

Abstract: Autonomous Marxism has generated a lexicon for responding to transformations in human labor, paying particular attention to the ways that labor is facilitated by technological development. Autonomists have mapped how the conditions of Post-Fordism have put elements of the mind, sociability, virtuosity—or “the soul” in Berardi’s terms—to work (Berardi 2009, see also Virno 2004, Lloyd 2010, Crary 2013, Pasquinelli 2014). But that labor, in accordance with capitalist valorization, is nearly always human. At best, it is human labor supplemented with machines. But what are we to make of the lively materials—of human and nonhuman provenance alike—now at ‘work’ alongside us? This paper takes up this question in an analysis of the field of biosensing. It explores Marx’s concepts of species being and the general intellect to reconsider what can be said of “living labor” and its potential at time when nonhuman life is increasingly a central component of production. I suggest that alongside the so-called Anthropocene, biosensing marks a redistribution of both the work and precarity associated with our mode of production. While the field forges engagements with nonhuman others and a growing awareness of planetary life, it also operates according to an imaginary of planetary management, the possibility of producing for a collective health and the “whole of nature.” But I suggest that the image of planetary natures produced is one characterized by threat and a drive to enroll nonhuman forms of life as workers in the bioeconomy.

Keywords: Living Labor, Species Being, Biosensing, Ecological Security

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At the Limits of Species Being: Sensing the Anthropocene

For labor, life activity, productive life itself, appears to man in the first place merely as a means of satisfying a need – the need to maintain physical existence. Yet the productive life is the life of the species. It is life-engendering life. The whole character of a species, its species-character, is contained in the character of its life activity; and free, conscious activity is man’s species-character. Life itself appears only as a means to life.

-Karl Marx, *The Economic and Philosophical Manuscripts of 1844*

Nature builds no machines, no locomotives, railways, electric telegraphs, self-acting 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; the power of knowledge, objectified.

-Karl Marx, *The Grundrisse*

I. Introduction

The U.S. Defense Threat Reductions Agency’s (DTRA) mandate is to make the world safer by neutralizing the threat of weapons of mass destruction. As part of that mandate, it maintains a research and development portfolio of \$1.8 billion. Successor to the Defense Nuclear Agency,

DTRA has funded cutting edge science on the detection and management of the world's most dangerous—and weaponizable--forms of matter including radioactive materials as well as biological agents (recently Ebola) and chemical weapons.

In 2015, DTRA, along with the National Science Foundation, the Department of Energy, and the National Institutes of Health, contributed grant funding to labs at Harvard's Wyss Institute for Bioinspired Design to develop genetically engineered eukaryotic cells (the cells in plants, yeast, and mammals) capable of registering the presence of certain molecules. In one experiment, they tailored plants with receptors for recognizing the heart care drug digoxin. By incorporating Green Fluorescent Protein (GFP) alongside the receptors, the re-engineered plant not only recognized, but also communicated the presence of the drug (Feng, *et al* 2015).

According to the scientists responsible, the value of the experiment lay not just in a new biosensor produced, but also in the versatility of the method developed. With this method, scientists can make virtually any eukaryotic cell a biological sensor capable of indicating the presence of specific environmental conditions. The applications are wide reaching. According to the project's Primary Investigator (PI), George Church, "You can imagine if [this method was] used in agricultural plants, they can tell you about the condition of the soil, the presence of toxins or pests that are bothering them" (quoted in McAlpine 2016). The paper's co-author, Dan Mandall, explained further that the plants could be used to not only signal threats to themselves, but also to other species (McAlpine 2016). As the director of the Wyss Institute, Donald McInbar noted, "these new reprogramming capabilities ... open up an entirely new realm where ordinary organisms can be transformed into extraordinary living cellular devices that can sense specific signals and produce appropriate responses" (McInbar, quoted in McAlpine 2016).

