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there IS NO
SUCH THING as a
technological
accident

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CHEAP Natures, climate
CRISIS & technological
Impasse

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Like Nature, *Technology* is one of our most dangerous words. It's a metaphysic, a narrative prime mover endowed with supernatural powers.

Such words are never innocent. They are never *just* words. They are guiding threads for the rulers. For the rest of us, they're everyday folk concepts. These concepts shape what we see and what we don't see, what we prioritize, and what we ignore.¹ Importantly, they not merely describe the world; they license and guide modern ways of organizing power and re/production. They have real force in the world, because of what they mystify, and because of what they enable. Such ideas present themselves as innocent. They are anything but.

These ideas are *ruling abstractions*.² They are ideological constructs that have made the modern world, a kind of software for the "hard" mechanisms of exploitation and extirpation.

Hence the uppercase. The ruling abstractions of Nature and Technology have very little to do with soils or machines; they have everything to do with modern fantasies of power and profit, and the dystopias they enable.

Such abstractions are dangerous for two reasons. First, they appear in our imaginaries as agentless forces of history: they are brain erasers for world-historical memory. They *seem* to have "lives of their own" – which they emphatically do not.³ For over a century, these abstractions have seduced the political left no less than centrist and "eco-modernizing" techno-fixers. Technology is particularly tempting; it easily becomes an "idea of mechanical progress, not merely as a necessary development but as an end in itself, *almost as a kind of religion*."⁴

Second, the danger extends beyond false consciousness. Ruling abstractions are material forces, not just ideas but belief structures.⁵ They are developed, used, and periodically reinvented by the imperial bourgeoisie and their intelligentsias to practically reshape the world in ways favorable to the endless accumulation of capital. Ruling abstractions are the building blocks of hegemonic ideologies that trickle down to the folk concepts of everyday life. From the Levellers to Blockadia, radical movements have challenged these abstractions. But they must also live with the contradictions – as Orwell underlines. When Lenin moved from the furious denunciation to the critical acceptance of Taylorism and Fordism after 1917, he was doing what all revolutionaries must do: wrestle with the contradictions of capitalism.⁶ Those contradictions are far more than mechanical.⁷ They are ideological, social, biological, cultural ... and planetary.

Sometimes demon, sometimes savior, the ruling abstraction *Technology* conjures something mystical, outside of history yet relevant to it. Its power is the

alchemist's illusion: the magical notion that machinery will produce something out of nothing. My uppercase emphasizes the double register of both Nature and Technology: as ruling abstractions, central to modern mythmaking, and as material processes of power, profit and life. Disentangling and resynthesizing the two moments – the ideological and the material – is difficult.

The difficulty stems from ideological mystification, not intrinsic complexity. I am not asking the reader to design a Mars rocket. The superficially counter-intuitive character of my argument shows how bourgeois ideology paints radical critique as unduly complex and unrealistic. Nowhere is this more evident than in its ruling abstractions, like Nature and Technology. Capitalism – through the media, the schools, and the professions – has so thoroughly indoctrinated us into the procedures of Cartesian thought, with its fantasy of thinking substances and extended substances, that it takes a deliberate and sustained choice to think dialectically.⁸ Either/or thinking is so hegemonic that our neural pathways often resist the dialectical imagination's emphasis on unity-in-difference, on flows that shape that inside, the outside, the in-between. This makes it challenging to grasp historical movements as "rich totalities of many determinations."⁹ The alternative asks us not only to interrogate the ruling abstractions that sneakily find their way underneath our critical sensibilities and set up shop in our preconceptual habitus; it asks us to see how those ruling abstractions operate in world history, becoming – as a young Marx once quipped – ideas with "material force."¹⁰

Nature and Technology, the ruling ideas, are so central to modern thought and everyday language that questioning them might sound absurd. Their common sense, descriptive innocence is so obvious that anyone who points out their ideological character must be insane – or some ivory tower thinker who prefers word games over hard-headed analysis. But these ideas are conceptual hammers of imperial rule and its false promise of Progress. As abstractions, they have material consequences. To liken the web of life to a machine, or the biosphere to a spaceship, is not merely an intellectual problem but a political and ideological project.¹¹ The responsibility of radical critique in the climate crisis is to lay bare the interpenetrating relations of class power, ideology and the forces of production in the web of life. How one *thinks* about Technology – and therefore Nature – is fundamental to one's world-historical conception of the crisis and its origins, and therefore essential to one's political assessments, "environmental" and otherwise.

The dominant intellectual and ideological view fragments the world into discrete concept boxes: Nature, Society, Economy, Technology, Race, whatever. The fragmented worldview – deeply indebted to the Cartesian primacy of parts over wholes – leads to interpretations of the climate crisis through causal pluralism, systems theory, and generalized schemes of interactivity rather than dialectical interpenetration and totality. In such approaches, parts trump the whole – or the whole overwhelms the parts (two sides of the same epistemological coin). The result is an intellectual and ideological impasse that fails to do what any radical climate critique must: identify the emerging “weak links” in the chains of imperial power and class exploitation in the unfolding planetary crisis.¹²

The dialectical – and I would say world-ecological – alternative begins neither with parts nor wholes, but with guiding threads. Let us take the example of the technology-resource nexus most closely identified with the climate crisis. On the left these days, the notion of “fossil capital” is hegemonic.¹³ It powerfully implicates the class relations of steam power and coal from the early nineteenth century; it identifies the epochal character of varied permutations of oil, gas, and combustion engines since then. There is much to recommend in the thesis, but only to a point. It runs dangerously close to technological determinism and resource fetishism. As we’ll see, the history of the steam engine is wrapped up with a broader ensemble of technological, ideological, and imperial transformations. It was a crucial node in nineteenth-century industrialization, but was it decisive? Was it even the era’s most epochal machine?

