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ANTHROPOCENE, CAPITALOCENE, MACHINOCENE: ILLUSIONS OF INSTRUMENTAL REASON

ABSTRACT
In their seminal work, *Dialectics of Enlightenment*, Horkheimer and Adorno interpreted capitalism as the irrational monetization of nature. In the present work, I analyze three 21st century concepts, Anthropocene, Capitalocene and Machinocene, in light of Horkheimer and Adorno's arguments and recent arguments from the philosophy of biology. The analysis reveals a remarkable prescience of the term "instrumental reason", which is present in each of the three concepts in a profound and cryptic way. In my interpretation, the term describes the propensity of science based on the notion of physicalism to interpret nature as the machine analyzable and programmable by the human reason. As a result, the Anthropocene concept is built around the mechanicist model, which may be presented as the metaphor of the car without brakes. In a similar fashion, the Machinocene concept predicts the emergence of the mechanical mind, which will dominate nature in the near future. Finally, the Capitalocene concept turns a perfectly rational ambition to expand knowledge into an irrational obsession with over-knowledge, by employing the institutionalized science as the engine of capitalism without brakes. The common denominator of all three concepts is the irrational propensity to legitimize self-destruction. Potential avenues for countering the effects of "instrumental reason" are suggested.

KEYWORDS
Instrumental reason, Anthropocene, Machinocene, Capitalocene

The melancholy science from which I make this offering to my friend relates to a region that from time immemorial was regarded as the true field of philosophy, but which, since the latter's conversion into method, has lapsed into intellectual neglect, sententious whimsy and finally oblivion: the teaching of the good life… Our perspective of life has passed into an ideology which conceals the fact that there is life no longer. (Adorno 2005: 15)

1. Introduction

Is it possible to analyze capitalism in light of biology? Provided that the question is understood as a philosophical question, a positive answer to it is identifiable in the works of the first generation philosophers of the Frankfurt School. In *Dialectics of Enlightenment* (DE) Max Horkheimer and Theodor Adorno interpreted

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capitalism as an irrational monetization of nature (Horkheimer and Adorno 2002). Here is a metaphor, which explains the relationship between capitalism and nature in the manner close to the Adorno-Horkheimer style of thinking.

Let us imagine that capitalism represents a form of a car. The driver of the car is the entire humanity via its socio-economic activity (Hawken et al. 1999; Soete et al. 2015; Schwab 2016). The car has the functioning engine and the functioning mechanism for speed enhancement controlled by the gas pedal. However, the car differs from standard car models in that it lacks the brake. It is not programmed to stop, slow down or reverse back because the economic recession is not computed in the car model. Instead, the car is modeled on the assumption that the global economy must grow – the pressure on the gas pedal is constant. If, for some reason, the car enters the unfavorable territory such as an uphill path, which leads to it slowing down (recession), the car is programmed to immediately search for solutions as to how to avoid such a path and return to the state of acceleration again (Soete et al. 2015).

In the language of cybernetics, the car without brakes as a metaphor for capitalism means that modern humanity constantly self-enhances positive feedback. All natural systems are exposed to two types of regulatory pressure. One type of pressure is the positive feedback loop (Camazine et al. 2003: 15–28) – the accelerating car metaphor. The alternative type of pressure is the negative feedback loop (Camazine et al. 2003: 15–28) – the brake metaphor. Constant balancing of positive and negative feedbacks, acceleration and brake, is the source of natural systems' stability or homeostasis.

The sources of positive feedback in natural systems such as plant or animal populations, for example, are their capacities to multiply through sexual reproduction and to maintain the scale of population growth through exploiting nutritional and other resources available in the ecosystem (De Angelis et al. 1986: 5–14, Schoener 2011). The sources of negative feedback include their natural predators, lack of nutritional and other resources in the ecosystem, various diseases and ecological catastrophes (De Angelis et al. 1986: 5–14, Schoener 2011). The biosphere itself is the super-system which (i) integrates numerous sub-systems produced by 9 million extant biological species[1] (Mora et al. 2011) and (ii) maintains its own homeostasis (Lovelock and Margulis 1974).

Modern humanity, as a natural system, defeated all predators, eradicated all major infectious diseases and invented technologies for the ecosystem alteration, thus eliminating important natural sources of negative feedback (Bateson 2000, Schwab 2016). This enabled capitalism, as the dominant human socio-economic form, to become the conquest of nature (Hawken et al. 1999, Moore 2017, 2018). Nature is seen as an unlimited source of cheap capital. The only requirement is the identification of the means by which the capital

1 Estimates of the species number vary. The most recent one (Larsen et al. 2017) suggests that the total number of species is 1-6 billion, with the 70%-90% of the species range representing bacteria. The estimate by Mora et al. 2011 excludes microbes (bacteria and archaea).

hidden in nature can be released. In the conquering attempt of this sort, any form of brake becomes an obstacle.

Given that a reliance on the positive feedback generates an enormous risk to the system as a whole (De Angelis et al. 1986: 5-14, Bateson 2000: 486–496, Camazine et al. 2003: 15–28), humanity must discover a form of a negative feedback loop. The self-imposed negative feedback loop could enable stabilization of the damaged ecosystem. In other words, without the functioning brake, the accelerating car is doomed to a crash, sooner or later, because the super-system eventually punishes the lack of negative feedback (Bateson 2000: 486–496, De Angleis et al. 1986: 5–14, Camazine et al. 2003: 15–28). Modern humanity has already entered the ecological disaster of its own making, known as the sixth mass extinction of species (Ceballos et al. 2015) or biological "annihilation" (Ceballos et al. 2017) which reduces biodiversity required for the long-term survival. Other manifestations of existential risks due to the lack of negative feedback include climate change, potential loss of control over technologies and vulnerabilities of human systemic technologies to external insults (Rees 2003). Thus, the invention of the brake on the imaginary car of capitalism becomes a necessary civilizational requirement.

In this paper I will argue that the greatest contribution of the Critical Theory of Frankfurt School, primarily Adorno and Horkheimer, to the modern philosophical, sociological and scientific discourses is demonstration, in an indirect way, that the invention of the brake on the accelerating car of capitalism constitutes an anti-barbaric act and thus a necessary civilizational advance, or more precisely an antidote against self-destruction. I will use the concept of Anthropocene (Crutzen and Stoermer 2000, Lewis and Maslin 2015: 171) and its more recent derivatives, Capitalocene (Moore 2017: 597; Moore 2018: 2) and Machinocene (Price 2016), as the ground for analysis. In the next section, I will outline the investigative platform on which this study is based and explain terminology. In subsequent sections, I will develop new analytics of modernity based on several recent developments in biological sciences.

2. Investigative Context and Definitions of Terms

The purpose of this section is to (i) outline the investigative framework on which this study is based and (ii) explain terms Anthropocene, Capitalocene and Machinocene. The main text that forms the investigative basis of the study is DE, first published in 1944. The concepts of Anthropocene, Capitalocene, and Machinocene, all invented in the 21st century, are predictable in principle, by the argumentation expressed in DE.

The starting point in constructing the investigative framework is the exposure of the accelerating car of capitalism metaphor (ACM in the rest of text) to the spirit of DE arguments, with a view to merging them together. One of the key concepts of DE is "instrumental reason" explicable by the criticism of the foundation of science. Scientific world-view, which dominates western civilization since Enlightenment, is based on the mechanistic understanding of nature.

> In Galileo's mathematization of nature, *nature itself* is idealized on the model of the new mathematics... Thought is reified as an autonomous, automatic process, aping the machine it has itself produced, so that it can finally be replaced by the machine. (Horkheimer and Adorno 2002: 19).

Interpretation of nature as a mechanical system, the machine, can only be invented by a form of reason that becomes irrational – "instrumental reason".