In the newly named era of the Anthropocene, the meaning of "mass destruction" has shifted. With it, biosensing has taken on new urgency. Once considered the products of "natural"

disasters, scholars and the popular press now attribute the potential for environmental catastrophes to a range of causes: large scale monoculture farming, industrial effluents, or excessive atmospheric CO₂. The field of biosensing ostensibly harnesses biological capacities to identify these threats and subsequently ensure the survival—of humans and other organisms--amid these forms of ecological precarity as well as geopolitical instability. In doing so, biosensing joins biomimicry and biotechnology in changing the role that organisms and their components play in the production of knowledge. Even more, as metabolic processes are increasingly used in biomining (see Labban 2015), fuel refining, plastics manufacture, or pharmaceutical engineering, the field of biosensing also promises to regulate the effectiveness of biomaterials. By signaling which “microbial 'workers' are the most efficient,” the Wyss Institute’s techniques “give microbes a voice to report on their own efficiency” in the production process (McAlpine).

Marx maintained that living labor endowed humans with the capacity to reproduce not only their own life, but also “the whole of nature” (1978: 76). The fields of biosensing, biomimicry, and synthetic biology seem to bear this out. Their products, like Harvard’s plants, are “natural materials” transformed into organs of “human participation in nature” (Marx 1993). But while fields like biosensing seem to bring these biomaterials into hand, channeling their capacities for human production, they simultaneously disrupt boundaries between human and animal, animal and machine, and living and dead labor. By combining the cognitive capital of technological innovation with the biological capacities of nonhuman organisms, biosensing at once draws out and redistributes the earth’s own “inventive” capacities (Braun 2008). This presents a challenge to Marxist analysis. Marx named the capacity to transform our collective development “species being.” With “free, conscious activity,” he claimed, humans mold material into objects of personal and social use. To be human, for Marx, was to remake: to unsettle and reshape the whole of the world. As Negri (2004) put it, living labor names that within us that is a “restless creator” (165).

Autonomous Marxism, in turn, has generated a lexicon for responding to transformations in labor, paying particular attention to the ways that labor is facilitated by technological development.

Autonomists have mapped how the conditions of Post-Fordism have put elements of the mind, sociability, virtuosity—or “the soul” in Berardi’s terms—to work (Berardi 2009, see also Virno 2004, Lloyd 2010, Crary 2013, Pasquinelli 2014). But that labor, in accordance with capitalist valorization, is nearly always conceived as human labor. At best, it is human labor supplemented with machines. But what are we to make of—and with—the capacities of nonhuman life that are now put to work alongside us? And what are we to do with the “restless” and dynamic physical processes and ecological transformations that with increasing urgency require a heightened sensitivity to nonhuman life, and, in turn, call forth nonhuman life as co-workers? Finally, amid these redistributions of nonhuman capacities, how, if at all, do notions of “species being” and “living labor” still possess revolutionary force?

In what follows, I take up these questions in an analysis of the field of biosensing. I begin with an exploration of Marx’s concepts of species being, living labor, and the general intellect to reconsider how the boundaries and relations between human and nonhuman life are being reworked in contemporary capitalism. I suggest that alongside the so-called Anthropocene, biosensing marks a redistribution of both the work and precarity associated with the capitalist mode of production. Moreover, while the field forges engagements with nonhuman others and a growing awareness of planetary life, it also operates according to an imaginary of planetary management, one that enrolls nonhuman forms of life as ‘workers’ in the bioeconomy, rather than attending to multispecies entanglements with an ethics of care.

II. Beyond Human Hands: Species Being and the General Intellect

Labour is the living, form-giving fire; it is the transitoriness of things, their temporality, as their formation by living time.

-Karl Marx, *The Grundrisse*

The capitalist process has subsumed the world, turning it into a dead creature...on the contrary living labour is *kairos*, the restless creator of the *to-come*.

-Antonio Negri, *A Time for Revolution*

Marx's *Economic and Philosophical Manuscripts of 1844* (1974) defined the human species by its capacity to transform the conditions of its existence. Living labor named the conscious activity of transforming the material conditions of the world, an activity attributable to humans alone. An animal creates, but its products belong only "immediately to its physical body" (76). Humans, on the other hand, express a capacity to confront their products as external objects. Marx named this capacity to engender transformation in our collective development "species being." Marx's human in those early texts is a species that knows herself in what she makes, that sees herself in the "world that [she] has created" (Marx 1978: 76). Capitalism perverted this capacity. The products of wage labor did not reflect the world the worker had created, but rather the world the capitalist had created. Replacing capitalism with a communism-to-come would restore the world to those who made it.