These questions must be posed if we are to develop a revolutionary strategy for climate justice. Narrowing the problem to specific technological-resource combinations is not only historically problematic. A politics that flows from such reductionism is intrinsically vulnerable to ruling class “fixes” that reshuffle capitalism’s energetic-technological mix while preserving violent and unequal relations of class exploitation.¹⁴

Here we can remember the New Left slogan: the issue is not the issue.¹⁵ Blow up a pipeline and you may slow global warming for days or weeks. Transcend the thinking – and its enabling webs of power and profit – responsible for the pipelines, and another biosphere is possible. To be sure, thinking is not enough; it is necessary but insufficient for revolutionary synthesis. Without an intellectual rupture that moves beyond substance fetishes, methodological nationalism, and Cartesian thinking, popular movements for fundamental democratization will remain vulnerable: easily divided, repressed, and co-opted

by the identitarian and eco-reductionist temptations of progressive neoliberalism.¹⁶ A *connective* alternative is called for, one that understands how all socio-ecological forces and dynamics are *not* created equal but rather concretely – and hierarchically – structured by five centuries of the imperial bourgeoisie’s triumph in the global class war.¹⁷ Any vision for planetary justice and emancipatory technology (with an emphatically lowercase ‘t’) will need to prioritize the development of international, feminist, and multi-racial working-class movements that can politically secure – and defend – popular hegemony over investment decisions, and ensure the liquidation of private power over the fate of the planet and its creatures.

natural disasters, technological accidents and other excuses

An environmental justice slogan gained popularity after 2005’s Hurricane Katrina and the devastation of New Orleans and the Gulf Coast: “There is no such thing as a natural disaster.”¹⁸ To this we may add: *There is no such thing as a technological accident.* Unpredictable events are, of course part, of life. No one thinks that scientific and technical discovery occurs without accidents and unforeseen developments. If our concern is, however, with the potentially catastrophic relations between modern technology, power and webs of life – let us say since the “long” sixteenth century (1450–1648) – a different interpretation is necessary.

Here we can build upon Paul Virilio’s perceptive and prescient amplification of Marx on the social relations of technology and its “accidents.”¹⁹ Every historical form of “technological” development is a social relation that invariably produces specific forms of risk and potential catastrophe. These unfold through the nexus of machinery, both “hard” (machinery) and “soft” (for example software, cartography). I would add that every epoch-making technology in the modern world is irreducibly socio-ecological – as cause and consequence.²⁰

For Virilio, *accident* and *technology* diverge from our everyday language. I cannot here reprise Virilio’s lifetime of work on the matter. Making sense of capitalist technology asks us, Virilio implies, to wrestle with the history of epochal possibility, danger, and destruction. The arc of capitalism is to activate the danger of “integral accidents.” These “incorporat[e] a whole host of incidents and disasters in a chain reaction.”²¹ The climate crisis is just such an integral accident. It is no more the unpredictable outcome of capitalism than

Chernobyl or Hiroshima were the unexpected results of nuclear fission. To paraphrase Engels (and Spinoza), every determination generates its own negation.²²

Does it also include *our* negation? This is what “existential threat” and other expressions of climate doom suggest. I am not convinced. And yes, I have read “*the science.*”

Such climate doomism is essentially the product of three ideological dynamics. All are intimately linked to capitalism’s technological fetishism. One is the Cartesian worldview. If your cosmology is Man against Nature, the *political* resolution of the climate crisis as a geohistorical event is unthinkable; climate fixes manifest as technocratic and technological, fused through some version of Rationality and Progress. Such arguments – like Development in an earlier era and Sustainability today – are “anti-political” infrastructures of policy and global power.²³

Secondly, climate doomism is tightly connected to the imperial bourgeoisie’s repressed unconscious about its own impending doom, about which we will learn more presently. Late monopoly capitalism has entered its zombie phase: dead, but moving. And very deadly.²⁴ As capitalism sinks deeper into a productivist stagnation, its militarized edge cuts ever more sharply. For half a century, we’ve been promised a new scientific-technological revolution that would liberate humanity and the planet from poverty and ecocide. We are still waiting, and there are few grounds for optimism.