ACM reflects mechanicism that permeates the scientific world-view dominated by physicalism (Barbieri 2016: 2). In brief, physicalism is the notion that all sciences are reducible to the mechanics of physics (Wächtershäuser 1997, Stoljar 2017). (I will argue later that nature cannot be reduced to mechanistic arguments of physicalism; see the Machinocene section). The shiny and fast car, which we drive, is a mechanical invention par excellence, with all attributes of progressivism. The fuel for the car is science and technology, also recognized by the acronym R&D (research and development) – the humanity's collective laboratory, turned-fuelling-station, which interprets the entire nature as the source for fuel extraction (Hawken et al. 1999, Soete et al. 2015, Moore 2017, Moore 2018). Everything seems perfectly rational in this laboratory. An army of 7.8 million scientists producing 1.5 million research papers and millions of patents per annum works on generating the fuel for the car in the most ingenious ways by applying powerful inventions based on the scientific method (Soete et al. 2015: 14–18).

However, the irrationality of the dominant scientific world-view manifests as the inability to see (blindness) that a car without brakes is doomed to a crash. There are enough signs to recognize that the car has already started colliding with its natural habitat. One of the signs is a recently reported phenomenon of "biological annihilation", which may damage the biosphere irreversibly (Ceballos et al. 2017: E6089). However, there is no mechanism on the car or within the car, which can detect the crash, the same way the mechanism for braking is non-existent. As a result, the global scientific laboratory-turned-fueling-station, continues to work unabated. The option of stopping the car to assess damage to itself and its habitat is not available. Instead, humanity continues to accelerate the car by using ever more powerful types of fuel leading to ever greater damage–a clear sign of irrationalism of "instrumental reason". The ACM model is further rationalized by suggesting that there is no need for inventing brakes (Hawken et al. 1999: 1–21). Instead, nature should undergo voluntary enslavement to capitalism by opening its avenues long enough and wide enough, so that the need for the brake on ACM is eliminated.[2]

2 This is the key message of the influential book (Hawken et al. 1999: 4). The authors identify four forms of capital: human, financial, manufactured and natural. The first three forms of capital use the fourth form (natural capital or the entire nature) as the material for creating "cars, highways, cities, bridges, houses, food, medicine, hospital and schools." The estimated value of the natural capital is $ 400 – 500 trillion in total, or $ 30 trillion annually (the equivalent of the world economic output).

The merger of ACM and the spirit of DE arguments thus represent the investigative framework summarized in Table 1. The merger is formally facilitated by selecting relevant quotes from DE and pairing them with the rationalist and irrationalist components of ACM outlined above (Table 1). This framework will serve as the basis for analysis in subsequent sections of the article. Before starting the analysis it is important to define the terms Anthropocene, Capitalocene and Machinocene.

Table 1. The investigative framework of the study constructed by combining relevant quotes from DE and the ACM metaphor discussed in the text.

	DE	**ACM**
Argument for rationalism	Enlightenment, understood in the widest sense as the advance of thought, has always aimed at liberating human beings from fear and installing them as masters. (Horkheimer and Adorno 2002: 1)	Human technological progress is deceptively rational: a perfect mechanism for enhancing positive feedback.
Argument for irrationalism	Yet the wholly enlightened earth is radiant with triumphant calamity. (Horkheimer and Adorno 2002: 1)	Human technological progress is hopelessly irrational: it lacks negative feedback required for balancing its potentially deadly over-drive.

All three terms express, each in its own way, forces of domination which humanity is trying to exert over nature. The term Anthropocene, coined by a Nobel Prize winning chemist, Paul Crutzen, and his colleague Eugene Stoermer (Crutzen and Stoermer 2000) is summarized by the following quote:

> ...humanity replaced nature as the dominant environmental force on Earth (Rudimman et al. 2015: 38).

This message, in the context of the scientific world-view, is the logical consequence of the growth of scientific knowledge governed by physicalism.

> Knowledge, which is power, knows no limits either in its enslavement of creation or its deference to worldly masters. (Horkheimer and Adorno 2002: 2)

However, the physicalist message was countered long before the term Anthropocene was invented:

> What human beings learn from nature is how to use it to dominate wholly both it and human beings. ...Only thought which does violence to itself is hard enough to shatter myths. (Horkheimer and Adorno 2002: 2)

Thus, DE reminds us that the roots of the Anthropocene concept are in "instrumental reason" but not in science. The origins of "instrumental reason"

precede science and can be traced to the territory of human culture we call mythology. Given that mythology is an ever-present part of human culture, at least since the origin of languages, the inevitable conclusion is that roots of "instrumental reason" may be in the human nature, as argued by biologist Edward O. Wilson (Wilson 2012:56). Science is nothing but a tool in hands of "instrumental reason" which becomes the victim of mythologization (see below).

The Capitalocene concept is a recent variation on the Anthropocene theme developed by Jason M. Moore (Moore 2017; Moore 2018). It represents a powerful criticism of the Anthropocene concept. Its critique is focused on how Anthropocene misinterprets its historical and philosophical roots. The key argument is that the Anthropocene concept represents a product of philosophical reductionism based on the Cartesian split. The Cartesian split turned humanity into an independent subject and nature into a passive object. This gave a license to the subject to dominate the object. However, humanity and its institutions are an integral part of nature. Moore used the phrases "humanity-in-nature" and "nature-in-humanity" to contrast the Cartesian stance of humanity and nature as separate and independent entities. Thus, Moore defines capitalism as the global ecology, which combines the quest for power and coproduction with nature into an organic whole. Whether this organic whole has any long-term future is a different matter.

The value of the Capitalocene concept is in highlighting important omissions that make Anthropocene almost untenable in the context of new developments in foundations of biology (see below). Also, it helps refine the ACM model. Even though the car is driven by the entire humanity through the acceptance of international regulations for the global capitalist economy (world-ecology) the ACM model itself is (i) invented by the minority and (ii) imposed by the minority on the majority without any explicit approval. Such approval was not required simply because at the time of the origin of the model (Europe around 1450 according to Moore) institutions for approval did not exist. This poses an important question of whether the imposition without approval is part of "nature-in-humanity".

The term Machinocene, used in a recent essay (Price 2016) expresses the view that AI (Artificial Intelligence) will dominate nature in a not so distant future (the end of the 21st century). The expectation is that some form of machine superintelligence may become autonomous and supersede human intelligence (Bostrom 2014). The Antropocene as the force dominating nature will be replaced by the mechanical mind of Machinocene. This view is based on the mechanistic understanding of nature and as such, it represents a powerful expression of "instrumental reason".

3. Analysis

Developments in biological sciences in the last several decades suggest that biology may not be fully reducible to physics (Bateson 1979, 2000; Rosen 1991, Capra 1997; Elsasser 1998; Maturana and Varela 1998; Kineman 2011; Slijepcevic

2018a). This is not to say that laws of physics are not applicable to biological systems; or that biological systems do not obey the laws of physics. Instead, it may be possible that the behavior of living organisms is not reducible to physicochemical causality. Here is an argument put forward by a mathematician and theoretical biologist Robert Rosen (Rosen 1991: 13):

> Why could it not be that the "universals" of physics are only so on a small and special (if inordinately prominent) class of material systems, a class to which organisms are too general to belong? What if physics is the particular, and biology the general, instead of the other way around? If this is so, then nothing in contemporary science will remain the same.

Some of the relevant developments in the biological sciences, which constitute a powerful argument against physicalism, and support the framework outlined in Table 1, will be explored in detail. Given that the physicalist outlook is at the heart of the Anthropocene and Machinocene concepts, I will next outline a critique of these concepts based on the Table 1 framework. The Capitalocene concept, which is closer to the DE style argumentation, will be refined in light of the framework.

