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Mechanical Powers: Engineering and Romantic Poetics in the Early Anthropocene

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Mechanical Powers: Engineering and Romantic Poetics in the Early Anthropocene

By

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Abstract

Mechanical Powers: Engineering and Romantic Poetics in the Early Anthropocene

By

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My dissertation, *Mechanical Powers: Engineering and Romantic Poetics in the Early Anthropocene,* retrieves how poetic and technological making converge at the onset of industrial modernity to produce an early industrial consciousness of humanity's terrestrial agency. One of the proposed start dates for the Anthropocene is James Watt's 1784 steam engine design, widely taken to mark the emergence of humankind as a geomorphic force with the Romantic advent of engineering and fossil capitalism. Contrary to Anthropocene narratives identifying this planetary power solely with the detrimental effects of industrial capitalism that we have remained unconscious of until the late twentieth and early twenty-first centuries, *Mechanical Powers* unearths how Romantic poets and engineers in fact developed an early form of Anthropocene consciousness of humankind's newfound planetary powers as ones that should not be applied for industrial capitalist ends. Dismantling critical narratives of the late eighteenth and early nineteenth century as unreflexively capitalist and unconscious of humankind's newfound planetary powers, and of poetry as anti-instrumental and anti-industrial, I show how Romantic poets such as Darwin, Wordsworth, Blake, and Byron came to re-envision poetic making in relation to the worldmaking powers of machinery to reckon with the emergence of humankind as a geomorphic force and counteract industrial capitalism's planetary damages. If today we no longer expect poetic and technological making to intersect, what allowed for this early industrial confluence was the fact that poetry (from *poiesis,* making) and engineering both came to stand in for humanity's terrestrial agency as a whole.

Chapter 1, "Blake's Industrial Revolutions," begins by recovering a critically neglected confluence between Blake's poetics and Romantic era industrial socialists, the Owenites and Mechanics Institutes, who attempt to develop forms of industry outside of industrial capitalism. In the final chapters of *The Making of the English Working Class,* best known for documenting industrial capitalism's damage to labor, E.P. Thompson turns to the Romantic era radical traditions that developed the first forms of industrial socialism. Such radical movements, Thompson writes, applied machinery's "force to the context of working-class struggle" to fight industrial capitalism for socialist industry. Thompson laments the loss of this radical Romantic era tradition, and its failure to come into contact with Romantic poetry: "After William Blake, no mind was at home in both cultures nor had the genius to interpret the two traditions to each other… In the failure of the two traditions – to come to a point of junction, something was lost.

How much we cannot be sure, for we are among the losers." What we have lost is the possibility of thinking industry outside of capitalism. Yet Blake and the radical elements of the Mechanics Institutes were far closer together than Thompson realizes, even coming into direct contact and sharing a desire to scale up the labor power of machinery for socialist industry. Rejecting the emergence of capitalist factories, Blake develops an industrial poetics that prefigures what he calls a "sweet industry" after capitalism, in which even the labor of making and using heavy machinery such as the mill would be poetic, pleasurable, and lyrical, and the benefits of the worldmaking powers of industry would be extended to "every population over the world" rather than unevenly distributed and extracted from the earth.

Chapter 2, "Wordsworth's Green Industry," recovers how railway and steamship earthworks prompted Romantic poets and engineers to develop an early Anthropocene consciousness of the human power to shape the earth as a geological force. Against railway capitalists who advocated for blasting through the earth to construct railway earthworks such as viaducts and tunnels as cheaply as possible regardless of ecological cost, William Wordsworth and an environmentally conscious group of railway engineers pioneer a strain of steamboat and railway poetry to develop ecologically sustainable forms of earthworks. Wordsworth and Romantic engineers came to reject the ecological devastation of fossil capitalism, instead imagining alternative forms of green industry figured in the earth's image. Rather than reading Wordsworth's persistent naturalization of poetic and industrial technologies as a symptom of productivist ideology, the nineteenth-century belief in the seamless continuity between nature and industry that fueled the ecological crises of industrial capitalism, I argue that this ecocritical drive of Wordsworth's poetics fuels his attempt to envision a form of green industry over his poetic career realized most fully in his late steamboat and railway poetry. Even in protesting the expansion of the Windermere Railroad into the Lake Distinct, often considered one of the nineteenth-century origins of the environmental movement, Wordsworth cites his steamboat and railway poetry as evidence that he is not against the railway but rather against fossil capitalism's disfiguring the environment, one year after the utopian-socialist Chevalier imagined the railway as a means of "universal association" between humanity and nature. Protesting the ecological crises of industrial capitalism, Wordsworth prefigures forms of green industry that anticipate the eco-socialist hopes of the Green New Deal.

Chapter 3, "The Rise of Thermodynamics: Mechanical Engineering and Byron's Poetic Machinery," charts the first history of Byron's and Romantic engineers' attempts to grapple with how the new concept of energy that emerges out of the steam engine did not in fact merely fuel industrial capitalism's visions of limitless steam power – as existing critical narratives assume – but radically erodes it, as Romantic era engineers discover that the universal dissipation of energy through friction sets strict material constraints on any mechanical power. Excavating the Romantic rise of thermodynamics in early nineteenth-century engineering and its impact on Romantic aesthetics, I show how Byron develops an engineering poetics directly influenced by early nineteenth-century engineering, calling his poetic vocation "my post as an engineer" and pioneering a new thermodynamic form of poetic machinery. Romantic poetry and engineering shared a mutual question fueling their thermodynamic aesthetics: what work can mechanical powers achieve under strict constraints of perpetual energy loss and unavoidable physical attrition? This question continues to bear on how we approach poetry and machinery today, and what we might anticipate from poetry and engineering in the industrial age we share with

Romanticism. As Byron explores through his engineering poetics, although the endless loss of energy erodes capitalist visions of limitless steam power, it can also provide tools for combating planetary scale dissipation in a time of climate change.

A final coda, "Geopoetic Futures," considers the fate and futures of Romantic industrialism. While by the late nineteenth century, this early form of Anthropocene consciousness where Romantic poetry and engineering intersected was eclipsed by the Victorian consolidation of industrial capitalism, it persists in a counter-modernity that runs from Romantic industrialism to contemporary Green New Deal and eco-socialist movements. This final coda also considers the promises and limits of Anthropocene narratives, and of an all too white and male strain of engineering that becomes bound up with the consolidation of industrial capitalism over the nineteenth century. Romantic poets and engineers begin to envision how the abolition of this white male strain of engineering is necessary for dismantling industrial capitalism. Turning from the metropole to the peripheries of British industrialization to the colonial subjects excluded from Anthropocene history, I show how Romantic poets and industrial socialists such as Robert Southey, Robert Owen, and George Numa Des Sources envision industrial socialist projects of global abolition to dismantle the plantation form that structured the dependency of British industrialization on slavery and sugar. Romantic poets and industrial socialists prefigure how to decolonize industrial modernity by abolishing the racialized logic of industrial capitalism, with its constitutive white industrialism and black other, forgotten Romantic possibilities which Victorian liberals such as Samuel Smiles work to suppress. Finally, I turn to Byron's daughter Ada Lovelace's rejection of Charles Babbage's narrowly masculinist and capitalist application of early computing machinery. Lovelace pioneers a "poetical science" between Romantic poetry and engineering that repurposes the worldmaking powers of poetry and machinery for progressive-gender political ends. Romanticism anticipates one of the most pressing theoretical questions of our own late moment in Anthropocene history that lives on in contemporary critical theory and eco-socialist projects like the Green New Deal and environmental justice movements: how to remake industrial modernity to combat our planetary crises by and for the sake of those whom capitalism has denied or excluded from having any such worldmaking powers in the first place. Returning to this early moment of Anthropocene history where Romantic poetry and engineering intersect provides access to imaginative tools to develop forms of human agency outside capitalism that might renew rather than exhaust the planet.

Dedicated to Rebecca, with all my love

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Thanks to the countless unnamed Romantic engineers who inspired me to write this dissertation, and ultimately to become an engineer. In the spirit of the Romantic machine-builders who freely circulated their blueprints for all of humanity and the software engineers who now publish their code on GitHub, I am making this dissertation open access so that everyone can make use of its mechanical powers. It's an idealistic, Romantic hope, but one with material weight.

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Introduction:

ENGINEERING POETICS

Consider two moments at either end of the Romantic period, which coincides with the onset of industrial modernity over the late 18th and early 19th centuries. Turning the "rising Arts" of engineering into the fuel of poetry around 1800, Erasmus Darwin, as much an engineer as Thomas Savery or James Watt, and a designer of machines such as rockets, steam-powered vehicles, and wind-mills, develops an engineering poetics that explores the materials "figur'd" by the "mechanic powers" of the steam engine that he helped pioneer, a power to "move the earth."[1] Twenty years later, with the earth transformed by the rise of such mechanical powers beyond even Erasmus Darwin's predictions, Byron responds enthusiastically to a letter from an engineer requesting his support to develop steam-powered airplanes, finding "a vast deal of poetry in the idea." Over his poetic career, Byron comes to define his poetic vocation as "my post as an engineer," developing a new thermodynamic form of poetic machinery and measuring his poetic force by the "horsepower" of the engine, the first instance of the engineer's measure of mechanical power in the *OED* outside of an engineering treatise. Byron applies his new engineering poetics to explore and combat the catastrophic dissipation of energy that emerges from the engine.[2] Romantic poetry and engineering converge in the world-transforming power to move the earth, the rise of human mechanical powers on a planetary scale that has now come to define the Anthropocene.

Charting the first history of the interactions between Romantic poetry and engineering, the art of machine-building that emerges around 1800, *Mechanical Powers* recovers how poetic and technological making intersect at the onset of industrial modernity to produce an early Anthropocene consciousness of humanity's planetary agency. Against deeply engrained scholarly assumptions about Romanticism's anti-industrialism, poets such as Blake, Wordsworth, Shelley, and Byron surprisingly came to envision poetry's figurative powers in relation to the powers of machinery that were transforming their rapidly industrializing world, reconceiving poetry and technology as forms of industry defined by their power to reshape materials, from railways to the planet itself: what Erasmus Darwin calls the "mechanic powers" to "move the earth." Contrary to Anthropocene narratives that conflate industrialization with capitalism, only as this geomorphic force to reshape the earth became increasingly exploited by industrial capitalism did it become a source of profound ambivalence. Romantic poets, engineers, and industrial socialists reckon with how such worldmaking powers become torn between capitalist logics – sparking the first flares of our ongoing planetary ecological crises – and radical possibilities left unfulfilled by industrial modernity. Wordsworth develops a green industrial poetics to combat the ecological crises that industrial capitalism set in motion, while Byron pioneers a new thermodynamic engineering poetics that melts down capitalist fantasies of limitless steam power and anticipates the problem of climate change. This forgotten junction between poetry and engineering prefigures imaginative tools to develop alternative forms of industry outside of capitalism that might renew rather than exhaust the planet.

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[1] Erasmus Darwin, *The Temple of Nature*, 3.289, 4.249, 4.272 in *The Collected Writings of Erasmus Darwin*, ed. Martin Priestman (Bristol: Continuum, 2004).

[2] Byron to John Murray, Nov 29, 1813; in *Letters and Journals*, v. 3. ed. Leslie Marchand (Cambridge, MA: Harvard University Press, 1973); Byron, in *Medwin's Conversations of Lord Byron,* ed. Ernest Lovell (Princeton, NJ: Princeton University Press, 2015), 187-88; *OED*, s.vv., "horsepower, n."

1. The Early Anthropocene

To reckon with the Romantic origins of the Anthropocene, we need a more robust understanding of the figurative resources of the mechanical than current critical-theoretical frameworks allow.[3] Existing critical tools often brought to bear on mechanical form in literary studies – long perceived to be anti-poetic and non-figurative, cut off from literary culture, and conflated with industrial capitalism – prove to be blunt, ineffective instruments.[4] Recent work in literature and science and the history of science and technology has begun to challenge such views of industrialization, recovering a figurative potentiality within machinery long neglected by literary studies.[5] Yet despite such recent developments, the conduits between Romantic poetry and engineering have been lost to literary history, particularly in the British Romantic context where industrialization happened first, in part due to concepts of the mechanical derived from narratives surrounding industrial capitalism and organic form that have long shaped Romantic studies.[6] Romantic poetics traditionally has either been identified with the dynamic living form of the life sciences that comes to eclipse the static, non-figurative form of Newtonian mechanics, or taken to resist an industrial modernity often conflated with industrial capitalism.[7] At the same

[3] See Paul Crutzen, "Geology of Mankind," *Nature* 415.23 (2012): 23. While the dating (and term) Anthropocene are hotly debated, James Watt's 1784 steam engine design has substantial traction. As Devin Griffiths sums up, "the Romantic period marks the dawn of the Anthropocene and a crucial stage in the formation of its sciences and technologies…both the industrial revolution and of global climate science." "Romantic Planet: Science and Literature within the Anthropocene," *Literature Compass* 14.1 (2017) 2,7. See also Noah Heringman, "Deep Time at the Dawn of the Anthropocene," *Representations 1*29 (2015): 56-85; Anahid Nersessian, *The Calamity Form: Poetry and Social Life* (Chicago: University of Chicago Press, 2021).

[4] For the mechanical as non-figurative, see Wai Chee Dimock, "Nonbiological Clock: Literary History Against Newtonian Mechanics," *SAQ* 102.1 (2003): 153-177; Cannon Schmitt and Elaine Freedgood, "Denotatively, Technically, Literally," *Representations* 125 (Winter 2014): 1-14.

[5] Major studies of the aesthetics of machinery in science and literature include Joseph Drury, *Novel Machines: Technology and Narrative Form in Enlightenment Britain* (Oxford: Oxford University Press, 2017); Helmut Müller-Sievers, *The Cylinder: Kinematics of the Nineteenth Century* (Berkeley, CA: University of California Press, 2012); Tamara Ketabagian, *The Lives of Machines: The Industrial Imaginary in Victorian Literature and Culture* (Ann Arbor, Michigan: University of Michigan Press, 2011); Jason Hall, *Machines of Meter: Nineteenth Century Verse and Technology* (Palgrave, 2017). John Tresch, *The Romantic Machine: Utopian Science and Technology after Napoleon* (Chicago: University of Chicago Press, 2012); M. Norton Wise, *Aesthetics, Industry, and Science: Hermann von Helmholtz and the Berlin Physical Society* (Chicago, IL: University of Chicago Press, 2019).

[6] See the recent turn to 'mechanical Romanticisms' in studies of French and German Romantic traditions, which has not yet extended to the British context. For the mechanical turn in French Romanticism, see Tresch, *The Romantic Machine*. For the German, see Leif Weatherby, *Transplanting the Metaphysical Organ: German Romanticism between Leibnitz and Marx* (Fordham, 2016); Helmut Müller-Sievers, *The Cylinder*, and Jocelyn Holland, *The Lever as an Instrument of Reason: Technological Construction of Knowledge around 1800* (Bloomsbury, 2019), and the 2016 special issue of *The Germanic Review,* edited by Jocelyn Holland and Gabriel Trop, "Statics, Mechanics, Dynamics." For one notable exception to this tendency in the British context, see Michele Speitz, "Lyres, Levers, Boats, and Steam: Shelley's Dream of a Correspondent Machine," *Studies in Romanticism* 58.2 (2019): 231-264.

[7] For the strong affinities of Romantic form with the life sciences, understood to eclipse Newtonian mechanics, see especially Peter H. Reill, *Vitalizing Nature in the Enlightenment* (Berkeley, CA: University of California Press, 2005); Denise Gigante, *Life: Organic Form and Romanticism* (Palo Alto, CA: Stanford University Press, 2009). One of the main problems with this narrative is its over-extension beyond the sciences of life to identify Romantic poetics in general with organic form. If it accurately describes the turn away from mechanical explanation *within* the life sciences (i.e., medical Newtonianism), it cannot accurately describe Romantic era developments within mechanics or the rise of engineering. It is not that this narrative is wrong so much as over-extended and over-generalized. Likewise, my argument does not require that Romantic poetics be any one thing – mechanical or

time, Anthropocene narratives tend to elide the distinction between industrialization and capitalism. Such narratives fail to account for how Romantic poets and engineers in fact explored technology as a dynamic figurative power with its own poetics not reducible to any single politics, a power that by its very material contingency could be applied to both capitalist and socialist projects. What rendered technology so productive in the early 19th century was the extent to which mechanical meant the human power to artificially make that which would not otherwise in exist in nature. It described a power to transform the earth that, on its own terms, was not bound to any particular social, political, or economic outcome. Romantic engineering had its own distinctive and more direct form of insight into humankind's emergence as a planetary force often attributed to geology.[8] This figurative power to transform the earth could be scaled up and down, so that it extended from local earthen materials to the planet itself.

One of the proposed start dates for the Anthropocene is James Watt's 1784 steam engine design, widely taken to mark the emergence of humankind as a geomorphic force with the advent of Romantic engineering and the onset of fossil capitalism. Romantic engineering is thus hardwired into the definition of the Anthropocene. Yet we rarely pause to reflect on this world-historical event in a form that does not reify engineering into nothing more than the cause of global warming.[9] Contrary to Anthropocene narratives identifying this planetary power solely with the detrimental effects of industrial capitalism that we have remained largely unconscious of until the late twentieth and early twenty-first centuries, Romantic poets and engineers in fact developed an early form of Anthropocene consciousness of humankind's newfound planetary powers as ones that should not be applied for industrial capitalist ends. If today we no longer expect poetic and technological making to intersect, what allowed for this confluence was the fact that poetry (from *poiesis*, making) and engineering both came to represent humanity's terrestrial agency as a whole. This early form of planetary consciousness was a partial and incomplete one that prefigures our own late moment in Anthropocene history, in a form that is neither teleological nor determinative. Of course, Romantic poets and engineers could not yet fully anticipate the climatological effects of fossil capitalism. Yet they did not need the scientific clarity of twenty-first century climate science to glimpse the cascading sequence of industrial capitalism's terrestrial damages. Nor do I claim that our own awareness is any more perfect, or a completion of Romanticism's imperfect and incomplete knowledge. On the contrary, the early Anthropocene allowed for a heightened awareness of the material contingency of humankind's planetary powers that granted Romantic poets and engineers an ability to imagine alternative futures outside of capitalism that is often absent in contemporary Anthropocene thought. It was precisely this early moment of industrialization that made possible this imaginative faculty that today is often overwhelmed and occluded by the ever-increasing clarity of capitalism's harms.[10]

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organic – but rather rejects the zero-sum logic presupposed by such narratives. Rather, certain strains of Romantic poetics might be understood to cross over with the life sciences; others, to develop in confluence with engineering.

[8] Engineering offered a more direct form of insight into humankind's planetary force than Romantic geology because it literally concerned those powers themselves.

[9] Much as Anahid Neresssian notes, this singular event of the Anthropocene that coincides with Romanticism often reifies into "a version of Marx's commodity fetish" in Anthropocene criticism. *The Calamity Form*, 6. Unlike Nersessian, however, I do not think that this reification is an inherent or necessary feature of Anthropocene thought.

[10] This is not to say that the possibility of imagining futures outside of capitalism has become impossible but rather more difficult than in the early Anthropocene due to the weight of our present knowledge of capitalism's planetary impacts, such as fossil capitalism's systemic intractability and the warming already baked in even if we ceased all emissions immediately. For this tendency in contemporary poetry and criticism, see, for instance, Margaret Ronda, *Remainders: American Poetry at Nature's End* (Palo Alto, CA: Stanford University Press, 2018).

Nor is the Romantic consciousness of humankind's planetary powers a mere presentist retrojection. I call these figurative powers "human" and "planetary" because these were the early nineteenth-century terms that poets and engineers used to describe humankind's newfound terrestrial agency.

This new, open-ended, and figurative logic of Romantic engineering displaced Newtonian mechanics over the late 18th and early 19th centuries.[11] In rejecting the rational, transcendental artifice of Newtonian mechanics in favor of a materially contingent knowledge derived from building working machines, Romantic engineers melted away the static mechanics of Newton's world, leaving a dynamic world and concept of human making with no fixed principles outside of matter itself marked by what one Romantic engineer called an "unceasing mutual interchange of figure." In this era, engineers developed a new concept of mechanical power as machinery's capacity for "shaping bodies into particular figures," where the shaped bodies ranged from particular metals to the earth itself.[12] Engines themselves (which John Tresch calls "Romantic machines") were dynamic, the branch of mechanics concerned with how machinery translated energy to reshape matter into artificial forms.[13] This new figurative logic was materialized in new forms of human industry ranging from steam engines, railways, steam boats, and industrial manufacture to the experiments in making known as Romantic poetry.

The moment that we turn to the writings of Romantic era engineers, whose voices have been lost along with their aesthetics, we find that they worked every bit as closely with the material dynamics of form and figure as Romantic poets. The formative power that mechanical engineers discovered by working with their tools was a logic at once material, dynamic, contingent, and figurative; it had no inherent politics determined in advance, although it could be readily politicized. Over the early 19th century, it also fueled a new form of materialist aesthetics distinct to industrial modernity but by no means antithetical to Romanticism. By figurative logic, I mean the logic of making – of *poiesis*, production, or industry – the site where Romantic

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[11] While the art of machine-building predates the late 18th and early 19th century – extending back to early modernity – it is only over the Romantic era that the figurative logic of machinery emerges in its modern form distinct to industrial modernity with the rise of engineering, which eclipsed Newtonian mechanics. On mechanical engineering's rise over the late 18th and early 19th century and its eclipse of Newtonian mechanics, see Robert Buchanan, *The Engineers: a History of the Engineering Profession in Britain, 1750-1914* (Kingsley, 1989); Simon Schaffer: "Machine Philosophy: Demonstration Devices in Georgian Mechanics"; *Osiris* 9 (1994): 157-182; Helmut Müller-Sievers, *The Cylinder* and "A Doctrine of Transmissions: On the Classification of Machines Around 1800," in *The Science of Literature: Essays on an Incalculable Difference* (De Gruyter, 2015), 176-194; John Tresch, *The Romantic Machine: Utopian Science and Technology after Napoleon.* For earlier pre-industrial mechanics, see Paola Bertucci, *Artisanal Enlightenment: Science and the Mechanical Arts in Old Regime France* (Yale University Press, 2017); Domenico Meli, *Thinking with Objects. The Transformation of Mechanics in the Seventeenth Century* (John Hopkins University Press, 2006); Bryan Lawton, *The Early History of Mechanical Engineering* (Brill, 2004).

[12] "Friction," Rees's *Cyclopaedia*, vol. 15 (1819), 364-65, 369, henceforth *RC*; Bentham, *Chrestomathia* (London: J. McCreary, 1816), 194. For a few instances of mechanical powers in this first sense, see "Machine," *RC*, v. 22; Olinthus Gregory, "On the Mechanical Powers," in *A Treatise of Mechanics*, v. 1, 70; "Machinery," *RC*, v. 22, 760.

[13] See John Tresch, *The Romantic Machine: Utopian Science and Technology after Napoleon* (University of Chicago Press, 2012). To be clear, this sense of the figurative logic of machinery and the work of art is my argument, not Tresch's. Tresch rightly identifies what he calls the "Romantic machine" with the new machinery of industrial modernity – above all the engine due to its dynamism—over against the static machines of Newton's world like the clock and chronometer, though Tresch is not concerned with what I call the figurative logic of machinery. Machines like clocks are often considered static rather than dynamic because they do not generate power or translate energy to refigure matter. While Tresch is right to date this change to the Romantic era and identify it with Romantic era machinery – above all the engine – my claim is that such machinery gives rise to what is best understood as a new figurative logic of machinery that extends to the mechanical artifice of all industry.

aesthetics and engineering intersected. This engineering poetics cut both ways: if Romantic engineering had its own internal poetics derived from machine-building, Romantic poets in turn re-engineered poetry's mechanical powers in relation to machinery's. For Romantic poets and engineers, such mechanical powers took forms specific to machinery and poetry and together came to represent art or industry as a whole, as an anthropogenic, industrial force that was transforming the earth. By recovering their confluence, we discover what we have neglected to our detriment: that Romantic engineering has its own critical capacity for poetic making; and that Romantic poetry has a crucial mechanical dimension we have missed only because of our own reflexive anti-industrialism. These mechanical powers enabled Romantic poetry and engineering to together reckon with and prefigure alternative futures for our own Anthropogenic age.

Mechanical Powers is not a close bore study of prosody or meter. Rather than delimited to meter, the Romantic poetics of this study extend to human making as a whole to produce an early Anthropocene consciousness of humankind's newfound planetary powers. Romantic poets come to reject the Kantian and formalist reduction of meter to the only mechanical element of poetry as a containment strategy for hiving poetry off from the mechanical. It is not that the poem is a machine but rather that it becomes a means of technological inquiry precisely due to Romantic poetry and engineering's shared capacity to stand in for human making as a whole at the onset of industrialization when humanity's worldmaking power was rapidly transforming the globe. This is not to downplay the material specificity of figuration in poetry and engineering, or to claim that poetic making is identical to technological making. After all, Romantic poetry's worldmaking power does not literally build railroads or steam engines or reshape the earth in the same form as Romantic engineering. Precisely because Romantic poetry appears in imaginative, tropic language rather than in earthen materials and is therefore materially different form engineering, it has its own distinctive form of worldmaking power. The very literariness of poetry's figurative power – its very capacity to stand apart from the empirical reality of early industrial capitalism – granted it agency to imagine worlds outside of that emerging mode of political economy and to imaginatively reshape humankind's changing material relation to the earth.

2. Industrial Art

Far from hived off from the mechanical arts, there was a heightened contact between poetry and engineering before the advent of specialist disciplines.[14] Engineering hovered between the arts and sciences, leading to a new industrial sense of art between literature, science and technology.[15] *Rees's Cyclopædia, or Universal Dictionary of the Arts, Sciences, and Literature*, a major industrial encyclopedia co-written by Romantic artists from poets to engineers, featured engineering blueprints and machine diagrams alongside Blake's engravings. Articles on the "art of mechanics" and "art of engineering" appeared alongside those on the art of poetry. The entry on "Art" that opened the *Cyclopædia* defined "art" as a "power in man" for the "production of certain effects" that "are fashioned by human industry" to "serve the purposes of mankind." "Where it is the operations of art end? "Either in some energy, or some work."[16] "Art

[14] On the heightened proximity of the mechanical arts to others before the disciplines, see Jon Klancher, *Transfiguring the Arts and Sciences: Knowledge and Cultural Institutions in the Romantic Age* (Cambridge, UK: Cambridge University Press, 2013).
[15] On mechanics' unique position between the arts and sciences, see Klancher, *Transfiguring the Arts and Sciences*.
[16] "Art," *RC*, v. 2 (1819).

makes the things man undertakes succeed." At once transitive and substantive, art was both the mechanical power or energy to figure something that would not otherwise exist in nature and the work of art produced by such mechanical power. Art became defined in the industrial, energestic terms of mechanical power, and referred to all human industry, to the power to make something that would not otherwise exist in nature by mechanical artifice. In this sense, "Mechanics…is an art," as is "poetry."[17] Hence Wordsworth, for instance, frankly acknowledges in the 1798 Preface that the "poet's art" is "altogether mechanical" precisely because poetry is an art, later referring to poetry, steamboats, and railways as "man's art."[18] Engineers referred to themselves as artisans or artists and developed a new industrial concept of the work of art. "Machine," one engineer wrote, "is derived from *μηχανή,* machine, invention, art."[19] Art as mechanical power came to radiate outwards to all human industry, to the arts and manufactures in general.

As the exemplary mechanical art, engineering was widely considered the foremost "useful or practical art," a category which opened outwards to include all forms of human industry.[20] Concepts like "mechanical art" operated less as a hard and fast classification scheme than as an index for the figurative power of mechanical artifice present in all human industry.[21] In the *Circle of the Mechanical Arts,* the Romantic engineer Thomas Martin addressed himself to all artists concerned with the "the practical part of the arts" or "engineering, and the [other] arts" – spanning "the art of mining" to engraving, founding, and metalworking, to every "art of modern invention" concerned with the "actions" of "figures, and of all their parts."[22] Charting the rise of this new sense of industrial art, the Romantic engineer Sadi Carnot reflected how the rise of the "powerful machines" like the steam engine "will afford to the industrial arts a range that can scarcely be predicted," that not only had already caused "rapid extensions in the arts" but "can even create entirely new arts," such as the art of the steamship, mining, industrial metallurgy, and engineering itself.[23] Likewise, when Jeremy Bentham, influenced by engineering, sketched the new "field of technology" in 1816, in one of the first uses of the term in English, he defined technology as art. In a section titled "Technology, or the Arts and Manufactures in general" – synonymizing technology with art and manufacture – Bentham traced "Technology" to "two Greek words," *techne* and *logos*, "the first of which signifies an art," and the second, its new figurative logic by which it is brought into material existence. Bentham identifies four core elements of technology's figurative logic that coincided with engineers' new concept of mechanical powers: "1. Operations, i.e. *motions,* produced with the

[17] "Art," *RC,* v. 2 (1819), 747.
[18] Wordsworth, 1798 Preface; "Steamboats, Viaducts, and Railways," 11. *Poetical Works of William Wordsworth,* eds. Ernest de Selincourt and Helen Darbishire (Oxford: Oxford University Press), 1949.
[19] "Machine," *RC,* v. 21 (1819), 747.
[20] For this sense of art as industry in the late 18th century, see Celina Fox, *The Arts of Industry in the Age of Enlightenment* (Yale University Press, 2010). This exemplarity is visible in the first issue of the London Mechanics Magazine, the publication of the London Mechanics Institute. While the mechanics included a range of artists beyond engineers, including engravers, painters, poets, and metalworkers, the frontispiece of the first issue featured the names of prominent British engineers on triumphal pillars over images of steam-powered machinery, effectively emblazoned with the words "MECHANICAL POWER" with the motto "KNOWLEDGE IS POWER."
[21] On the ever-shifting classification of the mechanical arts, see Jon Klancher, "Scale and Skill in British Print Culture: Reading the Technologies, 1680-1820," *Studies in Eighteenth-Century Culture* 47 (2018): 89-106.
[22] Thomas Martin, *The Circle of the Mechanical Arts, by Thomas Martin, Civil Engineer* (1813), vi, 1, 326-327. Note also Martin's self-consciousness of industrial modernity in the phrase "every art of modern invention."
[23] Sadi Carnot, *Réflexions sur la puissance motrice du feu et sur les machines propres à développer cette puissance* (Paris: 1824). Translated by R.H. Thurston (London: 1897), 38.

view of producing the *results:* 2. Subject matters operated *upon;* 3. Instruments operated *with,* or *by means of;* and 4. Results, which are mostly *bodies,* brought into some new form."[24]

Over the late eighteenth and early nineteenth centuries, Romantic engineers pioneered a new figurative logic of mechanical powers that fueled this new industrial concept of art. Mechanical power came to refer at once to the fundamental parts of machines – engineers theorized how "all machinery will be found" to be only configurations "of the six mechanical powers, and all derive their energy" from them – to machines themselves, and to the energy or force of machinery, its power for "shaping bodies into particular figures."[25] At once transitive and substantive, the figurative logic of mechanical power troubled any categorical distinction between energy and form. Mechanics, one Romantic engineer wrote, "treats of the energy of machines" as "forces or powers" to "figure." If "all bodies, it is manifest…are found existing under figure, or shape," machines had the capacity to figure material bodies through the energy of "mechanical powers."[26] Machinery's "force," one engineer put it, "is necessary for changing the state of all this matter, and frequently a very considerable force."[27] Whether a hammer, engine, drill, or any other tool or device, machines figured bodies through the operation of mechanical powers, anthropogenic, industrial forces applied to bodies to shape matter into a new "figure" or "form."[28] "The grand object of all mechanism, or machinery," as another engineer summed up, "is to convey and modify the first mover of the machine, and communicate it" to the figure "to be operated upon" to materialize some work of art through human industry.[29]

As a power to figure matter, the logic of machinery was by definition instrumental: a logic of material practice in which operativity coincided with figuration, performing work upon material bodies to figure them for various human ends. "Art," as engineers defined it, is a "power in man" for the "production of certain effects" that "are fashioned by human industry" to "serve the purposes of mankind." "Where is it the operations of art end? Either in some energy, or some work."[30] This materially contingent form of instrumentality is free of any pejorative import and not exhausted by the terms of the Frankfurt school photographic negative of instrumental reason or post-structuralist and deconstructive critiques of operativity and teleology. Anti-transcendental and materialist, Romantic era engineers understood operativity as a materially contingent and dynamic power to figure that they called the work of art. Also calling their new profession "operative" or "practical mechanics," engineers' watchwords of practice, operativity, work,

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[24] Bentham, *Chrestomathia* (London: 1816), 72, 194; emphasis in original. For important recent critical reappraisals of Bentham's aesthetics, see Frances Ferguson, "Not Kant, But Bentham: On Taste," *Critical Inquiry* 45.3 (2019), 577-600; Jon Klancher, "Scale and Skill in British Print Culture: Reading the Technologies, 1680-1820."