Third, climate doomism – which is different from acknowledging the extraordinary character of climate change at the end of the Holocene – ideologically excludes capitalism’s non-linear dynamics. Even in the absence of a climate crisis, capitalism’s volatility would be on the rise; the acceleration of capitalogenic climate change is not only *adding* a new “environmental” problem to a long-run set of contradictions; it’s amplifying those antagonisms, like inter-imperialist war and financial instability.²⁵

From the steam engine to networked computing, technological change has constantly stimulated future-gazing imaginations, dystopian and utopian. As if to move from the frying pan into the fire, utopian technologies for some have been dystopian for others – nuclear power is a dramatic case in point. This is hardly a novel observation. For Marx, the development of the productive forces ushered in a utopia for the rich – and a hellish dystopia of overwork, exhaustion and death for the working classes.²⁶

Capitalism's extraordinary expansion of the social surplus, instead of freeing humanity from misery and poverty, was an instrument of repression, domination, and endless exploitation from the outset. The "advancing" productive forces combined surplus value and surplus repression, psychic no less than bodily. Notably, that surplus repression has always been more than psychological and physical: it has been the accumulation of misery.²⁷

The misery of accumulation is bound to capitalism's sacrifice zone strategy, a dynamic of militarized accumulation and Prometheanism, of the domination of humans and the rest of life to render the "conquest of nature" profitable.²⁸ Technology for Marx is therefore mechanical, but always more than mechanical. It congeals power, profit and life into forms compatible with the compulsion to accumulate without cease (Moses and the Prophets!). Its absurdity grows daily, apace with its capacity to lay waste to humans and the rest of planetary life.²⁹

cheap natures, or the technological logic of historical capitalism

What if Virilio's compelling rendering of integral accidents – as "chain reactions" of "incidents and disasters" – is turned inside out, into the heart of capitalism's much-vaunted capacity for so-called innovation? Integral accidents issue from capitalism's specific integration of power, profit and life. This cannot be reduced to the narrowly economic; modern technologies are so destructive because they incorporate capitalism's *political* constitution of the conditions of profitability: hence the centrality of imperialism and states in capitalist environment-making. Unless we accept the fetish of Technology as a metaphysic of historical change, we must look at the specific relations that dominate the life of a civilization and its punishment/reward nexus for technological change. From this perspective, we may grasp capitalism's ongoing technological stagnation in the climate crisis. Technological *stagnation* refers not to some abstract benchmark of Progress, but to the specificity of capitalism's technological regime: the imperative to realize rising relative surplus value (labor productivity), necessary to counteract its tendency towards *economic* stagnation.³⁰

Among the great geohistorical insights of twentieth-century social thought is a simple thesis: capitalism destroys its capacity for technological innovation not because of its failures, but from its success.³¹ The claim that technological

progress has slowed considerably will surely elicit skepticism from readers.³² Bear with me.

From the standpoint of capital, one issue dominates: Does a given technology facilitate or undermine the endless accumulation of capital? The terms of that question are complex, but not unfathomably so. To clarify, we are not dealing with “better mousetraps” but the history of “epoch-making technologies.”³³ These have been relatively few and far between in the history of capitalism. Everyone has a different list, but early capitalism’s shipping-shipbuilding-cartography revolutions, successive military revolutions, the steam engine/cotton gin nexus, and the internal combustion engine are reasonable to include.³⁴

Whether or not the information/computing complex represents a new “industrial revolution” has been widely debated since the 1970s. Whatever change has occurred, the robust development of information and communications technology (ICT) doesn’t look all that revolutionary in historical perspective. I say this for a specific reason: technological developments over the past half-century failed to launch a significant advance in labor productivity growth and enable a new capitalist golden age.³⁵ This is hardly a controversial statement. As early as 1987, Robert Solow quipped that “the computer age [is] everywhere but in the productivity statistics.”³⁶ Notwithstanding a temporary and modest uptick after 1996, the trend has been persistently downwards since the early 1970s. That’s when futurologists – all pro-capitalist – started promising us robot factors in a “superindustrial revolution.”³⁷ Instead ICT has facilitated the global sweatshop and America’s permanent war regime.

Modern technologies become epoch-making to the degree that they join with new imperial and managerial movements to expand and appropriate frontiers of Cheap Nature. Here is a decisive limit to capitalism in the web of life: frontiers, opened at gunpoint after 1492, were exhausted by the 1970s. Today, those frontiers – terrestrial, aquatic, and atmospheric – are gone.³⁸ This is the source of capitalism’s zombie phase.

Technologies are epoch-making for two connected reasons. First, they open new opportunities for reviving, sustaining and advancing the rate of profit for capital as a whole – the enlarged surplus value accruing overwhelmingly to capitalists in the imperial centers. This is the economic moment. Secondly, they allow for the appropriation of geological and biological work – resources, crops, forest resources – in cheap, and geologically or biologically significant ways. Fossil fuels are a paradigm instance. This is the geophysical moment. The two join dialectically to resolve – or aggravate – the surplus capital problem.

Capital's dynamism is so great that it generates world surplus value above and beyond what can be reinvested profitably. Billionaires can only spend so much on hundred-million-dollar yachts and mansions. At the end of the day, they must find profitable investment opportunities – sufficient to expand an always-rising mass of accumulated capital. But suppose they do not find sufficiently profitable opportunities in the “productive” sphere. Then, the One Percent tends to sink its capital into unproductive sectors, favoring rentierism and militarism: real estate, finance, and war machines.³⁹