3.1 Criticism of the Anthropocene Concept

3.1.1 Mythologization of Science or How to Justify the Progressivism of ACM

According to Walter Elsasser, we live in the post-rationalist world. His analysis of Enlightenment parallels DE:

> The period of Rationalism, in its early phases usually called the "Enlightenment," began, roughly, around 1600 and lasted nearly 350 years, its last ripples being rather rudely terminated by history, through two world wars and, at the end of the second, by the knowledge then acquired of nuclear reactions which makes possible a sudden catastrophic termination of men's activities. Nothing less "rational" can readily be thought of. (Elsasser 1998: 127)

How can irrationalism of Enlightenment and its product, science, be justified? The answer of Horkheimer and Adorno was powerful. Irrationalism can only be justified by resorting to mythology:

> Humans believe themselves free of fear when there is no longer anything unknown. This has determined the path of demythologization ... Enlightenment is mythical fear radicalized. (Horkheimer and Adorno 2002: 11).

ACM reflects a belief that humanity will conquer the territory of the unknown and therefore free itself from fear. The means for conquest is science based on the notion of physicalism. It is widely accepted by the scientific community that all sciences are reducible to physics. This view is best summarized by a Nobel Prize-winning molecular biologist and the intellectual force behind the Human Genome Project, James Watson:

> There is only one science, physics. The rest is social work (cited in Rose 2005: 83).

The pro-physicalist attitude of modern science is further expressed by the title of a popular book, *What Remains to Be Discovered*, by a former editor of the leading science journal, Nature (Maddox 1999). The assumption on which the book is based is that nature represents a mechanical system. The logic of any mechanical system suggests that the number of steps required to fully understand it is finite and achievable by the human reason.

Similarly, modern physics assumes that a scientific theory integrating all physical forces is achievable. Speculation about this theory, known as "Theory of everything" (Barrow 2007), found its way into the Hollywood mythology through an eponymous movie. Thus, science in the form of physicalism is being mythologized.

The origin of mythologization of science can be traced to the aphorism usually attributed to the father of physicalism, Sir Isaac Newton:

> If I have seen farther, it is by standing on the shoulders of giants (Merton 1993: 1).

We can find the most recent attribution of the aphorism to Newton in the title of an eponymous book, which identified five giants of science: Copernicus, Galilei, Newton himself, Kepler and Einstein (Hawking 2003). However, according to Robert K. Merton, it seems that the Enlightenment's memory stops with Copernicus, Galilei, Kepler, and Newton. In his book, *On the Shoulders of Giants*, also known by the acronym OTSOG, Merton powerfully argued that the aphorism precedes science and Enlightenment and it is wrongly attributed to Newton by his followers (Merton 1993: 8–11). This discrepancy exposed by Merton indirectly agrees with the DE notion of mythologization of science. By adopting the OTSOG aphorism attributable to the father of physicalism, and by ignoring thinkers who used the aphorism long before Newton, science has been mythologizing physicalism since its beginnings (Cunningham and Williams 1993: 427).

The view of nature as a mechanical system, which can be conquered by human knowledge, as well as the notion of OTSOG, are challenged by a biological theory known as evolutionary epistemology (EE). EE is a programme of research in biology and philosophy of science based on three principles: (i) living systems are knowledge systems, (ii) evolution is the process of gaining knowledge, and (iii) there are features shared by all forms of knowledge gain (Plotkin, 1982: 3–13; Bradie 1986: 404, Slijepcevic 2018a: 24). The nature-wide quest for knowledge is practiced by all living systems, from bacteria to humans (Slijepcevic 2018a: 26). One of the proponents of EE was Karl Popper who memorably argued that there is little difference between Einstein and amoeba in their quests for knowledge (Popper 1979: 24–25). Similarly, Robin Dunbar likened science to natural hypothesis testing: all organisms are engaged in testing different possibilities, or natural hypotheses, based on their understanding of local environments (Dunbar 1996: 75).

The natural quest for knowledge has its own hierarchy (Figure 1; see also Slijepcevic 2018a). The founders of the knowledge-seeking quest are first living organisms –bacteria. Thus, Bacteriocene must have the primacy over Anthropocene (Figure 1). By the same logic Florocene (or Plantocene) and Insectocene, which emerged long before Anthropocene, must have primacy over it (Figure 1). Thus, the process of life is an epistemological process – epistemology naturalized according to Quine (1969) – coupled with its ontological counterpart into an epistemological-ontological unity (Plotkin 1982: 3–13; Bradie 1986: 404). Humanity is a late actor in the knowledge-seeking theatre of evolution. We are present in this theater, not as the main character, but rather as a background actor or an extra. If the entire process of biological evolution is condensed into an imaginary play or a movie, we only appear at its end, virtually in the last second.

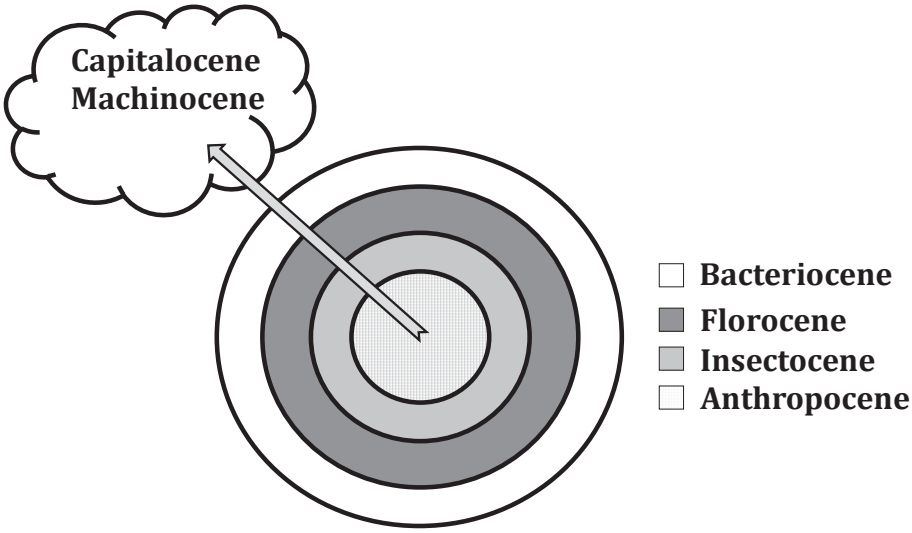

Figure 1. A nested evolutionary hierarchy of organisms capable of altering the environment (the suffix "cene" is used as in Anthropocene). Capitalocene and Machinocene are derivatives.

The fallacy of the Anthropocene concept, according to which humanity dominates nature, is exposed through the term Cyanocene (Sagan 2017). This term reflects the fact that photosynthetic cyanobacteria radically altered the Earth's atmosphere, by polluting it with oxygen, three billion years before all animals and plants emerged in the evolution. How can humanity (the Anthropocene) dominate nature when it depends on the ecological waste created by Cyanocene?

It is now clear that bacteria possess intelligence, which some philosophers call "bacterial cognitive tool-kit" (Lyon 2015: 4; Lyon 2017: 444–445). Furthermore, our quest for knowledge is dependent on bacteria. For example, our bodies, and the bodies of all plants and animals have accompanying populations of bacteria, which outnumber human cells 10 to 1. These conglomerates

of bacteria, known as microbiota, turn our bodies into complex ecological systems consisting of 37 trillion human cells (themselves formed by bacteria and archaea) and 400 trillion bacterial cells. The scientific name for meta-organisms (all plants and animals) is holobionts – ecological communities of bacteria and their hosts (Zilber-Rosenberg and Rosenberg 2008: 723). An integral part of this ecological relationship is the microbiota-gut-brain axis (Smith 2015: 314). Bacteria present in our gut drive intestinal cells to produce the neurotransmitter serotonin, which then circulates in the blood (Smith 2015: 314). This leads to altruistic behavior of the host, which benefits bacteria long-term, indicating that the ecological relationships within the holobiont proper, and effects of this relationship on the ecosystem, are complex (Levin-Epstein et al. 2017).