[25] "Machinery," *RC,* v. 22, 760; Bentham, *Chrestomathia*. In the first sense of mechanical power, the exact identity and number of the fundamental machine parts that engineers constantly invoked – which varied widely, but often included the wheel and axle, inclined plane, screw, wedge, lever, and pulley – mattered less than the underlying figurative logic itself. Each of these powers represented a different form of distributing force to transform materials: for instance, the rotary motion of wheel within the sun-and planet gear of the steam engine. Engineers considered the question of whether the parts of which all machines were configured could in fact be reduced to six or seven elementary machines to be notional, and in practice required far larger lists of mechanical powers. For a few instances of mechanical powers in this first sense, see "Machine," in *RC*, v. 22; Olinthus Gregory, "On the Mechanical Powers," in *A Treatise of Mechanics*, 1:70; John Banks's *On the Power of Machines* (1803) and John Smeaton's *Experimental Examination of the Quantity and Proportion of Mechanic Power* (1813).

[26] Olinthus Gregory, *A Treatise of Mechanics,* v. 1 (London: 1815), 1.

[27] "Machinery," *RC,* v. 22, 760.

[28] Olinthus Gregory, *A Treatise of Mechanics,* v. 1, 1, 64, 325, 448.

[29] "Machinery," *RC,* v. 22, 763.

[30] "Art," *RC,* v.2 (1819).

purposes, means and ends, all fueled a new understanding of figuration as operativity, the mechanical power – whether of machinery or poetry – to fabricate some work of art that would not exist in nature without human industry. The art produced by mechanical powers was not limited to discrete artifacts: rather, it extended to any material change in the world – any operation of figuring materials – that artificially shaped matter into some new form, whether substantive or transitive. Engineers understood applying mechanical power to refigure matter by machinery – whether transporting raw materials by an engine, translating power by a wind mill, or altering the form of a stream with an industrial water wheel – to be as much works of art as machines themselves, in that machines perform work by operating on materials to artificially refigure matter into a state that would not otherwise exist in nature. Engineers sought to physically shape the most "practical form" or "advantageous form" for mechanical powers that could never be achieved but only worked towards.[31]

Romantic engineers reckoned with the figurative power of machinery to be materially variable, dynamic, and contingent. As one engineer reflected, "Notwithstanding that many authors have supposed that the figure of the impression is generally the same as that of the impinging body"— that is, the same as the mechanical power of the machine applied – any fixed maxims regarding the form of machinery's figurative power are "attended with difficulties" and fail in practice due to the endless variations of "the forms of the impending body" and the powers applied.[32] As one Romantic engineer summed up, "Whatever may be their figure," irregularities in machinery's form "doubtless arise from a thousand circumstances, which with we are wholly unacquainted; in metals, it depends upon their purity, the heat at which they are melted, the manner in which they are left to cool, and many others, which totally escape our observation."[33] The same material contingencies extended to engineering's shaping of bodies into particular figures. The form that machines could figure and the ends to which they could be put to work were utterly materially contingent, "so that the number of mechanical powers, reduced to two, assume an infinite variety of forms and motions" limited only by matter itself. Machinery's figurative power varied with and had to be adapted to every material condition, with every work to which art is put. As one engineer summed up, "an engineer must not be tied down by too many inviolable maxims, because those contrivances which are the most improper in some situations …will be the best of all in other cases. There is great room for ingenuity" in "moving power." [34] "Ingenuity," etymologically linked to what Erasmus Darwin calls the "mechanical genius" of the engineer, described the engineer's capacity to artfully adapt mechanical powers to material exigencies: "Nothing shows the ingenuity of the engineer more than the artful…contrivances for obviating those difficulties that unavoidably arise from the very nature of the work to be performed by the machine, or in the power" applied to figure it.[35]

3. "Rough Power" / "Rude Idealism": The Analytic of the Mechanical

[31] Gregory, *Treatise of Mechanics*, v. 1., 113, 149.
[32] Gregory, *Treatise of Mechanics*, v. 1, 325.
[33] "On the Strength and Stress of Materials," *RC*, v. 34, 343-44. The "Machine" entry steers "skillful artists" to this article and several other key companion entries: "In the construction of machinery...several important considerations naturally arise in the mind of a skillful artist, such as the effect of FRICTION, RIGIDITY of ropes, the STRENGTH and STRESS of Materials...the laws of ROTATORY and ACCELERATED MOTION &c. &c.. These are all treated under the respective articles in the Cyclopædia," "Machine," *RC*, v. 22.
[34] Machinery, *RC*, v. 22, 760, 765.
[35] Machinery, *RC*, v. 22, 765.

If we now often associate industrialization with the rise of the industrial bourgeois, engineering's Romantic origins were working class. Far from predetermined in advance, the industrial bourgeois only emerged later in the nineteenth century as a contingent product of capitalism's formation. In retooling figuration as operativity – the vulgar work of art from drilling to metalworking – the figurative power of machinery came with a rough, rude, vulgar, anti-Kantian aesthetics of the work of art, of human labor power figuratively shaping the elements and raw materials, from drill-bits operating on metals to smelting ores and fitting engine parts together, abrading the containment devices of aesthetic categories like the sublime and the beautiful from the inside out with a rude materiality that refused to be contained under any concept. In *The Circle of the Mechanical Arts*, the engineer Thomas Martin addressed himself to "every workman who has to give form to rude materials": to all artists concerned with the "the practical part of the arts" or "engineering, and the [other] arts" – spanning "the art of mining" to engraving, founding, and metalworking, to every "art of modern invention" concerned with the "actions of the figures, and of all their parts."[36] Literally productive, this rough, rude aesthetics is the greatest critical strength of mechanical power as a working, operative, figurative logic that fuels its heightened practicality in working to give form to rude materials, and manifests the historical material conditions of labor power and the productive forces of society. The most "practical form" was not always the most beautiful: rather than prefabricated from Kantian aesthetic categories, mechanical power's form inhumanly emerged from the physical necessities of the work of art itself, the ends which the art was designed to achieve. Engineers noted the unavoidable "roughness of surfaces" of the figures of machine parts when any mechanical powers "act upon each other by means of machines" to shape figures, which became the basis for friction and the second law of thermodynamics. This rough aesthetic radiated outwards from the physical materiality of machinery – the rough texture of its formative power in physically shaping or figuring bodies by applying force – to inflect what engineers called their "rude mechanical practice" and their rude "terms of art," as well as the larger cultural constructs of the mechanical arts as rude or vulgar, a vulgar materialism that at once fueled the working class politics of mechanics and engineers. [37] Taking Thomson's poetry for their epigraph – though the engineers might just as readily have quoted Darwin or Shelley, as many engineers at the Mechanics Institute in fact did – the opening article of the first issue of the *Mechanics' Magazine* summed up its aim to apply "Industry! Rough Power" directly to the rough labor of working class politics: "— Industry! Rough Power / Whom labour still attends, and sweat, and pain / Yet the kind source of every gentle art, / And all the soft civility of life / Raiser of human kind!" The one part of Thomson's lines that the engineers critique in the article is the premise that "rough power" can be converted into the aesthetic category of the beautiful: "We do not pretend to assert that there is any thing in mechanical pursuits which peculiarly tends to soften and civilize mankind."[38] Rather, the engineers effectively argue that rough mechanical power stays rough, and distinguishes its figurative power. Erasmus Darwin waxes poetic over how the rough power of the engine "throws down all the splendid distinctions of mankind….by weakening the tyranny of the few over the many."[39] As the engineer Robert Stuart put it in his inaugural address before the Mechanics Institute, "Twenty years ago, Hornblower remarked 'the most vulgar stoker may turn up his nose at the acutest mathematician, in the world, for (in the

[36] Thomas Martin, *The Circle of the Mechanical Arts* (1813), vi, 1, 326-327.
[37] Martin, *The Circle of the Mechanical Arts,* 326.
[38] *Mechanics Magazine* 1 (1823). The epigraph is from Thomson's *The Seasons*, ll. 43-46.
[39] Darwin, *Botanic Garden,* 1.242n.

action and construction of steam engines), there are cases in which the higher powers of the human mind must bend to mere mechanical instinct;' and the observation applies with greater force now than it did then."[40]

So Shelley finds a "rude idealism" that is "rough at the edges" in likening his poetic power to the "Archimedian art" of the "mechanic or engineer," retooling Romantic poetry in the engineer Henry Reveley's workshop, whom Shelley commissioned to build a steamship.[41] "Exceedingly interested" in every detail of the "Casting of the Cylinder" of the Engine, the "splendor of the fusion" of the "operations of the molten metal…heated to an extreme degree, boiling with fury, and running into" its "form," Shelley writes to Reveley to "let me hear news" of "the boilers, the keel of the boat, and the cylinder, and all the other elements" of its "making," which he likens to poetic making.[42] Re-engineering Romantic poetics in Reveley's workshop, surrounded by engine parts, Shelley hopes that "Whoever wouldst behold me now…would think I were a mighty mechanist" – that is, an engineer – with the power to make "some machine" or "gin" (engine). Calling machine parts "figures" "transformed to metal," Shelley finds a "rude idealism" in the "screws, and cones, and wheels" of "tin and iron," "thumbscrews, wheels with tooth and spike and jag," the "shapes" and "forms" of "steamboats, frigates, and machinery": "Proteus transformed to metal did not make / More Figures" than those shaped by the engineer.[43] Urging Reveley to tell him every detail of the engine, Shelley insists that there is no shame in the rough forms of machine parts, shaped by the engineer's mechanical power, telling the engineer "I do not permit a false shame with regard" to "mechanical" forms that are "rough at the edges." On the contrary, Shelley tells Reveley that "I have a great esteem" and the "confidence and respect due to your powers" as a "mechanic and engineer," a rude idealism of mechanical power that Shelley identifies with poiesis and turns into the fuel of his engineering poetics.[44]

4. Finite Powers

Engineering led to a new concept of mechanical power as energy, the capacity to do work. The fact that mechanical power at once referred to the figurative power or energy of machines to shape materials into some new state and machines themselves expressed engineers' and Romantic poets' new understanding of form and energy as irreducibly co-constitutive (that is, co-operative and co-figurative). If any given mechanical power did not precede figures as a formative power, energy could at once not be reduced to any single material form. Energy and form were causally reciprocal: neither had causal priority. Any change of energy produced a mutual interchange in figure, and any change of figure produced a change in energy. Far from primarily conceiving of energy as what Ted Underwood calls a "formless force" in his influential study of Romantic concepts of energy, engineering gave rise to a new concept of energy as a formative power, since machinery applied energy to produce forms.[45] As one Romantic engineer wrote, the purpose of the "energy of machinery" is to "figure" bodies by the "impression" of

[40] Robert Stuart, *A Descriptive History of the Steam Engine* (London: 1824), v.
[41] Shelley, "Letter to Maria Gisborne," July 1, 1820. All citations of Shelley's work are from *Shelley and his Circle, 1773-1822,* eds. by Kenneth Neill Cameron (Cambridge: Harvard University Press, 1961).
[42] Shelley to Henry Reveley, October 28, 1819; Shelley to Reveley, "The Casting of the Cylinder," Nov 17, 1819.
[43] Shelley, "Letter to Maria Gisborne," July 1, 1820, 15-17, 45-47, 49-50.
[44] Shelley to Henry Reveley, October 28, 1819. Shelley might be said to experiment with engineering poetics over his career without necessarily exclusively committing to it. In other words, my argument does not require that Shelley's poetics be exclusively understood in engineering terms.
[45] Underwood, *The Work of the Sun: Literature, Science, and Political Economy, 1760-1860* (Palgrave, 2005), 9.

"mechanical powers."[46] Romantic engineering poetics thus operate not only through poetic form but through the energy of poetry and machinery to perform works of art by figuring materials.

Since mechanical powers were defined by their potential to artificially figure something that would not exist in the natural world by transforming natural forces, the figurative logic of machinery entailed a relationship with nature. This relation set strict material constraints on mechanical power. Realizing what would later become the first law of thermodynamics, engineers discovered that matter and energy could neither be created nor destroyed: far from creating *ex nihilo,* machines could only refigure natural materials and natural powers that already existed. As finite mechanisms, machines had "finite power" to translated forces that existed in nature for the work of art. As one engineer put it, all "species of machinery…are but the means of applying power which already exists" in nature. Hence, "we can only direct the application of power which already exists, and may be said to run to waste when it is not employed by man." [47] Nor were the power relations between mechanical artifice and nature reducible to the semantics of control but fundamentally materially contingent, taking a variety of forms. Figuring the material relation between machinery and nature as fundamentally co-operative, one civil engineer wrote that the engineer should be "experienced in local nature" in order "to assist and improve her" by "extending...[nature's] powers to practical purposes," refiguring the form of canals, reservoirs, aqueducts, tunnels, bridges, docks, and railroads to work with local nature.[48] Far from triumphalist, engineers understood the power of mechanical artifice to be a finite concessionary of natural forces. [49] As one engineer wagered, the main difference between "works of art" and nature is that "human industry" was always separated from "perfection" that "nature realized without effort" by "an immense space" that mechanical powers could never attain but only work towards.[50] My intention is not to dismiss the very real extractive logics of fossil fuels but rather to recover how for Romantic engineers and poets, mechanical power was not exhausted by any one relation to nature but rather had to be figured and shaped in all its material particularity on a case by case basis.[51] For them, the historical-material relation between technology and nature was not predetermined in advance but actively shaped by the work of history.

Mechanical Powers recovers a historical materialism distinctive to the figurative logic of machinery that insists on the critical power of the work of art within material limits. This figurative logic was productive but not inherently productivist. The critique of productivism –

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[46] Olinthus Gregory, *A Treatise of Mechanics*, v. 1 (London: 1815), 1.

[47] *Mechanics Magazine* 1 (1823), 5.

[48] Thomas Martin, "Engineering," in *The Circle of the Mechanical Arts*, 293.

[49] "Machine," v. 22, in *RC.* "Machines…increase the effect of a given finite power."

[50] Gregory, *Treatise of Mechanics*, v. 1, 113.

[51] Likewise, the critique of extractivism – often generalized in Anthropocene thought to rule out certain industrial activities like mining – has its limits, and is a much sharper critical tool when applied on a case by case basis to specific applications of machinery. Even Naomi Klein, one of the foremost critics of extractivism and popularizer of the term, admits that some amount of extraction is necessary and unavoidable, including even some forms of mining: "Living nonextractively does not mean that extraction does not happen: all living things must take from nature in order to survive. But it does mean the end of the extractivist mindset—of taking without caretaking, of treating land and people as resources to deplete rather than as complex entities with rights to a dignified existence based on renewal and regeneration. Even such traditionally destructive practices as logging can be done responsibly, as can small-scale mining, particularly when the activities are controlled by the people who live where the extraction is taking place and who have a stake in the ongoing health and productivity of the land." *This Changes Everything: Capitalism v. the Climate* (Verso, 2014), 386. On extractive logics, see especially Elizabeth Miller's new project, *Extraction Ecologies and the Literature of the Long Exhaustion, 1830s-1930s*.

the fantasy of endless energy closely identified with industrial capitalism– has been a forceful if blunt critical instrument in much scholarship on energy and industrial modernity, as it tends to obscure the extent to which the figurative power of machinery operated within strict material constraints of perpetual energy loss that could never be overcome by any work of art.[52] The blunt fashion in which productivism has been applied as critical tool has tended to obscure the material finitude, contingency, and dynamism of the figurative power of machinery and its application to forms of industry outside of industrial capitalism. The figurative logic of machinery that engineers discovered by working with their tools ruled out any productivist fantasies of endless productive activity. Yet even so, Romantic engineers and poets were not immune to productivist fantasies, which steam power could fuel, any more than Romantic life scientists were immune to vitalist fantasies that fetishized life force as a boundless formative power. Rather, the figurative logic of machinery already contained within itself an internal critique of capitalist ideology that at once insisted on the critical power of poetic making within strict material constraints. *Mechanical Powers* intervenes in critical debates regarding human power in the Anthropocene by recovering how the logic of machinery already contained within itself a critique of the limits and dangers of the rise of such human mechanical powers and at once held the potential to critically reshape them. The logic of machinery opens up the possibility of a renewed historical materialism that lies not in the rejection of science and technology but in its more critical application.

5. Poetry Figures Back

At once shaped by and shaping the new logic of machinery, Romantic poets reconceived the relation between poetry and machinery as fundamentally co-operative and co-figurative, with the power to shape human industry and the work that art can do.[53] Poetry figures back. *Mechanical Powers* gives analytic and causal priority to neither Romantic poetry nor machinery but rather to the interactions between them. Both act and react upon one another, figuring one another in turn. While poetry and engineering both came to exemplify human industry as a whole over the Romantic era, their mechanical powers take distinctive forms particular to their respective forms of human industry that at once shape one another in turn.[54] Erasmus Darwin, for instance, refigures machinery through his poetics, with the explicit intention of shaping an industry that spans poetry and machinery in the world at large. Pioneering a new form of engineering poetics, Darwin reflects how "Many of the important operations of Nature were shadowed or allegorized" in "the Rosicrucian doctrine of Gnomes, Sylphs, Nymphs, and Salamanders…thought to afford a proper machinery for a…poem" and are in fact the "figures

[52] The critique of productivism has been highly influential in literature and the history of science and technology. First introduced by Anson Rabinbach in *The Human Motor: Energy, Fatigue, and the Origins of Modernity* (University of California Press, 1992), the concept gained considerable traction in literary studies with Ted Underwood's *The Work of the Sun: Literature, Science, and Political Economy*, 1760-1860 (Palgrave, 2005), and is developed in most sophisticated form in Allen Macduffie's *Victorian Literature, Energy, and the Ecological Imagination* (Cambridge University Press, 2014). While I agree with Macduffie and others on the power of productivist critique, I am equally interested in the theoretical limits of the critique of productivism.

[53] Much like what Tito Chico has recently called the "reciprocally causal" relation between late 18th century literature and science. See Tita Chico, *The Experimental Imagination: Literary Knowledge and Science in the British Enlightenment* (Palo Alto, CA: Stanford University Press, 2018).

[54] Engineering shapes poetry by changing the material conditions in which poetic making takes place, shaping the historical-material form of poetry's power. Poetry in turn has the power to critically shape what form machinery should take, and the work to which it should be applied.

representing the elements," industrial forces like water, wind, and steam that fuel Darwin's engineering poetics. These "operations of nature" are the same "powers of nature" in "engines and machines" that engineers from Thomas Savery to Darwin himself come to define as the "mechanical powers" of machinery, as the "force or cause of motion" in machines "intended for the benefit and advantage of mankind," the technology that Darwin retools into the figurative logic that fuels his new engineering poetics. Darwin actively shapes machinery's figurative power through the force of poetic figures, images, and language, "mechanic powers collects / Means for some end, and causes of effects" to figure materials.[55] Locating mechanic powers in the materially contingent realm of the instrumental – "means for some end" – Darwin applies poetry's mechanical power to refigure the shape of physical materials through poetic verse, materializing the rougher, ruder figurative power of the work of "the rising arts" – in machine parts from pistons and cylinders – operating on materials to figure them into shapes, from the "piston" that "pressed by the ponderous air," "slides through its iron walls" of the engine cylinder to move "the balanced beam, of giant-birth" that "shakes the earth."[56]

Darwin's engineering poetics do not merely passively translate the energy of machinery into poetic language but rather apply poetry's own figurative power to shape machinery in turn. The semiotic force of poetic language actively shapes the form that machinery takes, the poem's subject matter in the engineering sense of materials "operated upon" or "figur'd," from shaping how machinery might "move the earth" to figuring machines not yet built that exist only in poetry and serve as transhistorical blueprints for future industry, from machines that Darwin would later build to airships, rockets, post-carbon engines, and climate engineering. Set aside for now Darwin's enthusiasm for steam power – the "explosive steam" that fulfills the Archimedean promise of mechanics to "move the earth" – which we will return to consider at length later in this study.[57] What matters for the moment is how the mechanical power of Darwin's engineering poetics figures a new logic of machinery that cannot be reduced to steam or any one power source but rather contingently takes various motive powers as means and operates upon them in turn, from the water- and wind-powered machines that Darwin himself engineered and in turn refigures in poetry to machinery powered by other energy forms, to the post-carbon future prefigured by Darwin's poetry in which other motive powers will "in time be applied to move machinery, and supersede the use of steam."[58] Like Darwin's engineering blueprints for making machines in his commonplace book, working images that engineers called figures, the images Darwin produces through his poetry reimagine how mechanic powers shape raw materials, from metals to the earth itself. Darwin's fundamental commitment lies not to steam but to actively shaping mechanical powers to human ends "for the benefit and advantage of mankind in general" through both his engineering poetics and engineering practice, which act and react upon one

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[55] Darwin, Apology to *The Botanic Garden*; *Temple of Nature*, 3.289. Darwin borrows the engineer Thomas Savery's phrasing in *The Miner's Friend*, a key treatise on the steam engine that he retools into Romantic poetry. *The Miner's Friend, or An Engine to Raise Water by Fire* (London: 1702), 8.

[56] Darwin, *Botanic Garden*, 1.259-262, 281-286.

[57] Darwin continunes,"Archimedes mark'd the figured sand; / Seized with mechanic grasp the approaching decks, /And shook the assailants from the inverted wrecks. / —Then cried the Sage, with grand effects elate, / And proud to save the Syracusian state; While crowds exulting shout their noisy mirth, 'Give where to stand, and I will move the earth.' / So Savery guided his explosive steam /In iron cells to raise the balanced beam; / The Giant-form its ponderous mass uprears, / Descending nods and seems to shake the spheres." *TN*, 4.242-250. Archimedes was one of the founders of practical mechanics, and Thomas Savery one of the engineers who developed the steam engine.

[58] Darwin, *Botanic Garden*, 1.242n.

another in turn.[59] This agency is not limited to the fact that many engineering treatises took inspiration from Erasmus Darwin's poetry, from Charles Partington's treatise on the steam engine to Thomas Gray's *Observations on a General Iron Railway*, the most influential railway treatise of the nineteenth century, which began with an epigraph from Darwin prefiguring the steamboat and railway: "Soon shall thy arm, unconquer'd Steam! / Drag the slow Barge, or Drive the rapid car."[60] Poetic making has its own distinctive form of figurative power in the energy of poetic language that at once shapes machinery and industry's impact on the globe.

6. Mechanical Power and its Others

While the figurative logic of machinery was entirely autonomous from other figurative logics, with its own distinctive technical and scientific materiality that did not need to be articulated in relation to any other, it is worth briefly considering its relation to Romantic logics of life to bring mechanical figuration into sharper relief and dispel some of the lingering illusions surrounding the relation between mechanical and living form, many of which we owe to Coleridge, a hostile witness to figurative logic of machinery, who defines poetic making as "directly opposed" to the "the *mechanic* power of the steam-engine." Hiving poetry off from the mechanical arts, Coleridge insists that "could a rule be given from without, poetry would cease to be poetry, and sink into a mechanical art. It would be morphosis, not *poiaesis*."[61] Coleridge's vitalism is the other half of his rejection of mechanical, which reduces to nothing figurative everything outside the vital power of the individual subject. The binary distinction between the mechanical and organic has largely occluded an understanding of mechanical form – since the mechanical has historically tended to be critically interpellated into life's photographic negative of "dead mechanism" or "negative exteriority" rather than by its own internal logic.[62] Unlike organic unity, mechanical form is not sublated under a preexisting totality but is rather open to figuration. Yet Romantic life, as Amanda Goldstein has shown, is not reducible to vitalism, and mechanical power has some points of confluence with more porous, non-vitalist Romantic logics of life from Darwin to Shelley that do not presuppose any form of organic unity or fetishize life force.[63] Both are materially contingent and dynamic forms of material figuration concerned with

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[59] Savery, *The Miner's Friend*, 8.

[60] See Charles Partington, *An Historical and Descriptive Account of the Steam Engine* (London: Taylor, 1826); Thomas Gray, "Proposition for a General Iron Railway." *Mechanics' Magazine* 19, January 23, 1824.

[61] Samuel Taylor Coleridge, *Hints Towards the Formation of a More Perfect Comprehensive Theory of Life*, ed. Seth B. Watson (London: Churchill, 1848), 66; emphasis in original. *Biographia Literaria*, in *The Collected Works of Samuel Taylor Coleridge, vol. 7, Biographia Literaria*, edited by James Engell and W. Jackson Bate (Princeton, NJ: Princeton University Press, 1984), 83-84.

[62] Both negative exteriority and dead mechanism are projections of life's imagined other with no actual descriptive purchase on mechanics. Dead mechanism is catachrestic because the descriptor dead only accurately applies to something that was once living, which mechanical form is not, and it implies that mechanical form is not dynamic, conflating life with energy. Mechanical form's dynamism is energetic yet non-living. Likewise, mechanical engineering rejects Newtonian negative exteriority in its materially immanent account of energy or force. On negative exteriority, see especially Helmut Müller-Sievers, *The Science of Literature*, 176-194.

[63] See Amanda Goldstein, *Sweet Science: Romantic Materialism and the New Logics of Life* (University of Chicago Press, 2018). Vitalism's fetishism of life lies not in the acknowledgement of life's formative power per se – which can be merely materialistic – but its valorization of life's power as boundless, unique, and not subject to material constraints, such that vitalist ideology takes precedence and directly contravenes materialism of the life sciences. Likewise, mechanical power of the figurative logic of machinery entails no power fetishism, but can be fetishized the moment that ideology directly contradicts and is valorized over the materialism of mechanics. The name for the technological counterpart to vitalism's power fetishism is productivism.

the figurative energy of matter and its strict limits, which is why Romantic engineers and life scientists were on the same side in the Vis Viva Controversy in rejecting the transcendental Newtonian understanding of force as negative exteriority in favor of the forces immanent to material bodies.[64] Hence, there is no shortage of instances in which Romantic writers reflect on machinery's confluences with life. Observing the figure of a "large machine" for "raising water out of mines" "heaving upwards once in half a minute with a slow motion, and seemed to rest to take breath at the bottom, its motion being accompanied with a sound between a groan and 'jike,'" Dorothy Wordsworth marvels that "it seemed to have made the first step from brute matter to life and purpose, showing its progress from great power."[65] At the same time, deconstructive, post-structuralist, and new materialist efforts to entirely dissolve the distinction between the living and mechanical risk occluding their very real material differences and figurative resources.[66] Most significant is the distinct forms their figurative power takes. If living form's dynamism derives from its epigenetic plasticity specific to organic matter – the malleable figures of soft tissues that is not a material property of inorganic matter like the rough metal figures of machine parts – mechanical form's dynamism derives from its reconfigurability, both of machine parts themselves – which can be re-figured in ways living forms cannot – and the works of art figured by machinery that would not naturally exist if not operated upon by mechanical powers. Likewise, while the Romantic engineering poetics of this study resonates with studies of figuration between the Romantic life sciences and poetry – and science and literature in general – machinery's figurative power takes a form distinctive to it.

7. Romantic Industrialism

This figurative power became profoundly ambivalent in the late 18th and early 19th century due both to machinery's transformations of labor, energy, and ecology – what Erasmus Darwin calls the "mechanic powers" to "move the earth" – but also to its historically contingent instrumentalization by industrial capitalism. Romantic poets and engineers realized that mechanical powers are not reducible to the logic of capital, even if machinery – like nature, labor, or any science or work of art – can be exploited by capital. If machinery had no inherent politics prefigured in advance, it could be made political. The very historical-material contingency of mechanical power could be put to work for a range of politics, from capitalist to proto-socialist. At the same time the new figurative logic of machinery was becoming autonomous over the Romantic era – as mechanical power to figure not reducible to any one politics – it was at risk of being subsumed by industrial capitalism. If it can now be difficult to decouple the logic of machinery from capitalism, this problem – and the tools for working

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[64] On the vis viva controversy, see Carolyn Merchant, "D'Alembert and the Vis Viva Controversy," *Studies in History and Philosophy of Science* 1.2 (1970): 135-44; "Leibniz and the Vis Viva Controversy," *Isis*, 62.1 (1971): 21-35; Helmut Müller-Sievers, *The Cylinder*, and "A Doctrine of Transmissions: On the Classification of Machines Around 1800," *The Science of Literature: Essays on an Incalculable Difference* (De Gruyter, 2015), 176-194.
[65] Dorothy Wordsworth, *Recollections of a Tour Made in Scotland, A.D. 1803* (New York: Putnam, 1874), 67.
[66] The new materialist valorization of matter as vibrant and alive regardless of whether it is organic or inorganic likewise collapses the distinction. The materialism distinctive to the figurative logic of machinery reminds us that metals and machine parts, while they may be energized, will never be alive. My point is not that deconstructive, post-structuralist, and new materialist readings of mechanical form are without value. On the contrary, such critical-theoretical frameworks help register some of materialities that the figurative logic of life and machinery share. But the formal divergences are at least as important as the points of convergence, and provide a fuller sense of the autonomy of the figurative logic of machinery and distinctive properties of mechanical form.

towards its critical resolution – dates to the Romantic era. Romantic poets and engineers – as well as socialists like Robert Owen and Mechanics Institutes – envisioned radical possibilities for industrial modernity and applied mechanical power directly to radical politics.

This study thus rejects the critical tendency to over-identify machinery or industrial modernity with industrial capitalism, which at once overlooks the autonomy of the new logic of machinery and obscures the radical alternatives that Romantic poets and engineers worked to realize. Historians of science and technology of otherwise differing views now reject any totalizing identification of industrial modernity with capitalism as historically inaccurate reinforced by the critical tendency to read machinery primarily through treatises on capitalist political economy from Smith to Ricardo. [67] This critical difference is most concretely manifested in this study's archives. *Mechanical Powers* works first and foremost with critically neglected Romantic engineering treatises and encyclopedias – where the new figurative logic of machinery is emerging – and Romantic industrial socialist writings on technology that Romantic poets often came into direct contact with. This is not to in any way downplay the very real economic and environmental crises of industrial capitalism. On the contrary, much of Romanticism's supposed hostility to machinery can be better explained as a more specific resistance to industrial capitalism, a Romantic industrialism that derived its force from its commitment to alternative industrial futures. Hence, there is no contradiction, for instance, between Byron's participation in the Luddite movement with his frame-breaking ode that protests the capitalist exploitation of machinery and his enthusiasm for engineering. Romantic poets and engineers reckon with how such mechanical powers become torn between capitalist logics of extraction and exchange – responsible for our planetary crises of energy, labor, and climate – and radical possibilities left unfilled by industrial modernity. Romantic poets and engineers work to refigure alternative forms of industry spanning poetry and machinery to combat the very crises that its capitalist application began to precipitate. Rather than rejecting industrial modernity, such Romantic possibilities prefigure its radical fulfillment.