Historically, such militarism – taking the form of successive “new” imperialisms in each great wave of capitalist development – worked because it opened new frontiers of Cheap Nature.⁴⁰ This was not merely about the redistribution of surplus value through imperialist rents; it was fundamentally about the quantitative and qualitative expansion of the ecological surplus: the ratio of unpaid work/energy to the mass of capital. All manner of investments suddenly become profitable when the ecological surplus is high – when raw materials and labor are suddenly cheaper and more abundant. Thus every great industrialization – from the long sixteenth century to the postwar golden age – called forth an imperialism that restored and expanded the supplies of the Four Cheaps: labor and unpaid work, food, energy, and raw materials. This is far more important to the history of capitalist technology than usually supposed. Successive military revolutions have been hothouses of proletarianization, financial innovation, and technological development.⁴¹ Advances in gun manufacture, for instance, were critical nodes in the “first” nineteenth century's industrialization (c. 1780s–1850s), first in Britain and then in the “American system.”⁴² Global capitalism's cybernetics-computing infrastructure since the 1940s was, for decades, incubated in the American military-industrial complex.⁴³

Technological “fixes” to the surplus capital problem – in Harvey's sense of the term – are never purely, or even primarily, technical. They materialize through the nexus of mechanization in the imperial centers and the political possibilities of appropriating unpaid work/energy on the frontiers.⁴⁴ Capitalism's epoch-making technologies have depended on, and often developed *through*, frontiers of Cheap Nature. Without these, epoch-making capitalist technologies don't happen.

**the machinery of cheap nature: industrialization from king cotton to the
washington consensus**

Consider the steam engine. It was developed at the pithead of coal mines to drain water in the early eighteenth century. The frontier in question was subterranean: vertical rather than horizontal. Cheap Energy was so abundant at the coal mines that the steam engine's inefficiency was economically tolerable. Decades of experimentation followed, underwritten by Cheap Energy. While Watts' rotary steam engine after 1784 saw gradual diffusion, the real breakthrough in British industry did not occur until after 1830.

Why the lag? Part of the answer is found across the Atlantic. The British textile industry consumed cotton, and cotton supplies were limited – and relatively expensive. *Cheap* cotton – which meant abundant cotton – was necessary for “the” industrial revolution. Marx knew it at the time: “Only the large fall in the price of cotton ... enabled the cotton industry to develop in the way that it did.”⁴⁵ Cheap cotton's technological pivot was the cotton gin. The gin has a very long history, but its modern breakthrough is typically dated to Eli Whitney's breakthrough in 1793–1794. The new gin enabled a prodigious advance in labor productivity in physical terms. Early adopting regions like South Carolina saw a 1266 percent increase in cotton exports per slave in the 1790s.⁴⁶ While slave prices rose modestly, cotton export prices plummeted. But the gin's extraordinary labor productivity advances offset those falling prices to make cotton cultivation a lucrative enterprise (itself made possible by a new slave regime organized through gang labor management).

This was no technological accident. The cotton gin's epoch-making character was closely linked to the consolidation of the American republic; its capacity to expel indigenous peoples and move to frontiers of fertile soil; flows of capital from West Indian sugar plantations; and of course the British empire and its deindustrialization of India. Cotton and textile output surged on both sides of the Atlantic. If there was a “key machine” of British-led industrialization, it was the cotton gin, not the steam engine.⁴⁷

Around 1830, the steam engine became dominant in British textile manufacturing. But its world-historical centrality was not in industry but in trade and empire. The steam engine's epoch-making character is therefore only partly a story of advancing labor productivity (of “relative surplus value”) – as Anglo-centric Marxists maintain.⁴⁸ The steam engine was not only an industrial but a

war machine, deployed to open new frontiers of Cheap Nature. Steam-powered gunships would be seen from the opium wars to the scramble for Africa.

Railroads were just as significant. Completing the first North American transcontinental railway in 1869 enabled US military power to destroy indigenous resistance. Globally, it's no accident that the railroad revolution more or less follows (and thence enabled) the British hegemonic ascent after 1815.⁴⁹

The nineteenth-century's railroad boom (c. 1850–1914) contributed mightily to fixing the surplus capital problem.⁵⁰ Along with the steamship and gunboat, railroads facilitated imperialism's unprecedented global reach, realizing the enclosure of planetary life for the first time. This allowed for the planet-wide appropriation of unpaid work/energy, setting the stage for the "second" industrialization (c. 1873–1914) and later, the long postwar boom. New flows of Cheap grain, tin, copper, oil, rubber, nickel and other strategic inputs directly subsidized the rise of the automobile, electrical, and petrochemical industries. Thus the steam-engine/railroad complex allowed for not only massive flows of surplus capital to find a profitable outlet. The railroads, carrying soldiers, settlers and colonial administrators allowed the militarized projection of capitalist power into regions previously untouched by capital: frontiers of Cheap Nature.⁵¹

The rise of American capitalism, for instance, turned on the annihilation of space by time, materialized through those continent-devouring ribbons of steel, appropriating the soil, water, forests, and metals of North America into feedstock for monopoly capitalism.⁵² But the process was hardly limited to North America. Through railroadization – and later, automobilization – vast ecological surpluses could be won from the minimally capitalized extraction of mineral resources and cash crops on the new frontiers. As the second industrial revolution gained traction in the 1870s, it could do so with abundant supplies of Cheap Nature, thereby avoiding the specter of underproduction faced by earlier waves of industrialization.

