganisms, plants, and animals that affect and are affected by each other. In this respect, we agree with new materialists that we live in a post-human world in which we are responsive to other material entities and form the alliances and networks, that constitute the ecosystems of planet Earth in which we live and act. We call this environment of conative responsive bodies World (Blok, 2021).

But can we extend this World of responsive conative material entities to the geosphere of the Earth? We are reluctant to extend the idea of the responsiveness of material entities to the geosphere. A tree or animal is not the same as a stone, the sun or the mineral structure of the Earth. Just as flowers are heliotrope and responsive to the course of day and night, so it is not the other way around. Nietzsche's Zarathustra is incorrect when he argues: "You great star! What would your happiness be, had you not those for whom you shine?" (Nietzsche, 2017: 11). Just as humans are responsive to the lithosphere, hydrosphere and atmosphere when settling and building a city, a dam, or a defence line, it is not the other way around. Even if Vernadsky argues that life is a geological force (Vernadsky, 1986), an idea that gained significance in the new geological era of the Anthropocene (Hamilton, 2017) in which human interventions alter natural ecosystems, the stocks and flows of elements like nitrogen and carbon, and the energy balance of the Earth (Steffen et al., 2007), its being affected doesn't imply that the geosphere is *responsive* to the terraforming capacity of human existence that increased significantly since the industrial revolution. The geosphere of tectonic plates and oceans is conative but not responsive. We call this domain of conative bodies that constitute the geosphere the domain of elementary Earth, in contrast with the World of responsive conative bodies.

We hypothesise that the difference between conativity and responsivity provides an entry point to consider the limit to the post-human World. This asymmetry between conativity and responsivity puts a limit to the idea of the co-evolution of living beings, the biosphere and the geosphere, as von Humboldt argued (Capra, 1979), although we acknowledge that the evolution of the biosphere is conditioned by changes in the geosphere. Stones and minerals, elements like wind and gulf streams and volcanoes *affect* the post-human World in which we live, but the geosphere of the Earth is not itself *responsive* to affordances set by plants and trees,

living machines and cyborgs[8]. The mineral composition of the earth, the wind and gulf streams etc. are conative and co-constitutive for the assemblages and ecosystems of the world in which we live and act. However their mineral and chemical structures are not *responsive* to plants, animals and humans. There is an asymmetry between being affective and being affected in the case of rocks, sand dunes and other mineral structures that constitute planet Earth.

New materialists and post-humanists tend to overlook this fundamental difference as they have the tendency to conceive the materiality of the Earth from the perspective of the organic, of what is alive, while neglecting that the eruptive nature of sand dunes, plate tectonics and oceans is indeed conative but not responsive at all. Contrary to the conative material entities that constitute the geosphere of the Earth, responsive conative entities like trees, plants, cell factories and cyborgs always live and act in alliances and ecosystems and constitute the World. In this post-human World, conative responsive bodies are responsive to conative material entities that constitute the lithosphere, hydrosphere and atmosphere of the Earth – a tree doesn't grow in the high mountains, cell factories emerge on land in a relatively stable climate etc. - and to other responsive conative material entities in the ecosystem – a tree forms an alliance or ecosystem with other responsive conative entities like birds, microorganisms and fungi, a cell factory forms an alliance or ecosystem with knowledge institutes, production facilities and distribution channels etc.

What about artefacts like tables or technologies like computers? Do they belong to the category of conative material entities or to the category of responsive conative entities? The reference to cyborgs, hybrids, production facilities and knowledge institutes indicate that not only organic entities like trees and animals but also computers and laboratories have to be understood as responsive conative material entities. The reason is that these technologies are insufficiently understood as artefacts, but have to be understood as relational phenomena, i.e. as human-technology-world relations (Blok, 2022a). Just like trees and animals constitute their identity in continuous response to affordances in the environment, the same holds for technologies. Let's consider for example the innovation and evolution of the first steam engine in the wake of the Industrial Revolution. Just like all material entities, steam engines are conative. What is at stake in the innovation of the first steam engine is however not only the creation of a new material entity, but with this, the creation of a new-to-the-world identity or self of the steam engine as differentiation from the environment. This process of creation is however not an autonomous process that can be explained by the principle of conativity only. The history of technology shows that their invention and evolution are not only conative but also determined by other

[8] The term affordance is derived from James Gibson's affordance theory (Gibson, 1979). According to Gibson, we do not perceive stimulus information from the outside world, which we process consciously or unconsciously, but rather affordances in the environment. The word affordance indicates the meaning of a thing or organism in the environment, which is detected or picked up by the perceiver and allows him or her to perform a specific kind of action; air affords breathing and water affords drinking for example, a chair affords sitting and a hammer affords hammering. The particular relation between the affordances in the environment and the conativity and responsivity of entities is beyond the scope of this article (see Blok, 2019).