Yet, in Marx's other writings, to be human also meant to be unsettled, to be affected by the changes wrought in the processes of production. As Nick Dyer-Witheford put it, new forms of production spark "'species changing' shifts in techno-social conditions" (Dyer-Witheford 2006: 23). In the *Grundrisse* (1993), Marx explored how the dead labor concretized within machines mixed with living labor to make social knowledge—rather than the human as such—"a direct force of production" (Marx 1993: 706). In the "Fragment on Machines", Marx refers to this social knowledge forged in a relationship between the past of production and its transformative present as the general

intellect.

While Marx maintained a focus on the industrial machinery of the factory, Feminist Marxists and Autonomists have shown how the constitution of this general intellect is not bound up in official sites of production; it takes shape in spaces of reproduction as well (Mies 1999, Virno 2004, Negri 2004, Hardt and Negri 2004, Federici 1975, Weeks 2011). Feminist Marxists have shown how capitalism's dominance as a mode of production always relied on the unpaid domestic labor of women, chattel slaves, and colonial subjects (Federici 1975, Mies 1999). Meanwhile and following the rise of advanced computing technology and declines in labor union memberships, Autonomists have followed the rise of service and affective labor, of the growing primacy of cognitive capital in the West, and of piece meal labor and the 'sharing' economy (Berardi 2009, see also Virno 2004, Crary 2013, Pasquinelli 2014).

Considering these emerging forms of labor, Negri (2004) has suggested an end to the very concept of the human. In its place, he wrote of the "[hu]man-machine," a term that better represented how "the production of man [sic] as multitude, gathered up in the common name, becomes indistinguishable from that of the production of the natural and historical Umwelt" (Negri 2004: 179). Matteo Pasquinelli (2014) has further argued for greater recognition of the recursive nature of technologies. They produce—and reproduce—a form of machinic intelligence that "keeps returning to challenge and capture the general intellect of the cognitive workers." (Pasquinelli 2014: 6). Through time, this machinic intelligence, rather than human intuition, comes "to shape the world after its original epistemic imprint" (Pasquinelli 2014: 6). Technology enrolls and codifies the cognitive and material futures we inhabit. The human brain, then, has become an organ of the machine rather than the other way around. Through Pasquinelli and others, we can understand the general intellect to describe how what we make shapes our ways of knowing. We apprehend the world through the tools and prosthetic technologies we use to modify it.

Crafting a political response to the continued alienation of human labor within such a world is no easy task. Much of the Autonomous tradition has called for the restoration of the power of living labor to workers. Here, innovation plays an extraordinary role: despite the recursive nature of post-Fordist technology, the capacity of living labor can ostensibly be organized otherwise. As the primary expression of Marx's species being, the living labor of the "(hu)man-machine" is the "power of the world," the sole progenitor of a new world to come. It is "*kairos*, the restless creator of the *to-come*" (Negri 2004: 165). The restoration of that power is crucial if we are to take "the world in hand" (Negri 2004: 165) and forge a post-capitalist future in common.

With a few notable exceptions (Dyer-Witheford 2006, Papadopoulos 2010), nonhuman life forms are rarely understood within the Autonomist tradition as part of this world to be taken "in hand." The naming of the Anthropocene, however, attempts to account for other elements of production, including extraction, the afterlife of production processes, and the effects of both on nonhuman life.¹ While global capitalism has built cities, manufactured airplanes, or developed the pharmacological cornucopia now part of everyday life, our products and machines of production are not dead, but have an afterlife, transforming nature in ways that go unseen. In addition to increased concentrations of atmospheric CO₂, writing on the Anthropocene typically emphasizes ocean acidification, residues of nuclear weapon testing from the mid-twentieth century, the spread of microplastic particles throughout all of the earth's bodies of water, and the accumulation of nitrogen and phosphorous across land and seas (MacFarlane 2016; Vaughn 2016). In doing so, this newly named era conjures geologic and biologic destruction both widely distributed and often imperceptible to the naked eye. We know the Anthropocene primarily through these lists of unseen matter, the residues of production.