What happens to technological change and world accumulation once the closure – and thence implosion – of frontiers begins? As we've seen, capitalist dynamism creates economic crises because it accumulates capital faster than it generates new outlets for investment. The chief counter-tendency derives from opening frontiers that deliver labor, food, energy and raw materials at well below the prevailing cost. This explains why great technological revolutions occur as input prices fall – including labor costs. In brief, restoring the Four

Cheaps increases profitability, encouraging investment and technical change. But this requires new, cheaply and consistently delivered natures.⁵³

The Great Frontier allowed capital to fix overaccumulation crises because successive industrial revolutions and their “operational landscapes” rely on one or another strategic primary commodity: Dutch *fluitschepen* were assembled with cheap timber from Norway; Manchester textile factories with cheap cotton from the American South; Henry Ford’s Model Ts were profitable to manufacture only because of cheap oil.⁵⁴ For every Amsterdam, there is a Norway; for every Manchester, there is a Mississippi.

Those commodities are Cheap in a specific economic sense. (This is not to abstract the geocultural relations of cheapening and its superexploitative character, which ideologically enable downward price movements.) Not only must they have a strategic, qualitative role in technological revolution (for example coal, oil, or bauxite). They must also meet two further requirements: 1) their supply must rise significantly; 2) their value composition must fall dramatically. Without rising labor productivity – in some concert of physical and price measures – Cheapness cannot be realized. In addition to its narrowly technical dimensions, the matter is also decisive because it raises questions about the strategic character of class struggle in primary sectors. To the degree that capital wins those class struggles (often but not always through technical change), labor productivity advances and unit costs fall. In these conditions, average labor-time in primary commodity output declines, allowing falling prices – and rising profitability, and investment with it. Primary commodity prices fell 1.2 percent annually from 1900 until 2003, when the latest commodity “supercycle” began.⁵⁵ Although temporarily stalled around 2013, by the end of the decade a new phase of this long commodity boom commenced: a “climate supercycle.”⁵⁶

The first significant signs of an epochal crisis of Cheap Nature – and the withering of the historical relation between technological change and productivity revolution – appeared in the long 1970s. I cannot reprise that history here. It’s enough to note that the long postwar golden age ended with the 1972–1975 commodity boom.⁵⁷ That commodity boom was characterized by sharply rising food, energy, and metals prices. By 1974, the capitalist world-economy was in the grips of the most severe economic downturn since the Great Depression. There were, of course, multiple contradictions in play. Among them was the growing assertiveness of Third World nationalism. It was dramatized by OPEC’s struggle to capture oil profits from transnational firms headquar-

tered in the imperialist countries – but also through the efforts of “semi-peripheral” developmentalist states, like Mexico and Brazil, to pursue nationalist industrialization strategies.⁵⁸ To make a long story short, the crisis of the 1970s was resolved through Washington’s capacity to subordinate both the petro-states and Third World developmentalism to a new model that – through the debt regime, death squads, and “economic hit men” – allowed for a renewal of Cheap Nature.⁵⁹

It worked. Sort of. After 1982, a significant decline in food, energy, and resource prices enabled the neoliberal boom. Commodity prices for food declined 39 percent – and metals by half – between 1975 and 1989. By 1983, oil stabilized, for the next twenty years, at a price per barrel about twice that of the postwar average.⁶⁰ Labor, too, became cheap again as trade union power was broken. Meanwhile, the promised robot factories were nowhere to be seen. Instead, the global sweatshop and disposable workers defined the neoliberal era.

This global fix was realized by enclosing the last meaningful frontiers of Cheap Nature. These were, however, smaller than ever. Meanwhile, the piles of surplus capital were greater than ever. Yes, there was the North Sea petro-bonanza. But this was no Ghawar field. There were “new agricultural countries.”⁶¹ But these were small fry compared to opening Australia and North America to capitalist agriculture in the long nineteenth century. The ecological surplus contracted and profitability faltered. Accumulation was reflat only through neoliberal “structural adjustment,” backstopped by US-sponsored Third World fascism.⁶² In other words, the new Cheap Natures were obtained through new regimes of austerity and authoritarianism, linked directly to financialization by any means necessary. As technical vitality in the productive sphere contracted, an increasingly predatory capitalism emerged that sought to win through political redistribution what it could no longer appropriate on the frontiers.⁶³

The neoliberal sweatshop regime was part of a far-flung Robin-Hood-in-reverse model of systemwide wage repression. Wage cuts for the proletariat and the dispossession of peasantries substituted for a labor-technological revolution. The plundered gains were then captured by Mr. Moneybags and his powerful friends in the richest countries; in contrast to previous eras, however, those gains were not reinvested on a scale sufficient to launch a new industrial revolution. This movement of plunder without productivity obviated two historical problems for capital. One of them was identified by Marx: the rising capitalized composition of production (crudely, more expensive machines) favors a falling rate of profit. This tendency can be seen across the imperialist centers since the

1870s.⁶⁴ That long-run movement had, however, been cyclically counteracted by the frontier movement towards cheaper raw materials: a cheapening of Marx's "circulating capital" could check the tendency towards rising machinery costs.⁶⁵ The other problem was the proletarian struggle. Highly industrialized, capitalized production systems generated new, increasingly militant working classes, as the postwar experience of Western Europe, Brazil, South Korea, and South Africa demonstrated.⁶⁶ Wage repression was, understandably from the perspective of capital, entangled with other repressive movements. These impinge directly on the neoliberal technological regime, whose innovations are centered on developing the machinery of global surveillance and militarization over a labor productivity revolution. These are technologies of the shock doctrine, the security services, and American regime-change wars.⁶⁷