Recent scholarship in literature and science has begun to recover Romanticisms concerned with the radical, utopian possibilities of machinery, from John Tresch's *The Romantic Machine,* which excavates how French utopian socialists that Marx called Romantic developed a dynamic view of machinery's potential for radical political projects in the wake of the French Revolution – from the founding of the *École Polytechnique*, the first French engineering school to Fourier – to Amanda Goldstein's new study of the radical possibilities of natural technology in such Romantic socialist utopias, to Leif Weatherby's recent study of the radical potentials of technology in German Romanticism.[68] *Mechanical Powers* investigates a British Romantic counterpart to such projects. Equally invested in the radical possibilities of machinery, the Romantic engineering poetics of this study rework the material finitude of human mechanical powers – like the limited utopian possibilities that Anahid Nersessian recovers – opening up a distinctively rougher, ruder, mechanical strain of Romantic aesthetics whose radical possibilities lie less within utopia than in the mechanical artifice of the everyday work of art. The historical

[67] See for instance, Maxine Berg, *The Machinery Question and the Making of Political Economy, 1815-1848* (Cambridge, UK: Cambridge University Press, 1982); E.P. Thompson, *The Making of the English Working Class*; Helmut Müller-Sievers, *The Cylinder: Kinematics of the Nineteenth Century;* John Tresch, *The Romantic Machine*; Andreas Malm, *Fossil Capital: Steam Power and the Roots of Global Warming* (New York: Verso, 2016).
[68] See John Tresch, *The Romantic Machine: Utopian Science and Technology after Napoleon* (Chicago: University of Chicago Press, 2012); Leif Weatherby, *Transplanting the Metaphysical Organ: German Romanticism Between Leibnitz and Marx* (New York: Fordham University Press, 2016); Amanda Jo Goldstein, "Attracting the Earth: Climate Justice for Charles Fourier," *Diacritics* 47.3 (2019): 74-105.

materialism that emerges out of the engineering poetics of this study joins with the historical materialism of Amanda Goldstein's *Sweet Science* and recent historical materialist approaches to technology from Tobias Menely to Andreas Malm to Helmut Müller-Sievers.

Romanticism entails no fetishism of technology: only historical materialism. On the contrary, the rougher, ruder historical materialism distinctive to the logic of machinery provides the strongest possible critique of any power fetishism. As Bloch puts it, "Marxism of technology" is "no philanthropy for maltreated metals" – no fetishism of technology – but only historical materialism: the end of the extension of the perspective of the animal trainer and colonizer to nature, the power relations of domination distinct to industrial capitalism.[69] As Bloch realizes, technological utopias turn out to be not a separate type of utopia at all but merely the technological element of any historical materialism.[70] This possibility takes on new urgency in the Anthropocene. As Dipesh Chakrabarty writes, "The hope that human beings will one day develop technology that will remain in a commensalist or congruent relationship with the biosphere for a period stretching into geological timescales – such a hope belongs to the realms of a reasonable utopia."[71] As Romantic poets reckon with at the onset of Anthropocene history, any such radical, Romantic possibility within machinery lies not in mere wish fulfillment but only in reshaping the historical-material form of mechanical powers, in refiguring the power relations of machinery through the work of art. If such possibilities are not yet realized by industrial modernity, for Romantic poets, they are nonetheless worth working towards.

As the historian of technology Maxine Berg remarks, before 1800, there was no machinery question.[72] Romantic poetics grapples with a series of machinery questions regarding what form mechanical powers should take, and how to figure the relation between mechanical powers and labor, energy, and ecology: what work the figurative power of industry can do at the dawn of the Anthropocene. This study attends most closely to how Romantic poetics critically reconceived mechanical powers in terms of labor power, energy, and ecology, three aspects of the figurative logic of machinery. Entangled and inseparable, such forms of mechanical power are best understood as overlapping affordances rather than strictly categorically distinct. Labor power, for instance, can also be figured in terms of energy, and the form that energy and labor power take likewise have ecological implications. As labor, mechanical power prompted questions of political economy, capitalist and otherwise, and what work art can do in industrial modernity. If pre-industrial tools readily manifested the labor power of the artist, complex machinery raised the question of abstract labor power of machines fueled by energy sources

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[69] Bloch continues, the "All theorists have pointed out this both insuppressible and helpful objective character of these laws…of concrete construction…the laws of technology…*not so that men should…make a fetish of them, but rather so that even in Marxist terms, precisely in Marxist terms, no attempt to take these necessities lightly and superficially should gain ground.* Marxism interprets the laws of science…as those of objective processes, occurring independently of the will of human beings…within which these changes can alone be concrete-beneficial, concrete-real ones…Freedom does not lie in the dreamed independence of the laws of nature, *but in the recognition of these laws and* i*n the possibility thus given to make them operate according to plan for specific purposes*" Ernst Bloch, "Technological Utopias," in *The Principle of Hope*, vol. 3, trans. Neville Plaice, Stephen Plaice, and Paul Knight. (Cambridge, MA: MIT Press, 1986), 668-69, 695; emphasis mine.

[70] Just as Marxism has discovered the really self-generating subject of history in working man, just as it only allows it to be discovered and to realize itself completely in socialist terms, so it is probable that Marxism will also advance in technology to the unknown…both together suggest the concrete utopia of technology, which follows the concrete utopia of society and is bound up with it" Bloch, *The Principle of Hope*, 674.

[71] Dipesh Chakrabarty, "The Planet: An Emergent Humanist Category," *Critical Inquiry* 2019 46.1 (2019): 27-28.

[72] See Maxine Berg, *The Machinery Question and the Making of Political Economy, 1815-1848* (Cambridge University Press, 1982).

outside of the human body. While new industrial processes of manufacture raised the specter of the alienation of labor under capitalism, they entailed no necessary social organization of labor and were at once open to proto-socialist forms of production that held the potential to free up labor power, open up collective forms of production, and socially redistribute the wealth produced by machinery. As energy, mechanical power raised the question of the limits of mechanical power and its exhaustion. What work could art do under strict material constraints of perpetual energy loss? Romantic engineers and poets discovered the unceasing dissipation of energy through friction that became the basis for the second law of thermodynamics, which set limits on the work that poetry and machinery can do. Romantic poets and engineers also reckoned with the problems of particular energy forms: the imbrication of fossil fuels in the logic of capital, and their viability in relation to energy sources such as water and wind power. A third category of question that machinery raised concerned the relation between technology and nature or ecology, as machinery refigured the natural world in a time of rapid industrialization with the profusion of engineering earthworks like steamships and railways. If mechanical powers refigured natural materials into forms that did not otherwise exist in nature, then what form should they take? Did some forms of mechanical power entail an ecologically damaging logic of extraction? Might machinery be ecologically adapted to nature, as Romantic poets and engineers hoped? How might the relation between technology and nature be made co-operative and collaborative rather than extractive? Such questions regarding the figurative power of machinery that continue to impact our late moment in Anthropocene history date to the Romantic era.

The first chapter, "Blake's Industrial Revolutions," begins by recovering a critically neglected confluence between Blake's poetics and Romantic era industrial socialists, the Owenites and Mechanics Institutes, who attempt to develop forms of industry outside of industrial capitalism. In the final chapters of *The Making of the English Working Class*, best known for documenting industrial capitalism's damage to labor, E.P. Thompson turns to the Romantic era radical traditions that developed the first forms of industrial socialism. Such radical movements, Thompson writes, applied machinery's "force to the context of working-class struggle" to fight industrial capitalism for socialist industry. Thompson laments the loss of this radical Romantic era tradition, and its failure to come into contact with Romantic poetry: "After William Blake, no mind was at home in both cultures nor had the genius to interpret the two traditions to each other… In the failure of the two traditions – to come to a point of junction, something was lost. How much we cannot be sure, for we are among the losers." What we have lost is the possibility of thinking industry outside of capitalism. Yet Blake and the radical elements of the Mechanics Institutes were far closer together than Thompson realizes, even coming into direct contact and sharing a desire to scale up the labor power of machinery for socialist industry. Rejecting the emergence of capitalist factories, Blake develops an industrial poetics that prefigures what he calls a "sweet industry" after capitalism, in which even the labor of making and using heavy machinery such as the mill would be poetic, pleasurable, and lyrical, and the benefits of the worldmaking powers of industry would be extended to "every population over the world" rather than unevenly distributed and extracted from the earth.

The second chapter, "Wordsworth's Green Industry," recovers how railway and steamship earthworks prompted Romantic poets and engineers to develop an early Anthropocene consciousness of the human power to shape the earth as a geological force. Against railway capitalists who advocated for blasting through the earth to construct railway earthworks such as viaducts and tunnels as cheaply as possible regardless of ecological cost, William Wordsworth and an environmentally conscious group of railway engineers pioneer a strain of steamboat and

railway poetry to develop ecologically sustainable forms of earthworks. Wordsworth and Romantic engineers came to reject the ecological devastation of fossil capitalism, instead imagining alternative forms of green industry figured in the earth's image. Rather than reading Wordsworth's persistent naturalization of poetic and industrial technologies as a symptom of productivist ideology, the nineteenth-century belief in the seamless continuity between nature and industry that fueled the ecological crises of industrial capitalism, I argue that this ecocritical drive of Wordsworth's poetics fuels his attempt to envision a form of green industry over his poetic career realized most fully in his late steamboat and railway poetry. Even in protesting the expansion of the Windermere Railroad into the Lake Distinct, often considered one of the nineteenth-century origins of the environmental movement, Wordsworth cites his steamboat and railway poetry as evidence that he is not against the railway but rather against fossil capitalism's disfiguring the environment, one year after the utopian-socialist Chevalier imagined the railway as a means of "universal association" between humanity and nature. Protesting the ecological crises of industrial capitalism, Wordsworth prefigures forms of green industry that anticipate the eco-socialist hopes of the Green New Deal.

The last chapter, "The Rise of Thermodynamics: Mechanical Engineering and Byron's Poetic Machinery," charts the first history of Byron's and Romantic engineers' attempts to grapple with how the new concept of energy that emerges out of the steam engine did not in fact merely fuel industrial capitalism's visions of limitless steam power – as existing critical narratives assume – but radically erodes it, as Romantic era engineers discover that the universal dissipation of energy through friction sets strict material constraints on any mechanical power. Excavating the Romantic rise of thermodynamics in early nineteenth-century engineering and its impact on Romantic aesthetics, I show how Byron develops an engineering poetics directly influenced by early nineteenth-century engineering, calling his poetic vocation "my post as an engineer" and pioneering a new thermodynamic form of poetic machinery. Romantic poetry and engineering shared a mutual question fueling their thermodynamic aesthetics: what work can mechanical powers achieve under strict constraints of perpetual energy loss and unavoidable physical attrition? This question continues to bear on how we approach poetry and machinery today, and what we might anticipate from poetry and engineering in the industrial age we share with Romanticism. As Byron explores through his engineering poetics, although the endless loss of energy erodes capitalist visions of limitless steam power, it can also provide tools for combating planetary scale dissipation in a time of climate change.

A final coda, "Geopoetic Futures," considers the fate and futures of Romantic industrialism. While by the late nineteenth century, this early form of Anthropocene consciousness where Romantic poetry and engineering intersected was eclipsed by the Victorian consolidation of industrial capitalism, it persists in a counter-modernity that runs from Romantic industrialism to contemporary Green New Deal and eco-socialist movements. This final coda also considers the promises and limits of Anthropocene narratives, and of an all too white and male strain of engineering that becomes bound up with the consolidation of industrial capitalism over the nineteenth century. Romantic poets and engineers begin to envision how the abolition of this white male strain of engineering is necessary for dismantling industrial capitalism. Turning from the metropole to the peripheries of British industrialization to the colonial subjects excluded from Anthropocene history, I show how Romantic poets and industrial socialists such as Robert Southey, Robert Owen, and George Numa Des Sources envision industrial socialist projects of global abolition to dismantle the plantation form that structured the dependency of British industrialization on slavery and sugar. Romantic poets and industrial socialists prefigure

how to decolonize industrial modernity by abolishing the racialized logic of industrial capitalism, with its constitutive white industrialism and black other, forgotten Romantic possibilities which Victorian liberals such as Samuel Smiles work to suppress. Finally, I turn to Byron's daughter Ada Lovelace's rejection of Charles Babbage's narrowly masculinist and capitalist application of early computing machinery. Lovelace pioneers a "poetical science" between Romantic poetry and engineering that repurposes the worldmaking powers of poetry and machinery for progressive-gender political ends. Romanticism anticipates one of the most pressing theoretical questions of our own late moment in Anthropocene history that lives on in contemporary critical theory and eco-socialist projects like the Green New Deal and environmental justice movements: how to remake industrial modernity to combat our planetary crises by and for the sake of those whom capitalism has denied or excluded from having any such worldmaking powers in the first place. Returning to this early moment of Anthropocene history where Romantic poetry and engineering intersect provides access to imaginative tools to develop forms of human agency outside capitalism that might renew rather than exhaust the planet.

Chapter 1:

BLAKE'S INDUSTRIAL REVOLUTIONS

In manufacture, the revolution in the mode of production begins with labour-power, in modern industry, it begins with the instruments of labour. Our first inquiry then is, how the instruments of labour are converted from tools into machines…The tool or working-machine is that part of the machinery with which the industrial revolution of the 18th century started.

– Marx, *Capital*

This in no way means that this use value – machinery as such – is capital...Machinery does not lose its use value as soon as it ceases to be capital…it does not at all follow that therefore subsumption under the social relation of capital is the most appropriate and ultimate social relation of production for the application of machinery.

– Marx, *Grundrisse*

Invoking a new sense of the mechanical power of the human species as a whole that political economists like Adam Smith likewise identified with the "great increase" in "industry and its productive powers," Robert Owen reflected in 1820 how machinery like the "steam engine" had "in a half century multiplied the productive power" of the human species "more than twelve-fold," adding "in an extraordinary manner to the powers of human nature." The transformation of the instruments of labor from tools to complex machinery like the steam engine and mill over the late 18th and early 19th centuries marked the onset of the industrial revolution.[73] Today, this scaling up of mechanical power with industrial machinery is at once understood to mark the onset of the Anthropocene, the moment "when we have…invented technologies on a scale large enough to have an impact on the planet itself."[74] For Romantic era writers like Owen, the transformation of the instruments of labor from tools to machinery raised the question of how to reckon with the labor power of machinery, and its transformations of human society, as well as the planet. On one level, Romantic era writers recognized the enlarged scale of human mechanical power with industrial machinery as a scientific and technological development that capitalist and proto-socialist thinkers from Smith to Owen both recognized held the potential to benefit "society at large." Yet at the same time, Romantic poets, engineers, and industrial socialists saw that this promise of modern industry was left unfulfilled by industrial capitalism, which worked to make capital appear the only and ultimate social relation for machinery. Since industrial capitalism had begun to create an "aggregate of wealth, and placed it in the hands of the few," Owen argued, "all now know and feel that the good" that "these inventions are calculated to impart" to "society at large…has not yet been realized."[75]

Since Owen's time, industrial capitalism has so successfully made itself appear identical to modern industry that it has become difficult to recover capitalism's damage to and difference from industry, a historical loss that continues to shape our own critical thought, a loss that at once dates to and is first challenged in the Romantic era. While industrial capitalism's damages to labor are widely known, and Romantic poetry is often taken to resist what Blake calls the dark

[73] Robert Owen, *Report to the County of Lanark* (1820), 15. Adam Smith, *An Inquiry into the Nature and Causes of The Wealth of Nations*, 1776, edited by Edwin Cannan (London: Methuen, 1904), 259.
[74] Dipesh Chakrabarty, "The Climate of History: Four Theses," *Critical Inquiry* 35.2 (2009), 207.
[75] Robert Owen, *Report to the County of Lanark* (1821), 15.

Satanic mills, Romantic criticism has tended to overlook the difference between industry and industrial capitalism that fueled Romantic radical traditions such as the Owenites and the Mechanics' Institutes, and their confluence with Romantic poetics. In this chapter, I consider Romantic attempts to reckon with the scaled up labor power of machinery, recovering a forgotten history of the work performed by late 18th and early 19th century liberal political economists to conflate machinery with capital, which Marx himself and Romantic socialists, engineers, and poets reject. Next, taking Blake as a case study, I argue that Blake develops an industrial poetics that works to scale up the instruments of labor from tools to machinery. At once interested in the labor power of machinery to realize the work of human-self creation and its alienation under industrial capitalism, Blake reckons with the problem of how to scale up mechanical powers for a proto-socialist form of industry outside of capitalism.

1. The Machinery Question

Over the late 18th and early 19th century, mechanical engineering gave rise to a new understanding of labor power based in quantifying the force of machinery. Labor power and mechanical power became equivalent as a measurable, quantifiable unit of work.[76] This development in mechanics that marked the emergence of modern industry at once shaped the development of political economy. As the historian of technology Maxine Berg sums up, "in the eighteenth century, there was no Machinery Question": no proto-socialist question of how to understand the scaled-up labor power of machinery that destabilized Adam Smith's and Ricardo's concept of machinery as advancing the arts and sciences – and the wealth of nations – through commerce without regard for its negative effects on labor under capital. "The machine was then simply understood" as an engine of "economic expansion which they believed would contribute to the general 'improvement' of society" that its increased mechanical power afforded. Yet by 1800, the "eighteenth century vision of improvement had become the machinery question of the early nineteenth century."[77] The machinery question addressed the problem of whether the quantitative increase of mechanical power translated into qualitative improvement in human lives. On one level, the machinery question was purely technological and scientific: how did the scaled-up labor power of machinery – more abstract than the manifest labor of the simple tool – qualitatively transform labor itself? Machinery was a question at all because of the effects of scale, which rendered labor power more abstract, not because of any inherent abstraction of machinery but simply due to the scaling up of the instruments of labor. Yet on another level, the machinery question was one of political economy. Machinery was not a question in the 18th century because (liberal) political economy assumed that the quantitative increase of mechanical power with the scaling up of machinery lead to qualitative improvement. It measured labor power in abstract, quantitative terms and assumed that qualitative improvements would follow by free market mechanisms. It is not, then, that liberal political economy entirely lacked any concept of labor power but rather that it remained merely abstractly quantitative. By contrast, the machinery question that arose with the Owenites and Mechanics' Institutes over the time of Romanticism – which E.P. Thompson credits with "the first elements of the labor theory of value" that "point towards [the] mature socialist theory" of Marx – questioned whether Smith's

[76] For more on how the quantification of the power of machinery in mechanics influenced political economy see Ted Underwood, "Energy becomes Labor," *The Work of the Sun: Literature, Science, and Political Economy*.
[77] Berg, *The Machinery Question and the Making of Political Economy*, 1815-1848 (Cambridge, 1982), 1.

and Ricardo's view of machinery was sufficient to realize the promises of modern industry.[78] While also valuing the quantitative measurement of the scaled up labor power of machinery, this Romantic era radical tradition insisted that scaled up labor power of machinery had to be understood not only in abstractly quantitative but also in qualitative historical-material terms.[79] At the same time that machinery emerged as an autonomous development of mechanical science and industry in the late 18th century, liberal political economy worked to make capital appear the ultimate social relation for machinery. Yet by the early 19th century, Romantic era industrial socialists were beginning to question this identification.

Before we turn to Romantic attempts to reckon with the machinery question, I want to begin with Marx's. The industrial revolution, Marx tells us, began with a revolution in the instruments of labor: the transformation of simple tools into complex machinery in the late 18th century. If the handheld tools of the artisan manifest the labor of human self-creation through the arts and sciences, the shift in scale from simple tools to machinery transforms the division of labor, running the risk of – if not necessitating – the real subsumption of human labor under capital as abstract, alienated work. Yet the moment Marx turns his attention to the words "mechanical power," the apparently simple binary distinction between tools and machines immediately fractures into a mobile army of metaphors and metonymies that destabilizes any distinction between the two, and shakes the very foundations of the labor theory of value. Mechanics and 18th century liberal political economists, Marx reflects, call a tool a simple machine, and a machine a complex tool: "They see no essential difference between them, and even give the name of machine to the simple mechanical powers, the lever, the inclined plane, the screw, the wedge, [the wheel and axle]. As a matter of fact, every machine is a combination of those simple powers."[80] This abstraction from the qualitative dimensions of labor power allows for liberal political economy to paper over capitalism's qualitative effects on labor. In acknowledging the ultimate validity of mechanics' scientific concept of machinery as not ontologically distinct from tools – but rather intermeasurable in terms of labor power – Marx at once insists that this definition must be supplemented by a qualitative historical-materialist analysis of labor power missing from 18th century liberal political economy.[81]

Attempting to qualitatively define the scaled up labor power of machinery – the "historical" element missing from 18th century political economy – Marx proposes that while simple tools take human work as their mechanical power, machinery performs abstract work fueled by mechanical powers outside the human body such as water, wind, and steam that less directly manifests human labor power. Yet this distinction in mechanical power also immediately threatens to fracture: Marx is forced to acknowledge that in terms of labor power, machinery thus extends back to antiquity, to the first water-powered mills like those that Lucretius uses to

[78] E.P. Thompson, *The Making of the English Working Class*, 778.
[79] Quantification in itself is not problematic so much as the specifically capitalist form that it takes in liberal political economy. Marx, as many have noted, also retains a quantitative analysis of labor power, even while he demands that it be supplemented with a qualitative account of labor power. Likewise, abstract work is non-identical to alienated work, though it can become it. While abstraction itself is merely an effect of scale and quantification (that can be rendered concrete and qualitative), capitalism exploits this abstraction to alienate labor.
[80] Karl Marx, "Machinery and Modern Industry," in *Capital: A Critique of Political Economy*, trans. Samuel Moore and Edward Aveling and ed. Frederick Engels, (London: 1886), 405. Unless otherwise noted, all references to Marx's *Capital* refer to this edition, the first English edition, which has high fidelity to 19th century mechanics.
[81] Marx, "Machinery and Modern Industry," *Capital*, 405.

explain the motion of the heavens, complex combinations of mechanical powers like wheels.[82] Yet if machines date to antiquity, the late 18th century for Marx marks the true onset of the industrial revolution, a revolution in the scale of the mechanical power of machinery that with the eclipse of the tool transforms the material basis of all social relations. As Marx reflects, the literal basis of the industrial revolution of the 18th century that defined the turn from simple tools to complex machinery was torque: the industrial revolution or continuous rotary motion of machine parts required to translate mechanical power between "complex systems of machinery" linked through wheels that made possible the scaling up of mechanical power. Watt's defining 1784 innovation to steam engine design was the invention of a rotary mechanism that converted steam into torque, which made possible complex machinery on an industrial scale. [83] Rather than inventing the steam engine, Watt's defining contribution was to render it "fully scalable." As Jon Klancher notes, "since it was fully scalable, Watt's engine could be linked up to any other tool or machine, and thus become what Marx would later call a truly Cyclopean machine. By scaling up or down, it could transform all other machine operations over the next century, to become a central mechanism for what Marx called… "the colossal scale" of [industry's] productive forces."[84] In particular, the rotary motion of the engine and mill allowed the labor power of machinery to take on inhuman "cyclopean" scale that set in motion the industrial revolution.

On one level, industrial machinery for Marx represents a moment in the scientific and technological development of mechanics that is not reducible to the logic of capital. Industrial machinery is only possible "after considerable development of the science of mechanics" as the "form of a machine becomes settled entirely in accordance with mechanical principles" that represents "the first scientific and technical elements of modern mechanical industry."[85] With the rotary mechanism – the literal industrial revolution – of the 18th century, the machine finally achieves an "independent form, entirely emancipated from the constraints of human strength" and the "form of the tool that gave rise to it." Hence, what Marx calls the machine form's "independence" and "emancipation" from the anthropomorphic figure of the tool gives rise to a formally autonomous poetics of machinery that represents the emergence of modern science and industry in the late 18th century.[86] Despite the scientific and technical autonomy of machinery that can in principle allow for social relations other than that of capital, machinery's form is readily transformed into capital by virtue of the scale of its power, readily abstracted from the human scale of the handheld tool, which is why machinery for Marx initially appears as "the most appropriate form of the use value of fixed capital."[87] Under capital, labor power is reduced to a tool for machinery: the mechanical power of the worker becomes quantified as abstract work, evacuated of qualitative significance. On one level, this alienation of labor under capitalism often takes the form of deskilling of labor through the division of labor made possible

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[82] Marx, *Capital*, 405-6. Marx also traces the prehistory of mills as an exemplary form of machinery to Lucretius's *De Rerum Natura* in *The Poverty of Philosophy*, 48-49.
[83] Marx, *Capital*, 412.
[84] Jon Klancher, "Scale and Skill in British Print Culture: Reading the Technologies, 1680-1820," *Studies in Eighteenth Century Culture* 47 (2018): 98. Klancher, however, overlooks the role of rotary motion in this scalar transformation. For the most comprehensive study of rotary motion to date, see Helmut Müller-Sievers, *The Cylinder: Kinematics of the Nineteenth Century* (University of California Press, 2013).
[85] Marx, *Capital*, 411.
[86] Likewise, Marx's empirical rhetoric of "inhuman" and "cyclopian" to describe machine form throughout *Capital* and the *Grundrisse* describes the poetics of machinery's formal autonomy from anthropomorphism.
[87] Marx, "Fragment on Machines," in *Grundrisse: Foundations of the Critique of Political* Economy, trans. Martin Nicolaus (New York: Penguin, 1973), 618.

by industrial machinery, separating skill and knowledge, intellectual and manual labor: for instance, Adam Smith's pin factories, the capitalist mills or factories of the late 18th century that Blake will call the dark satanic mill, reduce the worker's labor to mere mechanical power.

Yet if complex machinery allows for the development of capital, Marx at once insists that machinery's form it is not reducible to it, much as Romantic socialists would: "This in no way means that this use value – machinery as such – is capital, or that its existence as machinery is identical with its existence as capital…it does not at all follow that therefore subsumption under the social relation of capital is the most appropriate and ultimate social relation of production for the application of machinery." On the contrary, machinery holds the potential to "redound to the benefit of emancipated labour, and is the condition of its emancipation."[88] For Marx, with the industrial revolution, 18th century liberal political economists such as Adam Smith and Ricardo worked to identify machinery with capital to make it appear the "most appropriate and ultimate social relation for machinery," exploiting the reality effect of mechanical science and industry to render any alternative social relation for machinery invisible. Marx reflects that unlike money, "machinery does not lose its use value as soon as it ceases to be capital." For Marx, the use value – the mechanical power – of machinery's labor power is not reducible to the exchange value of capital but can be refigured into other forms of social relation, because machinery has an autonomous physical existence as the "technological application of the sciences."[89] Far from identical with capital, machinery's labor power can be put to work for other social relations, the "various uses" which Marx calls the "work of history."[90] The error lies not with modern "mechanical science and industry" but in how 18th century liberal British economists "exploit" mechanics' reality effect by identifying it with the logic of capital, which is why Marx insists that the objective scientific logic of machinery must be supplemented with the "historical" analysis of labor power. For Marx, recovering the non-identity between machinery and capital is the first step towards transforming industry for communist society to realize the manifest labor of human self-creation of the species being through the arts and sciences. Machinery for Marx holds the revolutionary potential to blow the social relations of capital "sky high" to "increase the surplus labour time of the masses by all the means of art and science" and ultimately realize the labor of human self-creation every bit as much as the artisan's simple tools, reclaiming the "technological application" of the arts and sciences for the "free development" of communist society, a promise left unfulfilled by the British industrial revolution.[91]

Much as Marx sketches, late 18th century liberal political economy worked to naturalize capital as the only possible social relation for machinery. As Berg notes, "the machine was then simply understood" as an engine of "economic expansion which they believed would contribute to the general 'improvement' of society" that its increased mechanical power afforded. [92] In the *Wealth of Nations*, Adam Smith most clearly elaborates this view of machinery that he standardized in political economy.[93] Using the scaled up productive power of the steam engine as his key example, Smith writes that "all such improvements in mechanics" that lead to better "machinery than had been usual before are always regarded as advantageous to every society" as

[88] Marx, *Grundrisse*, 618, 620.
[89] Marx, *Grundrisse*, 618.
[90] Marx, *Capital*, 125.
[91] Marx, *Grundrisse*, 622, 627, 625.
[92] See Maxine Berg, *The Machinery Question and the Making of Political Economy*, 1815-1848 (Cambridge, 1982).
[93] By liberal political economy, I refer most specifically to what Amanda Anderson calls "the narrow form of laissez faire economic liberalism" associated with Smith and 18th century political economy, which scholars of otherwise differing political views widely acknowledge to be capitalist.

machinery fuels a "great increase" in "industry and its productive powers," so that "the quantity of that work" that machinery is "useful for performing, will naturally be augmented, and with it all the advantage and conveniency which the society can derive" from it, driving "the natural progress of England towards wealth and improvement."[94] Smith's rhetoric naturalizes machinery into the engine of capitalist growth, summing up how machinery's scaled up productive power supposedly fuels progress under capitalism:

> Every body must be sensible how much labour is facilitated and abridged by the application of proper machinery….the invention of all those machines by which labour is so much facilitated and abridged, seems to have been originally owing to the division of labour.... more work is done upon the whole, and the quantity of science is considerably increased by it. It is the great multiplication of the productions of all the different arts [by machinery], in consequence of the division of labour, which occasions, in a well-governed society, that universal opulence which extends itself to the lowest ranks of the people… and a general plenty diffuses itself through all the different ranks of the society…The quantity of industry, therefore, not only increases in every country with the increase of the stock which employs it, but, in consequence of that increase, the same quantity of industry produces a much greater quantity of work. Such are in general the effects of the increase of stock upon industry and its productive powers.[95]

Note that Smith is not concerned about the uneven distribution of the wealth produced by machinery, or its potential alienation of labor by the industrial transformation of the arts and sciences. For Smith, machinery simply scales up the productive power of the arts and sciences, which leads to a "universal opulence that extends itself to the lowest ranks of the people." By Smith's logic, the quantitative increase of the productive powers of machinery are sufficient to advance the arts and sciences and the wealth of nations by laissez-faire market mechanisms: machinery leads to a "a general plenty [that] *diffuses itself* through all the different ranks of the society" by what we would now call trickle-down economics rather than through active social re-distribution or design. Indeed, after this passage, Smith continues to elaborate the invisible hand. The abstractly quantitative terms of Smith's analysis of labor power allows him to sidestep any concrete analysis of how fixed capital qualitatively affects labor. By this capitalist logic, qualitative improvement followed naturally from the quantitative increase of industrial power. Needless to say, pin-makers and factory workers would likely beg to differ whether machinery as capital in fact diffused wealth by the free market mechanisms that Adam Smith supposed.

This logic of machinery that we would now call capitalist became standard in late 18th and early 19th century liberal political economy, extending not only to Smith's Romantic successors like Ricardo and McCulloch – who likewise theorized how "the quantity of industry" increased by machinery elevated Britain in "the scale of civilization" and "universally diffused" commodities and wealth at "more equitable prices" – but to society at large.[96] Britain's commercial dominance in the arts and sciences was widely attributed to how it was rapidly turning into "a country of machinery."[97] As one engineer summed up: "The practical application of mechanics to the construction of machinery, is a subject of the utmost importance to the

[94] Smith, *Wealth of Nations*, 271, 327.
[95] Smith, *Wealth of Nations*, 10-12, 259.
[96] McCulloch, "Political Economy," in the Supplement to the *Encyclopedia Britannica*.
[97] Robertson Buchanan, *Essay on the Shafts of Mills* (London: 1814), 9.

welfare of our country, depending so materially as it does upon commerce, which is derived chiefly from our manufactures. They owe the pre-eminence they have over other nations to the general introduction of machinery, which has taken place within the last forty years, to abridge manual labor."[98] When labor was mentioned, it was often in the unproblematic terms of liberal political economy, which regarded "the practical application of mechanics" to commerce as a scientific fact that would self-evidently "shorten labor" and generate surplus value through commerce: "the importance of Machines" more "powerful in operation" unproblematically "abridged manual labor" and furnished a "greater quantity of commodities at moderate and equable prices." As Maxine Berg sums up, "the popular and political impact of [Smith's work] was to extend the identity between political economy and capitalism" in the late 18th century.[99]

Yet by the early 19th century, this capitalist logic regarding how machinery's scaled up productive power worked was called into question, as industrial capitalism's damages to labor became manifest. Reckoning with the new idea that "is very generally entertained, that machinery is prejudicial to the interests of mankind, as far as it tends to diminish the value of labor by which the lower classes of society can purchase the means of subsistence" the engineer who wrote the 1819 "Machinery" article in Rees's *Cyclopædia* (that Blake also contributed to[100]) argues that "individuals whose labours are superseded by machines, will suffer inconvenience for a time, yet it is only for a time…[until they] discover new channels for the exertion of their industry…as machines tend to increase the quantities of those luxuries which mankind are so anxious to obtain, it only requires that an equitable division of these benefits should be made to obviate every objection and really improve the condition of all classes." The author's rapid toggling in the space of a single sentence between a free market exhortation to the industry of individuals displaced by machines and a strikingly socialist call for the "equitable" redistribution of the wealth produced by machinery to "all classes" lays bare the extent to which machinery was no longer fully reducible to the terms of liberal political economy by the early 19th century.[101]

One need not wait for Marx to find the first socialist attempts to imagine industry outside of capitalism, which date to the Romantic era. In the final chapters of *The Making of the English Working Class,* best known for documenting industrial capitalism's damage to labor, E.P. Thompson turns to the Romantic era radical traditions of the Owenites and Mechanics' Institutes, who developed the first forms of industrial socialism. As Thompson reflects, "So far from being backward-looking in its outlook, Owenism was the first of the great social doctrines to grip the imagination of the masses in this period, which commenced with an acceptance of the enlarged productive powers of steam and the mill. What was at issue was not the machine so much as the profit motive; not the size of the industrial enterprise but the control of the social capital behind it…They fought, not the machine, but the exploitive and oppressive relationships intrinsic to industrial capitalism."[102] For this Romantic era radical tradition, the problem lay not with the scaled up labor power of industrial machinery but the specific form that industry takes under

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[98] "Machinery," in *Rees's Cyclopaedia or Universal Dictionary of the Arts, Science and Literature* (RC), vol. 21 (London: 1819), 760.