The nomination of the Anthropocene registers not only a denigration of life well beyond our lived experience and singular species being, it also highlights a catastrophe of productive social

relations that, paralleling humans' capacity for production itself, extends across the "whole of nature" (Marx 1978: 76). Read one way, the naming of this era reflects the potency of our capacity to transform the world. It names a world that has been taken "in hand." But rather than a celebration of humankind's ascension to a geologic force, it also forces a recognition that the world is being turned into "a dead creature" (Negri 2004: 165). The Anthropocene then also invokes a radical impotency, a knowledge that our productive efforts over the past three centuries are decidedly "out of hand." Whether caused by humans as a whole, or by capitalist alienation and a bourgeois society that allows its resources to be dominated by a "blind power" (Foster 2000: 159), it is as if the violence of capitalist social relations has "gone rogue," expanding outward to systems of ecological reproduction.

That such a world could be taken back "in hand" suggests a techno-utopian imaginary. It is just such an imaginary that legitimates the possibility of geoengineering the climate and micromanaging every ecosystem. In direct opposition to this tendency, Donna Haraway has given us another name for this era, the "Chthulucene" (Haraway 2015). Haraway's Chthulucene gives voice not to the power of the human hand, but rather to the "entangled myriad temporalities and spatialities and myriad intra-active entities-in-assemblages—including the more-than-human, other-than-human, inhuman, and human-as-humus" (Haraway 2015: 160). In the Chthulucene, we must act knowing that our actions—and their often unintended consequences—will be woven into the fabric of living processes on earth.

Consistent with this view, analyses of ecological conditions find that neither living labor nor the human body alone are the sole "bearers" of *kairos* (Negri 2005: 163). As Myra Hird and Nigel Clark (2014) have noted, the earth's own metabolic processes—in the effluents of production or elsewhere—continuously transform the earth and its forms of life. Ecological and physical dynamics are also restless creators of the "to come" (2005: 163). Accordingly and along with the unpaid labor

of women and the marginalized lives of colonial expansion, a wide swathe of literature in the social sciences and humanities has encouraged greater recognition of the social contributions of nonhuman animals (Derrida 2008, Haraway 2008, Buller 2013), nonliving things (Bennett 2010, Harman 2011, Yusoff 2013, Clark 2011), and configurations of techno-biological systems (Braun and Whatmore 2010, Franklin and Roberts 2006). In so doing, many of these accounts show that the world was never entirely in human hands, never fully the product of self-possessed “free, conscious” activity even for those (mostly white Western men) whose activities were the bearers of economic and social value (Haraway 2015).

‘Our’ capacity for transformation has always been more than human. Workhorses, oxen, mules, bees, etc. have and do work alongside the living labor of humans. Like machines, these organisms facilitate the transformation of the earth’s material, adjusting the parameters of space and time. With them, we have accelerated planting and harvesting, extraction, acts of war, and migration across landscapes. But other-than-human organisms are not merely ‘natural resources,’ the products of human innovation, or engines of extraction. They are biological entities that we have shaped and that shape us. At times their labor or lives are appropriated in ways that enhance human life. Most directly, the animals we reproduce, grow, and consume are living—and ultimately dead—commodities that facilitate our own daily reproduction. And, as Nicole Shukin’s *Animal Capital* (2010) showed us, the circulation of animal symbols and animal flesh was central to capitalism’s historic expansion. Just as often, however, nonhuman life is blamed for laying our best plans—and our lives—to waste (see Mitchell 2002).

Many accounts of nonhumans continue to detail these ways that animals bodies are either victims of capitalist production or recalcitrant vehicles of transgression (Papadopoulous 2010, Moore 2015). But, nonhuman organisms do not only act in concert with or opposition to human action. They also possess many of the world-shaping capacities that we claim as our own (Hird and

Clark 2014). This becomes particularly clear when considering the ways that animals and plants reveal the world to us, conditioning our ways of knowing. Like technology, nonhuman life shapes human apprehension of nonliving materials—and ourselves. Indeed, nonhumans, have always been a part of our technological apparatus.