material entities in the environment. For example, the invention of the steam engine is building on preceding innovations like the steam turbine and the steam pump. Furthermore, its invention is responsive to complementary innovations. The components of the steam engine like the piston and cylinder co-evolve and are responsive to each other in their convergence in the steam engine. Also, the innovation of the steam engine is shaped by the environment of material conditions, e.g., the availability of iron to build the steam boiler and coal to fuel the steam engine. These conditions already show that the process of innovation is not necessarily driven by the human agent as creator, but that the innovation of technologies like the steam engine is conative like any other material entity and is at the same time *responsive* to the material conditions with which they co-evolve (Blok, 2022a).[9]

The advantage of a materialist perspective on the responsive conativity of both organic and inorganic entities is, that it enables us to acknowledge the symmetry of machine, human life and the environment of the post-human World we live in. At the same time, it enables us to provide a progressive alternative to the concept of technological metabolism we criticized in the previous section. The invention of the steam engine is not understood as a direct metabolic process – i.e. the steam engine doesn't emerge due to the interiorisation of the exterior environment in the process of self-assertion like a tree or a plant – nor as a secondary metabolic process led by human agency. In fact, technologies like steam engines, trees, and cyborgs are responsive conative bodies that coevolve with other responsive conative bodies and constitute the post-human World. But responsive conative bodies are not only responsive to other responsive conative bodies like other plants in the ecosystem or other devices in the R&D lab but also responsive to conative bodies that are not responsive themselves and constitute the geosphere of the Earth. Like the flower is heliotrope and responsive to the sun while the sun is not the other way around responsive to the flower, the invention and evolution of the steam engine is responsive to a favourable climate for its invention – a stable subsoil for instance – and not the other way around.

While not responsive themselves, conative material entities like iron, coal and a favourable climate for the invention of steam engines constitute the geosphere of the Earth and are *prerequisites* for the emergence of responsive conative material entities like steam engines that form the alliances and ecosystems in which we live and act. The responsivity of material entities requires a difference between the self and the other to which it is responsive, and this difference is provided by the principle of conativity that can be found in conative and responsive conative bodies. The conativity of material entities is the condition of possibility for the emergence of the responsiveness of a subset of these conative bodies – ranging from trees, plants, steam engines, cell factories and cyborgs – that constitute the post-human World.

[9] As the main objective of this article is to develop a dualist concept of materialism as the limit of post-humanism, this brief description of the classification of technical objects in the category of responsive conative bodies, rather than in the category of conative bodies, is sufficient but requires more dedicated research in the future, as all kinds of border cases and intermediate forms might be possible.

To the extent that *responsive* conative entities like trees, plants, steam engines and cyborgs always live and act in alliances or ecosystems in which the self of these material entities is responsive to other conative and responsive conative entities, this responsiveness that constitutes the post-human World is preceded by *conative* bodies that exteriorize this exterior milieu of the geosphere of planet Earth to which responsive bodies are responsive.[10] While conative bodies are absorbed by the process of self-assertion and exteriorize the exterior milieu in the process of self-assertion, responsive bodies are freed from the sole focus on self- assertion of conative bodies. They are at the same time oriented on these others with whom they form the alliances and eco-systems of the post-human World. We characterize these entities, that constitute their identity in continuous response to affordances in the environment, as the other-assertion of responsive bodies, next to their self-assertion as conative bodies. The other- assertion of responsive conative bodies is not only responsive towards the other for the sake of the acknowledgement of the other. Responsive bodies remain also conative and require the recognition of their 'self' by these other responsive conative bodies; the self of an organ is what it is *in* an organism, while a tree is what it is *in* the ecosystem of a forest. On the one hand, responsive *conative* entities are dependent on other conative and responsive conative entities that constitute the exterior milieu on which the interiorization in the process of self-assertion depends (see section 2). On the other hand, *responsive* conative entities are freed from the sole focus on the interiorization and are at the same time responsive to these other material entities with whom they form alliances, ecosystems or the post-human World in which we live and act.

The post-human World of responsive conative material entities is not opposed to the geosphere of the Earth of conative material entities. The geosphere of the conative material entities is part of this World, for instance as a rock or humid environment that co-constitutes the ecosystem in which responsive conative material entities form the post-human World. Part of the World in which the plant and the cyborg exist is a favourable climatic composition for their survival. This favourable climate consists of conative bodies like the soil in which the plant is rooted. Conative bodies that compose the soil are not responsive, but self-sufficient in their perseverance in their own existence, autarkic rather than responsive, and yet, the condition of possibility of the emergence of the plant as conative and responsive to the soil. Responsive conative material entities are responsive to the geosphere of the Earth, but this responsiveness is not reciprocal like in the case of the trees and other trees and animals that constitute the ecosystem.