[99] Berg, *The Machinery Question*, 42. Berg rightly notes how "The connection Smith established between capital accumulation and [machinery] allowed him to ignore labour displacement" (33).

[100] Blake produced several plates for articles Rees's *Cyclopædia*, including most notably his *Laocoön* plate. See Rosamund A. Paice, "Encyclopaedic Resistance: Blake, Rees's Cyclopædia, and the Laocoön Separate Plate," *Blake Quarterly* 37.2 (2013): 44-62.

[101] "Machinery," *RC*, vol. 21, 759.

[102] Thompson, *The Making of the English Working Class*, 804.

capitalism. Smith's error lay not in his hopes for the industry's benefits to labor but in thinking that free market mechanisms were sufficient to realize them. Such radical movements, Thompson writes, applied machinery's "force to the context of working-class struggle" and elaborated a "force-multiplier" theory of how the labor power of machinery might be mobilized for the working class to fight industrial capitalism for socialist industry. Thompson credits the radical figures of the Mechanics' Institutes like its co-founder Thomas Hodgskin and the *Mechanics' Magazine* that he founded with the core "elements of the labour theory of value" that "points towards mature socialist theory."[103] In the final paragraph of his study, Thompson laments the loss of this radical Romantic era tradition, and its failure to come into contact with Romantic poetry: "After William Blake, no mind was at home in both cultures nor had the genius to interpret the two traditions to each other… In the failure of the two traditions – to come to a point of junction, something was lost. How much we cannot be sure, for we are among the losers."[104] What we have lost is the possibility of thinking industry outside of capitalism, a loss that Thompson suggests was exacerbated by the failure of Romantic poetry and industrial socialism to come to a point a junction.

2. Blake's Industrial Poetics

Yet Blake and the radical engineers of the Mechanics' Institutes were far closer together than E. P. Thompson realizes, even coming into direct contact and sharing a desire to scale up the labor power of machinery for socialist industry. While Blake is often understood to anticipate Marxist theories of labor-power, he is over-identified with the simple tools of the artisan over against the complex machinery of the industrial revolution.[105] Blake and Romantic socialists and engineers confronted the same problem of machinery over the 1810s-20s: how to reckon with the scaling up of the instruments of labor from simple tools to complex machinery in the industrial revolution. Rather than reducing the distinction between tool and machine into a mere negation, Blake reckons with the tool and machine as contraries whose resolution is the work of history. Like the Romantic era Owenites and Mechanics' Institutes, Blake rejects not machinery but the sublation of machinery – and industry as a whole – under the logic of capital that he comes to call the "counter-arts." While Blake himself remains largely unaware of this confluence, it makes its forces felt over the course of his career, as Blake develops an industrial poetics that that prefigure the conditions of possibility for a post-capitalist industry that would make common the labor power of machinery for the free development of the human species through a redeemed industry. If Newton, Bacon, and Locke – Blake's figures of modern science and industry – are redeemed at the end of *Jerusalem*, not only does sweet science reign at the end of *The Four Zoas* but also sweet industry, when the earth "rang sweet with the praises of industry."[106]

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[103] Thompson, 773, 785.
[104] Thompson, 778, 832.
[105] Morris Eaves argues that Blake considers "simple tools " over machines, anticipating "critiques of mechanization associated with the Industrial Revolution" in *The Counter-Arts Conspiracy: Art and Industry in the Age of Blake* (Cornell University Press, 1992), 183, 185. Saree Makdisi identifies Blake's poetics with the pre-modern artisan over against industrial modernity, despite the fact that in many respects Blake's image-making formally anticipates industrial production processes in *William Blake and the Impossible History of the 1790s* (Chicago UP, 2003).
[106] W.J.T. Mitchell rightly observes how the arts and counter-arts are in *Jerusalem* 98.6 in *Blake's Composite Art: A Study of the Illuminated Poetry* (Princeton University Press, 2019), 46-47. On sweet science's reign, see Amanda Goldstein, *Sweet Science: Romantic Materialism and the New Logics of Life* (Chicago UP, 2018), 1-2.

Blake's historical-materialist poetics of labor power has been widely understood to prefigure Marx's critique of industrial capitalism. If Raymond Williams long ago located Blake's industry on the fault line between residual 18th century industry and the emergence of industrial machinery, critics from E.P. Thompson to Saree Makdisi have influentially identified Blake with the simple tools of a pre-industrial, pre-modern mode of artisanal production over the against industrial machinery of the "dark satanic mill," now a critical shorthand for Blake's critique of the alienation of labor power under industrial capitalism. [107] Nicholas Williams is right: Rather than rejecting industrial modernity, Blake rejects its reduction to capitalism.[108] Blake's radical critique of machinery is best understood not as a totalizing rejection of the industrial revolution but rather a rejection of its reduction to capital in liberal political economy. This chapter's title, "Industrial Revolutions," refers to both Blake's emerging Anthropocene consciousness of a transformation of the instruments of labor from tools to machines in the late 18th century and the rotary motion of industrial machinery that came to define machinery over the Romantic era: the literal industrial revolutions of complex machines in the figures of gears and cog-wheels – that mills came to exemplify in Blake's time. Despite much scholarship recovering an industrial Blake – including what Makdisi has shown to be Blake's radical critique of the co-constitution of the liberal industrial subject and machinery under capitalism – the literal industrial revolutions of machinery that came to define machines over the Romantic era have received little attention, due to the tendency to over-identify machinery with capital and an emphasis on individual machines rather than the rotary motion that powers and defines them.[109] Blake's industrial poetics work to free modern industry spanning poetic and machinery from capital to extend the manifest labor of art to machinery for a radical industrial revolution left unfulfilled by industrial modernity.

Consider two moments at different points of Blake's career when he defines his industrial poetics in relation to mechanical power: the first, around 1800, when Blake first pioneers a critique of the "wretched state of political science in this country"— industrial capitalism fueled by liberal political economy – that he comes to call "the counter-arts," as Smith's capitalist logic of machinery began to alienate the instruments of labor; the second, in 1823, when industrial machinery like the mill had become the primary source of mechanical power. In his *Discourses*, Reynolds advanced a "general view" of the "progression" of the "opulence and power" of the British empire through commerce, advancing the power of Britain "as a commercial nation" through capitalist manufacture as in Adam Smith. [110] Reynolds denigrated the "useless industry" of the Dutch school and British artists who neglect genius and rely on merely "mechanical power for distinction" and the "mechanical part of the arts." In his Annotations to Reynolds'

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[107] Raymond Williams credits Blake with one of the earliest ideas of the industrial revolution or of a "new social order based on major industrial change" in "Industry," in *Keywords*: *A Vocabulary of Culture and Society,* 119. As Williams notes, if the phrase "industrial revolution" arises in the 1810s-20s, near the end of Blake's career, the concept of an industrial transformation of society dates to the 1790s or earlier. Over Blake's career, the phrase "industry" became increasingly torn between the older sense of skilled labor and the modern industrial sense of the term as the aggregate of human labor power formalized in machinery.

[108] As Nicholas Williams writes, "Blake's solution to the miserable conditions of the industrial city, like Owen's does not involve a renunciation of the industrial method, nor an abandonment of the hopes of the city builders, but rather their refinement within the limits of a truly utopian" form, *Ideology and Utopia in the Poetry of William Blake* (Cambridge University Press, 1998), 181.

[109] Joseph Viscomi, *Blake and the Idea of the Book* (Princeton: Princeton University Press, 1993), xxiv. On Blake's historical-materialist, proto-Marxist vision of labor-power, see Williams, "Industry,"; Makdisi, *William Blake and the Impossible History of the 1790s*; Ted Underwood, *The Work of the Sun: Literature, Science and Economy, 1760-1860,* 79-88, Eaves, *The Counter-Arts Conspiracy,* Goldstein, *Sweet Science*, 35-71.

[110] Joshua Reynolds, "First Discourse," in *The Works of Sir Joshua Reynolds* (London: 1798), 5-6, 14, 31, 104.

Discourses, Blake critiques the political economy implicit in Reynold's view of mechanical power. "The words mechanical power should not be thus prostituted," Blake writes, for "mechanical excellence is the only vehicle of genius."[111] Why does Blake valorize mechanical power – and specifically mechanical power characterized by mechanical excellence – as the defining vehicle of true artistic creation?

Rejecting Reynolds' separation of intellectual and mechanical power, Blake insists that art irreducibly entails mechanical artifice. By separating "genius" and "mechanical power," Reynolds abstracts from the qualitative particularity of labor power for a "general view" of advancing the commercial power of the British empire through industry.[112] Blake zeroes in on how Reynold's abstract, general view of mechanical power allows him to "manufacture art by the hands of ignorant journeyman," thus turning art into a "mill or machine" good for nothing except to sell commodities at an "immense price"[113]: abstracting the worker's mechanical power into a mere means for commerce. In calling mechanical excellence the only vehicle of genius, Blake insists that the creative labor constitutive of art has to be manifest in the mechanical powers of the worker's instruments of labor or not at all. (As Blake puts it, "invention depends altogether on execution.")[114] In rejecting any "prostitution of mechanical power," [115] Blake rejects any abstraction of the artist's labor power into capital to execute the abstract work of capitalist manufacture rather than the worker's own "genius" or "mechanical excellence" (the qualitative skilled labor constitutive of real art).

Blake expands his critique of the counter-arts in his "Public Address," where he diagnoses "the wretched states of the Arts in this Country and in Europe originating in the wretched state of political science:" in liberal political economy in which machinery is reduced to capital or commerce, "the science of sciences [that] demands a firm and determinate conduct on the part of artists to resist the contemptible Counter Arts."[116] Money evacuates art of any qualitative value, rendering art a "mill or machine" to sell commodities at an "immense price" (in a commercial nation, "a mill or machine [is] not a man nor a work of art: it is destructive of Humanity and of Art").[117] For Blake, no true art is possible under capitalism: "Where any view of Money exists Art cannot be carried on."[118] The satanic property of the dark satanic mill *is*

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[111] Blake, "Annotations to the Works of Sir Joshua Reynolds," 643, 652.

[112] Morris Eaves rightly notes how Reynolds extends the "scheme of development outlined by Adam Smith" in *The Counter-Arts Conspiracy*, 20.

[113] Blake, "Public Address," 575-76.

[114] Blake, Annotations to Reynolds," 637. Blake continues, "Whoever is set to undermine the execution of art is set to destroy art." Blake returns to this idea in the "Public Address": "execution is only the result of invention" (576). Blake likewise rejects "the pretended philosophy which teaches that execution is the power of one & invention of another....I say he who can invent can execute," 699. This line has sometimes been narrowly read to rule out any division of labor. Yet while Blake rejects the form of the division of intellectual and mechanical labor that comes to define industrial capitalism, it does not necessarily follow that he rejects any division of labor whatsoever, in the wider sense of specialized forms of labor that unify intellectual and physical labor, for instance, skilled design of machinery or collectively produced works that manifest the labor of all involved. Viscomi and Underwood, for instance, have both attended to forms of the division of labor that Blake allows for and even demands.

[115] Helmut Müller-Sievers notes a similar rhetoric of prostitution in Marx's labor theory of value: for Marx, "under capitalism's rule workers have to *prostitute* their ability to work." *The Cylinder*, 95.

[116] Blake, "Public Address," 580. One might multiply the list of what Eaves rightly calls Blake's "anti-commercialist" sentiments in his Public Address" and "Annotations to Reynolds" ad infinitum, from "Commerce is so far from being beneficial to Arts or Empire that it is destructive of both" to branding Reynolds a "hirling" "hired to depress art" and "give high price for the worst" (574, 635)

[117] Blake, "Public Address," 575-76.

[118] Blake, *Laocoön*, 275.

money: "Money, which is The Great Satan." True industry – any mill which is not Satanic – is only possible without money. In reclaiming mechanical power as "the only vehicle of genius," Blake articulates a theory of labor-power that fuels his industrial poetics: that real human industry is only manifest in mechanical artifice executed by the instruments of labor in all of its qualitative particularity –- the "industry" that Blake identifies with imaginative power, industry that is only possible outside of capitalism. "They knew my industry," Blake writes, "the proofs of industry in my works": the mechanical excellence manifest in the work of art, an industry that he will soon expand to all workers from poets to engineers, the "industrious" as a class.[119] "One power alone makes a poet," "imaginative power," the mechanical power that Blake calls the *only* vehicle of genius.[120] The "genius" or "mechanical excellence" constitutive of art is not Reynolds' or Kant's abstract faculty but the creative industry to materially envision and create something other than that which now exists through mechanical artifice, the labor-power of human-self creation that adds an irreducible qualitative surplus to human existence through human industry increasingly threatened by what Blake called "the counter-arts" of industrial capitalism, which abstracted industry into a mere means for the quantitative increase of commerce. If Blake will soon work to scale up industry as qualitative labor constitutive of art to industrial machinery, we can already see how Blake's early articulation of his industrial poetics combines a strong commitment to the mechanical power constitutive of art – refusing any separation of knowledge and power – with a rejection of industrial capitalism, exemplified by the dark satanic mill and defined by the reduction of mechanical power to commerce by modern industry under capitalism.

Blake's early biographer Alexander Gilchrist reports Blake's response to the first issue of the London *Mechanics' Magazine*:

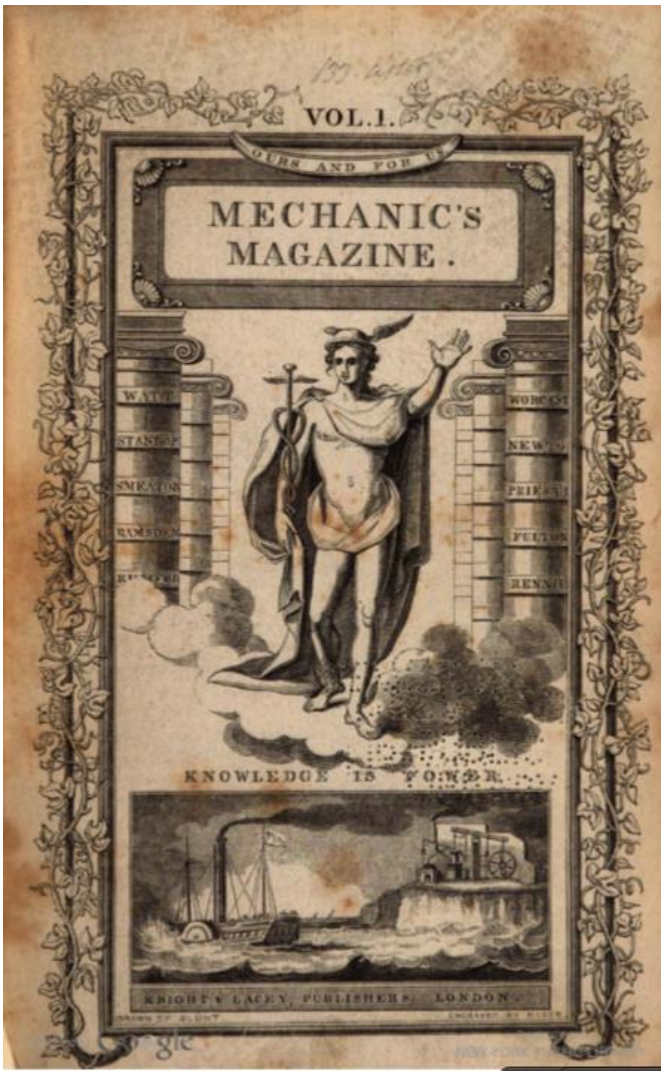
> In society, once, a cultivated stranger, as a mark of polite attention, was showing him the first number of The Mechanics' Magazine. 'Ah sir,' remarked Blake, with bland emphasis, 'these things we artists HATE!'[121]

Eaves takes Blake's response as an epigraph for a core chapter of his study on Blake's counter-arts without any commentary on Blake's response to the *Mechanics' Magazine* or examination of the Magazine itself.[122] Yet Gilchrist is very specific: Blake was shown the first issue of the *Mechanics' Magazine*, the periodical of the London Mechanics' Institute, published in 1823. What exactly would Blake have recoiled from in hatred when he was shown the first issue?

The frontispiece of the first edition effectively read MECHANICAL POWER: "KNOWLEDGE IS POWER" hovered over pictures of steam-powered machinery, including a steam-boat and steam-powered mill, against a backdrop of Britannia ruling the waves.[123] The names of famous British engineers and scientists, pioneers of modern science and industry who drove the industrial revolution, towered on two triumphal pillars, in billowing clouds of steam: "Watt, Stanhope, Smeaton, Ramsden, Rumford, Worcester, Newton, Priestley, Fulton, Rennie."[124] Newton founded mechanics as a science; Smeaton pioneered rotary motion in

[119] Blake to Thomas Butts, October, 2, 1800, 712; Blake to William Hayley, October 23, 1804, 757.
[120] See "Descriptive Catalogue," 547, and "Annotations to Wordsworth's Poems," 665.
[121] Blake, quoted in Alexander Gilchrist, *The Life of Blake* ed. W. Graham Robertson (London: Bodley, 1922), 346.
[122] Eaves, *The Counter-Arts Conspiracy: Art and Industry in the Age of Blake* (Cornell University Press, 1992), 182.
[123] *Mechanics' Magazine* 1 (1823).
[124] Robert Fulton invented the steam-boat; George Rennie invented the screw-propeller and built railways.

machinery that Watt applied to the steam engine; Robert Fulton invented the steam-boat; George Rennie invented the screw-propeller and designed railways. If Blake looked beyond the frontispiece to the opening pages, the first article featured a biography of James Watt complete with his portrait that extolled Britain's advances in industrial machinery depicted on the cover, all based in the engine's power to "apply directly the up-and-down movement of the steam engine in straight lines to wheels" so that "the movement of the steam engine backwards and forwards in straight lines, was converted into a rotary movement."[125] The article quotes Boulton's and Watt's famous advertising slogan for the steam engine: "I sell here, sir, what all desire to have – POWER."[126]



Frontispiece of *Mechanics' Magazine* 1 (1823), New York Public Library

[125] *Mechanics' Magazine* 1 (1823), 4-5.
[126] For more on Boulton and Watt's famous advertising slogan, see Shena Mason's biography of Boulton with the same title, *Matthew Boulton: Selling what All the World Desires* (Yale University Press, 2009).

There are many things that Blake might have hated from glancing at the cover. Structurally, Blake's first-person plural ("things *we artists* hate") opposes true artists as a class to the counter-arts, here identified with modern science and industry under capitalism. For Blake, the cover of the *Mechanics' Magazine* could seem to depict an explicitly industrialized counterpart to Reynolds' counter-arts that he rejected decades earlier, no longer delimited to the artisan's tools but now fully manifested in industrial machinery. "Watt, Stanhope, Smeaton, Ramsden, Rumford, Worcester, Newton, Priestley, Fulton, Rennie" might sound to Blake like an expanded, industrial form of "Bacon, Newton, and Locke." Blake might have hated how the industrial division of labor of the frontispiece itself – "Drawn by Blunt, engraved by Mason" – was amalgamated with the mechanical power of the industrial machinery that it celebrated. All these things are symptomatic of what Blake may have hated most of all in glancing at the cover: the prostitution of mechanical power under capital, now in industrial machinery. At first glance, the frontispiece would seem to sublate the mechanical power of machinery under industrial capitalism: Bolton and Watt's advertising slogan of selling what all the world desires: POWER. All of the arts of industry – including Blake's own that went into the frontispiece – appeared to be prostituted into a commercial engine for advancing the power of British empire, precisely what Blake rejected as the counter-arts.

Yet if Blake had taken a closer look at the *Mechanics' Magazine*, rather than quickly judging it by its cover, he might have found much with which he could sympathize that belied the commercial interests that it appeared to represent at first glance. In fact, in 1823, the Mechanics' Institute was pioneering what E.P. Thompson has called "the first elements of the labor theory of value" as a radical arts and sciences institute designed to advance the labor power of working artists through modern mechanical science and industry, and counter the very industrial alienation of labor that Blake condemned.[127] The Institute's motto on the frontispiece – "KNOWLEDGE IS POWER" – in fact represented its mission to counter the division of skilled knowledge and labor power through machinery by empowering the working class with the technical knowledge of modern science and industry. From the first issue, the magazine circulated collective design blueprints for types of machines designed to freely share knowledge amongst working artisans.[128] The Magazine's social ambitions, outlined in the first issue, were to be the "most valuable gift that the hand of science has given the artisan": where artisan was not limited to those working with simple tools but extended to industrial machinery.[129] The opening address in the first issue stressed the working-class origins of many of the scientists, artists, and engineers who held the potential to refigure the mechanical power of machinery to advance the arts and sciences not for commerce but for the benefit of labor, so "that numerous and important portion of the community, the Mechanics and Artisans, including all who are operatively employed in our Arts and Manufactures, can say, 'This is Ours, and For Us'" through the labor power of industrial machinery fueled by rotary motion like the mill.[130]

E.P. Thompson credits Thomas Hodgskin, the editor of the *Mechanics' Magazine*, with the first "elements of the labour theory of value" that "point towards mature socialist theory." In *Labour Defended Against the Claims of Capital*, based on his 1823 lectures at the Mechanics' Institute that appeared in the first issue of the *Mechanics' Magazine* that Blake saw, Hodgskin

[127] See Thompson, 778.
[128] On the radical politics of the London Mechanics' Institute in the 1820s, see also Kiyoko Takanashi, "The Romantic Origins of the Mechanics' Institute," NASSR, Providence, RI, June 2018.
[129] *Mechanics' Magazine* 1, 2.
[130] *Mechanics' Magazine* 1, 15.

critiques "the claims of the capitalists, as supported by the theories of political economy": Adam Smith's and McCulloch's logic of how machinery as fixed capital increases the "quantity of industry" as abstract labor power, pretending to abridge labor in general for all while in reality "shutting out of view man himself, in order to justify the existing order of society, which is founded on property or possessions, and the existing oppression of the labourer."[131] Like Smith, Hodgskin agrees that "unquestionably by using these instruments man adds wonderfully to his power… It is probable that since Mr. Watt's improvements on the steam engine one man can perform as much work with these instruments as ten men did before" and that sawmills "augment and abridge labor power."[132] Yet here his common ground with Smith stops. Sharing Blake's sense of the "wretched state of political science in this country," Hodgskin argues that machinery's labor power must be considered not merely in abstract quantitative but also in qualitative terms: otherwise, the worker's labor power is rendered invisible. Puncturing Smith's and McCulloch's claim that "the productive industry of any country is in proportion to its capital, increases when its capital increases, and declines when its capital declines," Hodgkin argues that "it is not, however, [only] the *quantity* but the *quality* of the fixed capital on which the productive industry of a country depends": the "skill and art of the laborer." "Fixed capital consists of the tools and instruments the labourer works with, the machinery he makes and guides, and the buildings he uses either to facilitate his exertions or to protect their produce. But the question then occurs, what produces instruments and machines, and in what degree do they aid production independent of the labourer, so that the owners of them are entitled to by far the greater part of the whole produce of the country? Are they, or are they not, the produce of labour? Do they, or do they not, constitute an efficient means of production, separate from labour?" Hodgkin continues, "A steam engine also is a most complete instrument, but alas! for the capitalist, it does not go of itself. A peculiar skill is required to make it and put it up, and peculiar skill and labour must afterwards direct and regulate its movements. What would it produce without the engineer?...Its vast utility does not depend on stored up iron and wood, but on that practical and living knowledge of the powers of nature which enables some men to construct, and others to guide it. The utility of the instruments the labourer uses can in no wise be separated from his skill. Whoever may be the owner of fixed capital — and in the present state of society he who makes it is not, and he who uses it is not — it is the hand and knowledge of the labourer which make it, preserve it from decay, and which use it to any beneficial end."[133] The

[131] Hodgskin, *Labour Defended Against the Claims of Capital, Or the Unproductiveness of Capital proved with Reference to the Present Combinations amongst Journeymen* (London: Knight & Lacey, 1825), 19.

[132] Hodgskin continues, "without a hand saw, a portion of fixed capital, he could not cut a tree into planks; with such an instrument he could, though it would cost him many hours or days; but with a sawmill he could do it in a few minutes. Every man must admit that by means of instruments and machines the labourer can execute tasks he could not possibly perform without them; that he can perform a greater quantity of work in a given time, and that he can perform the work with greater nicety and accuracy than he could possibly do had he no instruments and machines," *Labour Defended Against the Claims of Capital*, 14. Hodgkin quotes McCulloch's "Article "Political Economy" in Supplement to Encyclopedia Britannica."

[133] Hodgskin, *Labour Defended against the Claims of Capita*l, 16-19. Hodgskins is acutely critical of the mainstream identification of political economy with capitalism: "The only motive I have for selecting these authors, as the representatives of the political economists, is, that they are by far the more efficient and eloquent supporters of the doctrine I do not assent to…At least such are the doctrines of political economy; and the capitalist may well be pleased with a science which both justifies their claims and holds them up to our admiration, as the great means of civilising and improving the world" 5, 7.

only solution is "subverting a system which they must now believe is intended only to support all the oppressive exactions of capital," which the Mechanics' Institute worked towards.[134]

What is striking about the Mechanics' Institute's labor theory of value is its extension of creative, skilled labor to the makers and users of complex machinery. The mechanics and engineers called themselves "artists" or "artisans," so that the work of art was not limited to simple tools but likewise extended to machine-makers and users, breaking down any false binary between artisanal and industrial modes of production and intellectual and mechanical labor that Blake likewise rejected. Rather than protecting labor by the familiar strategy of ruling out any division of labor by means of industrial machinery, which effectively narrows the notion of skilled labor to exclude the working class, the Mechanics' Institute radically flips this idea inside out, developing a much more robust labor theory of value that extends skilled, creative industry to all forms of human labor, including the scaled up labor power of industrial machines. By claiming that "the utility of the instruments the labourer uses can in no wise be separated from his skill" – which resonates with Blake's claim that invention cannot be separated from execution, knowledge from power – Hodgskin recognizes the skilled labor involved in using even the most complex machinery and the rudest mechanical labor. Hodgskin elaborates: "At present also a great number of persons possessed of different kinds of knowledge and skill must combine and cooperate…before many of our most powerful machines can be completed and before they can be used. The labour of the engineer…who adapts the parts of a complicated machine to each other, is as necessary to the completion of that machine as the man who casts or fits any part of it… In like manner the labour and the knowledge of many different persons must be combined" in any work of art. "The knowledge and skill of the master manufacturer, or of the man who plans and arranges a productive operation…are just as necessary for the complete success of any complicated operation as the skill of the workmen whose hands actually alter the shape and fashion of these materials….The labour and skill of the contriver, or of the man who arranges and adapts a whole, are as necessary as the labour and skill of him who executes only a part, and they must be paid accordingly."[135] Not even the most powerful steam engine or mill can run for one second without the skill and labor of those who operate it, down to the lowest boiler operator. Hence, "the productive industry of a country, as far as fixed capital is concerned, is in proportion to the knowledge and skill of the people," as opposed to the capitalist logic that treats productive industry in the abstract to render this labor power invisible. [136] This is not to deny that certain forms of labor are relatively deskilled under industrial capitalism but rather that the industry is entirely reliant on labor in all its qualitative particularity, which irreducibly involves skill, no matter how rudely mechanical it may seem, and derives its utility from that skilled labor that the capitalist exploits: "the utility of the instruments the labourer uses can in no wise be separated from his skill."[137] Blake's insistence that invention cannot be separated from execution

[134] Hodgskin continues, "Mechanics Institutions will teach men the moral as well as the physical sciences. They excite a disposition to probe all things to the bottom and supply the means of carrying research into every branch of knowledge" to change the very "principles on which societies are formed and governed" 32.
[135] Hodgskin, 26.
[136] Hodgskin continues, "The most perfect instruments ever made by labour require…a peculiar skill to render them productive…To have and to use this fixed capital, knowledge, labour and skill are necessary. Without these it could not be made, and when it would be less productive than the clod from which its materials spring, or from which they are fashioned by the hand of man… After any instruments have been made, what do they effect? Nothing. On the contrary, they begin to rust or decay unless used or applied by labour. The most perfect instrument which the cunning hand of man can make is not instinct with life, and it constantly needs" skill and labor, 16.
[137] Hodgskin, 18.

– that mechanical excellence is the only vehicle of genius – might be understood in similar terms. While we have always understood that Blake was restoring the role of skilled labor to art (showing that invention can't operate without execution), there is a no less important parallel implication: all execution implies the presence of invention – there is no labor that is not skilled and no exercise of skilled labor without mental activity. There is no such thing as an absolutely "ignorant journeyman," and because all skilled labor requires human intelligence it needs to be recognized and compensated as such, i.e., needs to share in the wealth generated by labor.[138]

What Blake may have responded to as "the things we artists hate" in judging the *Mechanics' Magazine* by its cover was not industrial machinery itself but what he understood as the counter-arts of modern industry under capital in eighteenth century political liberal economy, despite the actual radical political ambitions of the Mechanics' Institute. The very structures of feeling of Blake's exchange telegraph his more specific rejection of the polite structures of feeling of public discourse that govern machinery in liberal political economy to assimilate its scientific and technological reality effect to the polite status quo. Blake mirrors the "polite stranger" in liberal society who shows him the Magazine for his approval with his own mock polite "bland emphasis" before expressing hatred ("these things we artists HATE").[139] Hatred, the agonistic, radical affect that Blake channels towards the counter-arts, works as the contrary solvent of politeness that destroys it as a structure of feeling, designed to dissolve the polite civility of the liberal status quo. Blake first mocks and then breaks down the polite norms of liberal discourse that govern the exchange with the polite stranger with his hatred, which overpowers the structures of feeling governing of the polite stranger's framing of the mechanical power of machinery in the terms of liberal political economy. By the same logic, *in Milton* Blake makes his millwright Satan a polite gentleman whose liberal "blandishments" are precisely what allows him to render invisible his exploitation of the labor power of workers through machinery. The radical Mechanics' Institutes in fact took aim at this very same polite civility. As E.P. Thompson notes, the Mechanics' Institutes loathed the "comforting system" of "charity and moral rescue" and developed a radical critique of its perpetuation of capitalism.[140] Nicholas Williams is right: Blake rejected "charity as a way of avoiding deeper injustices" inherent in "the mode of capitalist production and the exigencies of its continuing operation," although he does not unpack that logic here and remains unaware that he in fact shared this critique with the Mechanics' Institute[141] My intention for the moment is not to recreate an extensive argument regarding Blake's critique of pity, which has already been thoroughly demonstrated in Blake criticism[142], but simply to suggest how Blake's critique of pity as a structural principle of capitalist political economy might extend to machinery. In his lectures delivered before the Mechanics' Institute in 1823, Thomas Hodgskin, the editor of the *Mechanics' Magazine,* shared Blake's hatred for how liberal political economy used polite principles "in order to justify the existing order of society, which is founded on property or possessions, and the existing oppression of the labourer," critiquing how "they profess liberal principles — and they make laws to keep the labourer in thralldom" though industrial machinery.[143]

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[138] See "Public Address," 575-76.
[139] *Life of Blake*, 346.
[140] E.P. Thompson, *The Making of the English Working Class*, 760.
[141] Nicholas Williams, *Ideology and Utopia in the Poetry of William Blake* (Cambridge University Press, 1998), 21.
[142] See especially Steven Goldsmith's luminous account of Blake's critique of pity in *Blake's Agitation*. See also Lily Gurton-Wachter's extension of this logic to slavery in "Blake's Little Black Thing: Happiness and Injury in the Age of Slavery' ELH 87.2 (2020): 519-522.
[143] Hodgskin, *Labour Defended from the Claims of Capital*, 33.