Hence the distinctiveness of the neoliberal era, foreshadowing its zombie phase since 2008. The neoliberal era did not generate a "third technological revolution" along the lines of previous industrializations (c. 1800–1830, 1880–1910).⁶⁸ Technical development has undoubtedly occurred. But it "failed to release a productivity revolution that would reduce costs and free up income for an all-round expansion."⁶⁹

technology, climate crisis and the great implosion: "integral accidents" over the *longue durée*

This post-2008 technological impasse manifests not only in industry but also in agriculture, whose subordination in the long sixteenth century made the rise of capitalism possible. Every capitalist industrialization has depended upon an agricultural revolution that has produced more and more food with less and less labor-power. Thanks to the climate crisis, class struggles, and manifold bio-physical antagonisms swirling around the pesticide-herbicide regime, capitalism's agro-technological dynamism has come to an end.⁷⁰ This is the Great Stagnation.

The twenty-first-century demise of Cheap Nature won't be linear. There are no soft landings for civilizations in the thick of climate crisis. We are living through the relative calm of the Great Stagnation. It signals capitalism's planetary crisis. Technology will not save the day. It's hardwired to appropriate Cheap Natures, not resolve interconnected the biosphere's state shifts that result from those appropriations.⁷¹ To paraphrase Einstein, the technological regime

that creates these interconnected crises – Virilio’s integral accident on an epochal scale – cannot resolve them.

The planetary crisis is typically reduced to a biophysical danger misleadingly characterized as an “existential threat to humanity.”⁷² Climate catastrophism is a species of political rhetoric long mobilized by the political Right – not movements for democracy and socialism.⁷³ In the present conjuncture, catastrophism and doomism manifest as the repressed unconscious of the imperial bourgeoisie, whose historical conditions of reproduction are exhausted. This does not rule out a “decadent” transition through which ruling classes reinvent themselves and the mode of production – something that occurred after the crisis of feudalism (which was also climate-related).⁷⁴

Capitalism’s contemporary crisis reveals its epochal character through two developments. One is the unfolding crisis in life-making; the other, an emerging crisis in profit-making, registered in the discourse on “secular stagnation.”⁷⁵ Both are intimately connected to historical capitalism’s technological dynamism, and to its epochal technological impasse in the climate crisis.

Climate and technical change are intimately linked in the history of capitalism. Ours is not the first capitalogenic climate crisis. Between the 1550s and the early 1700s, a “long cold seventeenth century” of climate change, economic crisis, and political volatility descended upon the northern hemisphere.⁷⁶ It was amplified by the slaving-induced genocides that killed 95 percent of the New World’s indigenous population. Among its consequences was a modest (but significant) atmospheric decarbonization.⁷⁷ This contributed to significant cooling. The outcome was the most daunting passage of the Little Ice Age (c. 1300–1850), which was in turn the coldest period of the past 8,000 years.⁷⁸

Technical change in this long, cold seventeenth century was extraordinary. Indeed it was so rapid that we might call it the first modern industrialization, enabled by the new productivist empires across the Americas and unprecedented material flows of Cheap Nature, including African bodies shipped across the Atlantic to work the new sugar plantations and silver mines.⁷⁹ As empires of Cheap Nature wrapped their tentacles around life and labor from Brazil to the Baltic, new technical possibilities materialized. Innovations in shipbuilding, milling, mining and smelting, agriculture in Europe and on the sugar frontiers, and countless other sectors culminated in Newcomen’s atmospheric steam engine, introduced in 1712. These were technical and productivist moments of an audacious “climate fix.” European empires enclosed and exploited the unpaid work/energy of the Atlantic in an epoch-making

turn.⁸⁰ Its technological dynamism flowed from Cheap Nature: a geocultural and geopolitical regime of devaluation and wage repression. On this basis emerged the capitalogenic trinity of the climate class divide, climate patriarchy, climate apartheid.⁸¹ These are the sources, not the consequences, of the planetary inferno.

It also inaugurated the Great Frontier and its Great Cheapening.⁸² Windfall profits were realized through new sources of the Four Cheaps: food, labor, energy, and raw materials. For the greater part of four centuries, high profits and technological revolutions were made possible by a long-run secular decline in the price (value composition) of the Big Four inputs. A specifically capitalist historical nature was born: Cheap Nature. Its epoch-making service to world accumulation enabled the long-run reduction of re/production costs for capital. It epochal technologies were those that would either capitalize upon the Cheap Natures flowing into capital's vortex, or enable the forcible extension of the Cheap Nature regime to the whole of planetary life.

We are now witnessing that strategy's implosion. The web of life is rapidly moving from a source of Cheapness to an unavoidable vector of rising costs. Extra-human labor – the *biotariat*, if you will – is in open revolt.⁸³ This is the Great Implosion. The unfolding Great Stagnation, does not mean there are zero remaining frontiers of Cheap Nature. There *are* frontiers (for example, Amazonia). But these are tiny compared to the surplus capital problem. Without Cheap Natures to underwrite rising profitability, there will be no reversal of the ongoing collapse of investment, and no new scientific-technological revolution – at least, not in the ways capitalism has known it since 1492.

the great stagnation of profit and productivity: prelude to the great implosion

The Great Stagnation is the exhaustion of Cheap Nature and therefore the exhaustion of the specifically capitalist technological regime. The signs are everywhere. Three dominate, turning on overaccumulated capital and faltering labor productivity. They portend dramatic contractions.