Thus, if the concept of Anthropocene is to be taken seriously it must acknowledge that it is standing on the shoulders of Bacteriocene and Florocene. As a matter of fact, the entire biosphere is standing on the shoulders of "invisible dwarfs"– bacteria (Figure 1). The OTSOG thus becomes OTSOID (On the Shoulders of Invisible Dwarfs).

The OTSOID shatters the concept of Anthropocene by challenging the notion of physicalism in a major way. Nature is not a mechanical system because we live in an environment dominated by living systems invisible to our eyes. Bacteria are the founders of, and the main player in the planetary biosphere (Margulis and Sagan 1997). The biomass of bacteria exceeds the human biomass (Whitman et al. 1998, Kallmeyer et al. 2012). Given that our environment is biological and it consists of living systems (Okasha 2005), we will never be able to conquer it (Ben-Jacob 1998). The reason for this is that living systems are not mechanical systems, which are exhaustible by physicalist knowledge. Gregory Bateson argued that living systems are indeterministic and aesthetic systems, resistant to the conquest by mechanistic science (Bateson 1979; 2000). He famously likened nature to a giant mind beyond our reach. Bateson thought that our propensity for the ecological violence is the consequence of the epistemological error committed by the Western civilization – domination of mechanistic or physicalist epistemology.

Walter Elsasser openly challenged physicalism. Elsasser coined the term "biotonic laws" to highlight the notion that the behavior of living systems cannot be reduced to physicochemical causality (Elsasser 1958; Elsasser 1998). The school of theoretical biology known as relational biology provides detailed argumentation in support of this thesis (see the section on Machinocene). The key message of relational biology is that living systems may not be computable (Rosen 1991; Elsasser 1998). In other words, living systems are beyond physicalist science.

3.1.2. The Motivation for Building the Car

The previous section outlined arguments for mythologization of science. It is worth repeating that the roots of mythologization of science may be in human nature (Wilson 2012), rather than in science itself. Mythologization of science is partly responsible for justification to build the car without brakes (ACM)

driven by the entire humanity or the Anthropocene. The aim of this section is to outline the key motive for building the car. This motive, again, may be part of our biology.

Homo sapiens belong to a rare group of species practicing the highest form of social behavior known as eusociality (Wilson 2012). Other practitioners of eusociality are rare species of social insects: ants, termites, and bees (Crespi and Yanega 1995, Wilson and Hölldobler 2005). The consequence of eusocial behavior is the emergence of the social collective termed the superorganism in the case of ants, termites, and bees (Hölldobler and Wilson 2009). The equivalents of the human superorganism are modern states (Gowdy and Krall 2013). In the social structures of modern states individual freedom is formatted by the function of the collective:

> The power of all the members of society, to whom as individuals no other way is open, is constantly summated, through the division of labor imposed on them, in the realization of the whole, whose rationality is thereby multiplied over again. What is done to all by the few always takes the form of the subduing of individuals by the many: the oppression of society always bears the features of oppression by a collective. (Horkheimer and Adorno 2002: 16)

Let us search for an explanation of the phrase *oppression by a collective* within the phenomenon of eusociality. Eusociality is recognized by three features: (i) several generations within the social group, (ii) care for the young and (iii) division of labor including reproductive labor (Crespi and Yanega 1995; Wilson and Hölldobler 2005). In eusocial insects, the above three features of eusociality are easily identifiable (Crespi and Yanega 1995; Wilson and Hölldobler 2005). By contrast, one aspect of the third feature, namely the division of reproductive labor, may not be present in human societies leading some scientists to dispute the notion of human eusociality.

For example, ant and bee workers are sterile. The only reproductive worker in their societies is the queen. In human societies, all members are fertile from puberty to middle ages. However, women lose fertility not because of ageing but in a biologically programmed fashion known as the menopause. Research shows that the function of the menopause, also known as *grandmother effect*, is to help inexperienced daughters raise the young. Thus, the menopause in women may represent a form of reproductive division of labour in human societies (Foster and Ratnieks 2005). Other forms of reproductive division of labour in modern societies may be the surrogate motherhood (Teman 2008) and same-sex marriages, which require either the surrogate motherhood or specialized reproductive technology for raising a family (Eskridge 1993). According to Edward O. Wilson, *Homo sapiens* is a truly eusocial species (Wilson 2012).

Therefore, what Horkheimer and Adorno termed *realization of the whole* may represent the emergence of the human superorganism – the modern state governed by the physicalist science (Gowdy and Krall 2013; Soete et al. 2015; see also next section). In a further leap of social integration, states form unions (e.g. EU – European Union; ASEAN – Association of South East Asian Nations;

UNASUR or Union of South American Nations etc.), which eventually form the global socio-economic union (Soete et al. 2015). The new global union cannot function without the international monetary system. Thus, ACM is regulated by a set of internationally approved norms (Soete et al. 2015).

A key question becomes how the human superorganism exerts the function of *subduing of individuals* or *oppression of a collective*. Is the oppression of an individual by a collective a necessary biological manifestation of eusociality? A neurobiologist Thomas D. Seeley argued in his book, *Honeybee Democracy*, that this is not the case (Seeley 2010: 218–231). He presented arguments that honeybee societies practice a form of eusocial behavior, which prevents domination of the collective over individuals by allowing each individual worker to participate in the collective decision-making. For example, the influence of the queen as the elite individual is completely suppressed. To demonstrate her value to the collective the queen emits certain pheromones, which are constantly monitored by workers. Once the workers sense that the quality of the signal emitted by the queen is not worthy to the society as a whole, they simply replace the queen in the process of swarming. A large group of honeybee workers splits from the superorganism, raises the new queen by feeding a worker by the queen jelly and collectively searches for the suitable territory for a newly emerging superorganism. Decision-making in the process of the territory search is truly democratic. The group sends hundreds of scouts to identify the most suitable natural habitat for the new superoroganism. Each scout reports back her findings to the collective. The decision is made through a complex process of debating each find and assessing its merit for the collective.

The honeybee democracy is based on three principles: (i) all members of the superorganism show mutual respect and have united interests which exclude domination of the queen over the collective, (ii) the "thinking" of the society is a truly collective thinking which identifies multiple solutions to any given problem faced by the society, and (iii) the collective wisdom of the society identifies the best solution which is in the interest of all members of the society. It is important to stress that social insects are not automata lacking individuality. Recent research suggests that eusocial insects possess individuality and yet remain part of the eusocial collective (Robinson et al. 2014, O'Shea-Wheller et al. 2017).

The way in which modern human superorganisms, or states, practice democracy is in disparity with the principles of the honeybee democracy. First, the elites, who control the capital show little respect towards other members of society suggesting a disparity of interests (Klein 2007). Second, there is no truly collective thinking, which is in the interest of all members of the society. For example, the decision to go to war against Iraq in 2003 was not in the interest of all American citizens, but only in the interest of the elite (Seeley 2010: 223). Third, in societies in which there is a disparity of interests, there can be no collective wisdom (Klein 2007).

Differences in principles of eusocial democracy practiced by modern human states, relative to honeybee superorganisms, may be a consequence of the

dominant "instrumental reason" in the case of humans (Table 1). It is clear from previous arguments that "instrumental reason" may be involved in preparing the ground for the emergence of the ACM socio-economic model practiced by the entire humanity. But this model was imposed on the human collective by a small group of its influential members for their own interest (see the Capitalocene section). This small group, the few, then orchestrated the distribution of responsibility on the entire collective. This is reflected in the Anthropocene concept – the entire humanity, or Anthropos, is willingly behind the imaginary dashboard in our accelerating car (ACM). The manipulatory triumph of the few is hidden in the collective pride – the Age of Man – trumpeted from the pages of leading scientific journals (Monastersky 2015).