Over the course of his poetic career, Blake confronts the problem of labor power of machinery in the rotary motion of the mill. Much as Marx observed of the industrial revolution, engineers recognized how mills at once had a deep history extending back to antiquity and epitomized the rotary motion of industrial machinery. Late 18th century engineers and mill-wrights frequently noted how even while the mill defined the complex motion of industrial machinery, the "corn mill, or flour mill, is in some degree, an exception to our definition, because in the early stages of society it was the only mill in use, and hence the term became particularly attached to it…and any machine for grinding or reducing to power is called a mill."[144] If mills retained an association with grinding grain and bread – and, qualitatively, grinding labor in general – the late 18th century marked what one engineer called a "new era in the history of mills" in which the industrial application of mills rapidly proliferated far beyond its origins and came to exemplify the rotary motion of industrial machinery as the defining power technology.[145]

Over the Romantic era, mill came to refer not just to capitalist factories but to any industrial machinery whose scaled up mechanical power was produced by rotary motion, the defining quality of machinery. The mill in Blake's time meant something radically different from the narrow, unreflexively capitalist sense operative in most Blake criticism. As one engineer put it, "mill," in a "general signification," refers to "all machines whose action depends on a circular motion": that is, to all machinery, defined by the rotary motion that distinguished complex machines from simple tools.[146] Hence, the word "mill" is especially "applied to large and compound machines, or systems of machines;" "including their first mover...the water wheel, or steam engine, which actuates them all; so likewise, an iron mill, copper mill, rolling mill, grinding mill, logwood mill, worded mill, &c &c." and "the terms machine, engine, and mill, are used without a proper distinction of the classes of machinery" to refer to any "machine or engine" of "complicated construction."[147] As exemplary machines, mills were identified with the circular motion that defined industrial machinery, as evident from the titles of engineers' treatises from John Smeaton's *Experimental Enquiry concerning the Natural Powers of Water and Wind to Turn Mills, and Other Machines, Depending on a Circular Motion* to John Bank's *A Treatise on Mills. On Circular Motion* (1815).[148] Mills' industrial revolutions linked together the mechanical power of complex systems of industrial machinery, all of the arts and sciences carried into execution in industrial manufacture: as one engineer reflected, "mills in this sense, are machines of vast use in the manufactures, arts, and trades, for the making and preparing divers kinds of merchandizes." Without this "new era in the history of mills," there would not be "one tenth of the machinery which has of late years been erected in Great Britain."[149] Engineers thus defined the cog-wheels of mills to be their most important mechanical power, metonymic for the mills themselves and for complex machinery: of all the "parts and mechanical contrivances used in mills," one reflected, "cog-wheels are the most important and numerous

[144] "Machinery," *RC*, vol. 21 (1819), 759
[145] Robertson Buchanan, *Essay on the Shaft of Mills* (London: 1814), 18.
[146] "Mill," *RC*, vol. 23 (1819), 545.
[147] "Machinery," *RC*, vol. 21 (1819), 759.
[148] For Romantic engineering treatises on the rotary motion of mills, see John Smeaton, *Experimental Enquiry concerning the Natural Powers of Water and Wind to Turn Mills, and Other Machines, Depending on a Circular Motion* (1759); Robertson Buchanan, *An Essay on the Teeth of Wheels, Comprehending Principles, and their Application in Practice, to Millwork and other Machinery* (1808) and *Essay on the Shaft of Mills* (1814); John Banks, *A Treatise on Mills. On Circular Motion* (1815).
[149] Robertson Buchanan, *Essay on the Shaft of Mills* (1814), 18.

parts of mill-work," required "to modify the direction and adapt the power of the first mover, which actuates the mill, to the working point, or the machine which performs the operations the mill is intended for" to generate the mechanical power of industrial machinery "chiefly by the means of wheels, which, therefore, from their importance, deserve the first notice" (553). Mills came to exemplify the transformation of the instruments of labor from simple tools to machinery with the industrial revolution. On the one hand, by their sheer mechanical power, mills were readily reduced into mere means for capital: the textile mills of the late 18th century or Blake's dark satanic mill.[150] Yet at the same time, Romantic engineers and socialists recognized that mills have an autonomous technical and scientific form as machinery that is not reducible to capital and entails no single labor relation. Late 18th and early 19th century water mills in Blake's time were major rivals to steam-powered capital whose flows were less readily enclosed within the commodity form and thereby afforded more equitable distributions of mechanical power,[151] much as water power does today. Owen's New Lanark Mills were his main vehicle for working towards socialist industry over the 1810s, like the mills that the *Mechanics' Magazine* featured on its frontispiece, however imperfectly or fleetingly such socialist visions were realized.

Over the course of his poetic career, Blake pioneers an industrial poetics in relation to the circular motion of industrial machinery manifest in the mill. Like Marx, Blake's industrial poetics at once spans the deep time of mills as machines extending back to early modernity and antiquity – to Milton's time, and Milton's Samson – and exemplifies the rotary motion of the industrial revolution (synonymized in Blake's phrase "machine or mill").[152] Blake's machines revolve even more consistently than they are dark and satanic: "the *turning* mills" that are "moving up and down continually" in constant "revolution," wheels that are "rolled" or turned "round" over and over again without end.[153] As early as *There is No Natural Religion*, Blake's first articulation of his industrial poetics in opposition to the counter-arts, Blake identifies the mill with the rotary motion of complex machinery in critiquing the naturalization of machinery into the motion of capital in liberal political economy. Using the same language as Romantic era engineers, Blake identifies the mill with the rotary motion of industrial machinery: the "*complicated* wheels" that produce "the same dull round" again and again. Blake uses the engineering term "rounds" or "revolutions" of industrial wheels to figure the circular motion of mills and other industrial machinery. In each "revolution of the wheel," one engineer wrote, machinery should turn the "rounds which work upon one another equally" to perpetuate its "constant tendency to turn round," so that it is kept "constantly revolving by the machinery."[154] Engineers quantified the number of industrial "revolutions" per minute mills could make to measure their power.

Blake's anxiety in *There is No Natural Religion* turns on whether the revolutions of modern industrial machinery under capitalism might destroy the imaginative power, leading to a repetition without difference of the "same dull round" repeated "again and again" so that "the

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[150] "Mill," *RC*, vol. 23 (1819), 550. Marx, "The Poverty of Philosophy."

[151] See Andreas Malm, The Origins of Fossil Capital: From Water to Steam in the British Cotton Industry," *Historical Materialism* 21.1 (2013): 15-68; *Fossil Capital: The Rise of Steam Power and the Roots of Global Warming* (Verso 2018), especially Chapters 5-6, "Puzzles of the Transition: The Lasting Advantages of Water" and "Fleeing the Flowing Commons: The Expansion of Water Power that Never Happened." See also Elizabeth Miller, "Fixed Capital and the Flow: Water Power, Steam Power, and the *Mill on the Floss*."

[152] Blake, "Public Address," 575-76.

[153] "There is No Natural Religion," 2; "Jerusalem," 60.63, 75.6-8.

[154] "Mill," in *RC*, vol. 23 (1819), 545, 548.

entire universe turns into a mill with complicated wheels."[155] To an extent, the rotary motion of machinery demanded a certain degree of uniformity and equality to produce mechanical power. Romantic engineers reflected how the industrial revolutions of mills should be made as "equal" and "uniform" as possible to maximize its mechanical power, so that the "rounds" would "work upon one another equally" to "make a true uniform motion throughout the whole work": "the best *figure*, therefore, which can be given to the teeth, is that which shall cause them always to act equally and similarly...and which shall consequently give the machine the property of being moved uniformly by a power constant and equal."[156] Yet this dynamic only extended so far. Romantic era engineers were quick to note that the rotary motion of machinery demanded extensive creative ingenuity, as cog-wheels and gears had to be designed differently for every particular context, demanding the skilled, creative labor that Blake calls mechanical excellence.

Blake suggests that the problem is not machinery itself but rather its generalization into an universal measure of the arts and sciences, which must be counterbalanced with the qualitative labor of what he calls the "poetic character:" "If it were not for the Poetic or Prophetic character, the Philosophic and Experimental would soon be at the ratio of all things and stand still, unable to do other than repeat the same dull round over and over again," following Blake's logic of "Without Contraries there is no progression."[157] For Blake, without skilled creative industry, no true progress in modern science and industry is possible: mere science and industry in the late 18th century readily produced a liberal industrial subject in which the "same dull round even of a universe would soon become a mill with complicated wheels." Without the creative labor of the poetic character, rotary motion runs the risk of being reduced to the property relation of capital: the "round" turning into the "bounded that is loathed by its possessor," the purely quantitative "measure" of abstract work evacuated of qualitative difference.[158] Hence, the problem for Blake is not the motion of machinery so much as the specific form that it takes in the market theology of industrial capitalism (where mill rounds are standardized to maximize productivity at the expense of skilled labor). Blake's drive is to keep poetry and machinery productively turning round rather than standing still, towards progression, yet in a form distinct from the same dull round of industrial capitalism.

What then is the difference between the productive drive of Blake's industrial poetics and that of industrial capitalism? As Steven Goldsmith rightly points out, "the restless energy [Blake] valued as a creative, disruptive force historically overlaps with the industrious energies and perpetual desires indispensable to capitalist innovation," just as the scaled up mechanical power of machinery fuels progressive innovation in Adam Smith's political economy.[159] Blake's commitment to productive industry is so relentless that he even maintains that "the unproductive Man is not a Christian."[160] Yet at the same time, it is important to note that there is nothing inherently capitalist about industrial development as such, as Owenites and the Mechanics' Institutes worked towards non-capitalist forms of industry. The core distinction between the two lies in industrial socialism's emphasis on the qualitative aspects of labor power as opposed to industrial capitalism's merely abstract, quantitative measure of work to advance property ("bounded possession") rather than the bounding line. Blake likewise distinguishes between two

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[155] Blake, "There is No Natural Religion," in *Complete Poetry and Prose*, 2.
[156] "Mill," in RC, 545; Robertson Buchanan, *An Essay on the Teeth of Wheels, Comprehending Principles, and their Application in Practice, to Millwork and other Machinery* (London: 1808), 16.
[157] Blake, "The Marriage of Heaven and Hell," 3.
[158] Blake, "There is No Natural Religion," 2.
[159] Goldsmith, *Blake's Agitation*, 206.
[160] Blake, *Laocoön*, 274.

forms of industry – one the purely quantitative, abstract "measure" of the work of the same dull round of one form of mill without qualitative distinction, the sheer quantitative increase of mechanical power naturalized into capital in liberal political economy – and a form of industry involving the qualitative labor that he calls "the poetic character," not limited to poetry but extending to all industry or productive activity, including the rotary motion of machinery.

If Blake's industrial poetics span his entire career, they develop most fully in *Milton* and *Jerusalem*, where he reckons with the contrary forms of industry: the free development of the human species through the arts and sciences through the skilled creative labor of industry outside of capitalism – or the "arts of life" – and the counter-arts – the "arts of death" represented by the machinery of modern industry under industrial capitalism. Blake puts it most succinctly in *Jerusalem*: "What is the life of man but Art & Science?…That to Labour in Knowledge, is to Build up Jerusalem": the skilled, manifest labor of human-self creation through the arts of industry, "the liberty both of body & mind to exercise the divine arts of imagination" that is "plain and *manifest* to the thought."[161] Building up Jerusalem is a collective work that involves the skilled labor of all workers. Blake identifies these contrary forms with the transformation of the instruments of labor from simple tools to complex machinery with the industrial revolution:

> Then left the Sons of Urizen the plow & harrow, the loom
> The hammer & the chisel, & the rule & compasses; from London fleeing
> They forg'd the sword on Cheviot, the chariot of war & the battle ax,
> The trumpet fitted to mortal battle, & the flute of summer in Annandale
> And all the Arts of Life, they changd into the Arts of Death in Albion.
> The hour-glass contemnd because of its simple workmanship
> Was like the workmanship of the plowman, & the water wheel,
> That raises water into cisterns: broken & burnd with fire:
> Because its workmanship was like the workmanship of the shepherd.
> And in their stead, intricate wheels invented, wheel without wheel:
> To perplex youth in their outgoings, & to bind to labours in Albion
> Of day & night the myriads of eternity that they may grind
> And polish brass & iron hour after hour laborious task!
> Kept ignorant of its use, that they might spend the days of wisdom,
> In sorrowful drudgery, to obtain a scanty pittance of bread:
> In ignorance to view a small portion & think that All,
> And call it Demonstration: blind to all the simple rules of life.[162]

The simple tools – "the plow & harrow, the loom / the hammer & and the chisel & the rule & compasses" of the "Arts of Life" are "changed into the "Arts of Death in Albion" – in Britain. One could hardly imagine a sharper delineation of the transformation of the instruments of labor with the industrial revolution. The "simple worksmanship" of the pre-industrial handheld tools that Blake enumerates – from hammers, chisels, plows, rules and compasses, and hour-glasses – manifest the labor power of human-self creation that Blake calls the arts of life. Blake identifies the transformation from "simple" handheld tools to the abstract labor of complex machinery with the rotary motion – the industrial revolution – of industrial machinery: the "intricate wheels

[161] Blake, *Jerusalem*, 77. Note Blake's anti-vitalist sense of life: far from having any essence, life is nothing more than industry or labor power of Art and Science (What is the life of man but Art & Science?).
[162] Blake, *Jerusalem,* 65.11-28.

invented, wheel without wheel" that literally replace handheld tools, "invented, in their stead," as the simple tools are "broken and burned with fire" and scorned "because of their simple worksmanship." Blake identifies the Industrial Revolution with the industrial revolutions of machinery: the rotary motion or revolution of industrial cogs or wheels on which the Industrial Revolution turned. With complex machinery comes the alienation of labor so that "labours in Albion" turn into the "laborious task" of the "grind[ing] and polish[ing] brass & iron hour after hour." Blake diagnoses how such machinery abstracts labor to extract surplus value from the worker to maximize profits in liberal political economy: "kept ignorant" of the machinery, the worker only "views a small portion" of his labor power and is made to "think that all," while the remaining surplus value is extracted for profit. Blake identifies this alienated labor with a capitalist application of millwork defined by "grinding." Grinding refers to both the literal grinding of grain in the mill to produce a "scant pittance of bread" – the small portion of the surplus value produced by the machinery that the capitalist gives to the worker, scarcely at the level of subsistence – and the grinding form of alienated labor that millwork is reduced to under a capitalist system, evacuated of the qualitative distinction of skilled labor and reduced to abstract work.[163] Blake's critique aligns with Hodgskins' analysis that "the capitalists permit the labourers to have the means of subsistence because they cannot do without labour, contenting themselves very generously with taking every particle of produce not necessary to this purpose."[164] Blake clearly weighs in on the question of whether machinery under liberal political economy "tends to diminish the value of labor by which the lower classes of society can purchase the means of subsistence": the scant pittance of bread.[165] Pittance, we should recall, etymologically derives from pity, which Blake abhors as a liberal affect for how it reinforces structural inequality: here, how machinery fixes the industrial subject into a subject position in which his labor power is systemically exploited and devalued.[166] For Blake, this alienated form of machinery as capital in liberal political economy is co-constitutive of an at once imaginatively impoverished liberal industrial subject, "kept ignorant" and "made to think" a small portion of his labor power and the liberal political economy of machinery that produced it is "everything" in identifying modern science and industry ("demonstration") with the liberal logic of machinery as capital.

Yet the very instant that Blake makes a distinction between simple tools and complex machinery, he troubles it. The machinery on which the whole industrial revolution turns – the last in his list of simple tools – is in fact not a simple tool at all but an industrial machine, the industrial water wheel: the "water wheel / that raises water into cisterns." Engineering treatises in the late 18th and early 19th century took water-wheels and steam engines as the two exemplary industrial machines. The main rival to steam power technology, the industrial water wheel likewise exemplified the mechanical power generated by the rotary motion of industrial machinery – Blake's "wheels without wheels" – powered mills as part of the same power system, which Blake combines into "the water wheel & mill of many innumerable wheels resistless," complex machinery powered by the industrial revolutions of cog-wheels.[167] Indeed, the water

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[163] Meanwhile, Hodgskin, the editor of the *Mechanics' Magazine* expressed a similar idea: "The capitalists permit the labourers to have the means of subsistence because they cannot do without labour, contenting themselves very generously with taking every particle of produce not necessary to this purpose."

[164] Hodgskin, *Labour Defended from the Claims of Capital*, 23.

[165] "Machinery," *RC*, vol. 21 (London: 1819), 760.

[166] For a bravura reading of Blake's structural critique of pity, see Steven Goldsmith, *Blake's Agitation*, 181-87.

[167] In his history of the industrial water wheel, Terry Reynolds recalls that the water wheel "does not operate in isolation" but rather "part of a power system" that includes dams, reservoirs, canals, mill races, and gearing, cams,

wheels that here represent the "arts of life" for Blake were a critical part of milling technology, and epitomized the same revolutions of complex machinery. Water power, one engineer wrote, was often "the moving power of mills": The mill was either powered by water or steam: the mill "is especially "applied to large and compound machines, or systems of machines;" "including their first mover...the water wheel, or steam engine, which actuates them all."[168] Like the steam engine, water wheel technology was one of the first power sources fueled by mechanical powers outside the human body and a critical motive power of the Industrial Revolution, as the form of machinery achieved autonomy from the anthropomorphic tool: as Terry Reynolds observes in his history of the industrial water wheel, "the water wheel enabled man, for the first time, to use an inanimate power source for industrial production" rather than human power to produce mechanical power through rotary motion.[169] Rendering the logic of machinery radically contingent by doubling it, Blake troubles any non-dialectical form of the distinction between simple tools and "wheels without wheels" of complex machinery that he introduces, both the "arts of life" and the "arts of death" including the mechanical powers of the rotary motion of industrial machinery.

Yet if Blake demonstrates that the distinction between simple and complex machines cannot hold, then what is the fundamental change in the nature of labor that he describes in this passage in *Jerusalem*? How would such industrial revolutions of "wheels without wheels" that figure complex machinery such as the water wheel and mill be simple, or distinct from the form that modern industry takes in industrial capitalism, if it figures the same rotary motion of complex machinery? The "simple workmanship" of the complex machinery like the water-wheel comes to describe not machinery's form but the social relation of machinery manifest in it: "free from duplicity, dissimulation, or guile; innocent and harmless; undesigning, honest, open" (that is, in Blake's and Marx's term, "manifest")[170] that Blake distinguishes from the "intricate" dissimulation of machinery under capitalism, which exploits machinery's complexity to render its real labor relations invisible. Blake's very use of "workmanship" to describe machinery opens up the skilled labor manifest even in complex machinery that capitalism renders invisible. Like Hodgskin, Blake extends skilled labor to machine-builders and engineers, the makers of machines like industrial water wheels. Blake's critical doubling of machinery between the arts of life and death – between the arts and counter-arts – suggests that the problem lies not with the scale of industrial machinery but rather the form that it takes in industrial capitalism: how workers are "kept ignorant of [machinery's] use," the use value of their labor power produced by machinery, which allows their labor power to be abstracted into capital. Much like Romantic era socialists, Blake critically differentiates between the exchange and use value of machinery's labor power, which is not reducible to capital but offers the means to blow it sky high. Blake suggests that if workers are not kept ignorant of the machinery's use – if the conversion of machinery's use value into capital that is made to appear naturally and inevitable in liberal political economy is short-circuited – such as by his own doubling of such industrial revolutions – the very labor power of machinery might make the critical difference, the mechanical power to seize the means of production to blow the system sky high for a radical industrial revolution, to transform the social relations of industrial machinery for the unalienated labor that he will come

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cranks, and shafts that "transmit the motion of the water wheel to the machinery." *Stronger Than a Hundred Men: A History of the Vertical Water Wheel* (Baltimore, MA: Johns Hopkins University Press, 1983), 8. *Jerusalem*, 73.14.

[168] "Machinery," *RC*, vol. 21, 759.

[169] Terry Reynolds, *Stronger than a Hundred Men*, 4.

[170] "Simple, adj. 1," in OED.

to call sweet industry. For Blake, any such industrial revolution must be at once epistemological – imaginative – and material, transforming not only the labor relations of industrial machinery but also the liberal industrial subject's imaginatively impoverished, "ignorant" view of the figurative logic of machinery itself so that is no longer reducible to the social relation of capital. Blake suggests that the social relations of industrial machinery like the water wheel are not determined in advance, opening its mechanical power to other radical figurative possibilities.

Over the course of his poetic career, Blake develops an industrial poetics that reworks the industrial revolutions – "the wheels without wheels" – of complex machinery. Crucially, Blake will take such industrial revolutions as the vehicle of the mechanical power of his own poetics through the printing press in *Milton*: "it is the Printing-Press / Of Los: and here he lays his words in order above the mortal brain / As cogs are form'd in a wheel to turn the cogs of the adverse wheel."[171] On an anagogical level, Blake's wheels within wheels are situated partially within a visionary tradition of mechanics stretching back to Ezekiel.[172] Yet on a more empirical, modern level, Blake's "wheel without wheels" figure the defining form of machinery: the rotary motion of the industrial revolution.[173] The rotary motion of wheels without wheels translates mechanical power – the energy or labor power transmitted by wheels – to power machinery and figure materials. Yet Blake splits the figurative logic of machinery into two contrary forms: surveying "the water-wheels of Newton," Los sees the "cruel Works / Of many Wheels I view, wheel without wheel, with cogs tyrannic / Moving by compulsion each other: not as those in Eden: which / Wheel within Wheel in freedom revolve in harmony and peace,"[174] counterposing wheels without wheels "moving by compulsion each other" with a utopian form of the rotary motion of machinery, "wheels within wheels" that freely revolve in harmony and peace. Blake identifies the problem of the industrial revolutions of machinery: by necessity, the rotary motion of machinery is forced, artificial motion, since the gears of any complex machine have to turn one another by external compulsion to move. If "wheels without wheels" formalizes one aspect of the artificial motion of industrial machinery – forced compelled motion – "wheels within wheels" locates a freedom within the same rotary motion of machinery, not driven by external compulsion but rather freely co-operating or combining rather than forced together.

Retooling the labor power of machinery, Blake's industrial revolutions at once critically refigure industrial machines and their social relations. Blake critically applies – or rather, recombines – an anthropomorphic form of figuration with the figurative logic of machinery. Anthropomorphism aside – that is, to the extent that cog-wheels are just cog-wheels, inhuman parts of machines not signifying industrial subjects – rotary motion does not entail any particular labor relation for human subjects. No one would seriously complain that the gears of their rotary press or mill are violently forcing each other to move. That is, it is only once Blake personifies or otherwise socializes the rotary motion of the gears – the "cogs tyrannic" – that labor power becomes social, and we move from machinery to its social relations, since gears themselves cannot feel. In rejecting how in industrial capitalism, workers are forced to work like cogs in machines, Blake develops an alternative form of the rotary motion of industrial machinery that opens up socialist possibilities for new forms of co-operation and combination between workers

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[171] Blake, *Milton,* 27.8-10.

[172] See the "wheels within wheels" of Ezekiel 1:16-25. This visionary biblical layer of mechanics might be understood to tether this Greco-Romantic tradition of mechanics to the prophetic imagination.

[173] My claim is not that the more modern, empirical, and industrial signification of mechanics supplants the prophetic in Blake but rather than the two become layered on top of one another, so that Blake can at once tap into the mill-wheel's visionary and more terrestrial resonance.

[174] Blake, *Jerusalem,* 15.16, 18-20.

like the industrial relations that the Owenites and Mechanics' Institutes pioneered at the same time. Regardless of what form of machinery Blake envisions would be capable of the free, unforced motion of gears freely turning together – the contrary form of "wheels within wheels" rather than "wheels without wheels" – the figurative qualities of such motion are clear.

Such contrary forms of industrial revolution – free and unfree – are not delimited to machinery but extend outwards as the material basis of industrial relations for Blake. The free motion of machinery blocked by capitalism allows for the "liberty both of body & mind to exercise the divine arts of imagination" in labours of Art & Science, to "labour in knowledge [which] is to build up Jerusalem."[175] The unfreedom of the compelled motion of the wheels without wheels is the direct result of the abstract generalization of labor-power under capitalism: the "same dull round again and again" of "wheel without wheel" that "binds to labours in Albion / Of day & night the myriads of eternity that they may grind /And polish brass & iron hour after hour laborious task!"[176] The generalized, abstract form of labor power in capitalist mills in which workers are turned into cogs in machines conjoined together to produce mechanical power exerts a violence upon the minute particularity of the human worker by its logic of general equivalence: the cogs tyrannic "bruising my minute articulations" as workers are forced to perform the same dull round again and again.[177] The abstract generalization of the mill evacuates human labor of any qualitative distinction, and hence any creative industry, decoupling physical and intellectual labor so that the entire universe becomes a mill with complicated "wheels without wheels." For Blake, the logic of general equivalence of such abstract mill-work in turn drives the logic of capital: the industrial revolutions of the "wheels without wheel" that binds together the labors of Albion's youth so that they perform grinding mill-work hour after hour so that they are "kept ignorant of [the machinery's] use and receive only a "scant pittance of bread," the rest of the surplus value of their labor power extracted by the Urizenic mill-wright or work-master as his own private property, capitalist accumulation – and "made to think it all."[178] "They accumulate / A world in which Man is by his Nature the Enemy of Man, / In pride of Selfhood unwieldy stretching out into Non Entity / Generalizing Art and Science till Art & Science is lost."[179]

Blake clearly identifies the negation of industrial revolutions with the dark satanic mill with the private property relation in industrial capitalism, and the liberal laws that sustain it. The negation is "the reasoning power in man" – modern science and industry – "when separated from imagination, and closing itself as in steel" – the mill-wheel – "in a ratio of the things of memory. It thence frames Laws and Moralities / To destroy imagination."[180] Foremost among these "laws" that it forms is private property – commerce or money – that the mill in liberal political economy exists to serve. Indeed, "to mortals" – to liberal industrial subjects – "[Satan's] mills seem everything" precisely because they drive commerce, the property relation around which everything in liberal political economy is legally organized.[181] Grain or bread, we recall, was one of the exemplary commodities produced by the mill that reinforced the social relation of private property – money or commerce – and the moral system of liberal political economy. Hence the logic of Blake's rejection of "*lawful* bread bought with *lawful* money" – the law of private property or money framed to destroy imagination – in favor of "the bread that is our due & right

[175] Blake, *Jerusalem*, "To the Christians," 77.
[176] Blake, *Jerusalem,* 77; *There is No Natural Religion,* 2.
[177] Blake, *Jerusalem,* 15.13.
[178] Blake, *Jerusalem,* 65.27.
[179] Blake, *Milton,* 2.38.5-54; emphasis mine.
[180] Blake, *Jerusalem,* 74.10-13.
[181] Blake, *Milton,* 5.12.

by taking away Money or a Price or Tax upon what is Common to all."[182] Grain mills would have been on Blake's mind, given that Catherine and William Blake, as David Worrall has shown, were involved in the 1800 London Bread Riots.[183] The satanic property of the dark satanic mill *is* money, and the liberal legal framework of private property that frames the reduction of machinery – science and industry – to fixed capital: "Money, which is The Great Satan." Hence, "Where any view of Money exists Art cannot be carried on."[184] Any mill that is not satanic must not be turned into the social relation of capital. This law of private property is why Blake's Satan the millwright or work-master himself believes that he treats the mill-workers properly: "Satan's self, believed / that he had not oppress'd" the "overlaboured" workers who "turn the mills & day and night" because his ownership of the mill is within the law (the "laws and moralities" of liberal political economy). "Satan's *blandishments*" radiate the "incomparable mildness" for the same reason (the same "*bland* disinterest" that Blake hates on the frontispiece of the *Mechanics' Magazine*): Satan operates his mills within the moral and legal framework of liberalism that reduces the social relations of machinery to the dark satanic mill of money or capital.[185]

What then might the free form of the industrial revolutions of machinery look like for Blake? When Blake elaborates his own industrial poetics as the vehicle of the mechanical power through the printing press, he further challenges any over-identification of rotary motion with capitalism by identifying it with the "wheels without wheels" rather than the wheels within wheels: "it is the Printing-Press / Of Los: and here he lays his words in order above the mortal brain / As cogs are form'd in a wheel to turn the cogs of the adverse wheel." Blake used a rotary press, not a hand-press, a piece of complex machinery with cogs-wheels and rollers, even while it involves hand operation.[186] The cogs of Blake's printing press are "form'd in a wheel" to turn other cog-wheels by the same forced, external industrial revolutions of machinery, that Blake extends into a larger figurative logic of machinery not delimited to the press itself. Each word becomes a cog-wheel that in turn impresses its mechanical power on "the mortal brain." While this mechanical motion is forced, Blake's machinery does not translate into unfreedom on the human level like in the dark satanic mill, since he applies such industrial revolutions to realize radically different social relations. Blake's poetics of machinery reoccurs again and again and is identified with the arts of life throughout *Milton* and *Jerusalem*: "taking their forms from the Wheels of Albions sons; as cogs /Are formed in a wheel, to fit the cogs of the adverse wheel" like those of the industrial water wheel that Blake reclaims.[187] On one level, "the mortal brain" situates Blake's industrial poetics in the terrestrial, earthly world rather than eternity. While the Edenic wheels might turn in harmony and peace, Blake seems to acknowledge on some level the inescapability of the forced motion of machinery in the material conditions of this world: machine motion is forced, no matter how much it might strive to be free. Yet this forced quality

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[182] "Annotations to Thorton's Lord's Prayer," 668. Blake continues, "Give me us this Eternal Day my our Ghostly own right Bread & take away Money or Debt or Tax A Value or Price as we have all things common among us," 669.

[183] See David Worrall, *Radical Culture: Discourse, Resistance, and Surveillance, 1790-1820* (Wayne State University Press, 1992).

[184] Blake, "Annotations to Thorton's Lord's Prayer," 668.

[185] Blake, *Milton*, 5.10, 7.14, 7.39-40, 7.35, 7.4.

[186] Blake, *Milton*, 13.13-14. See Viscomi, *Blake and the Idea of the Book*, 103. Viscomi in fact identifies this line with Blake's rotary press, and takes this quote as the epigraph for his chapter on illuminated printing, though he does not analyze the rotary motion of machinery.

[187] Blake, *Milton*, 13.13-14.

does not necessarily translate into unfreedom for human subjects. Against Eaves, it is not in fact true that for Blake there are no tools or machines in eternity[188]: rather, in eternity – or at least in Eden – the industrial revolutions of machines move freely, without the external compulsion necessary even in his own industrial poetics that lays "words in order above the mortal brain / As cogs are form'd in a wheel to turn the cogs of the adverse wheel."[189] This free motion represents the alternative social relation of machinery that Blake works towards through his industrial poetics. The labor power of the freely moving machines of Eternity represents the fulfillment of the work of history, the moment at which poetry and modern industry are dialectically reconciled and made common to all.

Blake engineers every poetic word as a cog-wheel that is formed to turn the adverse wheels of the words around it, the mechanical power of poetic language forcefully applied to the mortal brain of readers to make a mark or impression: to figure, following the same logic that engineers used to define the figurative power of machinery. In his treatise on mills, for instance, Smeaton defines "the word power" in machinery as "the exertion of [force], compounded with motion, to be capable of producing an effect," a mark or "figure." As semiotic force – that reunifies knowledge and mechanical power – the agonistic, adverse cog-motion produced by Blake's machinery rouses critical thought (cog-words that in turn force the brain to revolve in intellectual labor), as a distinctly poetic form of the figurative power of machinery that bridges mechanical and intellectual labor.[190] Blake envisions this marking throughout *Milton* as an active process that demands the reader's intellectual labor, their industry: "Mark my words, for they are of your eternal salvation" (salvation which, as Blake elaborates in *The Last Judgement*, comes with "the overwhelming of bad art & Science" when the counter-arts are overpowered by real human industry).[191] Rather than interpellated as an industrial capitalist subject, Blake's reader labors to co-produce knowledge and power through his machinery.