If we conceptualize the conative responsiveness of material entities at an ontological level, i.e. at the level of the articulation and establishment of the identity of material entities in the world like plants, steam engines and cyborgs, we can conclude that the identity of these material entities is not only performatively constituted by the *conativity* of material entities, because the identity of these material entities is at the same time constituted by their *responsiveness* to other material

[10] The question of whether and how responsive conative material entities emerge out of conative material entities is beyond the scope of this article.

entities that are performatively constituted by the conativity of other material entities. In the conative differentiation of material entities, a subset of these conative entities is co-constituted by their responsiveness to other conative and responsive conative entities that constitute the post-human World.

With this, we introduce a dualist notion of the conativity of material entities that can provide a limit to hybridisation in the post-human World. A materialist perspective enables us to differentiate between the conativity and responsivity of material entities. While the responsivity of conative bodies constitutes the post-human World, the conativity of conative and responsive conative bodies enables us to acknowledge a remaining asymmetry that puts a limit to the total symmetry of machine, human life and the environment. The advantage of the dichotomy between the conativity and responsivity of material entities is that the conativity of material entities puts a limit to hybridisation, without falling back in traditional oppositions like organic versus inorganic, living entities versus non-living matter, or natural metabolism versus human-induced technological metabolism. While new and emerging phenomena like cell factories and cyborgs can be classified as responsive conative material entities that constitute the post-human World, their conativity guarantees that their self-perseverance remains asymmetric compared with their responsiveness. This can already be observed in the case of artifacts like a computer or an organism like an animal. On the one hand, they are part of an ecosystem – a laboratory, an ecosystem - and on the other, they withdraw from this responsiveness, resist their absorption in this ecosystem and remain differentiated from this environment. This difference can be found in the material stubbornness or obstinacy of artefacts that the engineer cannot control, the emergence of misfits in the ecosystem, or the emergence of invasive species in the ecosystems that disrupt the multi-stability of the system. As responsive conative entities ourselves, we are also not only responsive to the world and do not only form a symmetric relation with other conative entities – plants, animals, steam engines and cyborgs – that constitute the post-human World in which we live and act, as we are also able to *deviate* from the established World and explore new possibilities (Blok, 2022b). In this distinction between the conativity and responsivity of conative and responsive conative entities, we find the limit to the post-human World in which we live and act.

5 Conclusion

The point of departure of this article was the trend towards hybridisation in new technology development, which makes classical dichotomies between machines, human life and the environment obsolete and leads to the post-human World we live in today. We critically reflected on the post-human concept of the hybrid world. Although we agree with post-humanists that human life can no longer be opposed to machines but appears as a decentralized human-technology relation, alliance or network that constitutes a hybrid world, we asked for a limit to hybridisation. While post-humanists acknowledge the total *symmetry* of machines, human life and the environment, we asked for a remaining asymmetry that puts a limit to this symmetry or symbiosis between human life, technology and the environment.

We explored several potential limits to hybridisation. In section two, we explored the difference between living beings and non-living matter. Living beings are defined as metabolic systems while non-living matter is not metabolic. This dichotomy can be questioned, as we have seen because metabolism can be extended to the social domain of what is traditionally understood as non-living matter; economic metabolism of labour and technological metabolism of production consists in the transformation of the natural environment in organic products like food and inorganic products like artefacts that constitute the built environment in which we live and act. This extension of the domain of metabolism turned out to presuppose an anthropocentric position, i.e. human metabolism that manages and controls economic and technical metabolism. This anthropocentric position guarantees on the one hand that no limit to the hybridisation of organic, economic and technical metabolism can be found, while it on the other hand relies on a traditional dichotomy between human metabolism versus economic/technical metabolism that is precisely challenged by the experience of hybridisation. We concluded that the problem with potential limits to hybridisation is that they start with a *difference* – life versus death, organic versus inorganic – and cannot take the phenomenon of hybridity seriously anymore.

For this reason, we took the commonality between living beings and non-living matter into account in section three, i.e. their materiality. Inspired by new materialism, we reflected on the conativity of matter. On the one hand, the principle of conativity of material entities provides a materialist perspective on metabolism, which enabled us to conceive all material entities as self-assertive material entities that are differentiated from the material environment of which they are made. On the other hand, the principle of conativity of material entities turned out to be the condition of possibility of metabolic systems, as metabolic systems are dependent on a difference between the inside and the outside of the system - the energy in exterior food that the metabolic system interiorizes in the process of self-assertion – while the principle of conativity constitutes this differentiation of the self from the other of the self; the conativity of material entities consists in the exteriorization of the self from the other of the self that enables the interiorisation of this other in the metabolic process.