First is the secular decline of profitability. The world rate of profit has been falling since the 1870s – temporarily counter-acted at various junctures, especially between 1947 and 1966, and again, modestly, between 1983 and 2003.⁸⁴ The mass of accumulated capital continues to grow without a corresponding

expansion of profitable investment opportunities.⁸⁵ As these stagnate, rentier tendencies advance.⁸⁶ Capitalists gravitate towards “political accumulation.”⁸⁷ They grow increasingly reliant on state power to secure its reproduction – and away from productive investment. More and more, they “look for unproductive investments like property to replace investment in production when profitability in productive assets falls.”⁸⁸ One indicator is found in 2019 reports identifying \$17 trillion in government bonds with “below-zero yields.” Meanwhile, capitalist real estate investment has spiked. Such investment is not productive investment, but “property owned for the express purpose of achieving investment returns.” That grew 50 percent between 2013 and 2019, reaching \$9.8 trillion.⁸⁹ American financial corporations, whose rising share of corporate profits defined Euro-American neoliberal capitalism, saw that share decline sharply after 2002 and then stagnate.⁹⁰ Nonfinancial investment in the USA – and across the globe – collapsed in the early 2000s and has yet to recover.⁹¹ China’s aggressive Keynesianism during the Great Recession (c. 2008–2010) “rescued” global capitalism and cannot be counted upon in the next crisis.⁹² In China too, labor costs have been rising and the organic composition of capital with it. After a temporary rise during the Great Recession, profitability has fallen and remains well below 2008 levels.⁹³ This explains some measure of China’s savvy resource acquisition strategy (One Belt One Road). Without vast frontiers of Cheap Nature, China cannot lead capitalism into a new golden age.

The Great Implosion’s next two indicators turn on technological stagnation. Here our focus is the real basis of capital accumulation: labor productivity. We can distinguish two principal forms of labor productivity, in agriculture and the so-called secondary and tertiary sectors. We may consider these in their respective turns.

In the heartlands of capitalist agriculture, productivity growth has slowed dramatically since the 1980s. In American agriculture, labor productivity growth over the past four decades has declined by more than a third relative to the postwar average (1948–1980/1981–2014); in the European Union, agricultural labor productivity growth struggled to reach 1 percent annually in the 2010s.⁹⁴ American yield growth in such critical commodity crops as maize and wheat fell sharply in the 2000s against the postwar average. Relative to 1936–1990, American corn yield growth fell by 39 percent, and wheat, by 70 percent.⁹⁵ For Indian wheat, at the center of the Green Revolution, yield growth

collapsed in the same period, tumbling from 3.4 percent annually in the 1980s to just 0.6 percent in the 1990s.⁹⁶

Climate change explains a critical increment of this agricultural slump. Notwithstanding breathless talk of a biotechnology revolution in agriculture, there's been no reversal of this productivity stagnation for decades.⁹⁷ Nor has "climate-smart" agriculture – the latest in capitalist techno-babble – achieved anything.⁹⁸

The fact is that capitalist agriculture is becoming more – not less "climate sensitive."⁹⁹ That's a reasonably anodyne description with epochal implications. Recall capitalism's simple agricultural model: produce more and more food with less and less labor-power. If that logic – an expansionary and not steady-state model – breaks down, all bets are off. For now, the best that can be said of world agriculture is that it's treading water. But the climate crisis portends an epochal reversal, from slow to negative growth.¹⁰⁰ A sobering 2017 report sees climate change pushing agricultural productivity back to "pre-1980 levels by 2050 even when accounting for present rates of innovation."¹⁰¹

The climate's suppression of agriculture productivity isn't speculative. By 2008, global maize and wheat output was 3.8 percent and 5.5 percent lower than it would have been in a world without climate change.¹⁰² By 2021, Ortiz-Bobea and her colleagues found capitalogenic climate change responsible for a "loss of the past seven years of productivity growth." Suppose there was no climate change: the productivity gains realized in 2020 would have been achieved in 2013.¹⁰³ Like everything about climate change, the global mean obscures considerable unevenness. While climate change has suppressed world productivity growth by 20 percent since 1961, that figure was 30 percent greater for the Caribbean and a whopping 70 percent higher for sub-Saharan Africa.¹⁰⁴

If climate change is suppressing the biotariat's productivity, so too the proletariat's. A 2019 investigation by the International Labour Office found that rising heat stress "is a serious problem for a large proportion of the world's one billion agricultural workers."¹⁰⁵ As heat stress intensifies, by 2030, 2.2 percent of "total working hours worldwide will be lost, either because it is too hot to work or because workers have to work at a slower pace." Those losses will increase in a non-linear way, as heat stress and other moments of climate change intensify. In South Asia and West Africa, productivity losses will more than double the global average.¹⁰⁶ By 2030, world agriculture will bear one-third of global climate change costs. By 2060, two-thirds.¹⁰⁷