It is here – in the labor-power of machinery – that the Mechanics' Institutes and Blake begin to converge, however unconsciously. Recall the Mechanics' Institutes' motto on the frontispiece of the first issue of the *Mechanics' Magazine* that Blake saw: Knowledge is Power. The main machinery used to realize that knowledge power was the radical press: the *Mechanics' Magazine* itself, like Blake's press. As Thompson notes, the radical working-class movements of the Owenites and Mechanics' Institutes used the same motto: "knowledge is power," to elaborate a "force-multiplier theory" of how the press could radically multiply and scale up knowledge through the mechanical power of machinery, "applying it with force to the context of working-class struggle" for "the diffusion of reason and knowledge."[192] The Owenites and Mechanics' Institutes "frequently used analogies drawn from the great advance in productive techniques during the Industrial Revolution" to describe the power of the radical press: if the mechanical power of machinery, as Owen wrote in 1819, can "'enable one man, with the aid of a little steam, to perform the labour of 1,000 men.' Might not knowledge and moral improvement advance at the same pace?"[193] "The art of Printing is a multiplication of mind," another radical put it, "and the most important" gears "in the machinery of Reform" for what the *Mechanics' Magazine*

[188] Eaves contends that for Blake, "all tools signify compromises that this world makes necessary. There are no burins in eternity," in *The Counter-Arts Conspiracy*, 185.d
[189] Blake, *Milton*, 13.13-14.
[190] See Steven Goldsmith's bravura reading of the power of Blake's cog-motion to rouse critical thought through adverse emotion in *Blake's Agitation*, 172-87.
[191] Blake, "A Vision of the Last Judgment," 565.
[192] Thompson, 728, 733.
[193] Thompson, 787-788; Robert Owen, "An Address to the Working Class," *Star Newspaper*, April 15, 1819.

called "the diffusion of useful information" so that "all who are operatively employed in our arts and manufactures can say This is Ours, and For Us."[194] As Thompson observes, "Between 1816 and 1836 this multiplication seemed to work" as the radicals "were seizing the multiplying-machine" of the press and mill "on behalf of the working class" for "the steady extension of Radical organization."[195] *The Mechanics' Magazine* worked to empower the working class by reunifying physical and intellectual labor in machinery, through the press itself and the collectively produced machine blueprints and the maker's knowledge of machinery it circulated. In re-unifying and collectivizing the intellectual and physical labor power of machinery alienated by industrial capitalism, the Mechanics' Institute worked to render the scaled-up labor-power of machinery not abstract but qualitative, skilled knowledge-power, a goal it shared with Blake. If on the one hand, Blake's poetic machinery – what he calls the the cog-wheels of poetic language – have to be placed "*in order* on the mortal brain" – minutely organized with the skilled labor that Blake calls mechanical excellence – the reader likewise must skillfully work to mark Blake's language, co-operatively producing knowledge-power. Not limited to the printing press or any single machine, Blake's figurative logic of machinery might be understood to open up an unfulfilled, forgotten possibility of socialist industry lost to industrial modernity that we have perhaps not lost completely and can still work to recover, if Blake's industrial poetics might be understood to turn towards a vision of industry beyond capitalism that moves the reader to the imaginative labor necessary to envision what radical forms machinery might take.

Not only does sweet science reign at the end of *The Foar Zoas*, as Amanda Goldstein has shown,[196] but also sweet industry: the moment at which Urthona's industrial wheels and reels "sung with joy" and "Rang sweet with the praise of industry," a moment widely identified with Blake's 'realized utopia of human labor.'[197] Sweet industry marks the moment when industry is redeemed, when industry becomes sweet and the motion of machinery itself turns into lyric song. What occasions sweet industry's reign is the abolition of private property, and the making common of the surplus value of the worker's labor produced by the mills: Urthona takes "the Corn out of the Stores of Urizen" – deprivatizing the surplus value of the mill-worker's labor – and "ground it in his rumbling Mills, all "the distress of all nations of Earth" under capital "ground in the Mills of Urthona" to make the "bread of knowledge" and redistribute it to all "in golden & in silver baskets," de-privatizing the wealth produced by the machinery of the mill and making the products of its labor common to all and reunifying knowledge and mechanical power of machinery in the "bread of knowledge" produced by the mill.[198] As Blake reflects, "Give us the bread that is our due & right by taking away Money or a Price or Tax upon what is Common to all…Give us this Eternal Day our Ghostly Bread & take away Money or Debt or Tax A Value or Price as we have all things common among us."[199] The deprivatization of machinery and the

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[194] Thompson, 733; *The Republican* 5, March 1, 1822, p. 279; "Address to the Mechanics of the British Empire," *Mechanics' Magazine* 1 (1823), 15. While he does not consider Blake's poetic machinery or relation to industrial socialism, W.J.T. Mitchell explores some important elements of Blake's relation to the ambitions of the radical press in "Visible Language: Blake's Wondrous Art of Writing," in *Romanticism and Contemporary Criticism*, ed. Morris Eaves and Michael Fischer (Cornell University Press, 1986), 46-95.
[195] Thompson, 728, 733, 787-88.
[196] See Amanda Goldstein, *Sweet Science: Romantic Materialism and the New Logics of Life* (Chicago, 2018). Nicholas Williams has rightly identified Night the Ninth with Blake's "realized utopia of humanized labor." *Ideology and Utopia in the Poetry of William Blake*, 27.
[197] Blake, *The Four Zoas*, "Night the Ninth," 137.4.
[198] Blake, *The Four Zoas*, "Night the Ninth," 138.1-3, 16-18
[199] Blake, "Annotations to Thorton's Lord's Prayer," 668.

end of capital accumulation as Urthona seizes the means of production and makes it common to all coincides with the reign of sweet science and industry.

Blake's early form of industrial consciousness is not as overt as the Mechanics' Institute's, and does not contain any detailed blueprints for exactly what form such a sweet industry would take. Nor does Blake himself fully realize his own confluences with Romantic era industrial socialists. On the contrary, his encounter with the first issue of the Mechanics Magazine is a scene of misrecognition. Yet it is also more than that, and more than E.P. Thompon's tragic lamentation of such a lost possibility. Despite the imperfect form that Blake's industrial consciousness takes at this early moment in Anthropocene history, he lays the groundwork for envisioning industry after capitalism, a vision true to Blake's spirit all the more urgent that we work towards today in our own late moment in Anthropocene history.

3. Industry after Capitalism

Nature builds no machines, no locomotives, railways, electric telegraphs, self-acting mules, etc. These are the 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…that appear to capital as mere means, and are merely means for it to produce on its limited foundation. In fact, however, they are the material conditions to blow this foundation sky-high.

– Marx, *Grundrisse*

[Industrial] technology is already collective...But the private owner of the factory who does not collaborate in the production is still thoroughly individual – for social, not for technological reasons. It is in fact precisely the contradiction between the…long since collective form of production and the antiquated private capitalist form of appropriation which particularly demonstrates the nonsense of the capitalist economy. Technology…is itself already socialist.

– Bloch, *The Principle of Hope*

Blake often suggests that the internal contradictions of the capitalist system will ultimately fuel its own destruction: the exclusion of the imagination from the same dull round of the dark satanic mill has an entropic effect on the whole capitalist system, like Marx's law of the tendency of the rate of profit to fall. For Marx, as Helmut Müller-Sievers observes, "the progressive exclusion of the human hand and its uncontrollable freedoms from the process of industrial production has an entropic effect on the entirety of capitalism's economic structure… an expression of the inherent contradictoriness of capitalist production that will be overcome only by the abolition of private ownership."[200] Much like Marx, Blake is explicit that "without the poetic character," even a mill the size of a universe "will soon stand still," unable to maintain the extraction of labor power from workers and perpetuate private accumulation. For Blake, it is not handheld tools but rather the exclusion of the poetic character – with its potential for creative innovation in production on which the capitalist system is itself dependent – that will bring the same dull round of the capitalist system to a standstill and lead to a hatred of private ownership fueled by the same system (the bounded becoming loathed even by its possessor). "Taken to its extremes," Helmut Müller-Sievers notes, Marx's tendency of the rate of profit to fall in capitalist

[200] Müller-Sievers, *The Cylinder*, 100.

machinery could be interpreted in an "antinomian way: working toward full [industrialization] constitutes an even more efficient way of overthrowing capitalism" (100). Blake formally anticipates Marx's antinomian view of machine form, critically exposing how the privatizing, enclosing, self-reifying industrial revolutions of machinery under capitalism drives their own destruction from within: "from within" – internal to the dynamics of – "the Wheels of Albions' Sons: / Fixing their Systems, permanent: by mathematic power / Giving a body to Falsehood that it may be cast off forever / With demonstrative science."[201] The formalization of the capitalist system – the dark satanic mill – renders visible how the system's own internal dynamics – its own industrial revolutions – will ultimately drive it to a standstill, fixed and immobilized by its own reduction of all things to capital and its exclusion of the imaginative power of the arts. For Blake, giving the counter-arts a body – formalizing its internal logic of development and bringing the capitalist form of industry out into the open – allows the false negation of industrial revolution to be cast off. To an extent, this drive of Blake's industrial poetics operates like critique, in both Marx's and Sedgwick's sense, which puts its faith in the power of exposure.

Yet critique is only one moment of Blake's and Marx's industrial poetics. Blake's critique of machinery as fixed capital is not a mere negation of modern industry but the first step towards working to poetically remake it. Mere critique for Blake represents the undialectical negation that separates the imaginative power of poetry from science and industry ("the reasoning power in man when separated from imagination.") Rather, Blake's industrial poetics work towards new collective forms of industry irreducible to fixed capital, to reclaim its labor power for a radical industrial revolution of machinery after capitalism in which money would be abolished and the arts and counter-arts of modern science and industry would be reconciled, freeing up the creative power of real industry for the coming communist society. Reflecting how "machines are woven with [Albion's] life," Blake calls for new social relations for machinery: not capital but its opposite, "mercy," or forgiveness, the contrary to debt and property. [202] The new social relations that Blake figures take various forms, as what Marx calls real human social relations that in their concrete particularity are contraries to the general logic of exchange of machinery under capital. As Blake reflects even amidst the endless turning of the dark satanic mills, "There is a Moment in each Day that Satan cannot find. Nor can his Watch Fiends find it / but the Industrious find This Moment & it multiply, & when it once is found / It renovates every Moment of the Day if rightly placed."[203] Strikingly, Blake insists that it is the "industrious" who find the moment that renovates every moment of the totality. By "industrious," Blake refers not to the capitalist sense of the labor power of millworkers reduced to the cogs in the machine of liberal political economy to produce abstract mechanical power. Rather, Blake refers to the creative mechanical power of workers like that set in motion by his own industrial poetics to overturn capitalism and remake the world (to "renovate every moment"), including industry itself. Blake uses industrious, that is, in much the same way that Mechanics' Institutes used it in their radical valorization of the industry of "the industrious" or productive classes of "those who, by their labours, increase the funds of the community...[as] mechanics, labourers, &c.": rendering visible and mobilizing their skilled labor or industry "to establish for the productive classes a complete dominion over the fruits of their own industry... An entire change in society…amounting to a complete subversion of the existing "order of the world."[204]

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[201] Blake, *Jerusalem*, 12.10-12.
[202] Blake, *Jerusalem*, 40.25-26.
[203] Blake, *Milton*, 35.42-45.
[204] Thompson, *The Making of the English Working Class*, 771.

Blake leaves the exact form that industry after capitalism will take open to the imagination. Like Owen or Marx, he offers us no fixed blueprints for the future. As E.P. Thompson notes, this radical tendency to leave the details open to imagination had power: "It was the very imprecision of his theories, which offered, none the less, an image of an alternative system of society, and which made them adaptable to different groups of working people....Owen's [relationship to his readers] can be seen as ideological raw material diffused among working people, and worked up by them into different products," much the same mechanical power that Blake's industrial poetics – his cog-wheels of words – figures on the minds of his readers, moving them to the intellectual labor to imagine what radical forms machinery might take.[205] Still, some bounding lines are clear. First, industry outside of capitalism would have to scale up qualitative skilled labor to industrial machinery, so that unalienated labor extends to the makers and users of machines, reunifying the knowledge and power alienated by industrial capitalism into the mechanical power that Blake reclaims, so that, as the Owenites and Mechanics' Institutes hoped, "the co-operation of skills involved in building [would] be reflected in co-operative social power."[206] Like Blake's vision of expropriating Urizen's storehouses and redistributing the "bread of knowledge" produced by the mill to all (which is bread of knowledge, extending skilled knowledge to the work of machinery), machinery as such would have to involve the social redistribution of the surplus value produced by all the arts of industry for the commons rather than leaving it up to market forces. Blake calls for the mechanical power produced by industry to be redistributed for the commons. Redistribution as such is not merely "post-production" – in the sense of after poetic making – but itself a form of it. The water-powered mills that Blake identifies with the arts of life, for instance, distribute energy or mechanical power in a form not bounded by capital but opening to a commons. Second, for Blake, the social relation of machinery would have to allow for the freedom to exercise the arts of imagination and "labor in knowledge." In a post-capitalist society, if wealth were redistributed along the lines that Blake suggests, machinery could provide workers with the means of subsistence to free them up for creative labor. Most radically, machine form itself might directly take a post-capitalist form and directly manifest creative labor power. Modern industry itself might be turned into a collective, creative form of production: industrial revolutions not the same everywhere but differently imagined and fitted for every material condition of human life, every social relation – like the cooperatively produced machine designs of the *Mechanics' Magazine* – a collective future that Blake industriously works towards in the industrial revolutions of his own poetics. As Bloch reflects, this radical potential is already latent within industrial technology: "technology is already collective... It is in fact precisely the contradiction between the…long since collective form of production and the antiquated private capitalist form of appropriation which particularly demonstrates the nonsense of the capitalist economy. Technology…is itself already socialist."[207]

For some, Blake's and Marx's project to envision machinery after capitalism is bound to seem improbable or unimaginable. As Fredric Jameson has observed, it can now be "easier to imagine the end of the world than to imagine the end of capitalism."[208] Blake insists that this failure of imagination – of mere critique – is neither necessary nor inevitable but rather the limit

[205] Thompson, 789.
[206] Thompson, 804.
[207] Bloch, "Technological Utopias," in *The Principle of Hope*, 659.
[208] Fredric Jameson, "Future City," *New Left Review* 21 (2003): 76. For "winner loses logic," see *Postmodernism, or the Cultural Logic of Late Capitalism* (Duke UP, 1991), 5-6. See Goldsmith, *Blake's Agitation*, 291, 300, 304.

of mere critique, when "separated from imagination," which renders imaginative labor itself all the more urgent.[209] The winner loses logic that Jameson identifies with critique reinforces capitalist realism to the extent that it accepts machinery under capitalism as the only possibility and fails to imagine radical alternatives. Blake shows that such winner loses logic constraining what is possible is ideologically constructed, the product of human labor that originated historically and thus can be changed, but only by the imaginative labor necessary to re-envision the possibility of industry after capitalism, no matter how improbable it may at first seem. We tend to critically overlook the second half of Blake's call for a radical alternative to industrial modernity: "all is to them a dull round of probabilities and possibilities; but the history of all times and places, is nothing else but improbabilities and impossibilities; *what we should say, was impossible if we did not see it always before our eyes*."[210] Critics tend to focus on the first half of the statement as Blake's critique of industrial capitalism.[211] Yet Blake's impossible history is not in fact impossible: it only appears so to those who unimaginatively expect to see things as they are, and accept the same dull round of machinery fixed into capital. What Blake in fact demands is a practical application of such counterfactuals made possible by vigilantly keeping alternative radical industrial possibilities "always before our eyes," so that such visions can be acted upon and the human world remade at the first opportunity, the same dull rounds of industrial modernity recreated into common ones. "What is now proved was once, only imagin'd."[212] As Marx reflects on the transition to machinery after capitalism, in a Blakean spirit, "Everything that has a fixed form, such as the product etc., appears as merely a moment, a vanishing moment, in this movement. The direct production process itself here appears only as a moment [in] the constant process of their own movement, in which they renew themselves even as they renew the world...they create."[213] Or in Blake's words, "there is a Moment in each Day that Satan cannot find" but "the *Industrious* find this Moment & it multiply" to "renovate every moment."[214]

Like industrial socialists from the Owenites to the Mechanics' Institutes, the ultimate critical strength of Blake's industrial poetics lies not in mere critique of machinery under capitalism but in industriously striving to radically rework it. The point for Blake and our ongoing industrial socialist movements that date to the Romantic era is not only to critique industrial modernity but to radically change it. Blake's insists that machinery is not reducible to capital. On the contrary, its mechanical powers contain the potential to blow capitalism sky high for the free development of human life through collective industry, industrial arts made common for all humanity, and perhaps even including the natural world, a possibility which Wordsworth realizes most fully, as the next chapter will explore. This forgotten Romantic possibility takes on new urgency in our own moment of Anthropocene history, when renewed industrial socialisms may now provide the forces to combat industrial capitalism's planetary devastation.[215] For Blake, the antagonism in industry originated historically and can pass, for the radical fulfillment of

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[209] Blake, *Jerusalem,* 74.10-11

[210] Blake, "Descriptive Catalogue," 543; emphasis added.

[211] Saree Makdisi, for instance, focuses on the first half of Blake's remark as a critique of industrial capitalism, which he takes as the title of his study, *Blake the Impossible History of the 1790s*. While Makdisi rightly acknowledges that Blake's impossible history is not in fact impossible, and that the point is to change it, he sees it as a mere negation of industrial capitalism rather than a radical industrial alternative to it.

[212] Blake, "The Marriage of Heaven and Hell," 8.33.

[213] Marx, *Grundrisse,* 712.

[214] Blake, *Milton,* 35.42-45.

[215] The Green New Deal, for instance, might be considered one such renewed industrial socialist project. See Naomi Klein, *On Fire: The Burning Case for a Green New Deal* (Verso, 2019).

industrial modernity, but only by endlessly remaking the world we create, so that machinery redounds to the benefit of emancipated labor and is the condition of labor's emancipation rather than its oppression. Only then can industry be redeemed or labor ever hope to be free.

Chapter 2:

WORDSWORTH'S GREEN INDUSTRY

Earth it was, earth it is, and earth it will remain. So, as we say, ten thousand years hence our railway earthworks will remain. There will then be a hundred thousand miles of rail, and every village will have its branch.

– *Mechanics' Magazine* (1859)

We double head-lands, and take large offings in our progress from one spot to another, as though the earth was an element which could be traversed only, subject to the same endless windings and reduplications of our course as the ocean…Instead of toiling up, or winding round hill, we should force ourselves a way through them.

– *Observations on a General Iron Rail-Way* (1825)

One of the most challenging questions of contemporary ecocriticism is the possibility of an ecologically sustainable relation between technology and nature in the Anthropocene, a green technology that would counteract the planetary devastation of fossil capitalism. As Dipesh Chakrabarty remarks, "The consciousness that ESS [earth systems science] ushers us into simply could not have arisen without the development of technology that 'rifled'…the 'bowels of their mother earth' – as John Milton described early mines…climate scientists would not have been able to bore into the ice of eight hundred thousand years ago if…the much-denounced oil and mining companies had not developed the technology for drilling that was then modified to deal with ice…The hope that humans will one day develop technology that will remain in a commensalist or congruent relationship to the biosphere for a period stretching into geological timescales—such a hope belongs to the realms of a reasonable utopia." This Romantic and utopian yet ultimately rational hope left unfulfilled by industrial capitalism is now all the more urgent that we consider.[216] In reckoning with the sheer ecological contingency of modern engineering, that can at once be applied to capitalist and eco-socialist ends, Chakrabarty traces this hope of developing a green technology in a commensalist relation to the earth back to the same early industrial mining technologies depicted in Milton's poetry. If we can date the first flares of such earth systems consciousness to Milton's time, when industrial mining began to rifle the bowels of the earth, such industrial technologies first developed on a planetary scale with the rise of railway and steamboat engineering over the Romantic era, which at once gave rise to the planetary ecological crises of capitalism and the first attempts to develop a green technology that would counter it now critical for our own moment in Anthropocene history.

1. Earthworks: Romantic Terraforming

Railways and steamboats were the major public works projects of the 19th century that refigured the earth on a terrestrial scale built into the figurative logic of what Romantic engineers came to call "earthworks" in treatises with titles like *Railway Engineering; and General Table for the Calculation of Earthworks* and *A Practical Treatise on the Construction and Formation of Railways.*[217] Earthworks, infrastructural projects which engineers defined as "the application

[216] Dipesh Chakrabarty, "The Planet: An Emergent Humanist Category," *Critical Inquiry* 46 (2019): 17, 27-28.
[217] Thomas Baker, *Railway Engineering…and General Table for the Calculation of Earthworks* (London: 1848).

of mechanical power" to works "of great magnitude" that were "formed with the earth" or reshaped it, included railways, steamships, and the canals, tunnels, and viaducts formed for steamships and railways that refigured the earth on an unprecedented scale.[218] As one engineer reflected, with the steamship and railway, "we have excavated, and even embowelled the earth...in multiplying or improving these latter channels of communication."[219] Railway and steamship earthworks were explicitly conceived as terraforming projects that demanded refiguring the earth, leading to a proto-ecological earth systems consciousness of the relation between industrial technology and nature that ecocriticism has widely overlooked. As the major civil engineering of the 19th century, railways and steamships earthworks continued the tradition of the major engineering projects of the 18th century such as road building, canal cutting, and the draining of the fens.[220] Yet at the same time, they began to reshape the earth on a scale radically different from previous civil engineering projects.

Beyond their sheer scale, the ecological outcome of such terraforming projects was not predetermined in advance. For Romantic poets and engineers, railways and steamships were from the outset torn between industrial capitalism and radical possibilities that promised to fulfill the incomplete project of the French Revolution. On the one hand, they required the mobilization of massive amounts of capital that by the late 19th century increasingly seemed to fuel the rise of industrial capitalism. Yet at the same time, steamboats and railways often developed outside the domain of private enterprise, containing within themselves public alternatives to industrial capitalism that "manifest a desire to replace haphazard self-interest and pure individual capitalism with state-organized industrial projects."[221] As Romantic engineers summed up, "the great system of internal communication now going forward in Great Britain, forms…a singular example in the history of public works" for the "welfare of the public in general."[222] Moreover, for Romantic poets and engineers, they held the potential to combat the ecological crises already set in motion by the unchecked industrial capitalist expansion of such terraforming projects. One goal of this chapter is to bridge the gap between Romantic ecocriticism and the history of technology in literary studies to recover the critically neglected ecological possibilities latent within Romantic engineering. Another goal is to show how this ecological thought of a green industry was made possible by a critically neglected engineering aesthetics. First, I begin by recovering the Romantic origins of railways and steamboats as terraforming projects in a poetics of earthworks where Romantic poetry and engineering intersected. Next, I turn to Wordsworth's attempt in his railway and steamboat poetry to pioneer a green industry that would combat the ecological crises that industrial capitalism began to precipitate. Finally, I close by considering what value this forgotten geopoetic confluence between Romantic poetry and engineering in such terraforming projects might now have for working towards a green industry outside of industrial capitalism in our own moment in Anthropocene history.

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[218] James Day, *A Practical Treatise on the Construction and Formation of Railways* (London: 1839), 37, 86.
[219] William Wickens, *The Improvement of Public Roads*, quoted in Thomas Gray, *Observations on a General Iron Rail-way, Or Land Steam-conveyance, to Supersede the Necessity of Horses in all Public Vehicles* (London: 1825), 138.
[220] On 18th century infrastructure projects, see David Alff, *The Wreckage of Intentions: Projects in British Culture, 1660-1730* (Philadelphia, PN: University of Pennsylvania Press), 2017.
[221] David Alff, "Richard Savage and the Poetry of Public Works," *ELH* 86.1 (2019): 143. While Alff's remark is on 18th century public works projects, the nineteenth century widely viewed railways as a successor to this tradition.
[222] Wellington Williams, *Appletons' Railroad and Steamboat Companion* (New York: 1847), 22; Thomas Gray, *Observations on a General Iron Rail-way*, x.

Engineering earthworks prompted Romantic poets and engineers to reckon with the mechanical power to shape the earth as a geological force, an ecological relation that marks what we now recognize as the onset of Anthropocene history heightened by engineering's close proximity to geology and the fact that engineering earthworks from canals to railway tunnels were literally made by refiguring vast quantities of earth.[223] Railways and steamboat lines demanded "cutting" and "boring" railway tunnels and steamboat canals and viaducts through the earth, reshaping the landscape in steam's image to "alter the face of the country," whether through tunnels, which one engineer defined as "subterraneous passage or gallery bored through the earth, for the passage of a canal, road, or railway" or the "formation of the railway embankment," which often required "blasting" the earth to move "a large quantity of material at once" to create railway embankments "formed of coal, rubble stone, sand, or other materials."[224] From the outset, engineers became acutely conscious that their terraforming projects refigured the earth on an unprecedented scale.[225] Engineers reflected on the "the enormous outlay for earthwork, viaducts, and tunneling" in the sheer "quantity of land necessary for forming, canals, railways, and turnpike roads."[226] As one engineer put it, "within the last fifty years a great number of canals have been cut in various parts of England, which have greatly contributed to the improvement of the country" to refigure the "surface of the earth." The engineer John Macneill opened his treatise on *Calculating the Cubic Quantity of Earth Work in the Cuttings and Embankments of Canals, Railways and Turnpike Roads* by reflecting that "all practical engineers are well aware, by experience, of the inconveniences which arise from the length of time necessary for calculating" the massive "quantity of earth-work in the cuttings and embankments of canals, railways." Engineers "very frequently find that they have more earth to move than they had previously calculated upon" since "when the work is carried into effect, a large quantity of earth may be required" in the "cuttings for the embankments, according to the

[223] Romantic engineers thus had their own distinctive form of insight into mankind as a geological force that has much more often been attributed to Romantic geology. On this insight often attributed to Romantic geology, see Noah Heringman, "The Anthropocene Reads Buffon (or, Reading Like Geology)," *Anthropocene Reading: Literary History in Geologic Times*, 59-77; Stephanie O'Rourke, "Staring into the Abyss of Time," *Representations* 148.1 (2019): 30-56. For the relays between railway engineering and geology, see Michael Freeman, "Tracks to a New World: Railway Excavation and the Extension of Geological Knowledge in Mid-Nineteenth-Century Britain," *The British Journal for the History of Science* 34.1 (2001): 51-65 and *Railways and the Victorian Imagination* (Yale University Press, 1999). Freeman observes, "By the 1840s, as railway cuttings were in the making all across the country, it became possible to observe whole sequences of strata, with all their distinctive fossil remains, for the first time. A correspondent of Charles Lyell wrote in February 1838 of the fascinating sections of the Forfar-Dundee railroad, urging Lyell to come and examine them for himself… Early railway guides were quick to pick up on the potential interest of amateur geologists in travelling by train…J.C. Bourne, in *The History and Description of the Great Western Railway* (1846), claimed that 'it would be difficult to select a line or district possessing greater geological interests and better fitted for the convenient study of the science itself'," 55. Yet in addition to this confluence, engineering provided its own distinctive form of insight into humankind as a geomorphic force.

[224] Gray, *Observations on a General Iron Railway*, 86; S.C. Brees, *Railway Practice* (1837), 362; A Resident Engineer, *A Practical Inquiry into Laws of Excavation and Embankment on Railways* (London: 1840), 34, 118; Day, A *Practical Treatise on The Construction and Formation of Railways*, 113.

[225] While the terms "terraforming" and "geoengineering" enter English in the late twentieth century, Romantic engineering already has access to the concept in the language of "shaping" and "forming" the earth through mechanical powers. Some critics make a sharp distinction between geoengineering and terraforming, the former sometimes reserved to denote reshaping the earth and the latter to shaping other planets in earth's image. Yet as Amanda Goldstein notes, this distinction is untenable. "Attracting the Earth: Climate Justice for Charles Fourier," 47.3 (2020): 49. I use terraforming and geoengineering interchangeably, terms which are best understood to be synonymous, to emphasize the formative, figurative element of terra*forming* within engineering.

[226] Samuel Clegg, *Clegg's Patent Atmospheric Railway* (London: 1839), 16.

shape or figure" of the earth.[227] In calculating the "deep cuttings" of "earthwork" required for "removing this great mass of material," the engineer who surveyed the Manchester Railway projected that the line demanded "11 million cubic yards" of "earthworks" and "earth-slopes."[228] These terraforming projects were soon imagined to extend around the globe and from the outset imagined on a planetary scale. As another reflected of the London and Birmingham Railway, "as a mode of viewing the magnitude of this work, let us take the circumference of the earth in round numbers at one hundred and thirty million feet. Then, as there are about four hundred million cubic feet of earth to be moved in the railway" by "the quantity of this material alone, without looking to anything else, would, if spread in a band one foot high and one foot broad, more than three times encompass the earth."[229]

Romantic engineering gave rise to the rapid development of steam-powered built environments, and with it, earthworks that began to reshape the earth on a terrestrial scale. Romantic engineers built the first steamboats in the 1790s. The 1810s saw the widespread deployment of the first commercial and passenger steamships and witnessed an overwhelmingly rapid expansion of steamboat and railways. In 1816, Robertson Buchanan, one of the first Romantic steamboat engineers, surveyed the "the rapid progress" which has "already been made in navigation by steam" in "the "progressive alterations and improvements in steamboats."[230] Surveying the "use of steam boats" in "artificial canals" around the globe from America to Scotland, Buchanan predicts that "this mode of navigation will rapidly extend to other parts of the world…from the progress which has already been made in navigation by steam, it is reasonable to suppose that it will rapidly extend not only in those countries where it already exists, but that its benefits will be speedily extended to every civilized nation."[231] Buchanan observed how just four years after the first passenger steamship, the *Comet*, sailed on the river Clyde in 1812, there were regular passenger steamships in most major English cities and rivers.[232] The first transatlantic steamship sailed in 1819. By the 1820s, there were multiple steamship lines in any given port to most locations in Britain, America, and the continent. By

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[227] John Macneill, *Table for Calculating the Cubic Quantity of Earth Work in the Cuttings and Embankments of Canals, Railways and Turnpike Roads* (London: 1833), vii-viii.

[228] Charles Vignoles and John Locke, *Two Reports Addressed to the Liverpool & Manchester Railway Company* on the *Projected North Line of Railway…Exhibiting the Extent of its Cuttings and Embankments* (Liverpool: 1835), 7, 9-10.

[229] Thomas Roscoe, *The London and Birmingham Railway; with the Home and Country Scenes on Each Side of the Line* (London: 1839), 3.

[230] Robertson Buchanan, *A Practical Treatise on Propelling Vessels by Steam* (Glasgow: 1816), iii-iv.

[231] Buchanan continues to crediting steam-power's rise to its figurative autonomy from natural forces, reflects that "the utility of [steam-power] requires no stronger proof than the rapid progress it has already made. By increasing the velocity, certainty, and cheapness of conveyance, it may be regarded as producing the effect of diminishing distance, and thereby facilitating intercourse and promoting commerce." Buchanan, *Practical Treatise on Propelling Vessels by Steam*, iii-iv, 6. Framing his engineering manual as a guide to "the modes in actual use for impelling vessels, without the aid of wind," Buchanan opens his treatise by reflecting that "It being impracticable for high-sided vessels, in a heavy sea, to make use of the common kind of oars, it was long wished to discover some method of propelling vessels independently of the wind." iii-iv, 1,3.

[232] Including the Tay, Avon, Yare, Trent, Tyne, Ouse and Humber, Orwell, Mersey, and the Thames, and soon in Glasgow, Edinburgh, London, Liverpool, Hull, Bristol, and Southampton. From 1819, steamboats propelled the rapid development of a booming Romantic eco-tourism industry. As historians of transportation sum up, over the 1810-20s, the steamboat "pioneered the excursion" to "romantic and picturesque locations for steamboat excursionists" in pursuit of "natural beauty…By the mid 1820s excursions around the coast were a regular occurrence and by the 1830s commonplace." John Armstrong and David M. Williams, "The Steamboat and Popular Tourism," *The Journal of Transport History* 26.1 (2005), 62, 68, 71.