At once old and incredibly novel, biosensing uses animal bodies and animal capacities as a means of expanding human capacities for making and knowing. The concerted use of certain nonhuman animals to expand our senses dates back at least to pre-agricultural times. The heightened olfactory and aural capacities of domesticated dogs enhanced human abilities in tracking, hunting, and community protection. Today, canine noses help to find lost humans, drugs, explosives. Rats help to clear buried landmines. Scientists have trained bees to ‘sniff out’ explosive devices, radioactive materials, and even certain forms of cancer (Kosek 2010, Grozdanic 2014). For many, these circulations of animal flesh (living and dead) are merely one expression of an economy rooted in exploitation. If it is the exploitation of human labor that generates value in capitalism, the labor of animals represents what Jason Moore (2015) refers to as the extraction of the “four cheaps.” But it is not merely the labor of the animal (as those of the dog and rat here, or the work of mules in coal extraction) that is enrolled in human reproduction today. It is also the labor of living itself that produces knowledge of a changing world. Nonhuman life enables us to mark the boundary between conditions conducive to life and those destructive of it. Ever since John Scott Haldane introduced canaries and white mice into England’s coalmines as a way to register threats associated with extraction, the heightened sensitivity of nonhuman life itself—or, more pointedly, its passage into death—has been crucial in industrial production. And, as Joseph Masco has written in the context of nuclear testing, pigs and other living organisms are instruments indicative of the trauma inflicted on biological beings. In nuclear arms tests, the fragility of the human body was prefigured by "the vaporized, mutilated, and traumatized animal body" (Masco 2004, 529). Finally, animals’ bodies also

help to mark the internal boundary of our chemical and biological pharmakon. The sensitivity of rats, mice, rabbits and other nonhumans help scientists demonstrate which chemicals cure and which accelerate death.

Just as technologies condition the ways that we encounter, apprehend, and transform the world, this more-than-human sensorium facilitates the marking and measuring of our world. Today, as humans are grasping in the dark to understand what is coming, biological processes are being studied in new ways to shed light on, and respond to, the precarity of the world as a whole. Kathryn Yusoff (2013) and others have suggested that recognizing these entanglements and expanding our sensorium in the face of ecological degradation will lead to new regimes of care. But the growing enrollment and reorganization of the more-than-human sensorium in new efforts of planetary management would seem to contradict this hope.

IV. A More-Than-Human Sensorium for the Anthropocene

The recent explosion of the field of biosensing has entailed a redistribution and re-aggregation of nonhuman processes and their capacities. The field encompasses a wide range of techniques designed to reveal matter that is either imperceptible or imperceptibly dangerous to life. Scientists have refined their ability to identify ecological change (and, with it, ecological norms) by examining an array of biological factors and processes. Through these mechanisms of knowledge production, nonhuman life is revalorized for what it can communicate to humans about the vulnerability of life in the material world. Accordingly, the capacity to live and bear witness to that living becomes a productive enterprise. The making of multi-species biosensory arrays offers a unique window into this process.

While the Wyss Institute has heightened the sensory and communication capacities of eukaryotes through bio-engineering, other scientists draw on the study of whole organisms. Consider, for example, the work of LimCo International. Based in Germany, the corporation has

developed what they call a “unique LimCo BioSensor system” (LBS) that uses multiple species of whole body organisms to monitor fresh and marine water sources for pollutants. The LBS contains anywhere between eight and ninety-six “sensor chambers” that house an array of animal species—small fish, worms, mullosks, crustaceans, and microorganisms—whose expressions of life are under constant surveillance. The crude boundary between life and death is no longer the only indicator of environmental harm here. Having established a set of measurable norms around the functioning of these organisms, the LBS monitors a suite of “behavioral fingerprints” as these organisms are exposed to different systems. Locomotor activity, reproductive rates, and embryonic development are measured together to indicate the severity of hazardous anthropogenic chemicals as well as biologically produced toxins, such as blue-green algae. In this way, the company boasts, they can make “pollution measurable.”