Interestingly, there is evidence that eusocial insects are naturally protected against the practice of "instrumental reason" as a form of natural epistemology. In other words, they possess the brakes on their equivalent of the car – they may be naturally programmed to avoid the ACM-type models. Eusocial ants made a social conquest of Earth millions of years before humanity (Wilson 2012). Their global superorganism, which may appropriately be called the Insectocene, can generate enough ecological pressure to seriously damage the environment. For example, leafcutter ants, from the genera *Atta* and *Acromyrmex*, harvest fresh leaves from South American forests on the large scale and thus create the ecological pressure (Costa et al. 2008). However, they seem to "know" when to stop cutting leaves to allow trees to recover (Hölldobler and Wilson 1990: 623, Strassen 2018) and by doing so avoid serious damage to their natural habitat. Recall the imaginary theater of evolution, as the process of natural epistemology, mentioned earlier. If the play in this theater is condensed into 1.5 hours, eusocial ants appear in it for the entire last minute. By contrast, our time in the play is 500 times shorter, only 0.1 second. Within such a short time span we made irreversible damage to the ecosystem. In other words, we committed an epistemological error which, hopefully, is not irreversible. By contrast, ants live in harmony with the ecosystem. Are their superorganisms resistant to manipulation by the few, like the honeybee superorganisms?

3.1.3. Tool for Building the Car

The previous section outlined the key biological motive for building the car – human eusociality. The next question is: what is the tool for building the car? In other words, is there anything within the phenomenon of eusociality responsible for generating such a tool? Horkheimer and Adorno suggested, without being aware of eusociality, that this tool is technology:

> Kings control technology no more directly than do merchants: it is as democratic as the economic system with which it evolved. Technology is the essence of this knowledge. It aims to produce neither concepts nor images, nor the joy of understanding, but method, exploitation of the labor of others, capital (Horkheimer and Adorno 2002:2).

Interestingly, Horkheimer and Adorno equated science and technology and identified them as a unified tool available to "instrumental reason" in its model building.

> Power and knowledge are synonymous. For Bacon as for Luther, "knowledge that tendeth but to satisfaction, is but as a courtesan, which is for pleasure, and not for fruit or generation." Its concern is not "satisfaction, which men call truth," but "operation," the effective procedure (Horkheimer and Adorno 2002: 2).

Francis Bacon is singled out as the inventor of the physicalist scientific method. The establishment of the Royal Society in 1660 represented institutionalization of Bacon's method, which was taken over by the state as its own tool. The main concern of this institutionalized tool was not *the "truth," but "operation," the effective procedure*.

If we accept that technology is the tool for building the car, the question is whether technology constitutes a natural consequence of eusociality. For example, Horkheimer and Adorno suggested that *the realization of the whole* may represent the means by which the human superorganism exerts its power. The question can be answered by investigating the collective behavior of eusocial insects. If indeed, eusocial insects show obligate technological behavior then the answer may be affirmative.

Let us use Richard Li-Hua's concept of technology to start answering the question (Li-Hua 2013). His concept is a synthetic attempt to unify all definitions of human technologies. According to Li-Hua, all human technologies have four components: (i) technique, (ii) knowledge, (iii) organization of the work process and (iv) the product (Figure 2 A).

The technique is a group name for instruments (tools and machines), materials and the way in which instruments and materials are brought into a common function. The knowledge has forms of applied science, skills and intuition. The organization of the work process is the combination of the technique and knowledge with the aim of achieving a certain result. The result is recognizable as the fourth component of technology – the product. The product is the ultimate result of the association of the previous three factors, the technique, the knowledge and the organization of the work process (Figure 2 A).

When the collective behavior of eusocial ants from the genera *Atta* and *Acromyrmex* is assessed through the Li-Hua's technological prism (Figure 1 A), all four components of technology are identifiable in the practice of ant agriculture (Figure 1 B; Table 2). The source of food for leafcutter ants is the fresh green leaf biomass, which their digestive system cannot process. To overcome this biological barrier leafcutter ants made a symbiosis with a fungus and thus invented their version of agriculture, which is one of the first technologies in animals (Table 2, Mueller et al. 2005, Slijepčević 2018b).

The ants bring pieces of fresh leaves to the nest, chew them, and store them in gardens on which a fungus is planted. They fertilize gardens with their own faeces. The fungus processes all the leafy biomass and turns it into food for

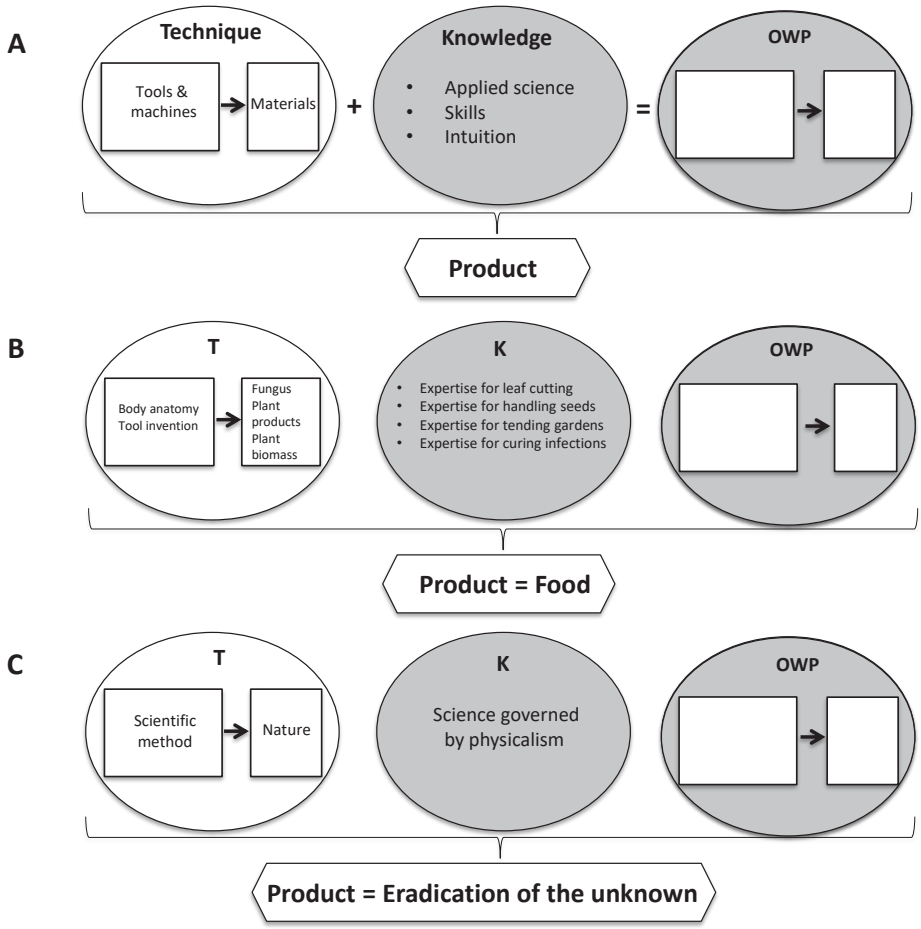

Figure 2. A. Synthetic definition of technology according to Richard Li-Hua (Li-Hua 2013). For details see the text. B. Analysis of ant agriculture as a form of technology using Li-Hua's definition as a model. (See also Table 2). C. Institutionalized global science as a form of technology (modeled on Soete et al. 2015). OWP – Organization of the Work Process.

the entire colony. The ant agriculture meets the above four requirements of technology (Figure 2 B, Table 2, Slijepčević 2018b).