1825, only ten years after the first steamships on the Thames, "45 companies in London alone had already been formed to establish steam-packets in every quarter of the globe."[233]

Romantic engineers pioneered the first steam-powered railways at an equally rapid pace. Before 1800, one Romantic engineer reflected, "animal power was the only means of locomotion originally employed on railways to any considerable extent."[234] Horses pulled carts on railways limited to transporting ores "from coal-works, and other mines" and on the natural constraints of horsepower.[235] Over the Romantic era, steam revolutionized railway technology by emancipating it from the natural limits of animal power. In 1804, Robert Trevithick built an "engine for moving railway carriages" that was the "the first steam-engine applied to locomotive purposes in Britain" which transported passengers and ores short distances.[236] Railway engineers designed the first working locomotive engines for public transport in the 1810s. From the 1820s, railways rapidly proliferated. The first major public railway line, the Stockton and Darlington Railway, opened in 1825; the Liverpool and Manchester railway began construction in 1826 and opened in 1830. By 1844, as one *Railway and Steamboat Companion* observed, there were "1900 miles of railway communication in full operation and the number of passengers that travelled over them exceeded thirty millions."[237] By 1839, another British *Railway Companion* observed that "engineers" had made us all "citizens of the world in the truest and the best meaning of the word" by their "earthworks" that now extended over "the whole habitable globe" to effect "a revolution which every person will confess is of such extent that its consequences and its bearings on all the circumstances of civilized life are not capable of being even guessed at."[238]

Romantic engineering gave rise to a steamboat and railway movement over the 1810s and 1820s, and with it, a new relation between technology and nature. The "utopian promise" of railway and steamboat earthworks for capitalists and industrial socialists alike as an "engine of progress"[239] lay in its capacity for universal communication or relation through the industrialization of the earth's surface – the industrialization of space and time – where universal communication ranged from the commerce, trade, and transport that fueled industrial capitalism to utopian socialist hopes of a universal association of humanity and the natural world.[240] The industrial revolution seemed poised to fulfill the Romantic hopes of the French Revolution, as engineering earthworks multiplied the relations between peoples by reshaping the face of the earth through canals, viaducts, tunnels, and railways.[241] The Saint-Simonian Constatin Pecqueur remarked that trains and steamers "truly are the chariots of equality, freedom, and civilization…The communal journeys on trains and steamships...inspire, to a great degree, the

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[233] John Kennedy, *The History of Steam Navigation* (London: Birchall, 1903), 43-44.
[234] See John Curr, *The Coal Viewer and Engine Builder's Practical Companion* (1797); Williams, *Railroad and Steamboat Companion*, 15.
[235] On pre-locomotive railways in Britain, see Marilyn Palmer and Peter Neaverson, "Pre-locomotive Railways of Leicestershire and South Derbyshire" in *The Impact of the Railway on Society in Britain: Essays in Honor of Jack Simmons*, ed. A.K.B. Evans and J.V. Gough (Ashgate: 2003), 11-32.
[236] Williams, *Railroad and Steamboat Companion*, 17.
[237] Williams, *Railroad and Steamboat Companion*, 22.
[238] Roscoe, *The London and Birmingham Railway with the Home and Country Scenes on Each Side of the Line*, 4.
[239] Alan Trachtenberg, Forward to Wolfgang Schivelbusch, *The Railway Journey: The Industrialization of Time and Space in the Nineteenth Century* (University of California Press, 1986), 11
[240] "Communication" was an engineering watchword often used to describe railway travel, as evident in the title of Nicholas Wood, *A Practical Treatise on Railroads, and Interior Communication in General* (London: 1825).
[241] As Schivelbusch notes, to Saint-Simonians and more broadly "adherents of progressive thought," the railroad promised to fulfill "all the egalitarian hopes left unfulfilled by Revolution…it was the material force that would realize the equality and fraternity of 1789 more effectively than any merely formal political emancipation" (71).

sentiment and habits of equality and liberty. By causing all classes of society to travel together…the railroads quite prodigiously advance the reign of truly fraternal social relations and do more for the sentiments of equality than the most exalted sermons of the tribunes of democracy. To thus foreshorten for everyone the distances that separate localities from each other, is to equally diminish the distances that separate men from one another."[242] Witnessing the rise of steamboat and railway engineering in Britain over the 1820s, the Saint-Simonian Chevalier reflected that "In the eyes of those who have faith that humanity marches towards universal association, and who devote themselves to leading it there, the railroads appear under a completely different light. The railroads, which along with men and products can move with a speed which twenty years ago we would have judged as a tall tale, will singularly multiply the relations of people and cities. In the material order the railroad is the most perfect symbol of universal association. The railroads will change the conditions of human existence."[243] As John Tresch observes, "Chevalier's view that 'the railroad [was] the most perfect symbol of universal association' described a paradise of communication that would be achieved among peoples previously in competition or at war. Yet the railroad – or rather, the steam engine that made it possible – symbolized in another way the universal association implied by the Saint-Simonians' pantheism, their goal of the 'rehabilitation of matter' and the material extension of spirit,"[244] and even, most idealistically, an overcoming of the war between industrial technology and the natural world seemingly intensified by the railway itself through a heightened ecological relation with nature, a hope of a technology in a commensalist or eco-mimetic relationship to the earth.

Such utopian hopes of French socialists and engineers for steam power's geomorphic force were at once ubiquitous in British railway engineering treatises and the Romantic public at large. Thomas Gray's *Observations on a General Iron Railway, or Land-Steam Conveyance,* predicted that the "the universal benefit which might daily be derived by the application of mechanic power to public vehicles" would "extend to all classes of society" so that "the great advantage of mechanical power, now so well and practically understood, will gain universal encouragement" for the "welfare of the public in general."[245] The "rapid improvements in mechanical power" with the railway allowed for a "perfectly new system of conveyance began upon, more constant with the spirit of the times, and better adapted to immense intercourse," a "new plan that will alter the face of the country" drawn out by "our most skillful engineers and mechanics."[246] Such Romantic hopes for the railway and steamboat were ubiquitous by the 1820s. One *Railroad and Steamboat Companion* looked forward to the "gradual annihilation, approaching almost to the final extinction, of that space and of those distances which have hitherto been supposed unalterably to separate the various nations of the globe...The whole population of the country would" be "nearer to one another by two-thirds of the time which now respectively alienates them....As distances were thus annihilated, the surface of our [globe] would, as it were, shrivel in size until it became not much bigger than one immense city."[247]

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[242] Constantin Pecqueur, *Économie sociale* vol. 1 (Paris, 1839), 335-36, trans. Wolfgang Schivelbusch in *The Railway Journey: The Industrialization of Time and Space in the Nineteenth Century*, 70-71.
[243] Chevalier, *Politique Industrielle*, 36, trans. John Tresch, *The Romantic Machine: Utopian Science and Technology after Napoleon* (University of Chicago Press, 2014), 207.
[244] John Tresch, *The Romantic Machine*, 208.
[245] Gray, *Observations on a General Iron Railway*, 8, 18, x-xi. Not to be conflated with Thomas Gray the poet.
[246] Gray, 68, 72.
[247] "*Quarterly Review* 125 (January 1839): 13. By 1824, British newspapers predicted that "among all the new projects and inventions with which this age teems, there certainly is not one that opens up such a boundless prospect of improvement as the general introduction of rail-ways for the purpose of commercial communication. We have

Reflecting how "a passage for the railway has been effected through the solid rock by a cutting" nearly "two miles in length," another British railway companion waxed poetic on engineering's new "giant power" to "annihilate – or at least, immeasurably extend – the bounds of time and space" through earthworks "to convert our hills and our valleys into level plains; to throw up towering mountains, and scoop out dread depths" from "the very bowels of the earth."[248]

Yet this early Anthropocene consciousness of humankind as a geomorphic force that steam power made possible could at once seem to sever any ecological relation to the earth, opening up an abyss between technology and nature formalized within the new figurative logic of machinery that Romantic engineers developed over the early 19th century. Romantic engineers reckoned with industrial technology's changing relationship to nature. As Schivelbusch sums up, the steamboat and railway entailed "a complex process of denaturalization" that exemplified the "process of industry's emancipation from nature": an emancipation that we now know was all too illusory and fleeting. "As the motion of transportation was freed from its organic fetters by steam power, its relationship to the space it covered changed quite radically. Pre-industrial traffic is mimetic of natural phenomena. Ships drifted with water and wind currents, overland motion followed the natural irregularities of the landscape...The earliest perceptions of how steam power dissolved that mimetic relationship can be found in descriptions of the first steam-powered ships. An eyewitness to John Fitch's steamboat experiment in 1790 found it particularly remarkable that the boat proceeded in a straight line, instead of tacking, as one would expect, in the traditional eotechnically 'natural' manner of maritime vessels."[249] "Steam power…reversed the relationship between recalcitrant nature (i.e., spatial distance) and locomotive engine. Nature…now succumbed to the new mechanical locomotive engine of the railroad that, in a frequently used metaphor, 'shoots right through like a bullet.' Motion was no longer dependent on the conditions of natural space, but on a mechanical power that created its own new spatiality."[250] No longer eco-mimetic, steam power refigured the earth in its own image.

Yet humankind's newfound geomorphic force in railway and steamboat earthworks did not entail any intrinsic opposition to nature, an opposition which was increasingly heightened by the rise of railway capitalism. By the mid nineteenth-century when Wordsworth composed his steamboat railway poetry, the Romantic period also witnessed railway capitalism's eclipse of the utopian industrial socialist hopes for the railway. The ecological relation between mechanical powers and nature became a point of debate between industrial capitalist railway companies and environmentally consciousness engineers who formed earthworks from the local environment. As one engineer wrote, railways should be shaped by the "rugged and uneven" terrain arising "from the irregularities of a mountainous country," and "formed in such a direction, and with such a declivity as may best suit the nature of the ground through which it passes," adapting the

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spoken of vehicles travelling at 20 miles an hour. But we see no reason for thinking that in the progress of improvement a much higher velocity may not be found practicable…Such a new power of loco-motion cannot be introduced without effecting a vast change in the state of society. With so great a facility and celerity of communication, the provincial towns of an extensive empire would become so many suburbs of the metropolis -- or, rather, the effect would be similar to that of collecting the whole inhabitants of a country into one city. Commodities, inventions, discoveries, opinions, feelings, would circulate with a rapidity hitherto unknown; and above all, the personal intercourse of man with man would be prodigiously increased. Were the ugly despotisms that retard civilization on the continent annihilated, Europe might be made as it were one family, by such a system of internal communication," all made possible by engineering earthworks. *Leeds Mercury*, December 18, 1824.

[248] *The Railway Companion, Describing the Excursion Along the Liverpool Line, Accompanied with a Succinct and Popular History of the Rise and Progress of Railroads* (London: 1833), 16-17.

[249] Schivelbusch, *The Railway Journey*, 9.

[250] Schivelbusch, *The Railway Journey*, 10.

railway's form to the figure of the earth wherever possible rather than disfiguring the earth in forcing railway lines through it.[251] By the mid 19th century, industrial capitalism increasingly ignored the ecological effects of the railway upon nature altogether in pursuit of maximum commercial profit with the Railway Manias of 1844-45.[252] On the one hand, productivist ideology naturalized industrial technology to fuel capitalist growth by celebrating the commercial potential of such powers to shape the earth while ignoring their potentially negative ecological consequences. Yet such terraforming projects were not inherently capitalist. As public works projects, the utopian potentials of earthworks were real. As late as 1845, William Gladstone, the President of the Board of Trade, and his correspondent William Wordsworth hoped to establish British railways as public works projects while reining in railway corporations.[253] However imperfectly, Romantic engineers and poets developed the first flickers of a green industry outside of capitalism, in an ecologically sustainable relation to the earth.

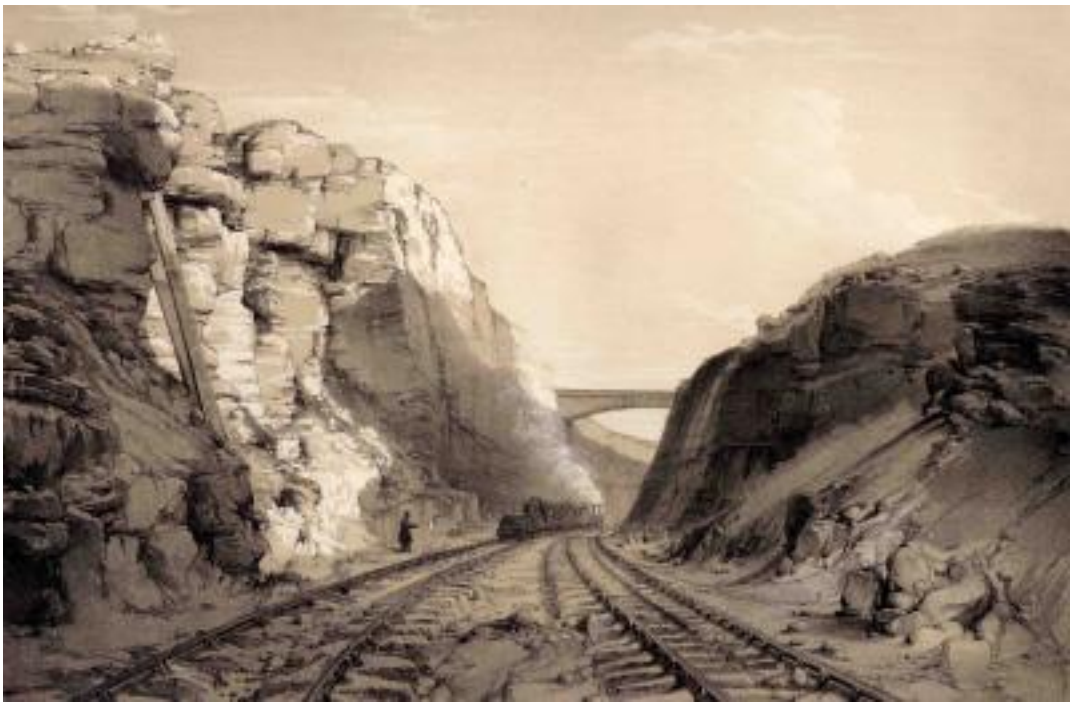
Romantic aesthetics from painting to poetry at once grappled with this changing figurative logic of earthworks that was transforming the ecological relation between industrial technology and nature through their own figurative means. Romantic painters and engravers from John Cooke Bourne to J.M.W. Turner depicted the railway line cutting through the landscape in *Rain, Steam, and Speed – The Great Western Railway* (1844):

J.M.W. Turner, *Rain, Steam, and Speed – The Great Western Railway (1844)*, National Gallery

[251] "To the Committee of the Promoters of the Intended Railway," "Jessop's Report to the Committee of the Proposed Railway," in *Observations on a General Iron-Railway*, 95-97, 104.William Wickens, in *General Iron Railway*, 134, 138. On ecologically sustainable railway practices, see Gordon Biddle, "Railways, their Builders, and the Environment," in *The Impact of the Railway on Society in Britain: Essays in Honor of Jack Simmons*, ed. A.K.B. Evans and J.V. Gough (Ashgate: 2003), 117-128.

[252] For the rise of railway capitalism in the railway manias of the mid-nineteenth century, see See P.J.G. Ransom, "The Railway Mania, and After," in *The Victorian Railway and How it Evolved*, (London: 1990), 79-111; Geoffrey Channon, *Railways in Britain and the United States, 1830-1940: Studies in Economic and Business History* (Ashgate: 2001). On ecologically sustainable 19th century engineering practices, see James Winter, *Secure from Rash Assault: Sustaining the Victorian Environment* (University of California Press, 1999).

[253] See P.J.G. Ransom, *The Victorian Railway and How it Evolved*, 85.



John Cooke Bourne, *Blisworth Cutting on the London and Birmingham Line* (1839), Science and Society Picture Library

John Cooke Bourne, *Blisworth Cutting – A View from Above,* Plate XXVI from *Drawings of the London and Birmingham Railway* (London: JC Bourne, Ackermann & Co, 1839)

As Michel Freedman observes, "in the emerging iconography of railway art, one of the most striking themes was the railway as straight line," from Turner's depiction of earthworks cutting

through the landscape to Bourne's lithographs of the Blisworth Cutting on the Birmingham Line slicing through the terrain.[254] Meanwhile, railway engineers and advocates took inspiration directly from Romantic poetry. Thomas Gray's *Observations on a General Iron Railway, or Land-Steam Conveyance,* the single most influential railway advocacy treatise that first appeared in the *Mechanics Magazine* (1824) and inspired many of the first railways, opened with an epigraph from Erasmus Darwin's poetry that prefigured both the steamship and railway: "Soon shall thy arm, unconquer'd Steam! / Drag the slow Barge, or Drive the rapid car."[255] By 1849, observers of railway earthworks found that "Engineers have realized the poet's dream [with] the locomotive" of "making matter and the elements" from the earth serve revolutionary ideals, as "within the last forty years, the giant power of steam may be said, literally, to have revolutionized the world."[256] One observer of the opening of the London and Birmingham Railway, Thomas Roscoe, wondered whether "any poet could have been found, capable of bringing into harmonious numbers the uncouth sounds of [railway] cuttings and embankments, – blocks and sleepers, and [earth]slopes of one thousand eight hundred to one"[257] – that is, colossal earthworks like those of the Birmingham Line's Blisworth Cutting depicted in John Cooke Bourne's lithographs that cut such a perfectly straight line through the landscape that it rose only one foot for every 1,800 feet of track, which demanded filling entire valleys and cutting through hundreds of miles of rock faces.[258] Some late Romantic poets soon answered Roscoe's challenge, from steamboat poems like *The Steam-Packet* and railway poems like William Pickering's *Railway Eclogues* to anonymous ballads on the Western Railway. Other poets from John Clare to William Wordsworth began to probe the ecological impact of engineering earthworks.[259]

2. Steamboat and Railway Poetry

The utility [of the railway], especially as expediting the communication between England and Ireland, more than justifies the labours of the Engineer…Once for all let me declare that it is not against Railways but against the abuse of them that I am contending. How far I am from undervaluing the benefit to be expected from railways in their legitimate application will appear from the following lines published in 1837.

– Wordsworth, 1844.

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[254] Michael Freedman, *Railways and the Victorian Imagination*, 223.

[255] Thomas Gray, "Proposition for a General Iron Railway, with Steam-Engines to Succeed the Necessity of Horses in all Public Vehicles," *Mechanics Magazine* 19, January 23, 1824, 2. Gray expanded his article into the most popular railway advocacy treatise of the nineteenth century *Observations on a General Iron Railway, or Land-Steam Conveyance* (1825) that inspired many of the first railways. Not to be conflated with Thomas Gray the poet.

[256] P.K. Mannex, *History, Topography, and Directory of Westmoreland* (London: 1849), 52.

[257] Thomas Roscoe, *The London and Birmingham Railway*, 5

[258] As James Winter notes, "Engineers would also need to slice straight through land contours…This was certainly the case with the building of the London and Birmingham Railway. A special feature of that project was that it cut across the grain. Its designer, Robert Stephenson...kept the grade at an average steepness of no more than 1 in 330. That meant his contractors had to force their way for more than a hundred miles across valleys and through hills that lay, transversely, in their path. They cut deep slashes and filled whole valleys so that locomotives could speed along at a nearly constant level. As one contemporary remarked, the result was that the whole line would need to be either a cutting or an embankment," *Secure from Rash Assault: Sustaining the Victorian Environment,*105.

[259] After witnessing engineering agents survey Royce Wood for the Manchester line, John Clare questioned the ecological impact of the railway in his June 4, 1825 journal entry: "Saw 3 fellows at the end of Royce Wood who I found were laying out the plan for an 'Iron railway' from Manchester to London it is to cross over Round Oak Spring by Royce Wood corner…they will despoil a boggy place that is famous for Orchises at Royce Wood end." *The Prose of John Clare*, ed. J.W. and Anne Tibble (Routledge & Kegan Paul: London, 1951),151.

Railways and all the mechanical achievements of this day are doing wonders for the next generation; indeed, it is the appropriate work of this age and this country, and it is doing it gloriously. That anxious money-getting spirit which is a ruling principle in England, and a passion and a law in America, is doing much by exhausting itself; we may therefore look forward with hopeful trust.

– Wordsworth, 1844.

Among those who answered this poetic challenge was William Wordsworth, an early supporter of the very Birmingham Railway line that became famous for its earthworks with slopes of 1,800 to one that Roscoe wondered if any poet could turn into poetic lines. In a way not yet sufficiently recognized by criticism, Wordsworth came to reject the ecological devastation of industrial capitalism with the spread of steamboats and railways, instead imagining alternative forms of green industry figured in the earth's image. If Barbara Johnson long ago noted how the word "mechanical" paradoxically returns as a value term for poetic making in the *Preface*, Ted Underwood has taken Wordsworth's naturalization of steam engines in the *Excursion* as a case study of productivism, the nineteenth-century belief in the seamless continuity between nature and industry that fueled the ecological crises of industrial capitalism.[260] Rather than reading Wordsworth's persistent naturalization of poetic and industrial technologies as a symptom of productivist ideology, I argue that this ecocritical drive of Wordsworth's poetics fuels his attempt to envision a green industry over his poetic career realized most fully in his late steamboat and railway poetry. Even in protesting the expansion of the Windermere Railroad into the Lake Distinct, often considered one of the nineteenth-century origins of the environmental movement, Wordsworth cites his steamboat and railway poetry as evidence that he is not against the railway but rather against fossil capitalism's disfiguring the environment, one year after the utopian-socialist Chevalier imagined the railway as a means of "universal association" between humanity and nature. Protesting the ecological crises of industrial capitalism, Wordsworth prefigures a green industry that anticipates the eco-socialist hopes of the Green New Deal.

Wordsworth himself does not use the term "green industry." On the contrary, he struggles to find the figurative language that does not yet exist to unify his ecological approach to industry into an overarching concept, grasping after and experimenting with a range of poetic and engineering language. Instead, I deploy the term green industry to signify the underlying coherence that slowly crystallizes in Wordsworth's poetics, a coherence that Wordsworth himself remains unable to fully articulate, and often leaves implicit. Wordsworth's green industry, then, is a partial and fragmentary form of early Anthropocene consciousness that emerges not from any explicit or programmatic attempt to explicitly define a green form of industry but rather emerges from the shadows, as a mirror-image of his negation of industrial capitalism.[261]

Wordsworth's green industry bridges the abyss between the ecocritical and the industrial Wordsworth. For Romantic ecocriticism, Wordsworth's embrace of industrial technology appears anti-ecological and contradictory. Romantic ecocriticism has yet to reckon with Wordsworth's enthusiasm for industrial technology, uncertain how to reconcile it with the ecological Wordsworth, due to a lack of knowledge of the ecocritical potentials within industrial

[260] Ted Underwood, *The Work of the Sun: Literature, Science, and Political Economy, 1760-1860* (Palgrave, 2005), 109-133; Barbara Johnson, *A World of Difference* (Baltimore: Johns Hopkins University Press, 1987), 89-99.
[261] Much in the spirit of Adorno's reflection that "consummate negativity, once squarely faced, delineates the mirror -image of its opposite." *Minima Moralia: Reflections from Damaged Life*, trans. E.F.N. Jephcott (Verso, 1978), 247.

technology. Industry and capitalism remain widely conflated within Romantic ecocriticism – and industry and ecology in binary opposition. This critical tendency has been exacerbated by the fact that much of the most prominent recent Romantic ecocriticism remains resolutely anti-instrumental.[262] At the same time, the rare scholarship that has recognized Wordsworth's embrace of industrial technology has remained entirely separate from Romantic ecocriticism. As Underwood notes in his important critical recovery of the industrial Wordsworth – still the most important scholarship on Wordsworth's industry – "Less has been said about Wordsworth's embrace of industrial technology itself...Wordsworth's poems praising mechanical power" such as "Steamboats, Viaducts, Railways" are not obscure."[263] Yet Underwood makes no mention of any ecological element within Wordsworth's embrace of industry, an omission which largely extends to critics who have noted Wordsworth embrace of the railway. Against Underwood's claim that Wordsworth ultimately naturalizes mechanical power in a productivist mode that fundamentally fuels capitalist growth, I argue that Wordsworth comes to reject the ecological damages of industrial capitalism in imagining a green industry outside of capitalism most fully realized in his late steamboat and railway poetry.

Wordsworth's green industry is not a facile naturalization of mechanical powers but an ecocritical asymptote of his poetics that works to overcome the tension between his dual fidelity to nature and to industrial technology. Underwood is right that Wordsworth's response to industrialization is fueled by "two conflicting impulses." Yet these conflicting impulses are not, as Underwood argues, the tension between what he calls Wordsworth's tendency to "naturalize his excitement about capitalist enterprise"[264] and his concern with the potentially negative social and economic (rather than ecological) impacts of machinery but the tension between Wordsworth's commitment to the radical utopian potentials of industrial technology and his growing awareness of the ecological damages of industrial capitalism. On the one hand, Wordsworth embraces the utopian potentials of railway and steamboat earthworks. Yet at the same time, Wordsworth rejects industrial capitalism's ecological damage to the earth precipitated by the uncritical application of industrial technology to fuel capitalist growth: what he calls the "superabundances of capital" invested in "railway mania" that threaten to disfigure the earth.[265] This tension between Wordsworth's industrial and ecological tendencies intensified by steamboat and railway earthworks fuels the ecocritical drive of his poetics to develop a green industry outside of capitalism, an alternative figurative logic of machinery adapted to nature.

Despite his protest of the expansion of the railway into the Lake District, Wordsworth was an enthusiastic supporter of railways and steamboats. Wordsworth himself had sought to invest in the railway at the early date of 1825, when the first major railway projects like the Birmingham Railway were beginning construction. In a letter to Charles Lloyd, Wordsworth writes, "I have been led to consider Birmingham as the point from which the railway companies now forming receive their principle impulse, and I feel disposed to risk a sum – not more than 500*l* – in purchasing Shares in some promising Company or Companies."[266] Yet with the rise of railway capitalism over the 1840s, Wordsworth became increasingly critical of the capitalist

[262] Anne-Lise François and Anahid Nersessian exemplify this anti-instrumental tendency of the most prominent recent Romantic ecocriticism. For a good overview, see Anahid Nersessian, "Romantic Ecocriticism Lately," *Literature Compass* 15.1 (2018): 1-16.
[263] Underwood, *The Work of the Sun*, 110.
[264] Underwood, *The Work of the Sun*, 109, 116.
[265] Wordsworth to Charles Pasley, October 15, 1844, *The Letters of William and Dorothy Wordsworth*, vol. 7., 617.
[266] Wordsworth to Charles Lloyd, January 6, 1825, *The Letters of William and Dorothy Wordsworth, 2nd Ed. III The Later Years Part 1 1821-1828*, ed. Alan G Hill. (Clarendon: Oxford UP, 1978), 299.

tendencies of railway corporations, shifting his support to the railway as a public works project. In 1842, Wordsworth wrote his brother Charles excited about the global proliferation of railways as public works projects rapidly expanding across America, the Continent, and every corner of the globe, encouraging Charles to support Pennsylvania's railway projects:

> Public works, such as Railways, Roads, etc, etc, have been commenced and carried on through all parts more or less of the Continent...But the resources of the State are inexhaustible, the activity and spirit of the people indefatigable, so that could we but give them credit for decent honesty, there is no doubt that the worst of them would erelong be able to discharge all their obligations. Thinking as I do that Pennsylvania is sound at heart in [its railway projects].[267]

Wordsworth's excitement regarding how railways are now "commenced and carried on through all parts" of the globe registers his enthusiasm about the utopian potentials of railway earthworks as "public works" projects distinct from capitalist railway corporations. The distinction that Wordsworth draws in 1844 in enthusiastically supporting the utopian potential of the railways while protesting what he calls the "superabundances of capital"[268] invested in it carefully differentiates between railways themselves and capitalist railway corporations, avoiding the conflation of industrial technology and capitalism common in Romantic ecocriticism:

> Railways and all the mechanical achievements of this day are doing wonders for the next generation; indeed, it is the appropriate work of this age and this country, and it is doing it gloriously. That anxious money-getting spirit which is a ruling principle in England, and a passion and a law in America, is doing much by exhausting itself; we may therefore look forward with hopeful trust.[269]

In his enthusiasm for "railways and all the mechanical achievements of this day," Wordsworth eagerly anticipates a post-capitalist future in which the "money-getting spirit" of railway capitalism predominant in England and America will have exhausted itself, leaving only the utopian potentials of the railways themselves no longer exploited by industrial capitalism. While Wordsworth's hopeful trust that railway capitalism would come to an end may now appear naïve, his insight that railways and capitalism are non-identical is accurate. In 1844, the romantic possibilities of the railway still loomed large despite the rise of railway corporations.

We can glimpse the other half of Wordsworth's ecocritical relation to industrial technology in his 1844 letters to the *Morning Post* protesting the expansion of the Kendall and Windermere Railway into the Lake District. In his second letter to the editor, Wordsworth includes a draft of the Simplon Pass passage from the *Prelude* that he had written "before the new military road had taken the place of the old muleteer track" in questioning whether he could have still composed the lines – or poetry at all – from a modern road or railway:

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[267] William Wordsworth to Charles Wordsworth, February 9, 1842, in *The Letters of William and Dorothy Wordsworth*, vol. 7, 1840-1853 ed. Alan Hill (Oxford, 1988). Significantly, the Pennsylvania railway was one of the largest in America at the time.
[268] Wordsworth to Charles Pasley, October 15, 1844, *The Letters of William and Dorothy Wordsworth*, vol. 7., 617.
[269] Wordsworth, October 6, 1844, quoted in Caroline Fox's *Memories of Old Friends,* vol 1. (London: 1882), 194-95, in *The Letters of William and Dorothy Wordsworth*, vol. 7, 616.

Brook and road
Were fellow-travellers in this gloomy pass
And with them we did journey several hours
At a slow step. The immeasurable height
Of woods decaying never to be decayed
The stationary blasts of waterfalls,
And in the narrow rent, at every turn,
Winds thwarting winds bewildered and forlorn
The torrents shooting from the clear blue sky
The rocks that muttered close upon our ears,
Black drizzling crags that spake by the way-side
As if a voice were in them, the sick sight
And giddy prospect of the raving stream
The unfettered clouds and region of the heavens,
Tumult and peace, the darkness and the light,
Were all like workings of one mind, the features
Of the same face, blossoms upon one tree,
Characters of the great Apocalypse,
The types and symbols of Eternity,
Of first, and last and midst, and without end.

> Thirty years afterwards I crossed the Alps by the same Pass and what had become of the forms and powers to which I had been indebted for those emotions? Many of them remained of course undestroyed and indestructible. But, though the road and torrent continued to run parallel to each other, their fellowship was put an end to. The stream had dwindled into comparative insignificance, so much had Art interfered with and taken the lead of Nature, and, although the utility of the new work, as facilitating the intercourse of great nations, was readily acquiesced in, and the workmanship, in some places, could not but excite admiration, it was impossible to suppress regret for what had vanished forever.[270]

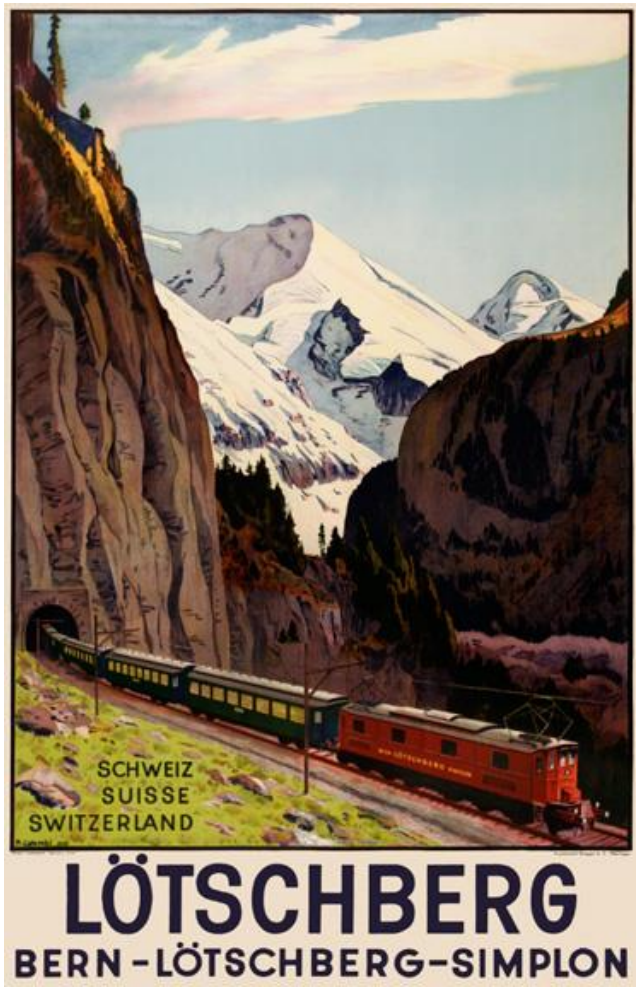
The new road through Simplon Pass that Wordsworth crossed thirty years after he composed these lines from the *Prelude* was a major Napoleonic highway that the engineer Nicholas Ceárd built in 1805 (Figure 1). Wordsworth worries that industrial technology like the railway will sever the ecological relationship between technology and the earth – between humanity and nature – rendering lyric poetry no longer possible. Whereas the old road was in "fellowship" with the stream, the new highway put an end to the fellowship between technology and nature, a loss that the proposed railway threated to intensify. Considering the proposed Kendall and Windermere Railway closer to home, Wordsworth anticipates that future railways through the Lake District and the Alps will be extensions of the same tendency.[271] Even though engineering limitations made cutting railways through Simplon Pass impossible in 1854, Wordsworth

[270] Wordsworth, Letter to the Editor of the *Morning Post*, December 20, 1854, in *The Prose Works of William Wordsworth*, vol. 3, eds. W.J.B. Owen and J.W. Smyser (Oxford, 1974), 353-54. This was the first time that Wordsworth's Simplon Pass lines appeared in print.