The scientific analysis of these lively metrics renders potential harms—both acute and chronic—knowable. These biological systems are therefore capable of registering the multiple temporal and spatial dynamics at play in the Anthropocene. While chemical trace analysis is typically used to detect known hazardous substances, exposing multiple species to potential ecotoxicological hazards enhances the ability to identify harms that would otherwise go undetected (“Limco International” 2016). Through these methods, imperceptible harms can be made visible. Even unknown substances can be identified “in due time before pollution irreversibly spreads in the environment or even harms human health” (“Limco International” 2016).

As described in this paper’s opening pages, the capacity to register ecotoxicological or human-intended harms has also been distributed through and across techno-biological apparatuses. These involve the isolation or transformation of particular bio-materials or processes. Cornell University’s Bioanalytical Microsystems and Biosensor (BMB) lab, for example, has synthesized liposomes for use in small-scale technological devices. BMB has tested the way that these fatty structures can be

used to signal the presence of pathogenic organisms, as well as toxins in food, drinking water, or the generalized environment (biosensors.bee.cornel.edu). Like the products of the Wyss Institute, BMB's liposomes are most useful because of their wide applicability. From "hamburger meat to apple cider, from surface water to manure, from whole blood to saliva," the BMB biosensors are capable of detecting the slight presence of harmful agents like the *C. parvum*, *E. coli*, the Dengue virus, and even biological warfare agents (biosensors.bee.cornel.edu).

Across the spectrum of biosensory techniques, the most widely used biological tool is the Green Fluorescent Protein (GFP). This is what makes the Wyss Institute's re-engineered plants glow. Identified in 1961 in the jellyfish *Aequorea victoria*, GFP was initially considered structurally unique as a chromatic expression. In most luminous organisms, the capacity for fluorescence is found in chromophores that exist alongside amino acid sequences of proteins. In contrast the part of *A. victoria's* molecular structure responsible for its color and iridescence is generated by an amino acid reaction. Because it requires no special substrate or external enzyme to produce fluorescence, it can therefore be used *in vivo*, the chromophores forming in live tissue or cells (Stepanenko, *et al.* 2008). This reaction has proven easy to clone and modify for use within an array of bioimaging and biomarking methods in the biosciences. Fluorescent proteins of any hue can help to signal a wide range of both toxic and therapeutic elements. Like the BMB's liposomes, FPs can be used to identify the presence of pathogens like *E. coli*, as well as minor changes in pH, the presence of cancer cells, cancer-causing geno-toxic agents (in water, food, or tissue), copper ions, heavy metal pollution, and a host of other toxic compounds. And, like LimCo's BioSensor system, fluorescent proteins are often used to pick up on potential contaminants for which scientists have not thought to look.

As a response to the conditions of the Anthropocene, biosensor systems, GFPs, and synthesized liposomes enable us to identify potential harms. In spite of the differential temporalities and scales of ecological degradation, the violence of past labors is made visible and measureable. In

the process, risk is not only generalized, but also made generic. The planet appears through biosensing as beset on all sides by potential toxins. Wherever we choose to place the origins of the Anthropocene, whatever markers of potential “mass destruction” we wish to identify—whether threats to the security of the nation or that of the species—biosensing produces an imaginary in which those threats are now identifiable and manageable, not by humans, but by ecological processes themselves. Here it is not that, as Marx wrote, human have harnessed living labor to reproduce “the whole of nature,” but that the whole of nature has been enrolled in maintaining the conditions for human life and its current for of production.

V. Recursions of Productive Life

Investments in the biosciences are producing new ways of harnessing nonhuman capacities and putting biomaterials to "work" in industrial production and extraction (Labban 2014; Johnson and Goldstein 2015; Barua 2016). This goes well beyond biosensing. As Mazen Labban (2014) has recently noted, for example, practices of biomimicking and bioleaching—part of efforts to extend mineral extraction beyond the mine—have affixed "the metabolic and reproductive functions of microorganisms" to vast networks of value production. Alongside extraction, the growing bioeconomy has sutured the biosciences and its lively subjects of inquiry to economic and legal infrastructures of accumulation (Sundar Rajan 2004, Dumit 2012, Cooper and Waldby 2013, Franklin 2013). However, endeavors in bio-innovation are also reconfiguring the parameters of capitalist production. Human bodies now take on a panoply of roles that are, arguably, more-than-human. Waldby and Cooper have shown, for example, how clinical trial patients and reproductive materials are 'soaked' in the chemical and intellectual labor of medical industries to perform as materials of production, wage labor, and commodity, often simultaneously (Cooper and Waldby 2010). Similarly, nonhuman life forms are put to work in ways that resemble human categories of