Thus, it seems reasonable to argue that technology may constitute a consequence of eusociality – the division of labour within the superorganism generates a collective behavior that becomes an ecological force (Slijepčević 2018b). Furthermore, it may be argued that food production is an obligate requirement for highly eusocial animal collectives (Mueller et al. 2005). The most common way for collective food production is the practice of agriculture identifiable in ants, termites and humans (Mueller et al. 2005). Honeybees produce food through a different technological process: chemical modification of the ready-made plant material. As a result, there may be two forms of eusociality:

Table 2. Ant agriculture as a form of technology. Sources: Mueller et al. 2005, Wilson 2012, Slijepčević 2018b.

	Technique	**Knowledge**	**OWP**	**Product**
The technology of eusocial ants from genera *Atta* and *Acromyrmex*.	*Instruments (Tools & Machines):* (i) Sharp jaws controlled by powerful muscles. Ant jaws represent a vibrating knife or microtome. (ii) Ant bodies act as transport vehicles. *The material* used by ants is the green leaf mass and the fungus.	*Instinct-based knowledge:* (i) how to cut leaves, (ii) how and when to transport pieces of leaves (iii) how and when to form new fungal gardens and (iv) how and when to cure the gardens from infection.	Leaves are cut, transported from the cut-off site to the nest and surrendered to other workers. Specialist workers chew the pieces of leaves and turn them into a pulp. The pulp is stored in fungal gardens, fertilized, inoculated by fungal seeds and processed through the agricultural practices.	The product is food for the ant colony. The green pulp is completely processed by a symbiotic fungus into an edible product. This is an obligatory process (there is no eusociality without agriculture).

ultra-eusociality in which collective food production is obligate (ants, termites, honeybees and humans) and ordinary eusociality in which it is not (Gowdy and Krall 2016: 181; Slijepčević 2018b: 202).

However, humanity achieved a technological leap beyond agriculture. The practice of human agriculture generated an economic surplus (primitive capital), which transformed the agricultural technology into a global technological conquest of nature (modern capital) (Diamond 1991, Mithen 1996, Hawken et al. 1999). The cultural framework for the conquest was the institutionalization of science and adoption of the scientific method by European states. For example, English and French academies of sciences were established in 1660 and 1666 respectively, under state protectorates. Similar practices were employed by other European states soon after. The new practice allowed European states to (i) gradually eradicate the populace's reliance on magic, which was widespread in the pre-Enlightenment Europe and (ii) set humanity on the course of exploitation of nature via institutionalized science (Ferguson 2012).

However, DE revealed a weak spot of institutionalized science based on physicalism (see sections 3.1.1. and 3.1.2). Furthermore, modern institutionalized science, a globalized process according to UNESCO, conforms to Li-Hua's criteria of technology (Figure 2 C, Slijepčević 2018b). The global scientific community and its institutions in the form of universities, institutes, and techno-corporations, created and embraced by modern states as the key generator of the capital (Hawken et al. 1999; Soethe 2015) represent the global laboratory

turned-fueling-station for ACM (Table 1, Figure 2 C). This means that institutionalized science as a form of technology employed by global humanity may be a consequence of eusociality (Slijepčević 2018b: 222). The problem, according to DE, is that humanity has so far been unable to recognize that the product of institutionalized science – the conquest of the territory of the unknown by physicalist science (Figure 2 C) – is irrational (see below).

Thus, the key element that links the practice of human eusociality with modern capitalism is the propensity of the few (the elite in European states responsible for the exploitation of physicalist science) to associate an extra value with the fourth component of technology, the product (Li-Hua 2013, Moore 2017, Moore 2018). The product, as the final component of the eusocial technological process, may be equated with the concept of capital.

3.2. Critique of the Machinocene Concept

Let us start this section with a relevant quote from DE, used earlier. The consequence of "instrumental reason" is that nature is interpreted as an automated system, or the machine:

> Thought is reified as an autonomous, automatic process, aping the machine it has itself produced, so that it can finally be replaced by the machine. (Horkheimer and Adorno 2002: 19)

The phrase *aping the machine* is a particularly illustrative description of "instrumental reason". It can be interpreted as an attempt of "instrumental reason" to force nature to succumb to its rules, which are the rules of science based on physicalism. This is in line with the Anthropocene's principle according to which humanity, not nature, is the dominant ecological force on Earth (see above). The logical continuation of this type of reasoning is the concept of Machinocene – the emergence of the mechanical mind in the form of the machine superintelligence constructed by mechanistic science based on physicalism (Price 2016). Some philosophers and scientists argue that the new mechanical mind may become autonomous – it may not require the human input after a certain point known as a technological singularity (Bostrom 2014, Price 2016). However, the machine autonomy may be an example of flawed reasoning in light of arguments from biology outlined earlier (e.g. Rosen 1991, Elsasser 1998) but also new arguments, which will be outlined below.

A school of theoretical biology, known as relational biology, offers a powerful challenge to the concept of instrumental reason and the Machinocene concept, in particular, their mechanistic bases, which are insufficient to fully understand complex systems such as organisms, ecosystems and the biosphere as a whole. If the organizational principles of the biosphere, including the concept of natural mind in the sense used by Gregory Bateson (Bateson 1979, Bateson 2000), cannot be fully grasped by the mechanistic science, it seems likely that the anticipated machine's mind dominance over nature– the Machinocene – may be a case of gross misunderstanding, or Batesonian epistemological error.

Nevertheless, this misunderstanding is a perfect opportunity for mechanistic science to expand the practice of "instrumental reason". The words of the founder of cybernetics, Norbert Weiner, sound prophetic and in unison with ACM:

> Let us remember that the automatic machine…is the precise economic equivalent of slave labor. Any labor which competes with slave labor must accept the economic conditions of slave labor. (Weinner 1989: 162)

The founder of relational biology was a theoretical physicist Nicolas Rashevsky. The school's most influential proponent was Robert Rosen, who established philosophical and mathematical foundations of relational biology. Even though Rosen has not mentioned DE in his writings, he identified a version of "instrumental reason": he thought that the mechanistic foundation of science is irrational (Kineman 2007). Here are two relevant quotes from Rosen's book *Life Itself* which sum up his stance towards the mechanistic understanding of living systems:

> The question "What is life?" is not often asked in biology, precisely because the machine metaphor already answers it: "Life is a machine." (Rosen 1991: 23)

> It may perhaps be true that the question "What is life?" is hard because we do not yet know enough. But it is at least equally possible that we simply do not properly understand what we already know. (Rosen 1991: 17)

Let us briefly outline Rosen's understanding of the differences between the organism and the machine. This will bring Rosen's thought in line with the DE argumentation and provide a powerful refutation of the Machinocene concept. Rosen postulated that all living systems are anticipatory systems. He defined the anticipatory system as a natural system that contains an internal predictive model of itself and of its environment. The predictive model allows the system to change the state at an instant in line with the model's prediction.

An outline of the anticipatory system is shown in Figure 3. Every organism from a bacterium to an elephant must contain information about self, about species and about the environment, encoded into the organization of the living system. This information acts causally on the present behavior of the organism based on the modeling relations projected to be applicable in the future (Figure 3). The relationship is primarily epistemological. In the natural epistemological process organisms or Natural Systems (NS) generate internal models of themselves called Formal Systems (FS). The links between NS and FS is one of the epistemological-ontological unity in which the natural "glue" holding the relationship together is natural information (for details see the legend for Figure 3).