Finally, since the early 1970s, labor productivity growth in manufacturing and services has also slowed dramatically. In the US, labor productivity surged

between 1920 and 1970, advancing 2.84 percent annually. Between 1970 and 2014, that rate was cut by more than a third, to 1.62 percent.¹⁰⁸ It hasn't revived, and it probably won't. In American manufacturing, real output per hour "was lower in 2017 than at its peak in 2010." For France and Germany, the decline is even steeper. German productivity growth tumbled from 6.3 percent in the 1950s and 1960s to just 2.4 percent after 2000.¹⁰⁹ Service sector productivity growth is still weaker – and in most of the Global South, probably negative.¹¹⁰ Even China's spectacular labor productivity growth – some 7.2 percent a year between the 1993 and 2013 – did not offset the systemic tendency.¹¹¹ Labor productivity in the Global North is still four times greater, and China's productivity advances have been counter-acted by rising unit labor costs – 85 percent between 2000 and 2011.¹¹²

The paradox is that "productivity growth rates in manufacturing collapsed precisely when they were supposed to be rising rapidly due to industrial automation."¹¹³ Arguably the greatest non-event of the neoliberal era is the non-appearance of a new "industrial revolution" premised on automation and its promise of significant productivity advances.¹¹⁴

In the 1970s, social critics as diverse in their politics as Alvin Toffler and Ernest Mandel breathlessly anticipated an automated world.¹¹⁵ But it did not come. That non-appearance has everything to do with the enclosure of the Great Frontier and the corresponding exhaustion of Cheap Nature. Why? Because frontier appropriations geographically condition capitalism's epoch-making technological revolutions. While appearing to be a prodigious technological advance, ICT hasn't revived labor productivity growth. Nor have other "high-tech" and "green" technologies.¹¹⁶

technology, capitalism, and the alchemist's illusion

The non-linear Cheapening and devaluation of life and labor that enabled capitalism's survival in the seventeenth century is today activating its non-linear negation. This is negative-value: relations that initially become resistant, then pose increasingly intractable barriers, in the face of capitalism's business-as-usual (including its technological fixes.).¹¹⁷ Whereas limits-to-growth thinking privileges substances, dialectical critique emphasizes relations that enfold substances, which in turn materially condition the relations.¹¹⁸ The faces of negative-value are manifold – they encompass everything from superweeds to the

proliferation of “justice” movements (food, climate, energy, and so on) to climate change. These cannot be “fixed” in the ways established during the long, cold seventeenth century. The more the Great Frontier closes, the greater the desperation and force of the climate class divide, climate apartheid, and climate patriarchy. The Great Stagnation, in this conjuncture, becomes a Great Involution – capital’s contradictions turn inwards on itself, yielding an unprecedented onslaught of toxification and violence. Why this should be so is straightforward: capitalism’s business as usual, its ensemble of technical innovation, militarized accumulation, and Cheap Nature flowed through the Great Frontier. Frontiers enabled imperial bourgeoisies to check the tendency towards rising production costs, and to contain the dangerous classes set in motion by industrialization and imperialist superexploitation. Its closure represents a quantity-quality tipping point: an epochal crisis of capitalism.

We have now come full circle. The epochal crisis was entirely foreseeable. There is no such thing as a technological accident. “Technological” disasters, accidents, and revolutions are always entwined within power, profit and life. They are social relations – and therefore *socio-ecological*. In the history of capitalism, these are shaped by a self-destructive and self-undermining logic: endless accumulation. Virilio’s integral accidents are not the mechanical interactions of a complex world-machine, as the cyberneticist would have it. They interpenetrate relations of power, ideology, profit – *and* mechanical systems in the web of life.

Those modern relations emerged and assumed their dominant forms through a historical geography of frontier-making. Thus capitalism’s socio-technical antagonisms – nowhere more clearly than in today’s capitalogenic climate crisis. These were, historically, offset and offloaded to the degree that the One Percent could move to the frontiers: to extract human and other Cheap Natures; to deposit wastes and pollution of every kind.¹¹⁹ For every technological revolution there must be a place to dump the waste – on land, in the sea, and in the air. Those places include “disposable workers” whose bodies have been enclosed as walking toxic waste dumps.¹²⁰ When the sources of modern technological dynamism – “the soil and the worker” – are exhausted, integral accidents begin, leading simultaneously to productive exhaustion and ecocide. Militarized “fixes” become more attractive.

What happens when capitalism’s sacrifice zone strategy has enclosed the biosphere, underscored by the imperial enclosure of the atmospheric commons

as a dumping ground for greenhouse gases? I believe we see it in the Great Stagnation, and its unfolding Great Implosion.

This reminds us of something easily forgotten: technological change is not alchemy. It cannot transmute lead into gold. It is a specific logic, a pathway, of technical change that enables the endless accumulation of capital. Every epoch-making technology has been forged in and through planetary life, nurtured and refined through an imperial strategy that seeks to turn all webs of life into profit-making opportunities.

Capitalism's great technological revolutions never created something out of nothing. The world-ecological storehouse of such stimuli is not inexhaustible – new energy sources, scientific regimes, technical packages and organizational forms cannot be conjured out of the productivity-maximizing magic of bourgeois ingenuity. *These stimuli must come from somewhere.* That somewhere is the frontier – precisely what's been enclosed to enable capitalism's greatest successes. It's this socio-ecological logic of technology, space and nature that must be revolutionized. From what to what? In my view, from a privatized logic of planetary dictatorship to one that favors a biospheric socialism of the associated reproducers. Only then can we navigate the climate crisis through world praxis in the web of life that is democratic, egalitarian, and life-affirming.

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