labor. The Wyss Institute’s biosensors-cum-middle-management, which monitor the productivity of biological workers, attest to this. Encoded within these organisms is an imperative to produce or die. In the making of these biological entities that signal their own productive capacities, productivity itself becomes the most essential feature of life. Accordingly, production—not for the reproduction of a species or an ecosystem, but for profit—becomes the very condition of life.

Like the machinery of Post-Fordist capitalism, the emerging fields of biosensing and biomimicry are recursive. In a parallel to the rise of the “social factory” that has been so central to Autonomous Marxism, biosensing appropriates and enrolls nonhuman life in cognitive and communicative endeavors. The field has given rise to the production and appropriation of “biological intelligence,” alongside “artificial intelligence” and computing algorithms (Pasquinelli 2013; Johnson and Goldstien 2015). But it also blurs the boundary between technology and biology, making and knowing, producing and reproducing. Produced through this is a way of seeing *with* nonhuman life. There is no denying that fields like biosensing expand our sensorium and potentially shift perspectives in environmental health. There is some hope here, that by enrolling animal life in these ways, humans might be more deeply affected by the world around us, shifting our ethical and political frameworks. Like technological machinery, nonhumans are increasingly part of the knowledge-making capacities of the world. These organisms and our knowledge of them are not outside of capitalism, but neither are they limited to it. They operate with alternative logics, temporalities and dynamics to which we might find ourselves responding with something like care. This is not “the power of knowledge, objectified,” (Marx 1993: 706), but rather the power of knowledge revived. Rather than the objects of scientific inquiry, organisms have also been rendered collaborative participants (see Johnson and Goldstein 2015). However, as nonhuman capacities are enrolled in the endeavor to prolong or enhance the reproduction of human life as well

as “the whole of nature,” value and productivity both become naturalized. The productive survival of the species becomes synonymous with the reproduction of life on earth.

As Jason Read has written, labor’s displacement is made possible by the rise of machinic production and its “incorporation of science, chemistry, and even what Marx refers to as ‘accumulated experience’ on a large scale” (2003: 117). But that “accumulated experience” has been largely confined to human experience. Marx’s general intellect was after all built on human ingenuity and the architectural logics of machinery. Mateo Pasquinelli’s writing on algorithms is an updated expression of this. It is one that, as he describes, is internally recursive: machines produce a form of machinic intelligence that “keeps returning to challenge and capture the general intellect of the cognitive workers” (Pasquinelli 2014: 6). This machinic intelligence—produced by and for capital—rather than human intuition, comes “to shape the world after its original epistemic imprint” (Pasquinelli 2014: 6). Through this lens, biosensing creates a way of reading matter and biological processes in conjunction with what Helen Pritchard (2016) has referred to as a “computational aesthetics.” The field allows us to see matter in particular ways, lighting up certain transformations in our ecological systems, while allowing others to remain dark.

These trends are accelerated by the conditions of the Anthropocene, as a growing emphasis on environmental 'costs and benefits' has intensified the need to 'see' connections across matter, materials and forms of life and register the value of ecosystem 'services' (Robertson 2012, Schrader 2012, Pasquinelli 2014, Nelson 2014). Alongside Pritchard’s computational aesthetics, biosensing in the Anthropocene also enables a vision of the earth as a solution space, a repository of ecological systems to be surveilled and potential solutions to be enacted. This requires a narrowing of what we see, where we look, and where we look away. The earth as solution space offers us only one reading of the multiple temporal, geologic, and spatial shifts that accompany the era of the Anthropocene. This is a linear narrative of history in which the past is read as an accrual of trauma (to humans and

nonhumans alike) while the present is a pivot point from which to launch a future transformed. In this version of history, we find a clear set of possible solutions, rationalized responses, prescriptive measures that promise to continue a progressive path into the future. As a result, ‘fixing’ ecological degradation relies on innovation rather than the forms of organization and modes of becoming with which we enjoin with nonhumans in a struggle for collective existence. This is a multi-species worlding that creates conditions for extending the capacities of capitalist production rather than capacities of care.