Thus, the behavior of Rosen's anticipatory systems at any present instant involves aspects of past, present, and future, because the internal model serves to pull the future into the present. By contrast, physicalist science admits only Reactive systems – those systems that react in the present to changes that have already occurred in the causal chain. Rosen's "Zeroth Commandment" is a

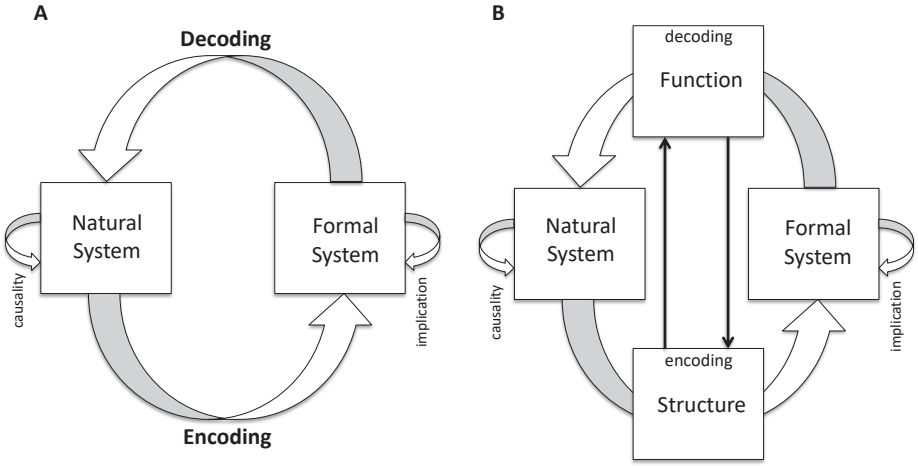

Figure 3. A. The relationship between the natural entity or NS (Natural System – any organism from a bacterium to an elephant) and knowledge of it or FS (Formal System – a species-specific information processing system). Mapping in the model, which is category-theoretic mapping (based on mathematical category theory), is informational in nature. Information, as a process of encoding and decoding, is a "glue" holding NSs and their environments together. "Encoding" or abstraction is a set of qualities or quantities (epistemological and ontological) from a NS for use in the FS or a model. Senses employed in a species-specific manner are equated with natural abstractions. Such abstractions reflect what is usually meant by the term biological "structure" (see panel **B**). On the other hand, "decoding" (in the epistemological and ontological sense) is best described by Bateson's notion of information as "a difference that makes a difference" or "patterns that connect" (Bateson 1979). In other words, "decoding" is associated with the concept of biological "function" as shown in panel **B**. Thus, structure and function are emergent properties of the modeling relationship "representing the empirical world emerging from the ontological". Adapted from Rosen (1991) and Kineman et al. (2007).

critique of the dogmatism of mechanistic science, which obeys the so-called objective causality:

> Thou shalt not allow future state to affect present change of state. (Rosen 1991: 49).

One of the postulates of mechanistic science is that the true objective causality cannot argue from final causes. By contrast, living organisms (Figure 3 A) are capable of constructing an internal surrogate of time as part of the modeling relations (Rosen 1985) that eventually produce anticipation.

Using the mathematical category theory, which allows mapping of relations between NS and FS (Figure 3) Rosen identified a key difference between the organism and the machine. The machine is not capable of constructing the closed causal loop, whereas every organism, from a bacterium to an elephant, is (Rosen 1991: 241). This roughly means that machines cannot have autonomy as they are not constructed through the principles of self-organization or

autopoiesis – a process behind the construction of organisms or anticipatory systems, which effectively closes causal loops (Maturana and Varela 1998, Capra 1996). The machine thus remains an automaton lacking the capacity of anticipation and entirely dependent on its creator.

Therefore, if there is no closed causal loop in the machine, as Rosen's work based on the category theory suggests, then the concept of Machinocene– an autonomous mechanical mind – may be invalid. Even though Rosen's theories have been criticized by proponents of the mechanistic world-view, the way for refuting the criticism may be in integrating Rosen's theories with the principles of autopoiesis of Maturana and Varela (Maturana and Varela 1998), Bateson's version of natural mind (Bateson 1979, Bateson 2000) and principles of EE (Slijepcevic 2018a).

3.3. Refining the Concept of Capitalocene

As stated earlier, the Capitalocene concept shares significant similarities with the DE style of argumentation. Therefore, what follows cannot be called a critique of the Capitalocene concept, but rather an attempt to refine certain points within its structure.

Similarly to Horkheimer and Adorno, who identified technology as the key force behind generation of the capital (see above), Jason W. Moore (Moore 2017; 2018) argued that the notion of *technics*, as used by Lewis Mumford (Mumford 1934: 26), allowed integration of tools and knowledge in a new world praxis – capitalism – capable of opening the doors of nature in the search for cheap capital. The key point, according to Moore, is that humanity is an integral part of nature: "humanity-in-nature" or humanity in the web of life. The phrase "web of life" is attributed to Chief Seattle:

> Man did not weave the web of life;
> He is merely a strand in it.
> Whatever he does to the web,
> He does to himself.[3]

Thus, capitalism silently becomes a way of organizing nature through the technological activity of one of its numerous strands: man. The hierarchical organization of human superorganisms, or states, allows implementation of the practice of "instrumental reason" through the imposition of concepts invented by the few, on the entire collective (see above). The collective becomes a slave executor of the will of the inventors.

This line of reasoning is in contrast with the reasoning of the Anthropocene concept which is Cartesian: there is an artificial split between humanity and nature. Humanity acts as an artificial external force, which interprets the web of life as a passive foreign territory open to a massive conquest. The identity

3 Adapted by Ted Perry.

of true instigators is hidden and deliberately masked through the practice of "instrumental reason" – subduing the collective by the few (see above).

Lewis Mumford argued that non-European civilizations (Chinese, Greek, Arab etc.) differed from their European counterpart in one important respect. Non-European civilizations were technological civilizations but did not interpret nature as a source of cheap capital. As Mumford commented: *They had machines but they did not develop "the machine"*. In other words, only the European civilization followed the mechanistic path of Newtonian science based on physicalism. Similarly to Horkheimer and Adorno, who singled out Francis Bacon as the founder of this path, Moore's colleague Justin McBrein (McBrein 2017: 125) used the general concept of the scientist as "a gunslinger in a sidereal wild west, an imperialist fantasy that would overcome the contradictions of capitalist surplus extraction."

Thus, the Capitalocence concept and DE singled out the European civilization as the founder of capitalism and modernity that is affected by irrationalism. For Horkheimer and Adorno, the irrationalism was caused by the Enlightenment's fear of the unknown, which turned a perfectly rational ambition to expand knowledge into an irrational obsession to over-know by taking the map for the territory (Table 1). For Moore, irrationalism is the abstraction of man and its replacement by a new artificial species: the capital or the fourth component of the natural technological process – the product (Figure 2). This new species can be interpreted as collective humanity in its mechanicist vehicle with no brakes fueled by the physicalist science (ACM). As Justin Mc'Brien (Mc'Brien 2017: 116) put it:

> Capital is the Sixth Extinction personified: it feasts on the dead, and in doing so, devours all life. The deep time of past cataclysm becomes the deep time of future catastrophe; the residue of life in hydrocarbons becomes the residue of capital in petrochemical plastics. Capitalism leaves in its wake the disappearance of species, languages, cultures, and peoples. It seeks the planned obsolescence of all life. Extinction lies at the heart of capitalist accumulation.

Here is an outline of developments in biology, which support Moore's concept of "humanity in the web of life". Humanity is just one of 9 million species estimated to inhabit the planet (Mora et al. 2011). All our activities, including the socio-economic organization, are formatted by our experiences of being a part of the natural collective from which we emerged in the process of evolution. There is nothing special about us in a biological sense. For example, if the biological success is measured by the contribution to the biomass of the entire biosphere, then the most successful organisms are plants. Their biomass exceeds the animal biomass 1,000 times. As one botanist commented we only exist in traces compared to plants (Mancuso and Viola 2015).