While the advantage of the principle of conativity is that it provides the *commonality* of all material entities we were looking for, it doesn't help to limit the post-human World we live in. In section four, we therefore reflected on a second characteristic of all material entities that is put forward by new materialists, namely the idea that material entities are responsive to one another and form the relatively stable bodies that we encounter in the environment, ranging from stones and algae to complex bodies like cyborgs and complex networks like the ecosystems of planet Earth. While new materialists see responsiveness as a second commonality that all material entities share and constitute the post-human World in which each and every material entity is conative and responsive to each other, we provided reasons to reject such a symmetry between the conativity and responsivity of material entities. On the one hand, we agree with new materialists that we live in a post-human World in which we are responsive to other material entities and form the alliances, networks and ecosystems in which we live and act. On the other, we reject the extension of the idea of the responsiveness of material entities to the geosphere of planet

Earth, as rocks and sand dunes, elements like water and air, and geological phenomena like tectonic plates are in fact conative but not responsive.

This difference enabled us to disconnect the conativity and the responsivity of material entities. While all material entities are conative, a subset of these entities is both conative and responsive. We subsequently explored the difference between conativity and responsivity as a way to acknowledge the symmetry of machines, human life and the environment in the post-human World, and at the same time to limit this post-human World. In the conative differentiation of material entities, a subset of these conative entities is co-constituted by their responsiveness to other conative and responsive conative entities that constitute the post-human World. While the responsivity of conative bodies constitutes the post-human World, the conativity of conative and responsive conative bodies enables us to acknowledge a remaining asymmetry that puts a limit to the symmetry of machine, human life and environment.

The first advantage of our rehabilitation of an asymmetry between the conativity and responsivity of material entities is, that we do not presume the difference that we want to demonstrate, like in the case of metabolism, but acknowledge both the identity of different material entities (based on the principle of conativity) and a fundamental difference between various types of material entities (based on the principle of responsivity).[11] The second advantage of our rehabilitation of an asymmetry between the conativity and responsivity of material entities is, that we can acknowledge the post-human World in which machines, human life and the environment are responsive to each other, without acknowledging total symmetry. Because post-humanists focus on the responsivity of material entities, everything is absorbed by the assemblages or networks they constitute, while our conceptualization of the asymmetry between the conativity and responsivity of material entities leaves room for the agency of material entities beyond the assemblages and networks they constitute. The third advantage of our rehabilitation of an asymmetry between the conativity and responsivity of material entities is, that we can rehabilitate human responsibility in the post-human world. In section 1, we saw that an asymmetric relation is needed to enable humanity to take the blame for climate change and to take political responsibility. Humans are responsive conative beings, and the asymmetry between responsivity and conativity enables us to put a limit to the absorption of the human in the post-human World. As responsive bodies, humans are part of the post-human World. But as conative bodies, humans are differentiated from the world, leaving us room to take political responsibility, decide and act upon our decisions. In other words, the responsive conativity of human existence enables us to assign agency and

[11] The acknowledgement of identity and difference also enables us to respond to a possible objection to our concept of hybrids. One could argue that a hybrid by definition contains non-hybrid components. We provided the example of cell factories, which can also be seen as non-hybrid 'living' entities that are engineered. The asymmetry between the conativity and responsivity of material entities enables us at least to acknowledge both the hybridity and non-hybridity of material entities, although it also raises new questions about the nature of the difference, non-difference and maybe even in-difference of hybrids, which is beyond the scope of this article. It also enables us to open the debate about the political dimension of the question about hybridity beyond the theoretical perspective that we mainly focussed on in this article.

responsibility for the catastrophe of climate change, without falling back in the modernist position of the Cartesian subject.

The acknowledgement of a remaining asymmetry doesn't indicate a 'weak' post-humanism, contrary to the 'strong' versions of post-humanism that can be found in the work of Haraway and Latour (section 1). Our position is not weak post-humanist, as if we primarily rehabilitate a remaining asymmetry between human existence and the environment. Rather, our position is materialist in nature, as the asymmetry is found in the conativity and responsiveness of *material* entities like trees, technologies *and* human life. It is not so much the case that human existence requires a post-human world to survive in times of climate change, but a dichotomy between the conativity and responsivity of material entities to enable human existence to take political responsibility.

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