But the nomination of the Anthropocene and the development of biosensing both offer a wider and less cohesive view of accumulated experience. Like the dead labor of machinery, waste materials return as a disaggregated, diffused threat, capturing the intellect of cognitive workers, but in ways that threaten to destabilize production rather than sustaining it. We might also take recursion and the more-than-human general intellect further. By incorporating the productive capacities of life within production, we also open it to alternative logics—other than human logics—that do not necessarily conform to the computational aesthetic. A more expansive aesthetic, one that is neither strictly machinic nor biological, may provide resources for alternative ways of reproducing life. Such a transition will certainly not happen “naturally,” however. The question that remains then is this: what would the re-organization of a more-than-human general intellect for the collective look like?

VI. Conclusion

There may be no better area of research than biosensing through which to consider the ways that technological advance has made the production of humans, as Negri has written, "indistinguishable from that of the natural and historical *Umwelt*" (2004: 192). In the first decade of the twenty-first century, the ills of industrial production come as a surprise only to those who have been relatively shielded from them. The bodies of laborers (waged and enslaved) who engaged in

the extraction of fossil fuels or the transformation of materials to commodities have directly borne the precarity required by capitalist production. The naming of the Anthropocene, however, marks a shift in where we identify a redistribution of both the work and precarity associated with our mode of production. Biosensing stands here as a response to bio-techno worlds in which new threats – to human health and to forces of production– are ever more entangled. It appears as a way to reconnect with the liveliness of other living things. Its engagements with nonhuman others promote a growing awareness of planetary life. But it risks organizing the knowable (and even unknowable) world around the collection of planetary threats. And, as Jason Moore has argued, such a characterization makes it easy to struggle against threats to production rather than the violence of our “strategic relations of power and production” (2014: 2).

Considering biosensing and other bioeconomies makes clear that it is no longer enough to consider the ‘matter’ of the Anthropocene or our engagements with nonhumans. The injunction of living labor to “take the world in hand” also no longer seems a viable response to contemporary capital or to the conditions of the Anthropocene. While the Autonomists effectively displaced labor from the confines of the human body, the failure to consider animal and biological processes has hamstrung an ability to respond to these ecological concerns. An alternative may lie in a growing attention to cognitive capital and its circulation as the product not only of human labor, but of animal reproduction and the forces of evolution and development—that is, a heightened attention to the way that the generative (and destructive) processes of living things constitute our social lives. In light of biosensing and the bioeconomy, the more-than-human common appears utterly recuperable by capital and national interests in securitizing the planet. Perhaps what we need to work toward is a more-than-human undercommon (Harney and Moten 2015) that has as its goal the active subversion of the enclosure of knowledge and life’s generative processes. Perhaps this was the power of species being all along: that it drew together a critique of the mode of production with

concerns about reproduction. Taking those concerns beyond the reproduction of selves to the that of whole ecosystems, it may be possible for us to imagine enjoining with nonhuman life in a refusal of capitalism's ultimatum to produce or whither away.

ⁱ The debates over the term the "Anthropocene" are well rehearsed elsewhere. Among the chief complaints is the term's false invocation of a universal, undifferentiated humanity. The term the Anthropocene explicitly attributes geological change to the species as a whole. In so doing, it erases a 300-year history of uneven development, colonialism, and resource and labor exploitation. As many have argued, this era might be better named the Capitalocene (Malm 2016; Haraway 2015; Moore 2014). Haraway (2015) marks an important tension that accompanies these conflicts on the causal mechanisms of ecological degradation. While laying blame at the feet of an undifferentiated humanity is an obvious injustice, Haraway nevertheless insists that "blaming Capitalism, Imperialism, Neoliberalism, Modernization, or some other 'not us' for ongoing destruction webbed with human numbers will not work either" (164).

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