Furthermore, we are not special even in the phenomena of technology, as mechanistic science would like us to believe. The inventors of technology among animals are insects (Mueller et al. 2005, Slijepčević 2018b). The first evolutionary form of technology was insect agriculture (Figure 2 B). Our techno-science

is nothing more than an evolutionary derivative (Diamond 1991). Even modern human technologies such as the Internet and future technologies such as the Internet of Things may have equivalents in bacteria which we do not usually take as intelligent (Margulis and Sagan 1997, Slijepcevic 2017). There is a large body of specialist literature supporting the notion of animal technical intelligence (summarized in Schumaker et al. 2011). Therefore, Moore's argument of humanity being an integral part of the web of life, not only in the material sense but also in the functional sense, which eventually generates a form eusocial practice we call capitalism, is correct.

Given the destructive potential of Capitalocene and its deadly effects on the biosphere in the form of biological annihilation (Ceballos et al. 2017), also dubbed the Necrocene (McBrien 2017: 116), an important question is why only the European civilization invented capitalism even though other civilizations had basic technological means at their disposal to develop it long before Europeans. This is the question that begs a comprehensive analysis. Horkheimer and Adorno provided a clue: propensity to over-know or degeneration of Enlightenment. The consequence of this propensity is the ACM model imposed on the entire humanity as a result of the irrational ambition of the few to legitimize potential for self-destruction (Table 1).

4. How to Counter "Instrumental Reason"

There are three avenues that can be explored to reduce the negative effects of "instrumental reason" or even to fully eliminate it. First, given that science based on physicalism most likely interprets nature in a wrong way – a mechanical system or the machine, which can be fully understood by physicalist science – a reform of foundations of science may reverse this epistemological error. Many scientists and philosophers argued that the biosphere is a cognitive system with the epistemological-ontological unity (Lovelock and Margulis, 1974, Bateson 1979, Bateson 2000, Capra 1997, Maturana and Varela 1998, Nicholson and Dupre 2018). The biosphere is not an organism, but a super-system composed of organisms so that organisms form epistemological-ontological unities with their environments consisting of different kinds of organisms. This holarchy[4] of systems must be explored by a form of science that should suspend the primacy of physicalism, at least temporarily, to allow biology to take the lead. Anticipatory systems (Rosen 1985, Rosen 1991), mind and nature (Bateson 1979, Bateson 2000, Capra 1997, Maturana and Varela 1998), holarchy (Koestler 1981), symbiogenesis (Sagan 1967, Margulis 1970), nature of biological intelligence (Slijepcevic 2018a), processual biology (Nicholson and Dupre 2018) and a range of other questions in biology must be explored from the new perspective which should confirm, or not, the validity of physicalism. Philosophically, this is a sound approach. The foundation of science is not a given. There is no reason as to why the foundations of physicalism cannot be

4 The term used by Arthur Koestler related to his concept of the holon.

challenged by right arguments. One of the components of physicalism ripe for criticism is reductionism. As Karl Popper (Popper 1982: 171) argued: "None of these reductionist efforts explain the creativity of the universe: life, and its incredible intricacies and wealth of forms."

Second, a greater emphasis on investigating natural phenomena such as eusociality and technology would allow identifying elements in our ultra-eusociality, which predispose us to the practice of "instrumental reason". By the same token, identifying elements of ultra-eusociality in insects, which make them resistant to the development of "instrumental reason", as a form of natural epistemology, would be useful. For example, ants could be a good role model for humanity in the search for breaks on the collective car (Slijepčević 2018b). Their biomass is roughly equivalent to the human biomass (Wilson 2012). Yet, ants live in the ecological harmony with the planetary ecosystem. By contrast, the Capitalocene may have already altered the ecological balance of the biosphere irreversibly.

One of the most pressing questions is why only the European civilization invented capitalism as the world ecology. Earlier civilizations, Arab, Chinese, Greek, and others, had technological means at their disposal and yet they did not move in the direction of technology dominated by science. Jared Diamond argued that the pre-agricultural humanity was the only form of human superorganism in harmony with nature (Diamond 1991).

Finally, the third avenue is the appreciation of the aesthetics of nature as argued by Gregory Bateson (Bateson 1979: 18):

> Observe, however, that there have been, and still are, in the world many different and even contrasting epistemologies which been alike in stressing an ultimate unity and, although this is less sure, which have also stressed the notion that ultimate unity is aesthetic. The uniformity of these views gives hope that perhaps the great authority of quantitative science may be insufficient to deny an ultimate unifying beauty.

Bateson's view parallels views of Elsasser (Elsasser 1998: 4), who thought that biology must take account of the creativity of nature. Nature's creative act is ultimately aesthetic. This is in line with the concept of biophilia (Wilson 1984), the love for living organisms, as the powerful contrasts for the notion of mechanophilia (Slijepčević 2018b: 273), or love for the machine, which typifies the modern world.

5. Concluding Remarks

In this study, I attempted to expose the three 21st century concepts to the arguments from DE constructed roughly 60 years earlier in a different historical background, that of the biggest destruction in human history in the form of two world wars and the creation of nuclear weapons as the means for mass destruction. In the post-rationalist world of modernity (Elsasser 1998), the capitalism as the world ecology (Moore 2017; Moore 2018), or ACM in my interpretation (Table 1), become the new means for mass destruction in the form

of biological annihilation (Ceballos 2017). Thus, the peak of "instrumental reason" is the irrational attempt to legitimize self-destruction.

The inevitable conclusion is that DE arguments did not lose any of their philosophical and sociological appeals. It can be argued that DE can help us refine the analysis of modernity by integrating its own style of argumentation with the thoughts of scientists critical of the dominant scientific world-view (Bateson 1979; Elassser 1998, Rosen 1991) rooted in the physicalist science. This new framework requires a deep analysis of human eusociality in light of "humanity-in-nature" and "nature-in-humanity" (Moore 2017, Moore 2018).

Some philosophers and scientists think that the emergence of an autonomous machine superintelligence may constitute a qualitatively new phenomenon never experienced before in the human existence and in the existence of the biosphere (Bostrom 2014; Price 2016). This is a bold assumption, which may not be entirely justifiable given the criticism of mechanistic science outlined above. Therefore, there is a pressing need to discuss the concept of "instrumental reason" in a truly democratic fashion and assess its future risks. To paraphrase Robert Rosen, we cannot rely on yesterday armies to fight future wars.

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Predrag Slijepčević

Antropocen, kapitalocen, mašinocen: iluzije instrumentalnog razuma

Apstrakt

U svom uticajnom delu *Dijalektika prosvetiteljstva*, Horkhajmer i Adorno su tumačili kapitalizam kao iracionalnu monetarizaciju prirode. U ovom radu analiziramo tri dvadesetprvovekovna koncepta, antropocen, kapitalocen i mašinocen u svetlu Horkhajmerovih i Adornovih argumenata i skorašnjih argumenata iz filozofije biologije. Analiza otkriva izvandredno prisustvo pojma "instrumentalnog razuma" koji je pristuan u sva tri koncepta na duboko zagonetan način. Naša interpretacija je da pojam opisuje sklonost nauke zasnovane, na shvatanjima fizikalizma, da tumači prirodu kao mašinu podložnu analiziranju i programiranju od strane ljudskog uma. Rezultat toga je da je koncept antropocena izgrađen oko mehanicističkog modela, koji može biti predstavljen metaforom automobila bez kočnica. Na sličan način koncept mašinocena predviđa nastanak mehaničkog uma koji će dominirati nad prirodom u skoroj budućnosti. Konačno, koncept kapitalocena pretvara savršeno racionalnu ambiciju za širenjem znanja u iracionalnu opsesiju prekomernim znanjem putem institucionalizovane nauke kao motora kapitalizma bez kočnica. Zajednički sadržalac sva tri koncepta je iracionalna sklonost za legitimacijom samouništenja. Potencijalne mogućnosti za suprotstavljanje efektima "instrumentalnog razuma" su predložene.

Ključne reči: instrumentalni razum, antropocen, mašinocen, kapitalocen