[271] Complete with major engineering earthworks, the Napoleonic road built in 1805 was initially intended to carry supplies through Simplon during the Napoleonic Wars.

foresees that the railway eventually would even extend through the Alps. Wordsworth was proven right: the Simplon Pass Tunnel – which began construction in 1898 and opened in 1905 – became the longest railway tunnel in the world for most of the 20th century (Figure 2). What occasions this loss of ecological relationship for Wordsworth is a growing imbalance between nature and technology with the industrialization of the natural world: "the stream had dwindled into comparative insignificance, so much had Art interfered with and taken the lead of Nature." This loss of ecological relation is in part a question of scale: of "*how much* art interferes with and takes the lead of nature" rather than co-existing with or adapting itself to the natural world, a scalar disjuncture that he will soon trace to industrial capitalism's harms.

Mathias Lowry, *Vue de la nouvelle route près la grande galerie* [Simplon] (1811), Bibliothèque Nationale



Plinio Colombi*, Bern-Lötschberg-Simplon (1937)*

Yet it would be wrong to conclude from this passage that Wordsworth's relation to the railway is as stark as this moment first appears, which represents only half of the ecocritical drive of Wordsworth's poetics. Immediately after this passage of the letter, Wordsworth pivots to imagine how this ecological relation between nature and technology is not in fact lost forever but can be extended to industrial technology such as steamboats and railway earthworks, quoting

"Steamboats, Viaducts, and Railways" to prefigure a green industry that through poetry can be reconciled with nature. Wordsworth continues to identify this loss of ecological relation with how railways built by "railway companies" solely concerned with the "the profit of the shareholders" regardless of the ecological cost of industrial growth increasingly "disfigured" the surface of the earth. Precisely this loss of relation to the earth drives Wordsworth to imagine an alternative green industry that adapts railway and steamboat earthworks to nature. [272]

Before we turn to consider Wordsworth's steamboat and railway poetry and protest of the Windermere Railway into the Lake District, let us commence with Wordsworth's early embrace of mechanical powers and attempt to prefigure a green industry that would reconcile poetry and technology in *The Excursion* to trace how this impulse evolves across his poetic career with the course of industrialization. Wordsworth significantly expanded and revised his poetry of industrial technology in the *Excursion* while composing his steamboat and railway poetry in 1837-1843. *The Excursion*'s sharply polarized critical reception and tendency to generate apparently contradictory accounts of Wordsworth's relation to technology and nature exemplifies the critical chasm between the ecocritical and the industrial Wordsworth that Wordsworth's green industry bridges. On the one hand, *The Excursion* has been a foundational text of Romantic ecocriticism. Jonathan Bate reads *The Excursion* as a key instance of Romantic ecology exemplifying the anti-industrial, ecocritical Wordsworth.[273] At the same time, Ted Underwood develops his important recovery of an industrial Wordsworth's productivist naturalization of steam engines and industrial capitalism on a reading of the poem. In 1843, Wordsworth added a long explanatory note to the *Excursion* while composing his steamboat and railway poetry that explicitly identifies the Wanderer's account of industrialization with his own experience: as Wordsworth sums up, "The changes he had witnessed in rural life, by the introduction of machinery, truly described what I myself saw during my boyhood and early youth" with the onset of industrial modernity.[274]

The poem contains some of the most explicit instances of Wordsworth's embrace of industrial technology. In a famous long passage in Book 8 that Underwood takes to celebrate the mechanical powers of the "potent enginery" of industrial technology, Wordsworth writes:

> I exult,
> Casting reserve away, exult to see
> An intellectual mastery exercised
> O'er the blind elements; a purpose given,
> A perseverance fed; almost a soul
> Imparted – to brute matter. I rejoice

[272] While Alan Bewell does not address Wordsworth's relation to the railway, we might understand Wordsworth's concern for a loss of relation to the earth in the context of what he calls Wordsworth's tendency of "focusing on what it means to lose" the relations that "link human beings to the earth…" and "what it means to live with a nature that is passing out of existence or being replaced with another [nature]" with the onset of industrial modernity. As Bewell rightly observes, for Wordsworth this entails not the loss of any relation to nature altogether but the loss of a specific historical nature that is replaced with another with industrial modernity in "a language that looks as much to the future" for a "prophetic gesture toward a recovery that is to come." As "Wordsworth learned to see nature in historical terms… [he] did not believe that there was a preestablished or fixed relationship between [human powers] and nature, but instead that both were the products of a dynamic interaction that changed over time." *Natures in Translation: Romanticism and Colonial Natural History* (Johns Hopkins UP, 2017), 232, 234, 236-37, 247.
[273] See Bate, *Wordsworth and the Environmental Tradition*, 40.
[274] Wordsworth, *Excursion* 8.87n, in *Poetical Works*, v. 5, 468-469.

Measuring the force of those gigantic powers
That, by the thinking mind, have been compelled
To serve the will of feeble-bodied man.[275]

At first glance, it is hard to imagine a more unreserved celebration of mechanical power. As Underwood notes of this passage, Wordsworth "celebrates" the "instrumental treatment of inanimate nature."[276] Romantic ecocriticism had tended to recoil from these lines that seem to contradict the ecological thought that Wordsworth is widely considered to develop in the *Excursion*, for understandable reasons: at first glance, Wordsworth's exultation in industrial technology's "intellectual mastery exercised / O'er the blind elements" seems to celebrate an anti-ecological domination of nature. Yet the relation is more complex than it at first appears. Much as for the utopian socialist Chevalier, industrial technology for Wordsworth promises the material extension of mind or spirit to inanimate matter that does not necessarily preclude an ecological relation to nature. Wordsworth distinguishes between animate and inanimate nature in celebrating the humanization of the "brute matter" of machinery. Wordsworth's later revisions to the lines while composing his railway and steamboat poetry – which Underwood and Bate alike entirely overlook – systematically reshape the relation between industrial technology and nature from one of domination to ecological sustainability. Wordsworth changes the language of "mastery" to the non-domineering "aim" and changes every instance of the word "will" to the more ecologically sustainable fulfillment of human "needs" in extending the passage to reframe it in terms of ecological limits. The new lines that Wordsworth adds to the end of this passage resituate its celebration of industrial technology within ecological limits: "Yet I should deem this [power] too dearly bought / Unless I dared to hope that time may come / When strengthened, yet not dazzled, by the might / Of this dominion over nature gained, / Men of all lands shall exercise the same / In due proportion to their country's need" without marring the "face of the earth."[277] Wordsworth suggests that industrial technology is not worth the ecological cost unless a time comes in which, rather than extending the human "dominion over nature," machinery instead is brought into a sustainable relation to the earth. While the ghost of capital only appears in the form of Wordsworth's suggestion that mechanical powers should be proportioned to human needs rather than their insatiable wants, it will soon make a much more explicit appearance.

Wordsworth continues to gaze in "wonder" at the earthworks of engineering projects: roads, canals, and to the "progress" of a road "on the side of some bare hill," which in 1837 (significantly, the same year that he published "Steamboats, Viaducts, Railways"), he revises to an even more formidable road or railway line cutting "the naked mountain's lofty side":

I have lived to mark
A new and unforeseen creation rise
From out the labours of a peaceful Land
Wielding her potent enginery to frame
…
The foot-path faintly marked, the horse-track wild,
And formidable length of plashy lane

[275] Wordsworth, *Excursion* 8.199-207 in *Poetical Works of William Wordsworth*, vol. 5, eds. Ernest de Selincourt and Helen Darbishire (Oxford, 1949). Unless otherwise noted, all citations of the *Excursion* refer to this edition.
[276] Underwood, *The Work of the Sun*, 116.
[277] Wordsworth, Excursion 8.201, 8.207-213, 8.121. See *Poetical Works*, v. 5, 269-70n for these revisions.

(Prized avenues ere others had been shaped
Or easier links connecting place with place)
Have vanished – swallowed up by stately roads
Easy and bold, that penetrate the gloom
Of Britain's farthest glens. The Earth has lent
Her waters, Air her breezes; and the sail
Of traffic glides with ceaseless intercourse,
Glistening along the low and woody dale;
Or in its progress on the naked mountain's lofty side
With wonder kenned from far.

Meanwhile, at social Industry's command
How quick, how vast an increase!
From the germ of some poor hamlet, rapidly produced
Here a huge town, continuous and compact,
Hiding the face of earth for leagues – and there,
Where not a habitation stood before,
Abodes of men irregularly massed
Like trees in forests, spread through spacious tracts,
O'er which the smoke of unremitting fires
Hangs permanent, and plentiful as wreaths
Of vapour glittering in the morning sun.
And, wheresoe'er the traveller turns his steps,
He sees the barren wilderness erased[278]

At first glance, the passage appears to continue the poem's celebration of industrialization. Underwood takes this passage as a key instance of Wordsworth's naturalization of mechanical power. After all, the Earth lends her waters and the air her breezes to the "ceaseless intercourse" of land and sea traffic naturally adapted to engineering earthworks. Industrial metropolises that now cover "the face of the earth" are naturalized into trees in forests. Even the unremitting industrial smoke seems to harmoniously blend in with the morning sunlight. As Underwood sums up, industry "cooperates with nature" through the industrial appropriation of forces "lent by the earth." [279] Yet in 1843, Wordsworth adds a key note commenting on the four lines on canals and railways above ("Earth has lent / Her waters, Air her breezes" to "the naked mountain's lofty side") that extend to the engineering earthworks as a whole. Wordsworth's note, which Underwood and Bate alike entirely overlook, qualifies his enthusiasm for industrial technology:

> In treating this subject, it was impossible not to recollect, with gratitude, the pleasing picture, which, in his Poem of the Fleece, the excellent and amiable Dyer had given of the influences of manufacturing industry upon the face of this Island. He wrote at a time

[278] Wordsworth, *Excursion*, 8.89-92, 105-129.
[279] As Underwood notes of this passage, industry is "interwoven with nature. Objectively it relies on waters and breezes 'lent' by the earth. Subjectively the gliding sail is integrated into the landscape....Even 'the smoke of unremitting fires,' which might have darkened this picture, 'Hangs permanent, and plentiful / As wreaths of vapour glittering in the morning sun'… Wordsworth's poetic relationship to nature thus turns out to be congruent, on several levels, with the productivist relationship to nature imagined by early nineteenth-century advocates of industrialization." *Work of the Sun*, 128.

> when machinery was first beginning to be introduced, and his benevolent heart prompted him to augur from it nothing but good. Truth has compelled me to [also] dwell upon the baneful effects of the ill-regulated and excessive application of powers so admirable in themselves.[280]

Unlike Dyer, Wordsworth can no longer merely celebrate canals and other engineering earthworks bored through the earth for the sake of commerce that anticipated steamboat and railway earthworks.[281] While Wordsworth still shares Dyer's admiration for the mechanical powers of industrial technology as "powers so admirable in themselves" (when not applied for industrial capitalist ends), Wordsworth can no longer merely celebrate them. Instead, Wordsworth dwells on "the baneful effects" of their "ill-regulated and excessive application." Counterbalancing Wordsworth's enthusiasm for industrialization is an ecological concern: while the new earthworks of "stately roads / Easy and bold" provide "easier links connecting place to place," in replacing footpaths, they also erase the "barren wilderness" of nature unmodified by earthworks that now penetrate England's "remotest glens." Wordsworth expresses an ecological concern regarding the unchecked and unregulated expansion of engineering earthworks that takes a form strikingly similar to that which he will later express regarding the projected railway penetrating Simplon Pass. Throughout the poem, Wordsworth identifies the baneful effects of this ill-regulated and excessive application of mechanical powers with the ecological damages of industrial capitalism: how "the green earth" is disfigured by "perpetual sacrifice" to "Gain, the master-idol of the realm" that is "industrious to destroy" the "green hill or bank of rugged stream." Bate is right that Wordsworth critiques the "new religion of capital" in developing the insight that "the earth is a single vast ecosystem which we destabilize" by industrial technology "at our peril."[282] Yet this ecocritical drive of Wordsworth's poetics emerges not out of a rejection of industrial technology from canals to railway earthworks but from Wordsworth's distinction between such powers as "so admirable in themselves" and his critique of their "excessive" and "ill-regulated" industrial capitalist application, in which industrial growth increases by unregulated laissez-faire market mechanisms without regard for ecological limits. Far from celebrating the productivist naturalization of limitless industrial capitalist growth, Wordsworth suggests that any truly green industry has to be regulated and scaled to terrestrial limits.[283]

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[280] Wordsworth, *Excursion*, 8.111-12n, in *Poetical Works*, vol. 5, 469.

[281] In *The Fleece*, 3.542-47, Dyer celebrated how engineers "teach / The stream a naval course, or till the wild / Or drain the fen, or stretch the long canal / Or plough the fertile billows of the deep," asking "Why to the narrow circle of our coast should we submit our limits" when we can cut new coastlines?

[282] Bate, *Wordsworth and the Environmental Tradition*, 40

[283] Wordsworth elaborates another instance of this unchecked industrial growth in the Lake Distinct in 1843. In the 1843 note to this passage in the *Excursion*, Wordsworth conjures up a nightmare vision of the Lake District in which every stream and body of water is fully harnessed to power capitalist millworks, disfiguring the landscape. Wordsworth expresses relief that the lack of coal in the Lake District diverted industrial development: "Happily, most happily, for these mountains" of the Lake District, the machinery was "transferred to open and flat countries abounding in coal, where the agency of steam" prevented "every torrent and river in this district" from being harnessed for the "power of the water that could there have been commanded" for "the banks of their beautiful streams." *Excursion* 8.87n, in *Poetical Works*, vol. 5, 468-69. Here the excessive and unregulated application of industrial technology takes the form of engineering earthworks that harness every river and torrent in the Lake District. Yet at the same time, Wordsworth does not oppose water or steam-powered engines, which the Excursion converts into the motive power of poetry in 4.550-58:

> Compatriot, Friend, remote are Garry's hills,
> The streams far distant of your native glen;
> Yet is their form and image here expressed

Wordsworth continues to more fully develop this ecocritical drive of his poetics in his 1830s-40s steamboat and railway poetry. In 1833, Wordsworth went on a steamboat tour of Scotland – including of Fingal's Cave, the subject of Turner's 1831 steamboat painting one year earlier – that occasioned his composition of a volume of steamboat poems, *Sonnets Composed or Suggested During a Tour of Scotland, in the Summer of 1833*. Wordsworth may have chosen the sonnet form for his steamboat and railway poems not only due to its reputation as among the most mechanical of verse forms but also because sonnets provided a verse form sufficiently compact to engineer while on a steamboat.[284] Wordsworth writes on the first page that the volume was "composed on a tour…by the steamboat."[285] If Wordsworth does not explicitly critique industrial capitalism in the terms that he adumbrates in the *Excursion* and develops most fully in his late railway poetry, the steamboat tour became the first major occasion for Wordsworth to grapple with the changing relation between industrial technology and nature with the rise of engineering earthworks of steamships and railways that increasingly reshaped the earth on a terrestrial scale. Eric Gidal rightly observes how in the 1833 volume Wordsworth explores how the "advent of steam locomotion… helped to reshape the geopoetic imaginary, pointing it as much towards an [industrial] future as away from a vanishing past." [286] The volume oscillates between extreme ecological pessimism and optimism in grappling with the rise of steamships and railways, as Wordsworth attempts to engineer a form of poetry adequate to reckon with and reshape the ecological impacts of industrial modernity.

> With brotherly resemblance. Turn your steps
> Wherever fancy leads; by day, by night,
> Are various engines working, not the same
> As those by which your soul in youth was moved,
> But by the great Artificer endowed
> With no inferior power.

Engines for Wordsworth power the imagination just as readily as streams. In replacing natural forces, mechanical powers provide abundant recompense for the loss of a pre-industrial relation to the earth ("Not the same / as those by which your soul in youth was moved," but of "resemblance" to nature's forces and moving the fancy with "no inferior power"). As Underwood rightly notes, "The soul-moving power of hills and streams is compared here to mechanical power...Imagination need never be idle, because the engines that power it are at work constantly and everywhere," which "blocks any systematic nostalgia for a pre-industrial world." Underwood, *The Work of the Sun*, 118, 123-24. The difference between these engines and those that Wordsworth imagines invading the Lake District and harnessing the power of every torrent and stream is how industrial capitalism disfigures their ecological relation to nature. Whereas the engines that power the imagination co-exist with the streams, allowing for the streams to largely retain their natural form, in attempting to harness all of the available motive power from the streams, industrial capitalism disfigures nature. Here we can begin to glimpse the consistency of this figurative logic over the course of Wordsworth's poetic career. Wordsworth articulates his anxieties about capitalist applications of railway earthworks by the same figurative logic of the scale of industrial technology's reshaping of the earth: "so much had art interfered with and taken the lead of Nature that their fellowship was put an end to." Industrial capitalism intensifies earthworks' unregulated and excessive reshaping of the earth without regard for nature itself. Any green industry – any ecological relation between technology and nature – is only possible for Wordsworth if art does not excessively interfere with or take the lead of nature to the extent that it transgresses nature's figurative autonomy.

[284] In a number of poems in the volume, Wordsworth draws attention to how he composed his sonnets while on a steamboat: "Stanzas Composed *in* a Steamboat." On rhyme (and the sonnet's) mechanical reputation, see Gerard Cohen-Vrignaud, "Rhyme's Crimes," *ELH* 82.3 (2015): 987-1012.

[285] See Turner, *Staffa, Fingal's Cave* (1831-32). Wordsworth, "Prefatory Note" to *Sonnets Composed or Suggested During a Tour of Scotland, in the Summer of* 1833, in *The Cornell Wordsworth: Sonnet Series and Itinerary Poems by William Wordsworth, 1820-1845*, ed. Geoffrey Jackson (Cornell University Press, 2004), 573, henceforth *SS*. Unless otherwise noted, all citations to Wordsworth's steamboat tour volume refer to this edition.

[286] Eric Gidal, *Ossianic Unconformities: Bardic Poetry in the Industrial Age* (Charlottesville, VA: University of Virginia Press, 2015), 161.

Wordsworth's steamboat poetry participates in the Romantic rise of steamboat ecotourism. As one Romantic steamboat engineer observed in 1816, "the number of passengers which now go in these boats, may seem incredible to those who have not witnessed it….Before the introduction of steam boats, the whole number of passengers in the common passage boats, did not, it is supposed, even in summer, exceed 50....But now, in fine weather, it is no uncommon thing for 500 or 600 passengers to go and come in the same day. One of these boats alone, has been known to carry 247 at one time. In the summer, the pleasure of the voyage, and the beauty of the scenery, attract multitudes...The scenery near Glasgow is mild and beautiful: it becomes bolder and more picturesque as the river descends."[287] By 1820, a *Steamboat Companion* to the part of Scotland that Wordsworth visited, one of many popular Romantic guides to steamboat eco-tourism that began to proliferate for every English waterway, held that "the very general use of steam vessels on our rivers and seas...have greatly diminished, if not wholly obviated, those obstacles which formerly rendered...tours so irksome and laborious." "Steamboats provide access" to "beautiful, romantic," scenery from the "romantic glen" to the "romantic and picturesque mill," to the "romantic grandeur" of rivers.[288] "Romantic" became a watchword for the aesthetic features of local ecology that the steamboat facilitated. How too, one might wonder, does one differentiate between the steamship's commodification of nature in the form of cheap ecotourism, and the legitimate heightened access to and communion with the natural world that the steamer makes possible, as Wordsworth and the Saint-Simonians hope?

Wordsworth begins his steamboat poetry on a hopeful note that nature and industrial technology can be reconciled that counters any ecological pessimism:

> Why should the Enthusiast, journeying through this Isle
> Repine as if his hour were come too late?
> For eye and mind, the present and the past
> With golden prospect for futurity
> If that be reverenced which ought to last.[289]

Despite the onset of industrial modernity, the poet need not worry that "his hour were come too late." Railways and steamships need not preclude a poetry of nature if that relation to nature "is reverenced which ought to last." Yet Wordsworth frames this possibility as a response to a felt sense of the loss of ecological relation that the steamboat volume struggles to overcome. Wordsworth's attempt to reckon with this ecological loss becomes most palpable in "Stanzas Composed in a Steamboat off Saint Bees' Head." Surveying how steamship and railway earthworks now terraform the globe, Wordsworth reflects that "much has Art gained thus linking short with shore." Yet the next line asks, "while each useful art augments her store / What boots the gain if Nature should lose more?"[290] What good is industrial growth if it comes at the expense of ecological loss, at least in its capitalist form in which steamships and railways threaten to excessively interfere with nature? Here we should recognize the heat signatures of the same ecological approach to industry that Wordsworth develops in the *Excursion* and in his late

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[287] Buchanan, *A Practical Treatise on Propelling Vessels by Steam*, 13-14.
[288] *The Steamboat Companion to the Western Islands and Highlands of Scotland* (Glasgow: Lumsden, 1820), ix-x, 2, 13, 15, 96, 105. On its frontispiece, the guide offered a "description of the scenery" of the "Western Islands and Highlands of Scotland," including Staffa, Iona, and the River and Frith of Clyde.
[289] Wordsworth, "II.," ll. 1-2, 13-14 in *ST*, 575.
[290] Wordsworth, "Stanzas Composed in a Steamboat," 28-29 in *SS*, 623.

railway poetry. Wordsworth worries that the steamship – and steam power more broadly – might block poetic feeling, leading to the loss of ecological relation with nature:

> This independence upon oar and sail,
> This new indifference to breeze or gale,
> This straight-lined progress, furrowing a flat lea
> And regular as if locked in certainty
> Depress the hours. Up, Spirit of the storm![291]

Zeroing in on the transition from wind to steam power, Wordsworth worries that steamship's "new indifference to breeze or gale" – steam power's autonomy from the natural forces of the wind in "this new independence" from "oar and sail" – will block any poetic feeling of nature. Like Romantic engineers at the time, Wordsworth reflects on the implications of the steamship and railway's power to progress in a straight line.[292] If here steam-power threatens to block poetic feeling, in other lines Wordsworth imagines that its mechanical powers fuel poetry:

> Or, adverse tides and currents headed,
> And breathless calms no longer dreaded,
> In never-slackening voyage go
> Straight as an arrow from the bow;
> And slighting sails and scorning oars,
> Keep faith with Time on distant shores?
>
> But oh! What transports, what sublime reward
> Won from the world of mind, dost thou prepare
> For philosophic Sage; or high-souled Bard.[293]

The very same figurative autonomy of the steamship from nature that Wordsworth worries will block poiesis in one poem Wordsworth celebrates in another. Here the steamship's very freedom from the wind allows for a newfound autonomy of poetic motion, which travels against "adverse tides and currents" and no longer dreads "breathless calms" to move in a linear progress "straight as an arrow from a bow" to "keep faith with Time on distant shores." Rather than reading these poems as merely contradictory, they attest to Wordsworth's deep ambivalence regarding poetry's role in shaping the changing ecological relation between technology and nature symptomatic of industrial technology's increasing autonomy from nature.[294]

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[291] Wordsworth, "Stanzas Composed in a Steamboat," 10-14 in SS, 622.

[292] See for instance, the steamboat engineer Robertson Buchanan's reflection on steam power's autonomy from the wind and waves in his *Practical Treatise on Propelling Vessels by Steam,* iii-iv, 6.

[293] Wordsworth, "To Enterprise," 17, 78-83, 85-87, 146, 149 in *SS*, 400. Wordsworth added these lines in 1832.

[294] In another poem in the sequence, "On the Frith of Clyde (In A Steam-boat)," Wordsworth initially worries that "this dull Monster and her sooty crew" will sever the ecological relation to "the peaks and ridges blue" before rejecting this feeling to realize that a "natural bond" between the steamship and the "stern mountains" – between the "boldest schemes" of industrial technology and nature's "humilities" – is still possible.[294] Wordsworth, "23. On the Frith of Clyde (In a Steam-Boat)," ll. 7, 10-12, in *ST*, 590. Gidal rightly notes how the poem "reconciles these contrasts" through "the conceit of a geomorphological harmony" to achieve an "abundant recompense" through the "industrial machines that have enabled his tour" and "so that nature" demonstrates the "necessary compromise with the engines of modernity" (*Ossianic Unconformities*, 161). While composing a poem "on the deck of the steamboat," Wordsworth worries that "not one" of the other passengers on the steamer's deck "seemed to notice the

"Steamboats, Viaducts, and Railways," one of the last and by far the best-known poem of the steamboat tour volume and one that Wordsworth and engineers alike will cite in the Windermere Railway Controversy, is widely taken to advance what Eric Gidal calls a "romantic narrative of global industrialization" in industrial technology's annihilation of space by time.[295] While often cited in passing, close readings of the poem are rare. Without reading the poem, Robert Carlisle takes the final lines of "Steamboats, Viaducts, and Railways" for the title and epigraph of his study of the Saint-Simonians' industrial socialism, suggesting that the poem epitomizes that movement. The poem ends by placing its hope in "time's triumph over space" through the steamship and railway:

> Motions and Means, on land and sea at war
> With old poetic feeling, not for this,
> Shall ye, by Poets even, be judged amiss!
> Nor shall your presence, howsoe'er it mar
> The loveliness of Nature, prove a bar
> To the Mind's gaining that prophetic sense
> Of future change, that point of vision, whence
> May be discovered what in soul ye are.
> In spite of all that beauty may disown
> In your harsh features, Nature doth embrace
> Her lawful offspring in Man's art; and Time,
> Pleased with your triumphs o'er his brother Space,
> Accepts from your bold hands the proffered crown
> Of hope, and smiles on you with cheer sublime.[296]

Romantic ecocriticism has been unable to reckon with Wordsworth's progressive view of industrial technology in the poem.[297] Yet the poem works to overcome precisely the binary opposition between industry and nature. Far from anti-ecological, in "Steamboats, Viaducts, and Railways," Wordsworth envisions the possibility of a green technology that would no longer "mar the loveliness of nature" that Romantic ecocriticism has entirely overlooked. Apostrophizing the "means and motions" of steamboats and railways – that at once metonymize industrial technology as a whole "at land and sea at war with poetic feeling" – Wordsworth rejects the ecological damage of industrial technology that "mars the loveliness of nature." Disfiguring the surface of the earth, the industrialization of land and sea with the steamboat and railway threatens to block poiesis. Industrial technology's "war" with poetry and nature is one

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magnificent [natural] objects with which they were surrounded" because their attention was so captivated by the human world of the steamship rather than nature. Yet the steamship does not prevent Wordsworth himself from noticing how "exquisitely beautiful" the crag is and composing a sonnet to it, and reflecting that the passengers are equally capable of appreciating nature by steam travel despite the "harsh features" of the steamship. Wordsworth, Note to "22. In the Frith of Clyde, Ailsa Crag," in *The Complete Poetical Works of William Wordsworth,* vol. 8., *1823-1833* (New York: Houghton Mifflin, 1919), 315.

[295] Gidal, *Ossianic Unconformities*, 180. See Robert Carlisle, *The Proffered Crown: Saint-Simonianism and the Doctrine of Hope* (Johns Hopkins University Press, 1987), suggesting a convergence between Wordsworth's and early socialist views of industrial technology.

[296] Wordsworth, "Steamboats, Viaducts, and Railways," in *SS*, 604.

[297] Eric Gidal, for instance, finds the poem's "Romantic faith in [technological] progress" in "jarring contrast" with Wordsworth's "environmental ethics." But are the two really at odds? *Ossianic Unconformities*, 164.

and the same to the extent that for Wordsworth "poetic feeling" is largely (if never exclusively) predicated on forces of nature, a natural world rapidly passing out of existence and no longer natural, refigured by railway earth-works. The "harsh features" of the railway and steamboat disfigure nature with machinery's rude, rough aesthetic. Yet Wordsworth continues to imagine how the antagonistic relationship between technology and the earth might be replaced by a commensalist one: how industrial technology might be reconciled with the earth as "nature's lawful offspring in man's art." "In spite of all that beauty may disown / In your harsh features," Wordsworth insists, "not for this, Shall ye, by Poets even, be judged amiss!" The lyric subject of the poem turns into the fissure that opens up between the "Steamboats, Viaducts, and Railways" of the title – the steamboat and railway's ecologically untenable material reality – and its future potential form that would be "nature's lawful offspring in man's art," a natural technology that would no longer disfigure nature.[298] This green industry is not the easy and uncritical naturalization that Underwood identifies with productivist ideology but an ecocritical asymptote of Wordsworth's poetics, a counterfactual "hope" of "future change" fueled by his dual fidelity to nature and to humanity. This reconciliation can only be achieved by poetry's remaking of industrial technology, by making poetic feeling anew. Poetry becomes the means necessary for "the Mind's gaining that prophetic sense / Of future change, that point of vision, whence / May be discovered what in soul ye are": a form of industrial technology that would be nature's "lawful offspring in Man's Art." The same industrialization of the face of the earth that threatens to block poiesis becomes the source of hope by the end of the poem: the "triumph" of "time" over terrestrial "space" made possible by the railway. Industrial technology for Wordsworth is itself ultimately a part of nature – "nature's lawful offspring through man's art" – that can only be reconciled with nature as a whole once it achieves an ecologically sustainable form.

Wordsworth reengineers poetry in "Steamboats, Viaducts, and Railways" so that it is capable of reshaping industrial technology by extending poetic feeling to include industrial technology itself. The very act of apostrophizing steamboats and railways as the lyric subject – of extending "poetic feeling" to industrial technology by making steamboat and railway poetry – demonstrates that poetic feeling and industrial technology are not incompatible and works to overcome how industrial technology threatens to block poiesis in the opening lines, retooling and extending the poetics that Wordsworth formalizes in the Preface for industrial modernity. Mobilizing the figurative technologies of the lyric, Wordsworth's tropic language works to extend poetic feeling to industrial technology as "means and motions" with a "soul" (so that the mechanical power of the railway and steamboat converges with and fuels poetic emotion, in that it precipitates the occasion of the poem). Wordsworth's retooling of Romantic poetry so that it extends to the "harsh features" of the steamboat and railway becomes the material precondition for any poetry capable of working towards a reconciliation of technology with nature.

Wordsworth's attempt to pioneer an alternative form of green technology spanning poetry and technology that would combat the ecological crises precipitated by industrial capitalism achieves its fullest manifestation in his late 1844 railway poetry and protest of the expansion of the Kendall and Windermere railway into the Lake District.[299] What Scott Hess

[298] As Marjorie Levinson notes in regards to industrialization, the most powerful generalizations of Wordsworth's poetics are fueled by the need to work through "some disturbing particular," here how industrial technology mars nature. *Wordsworth's Great Period Poems*: *Four Essays* (Cambridge UP, 1996), 1-2.

[299] For an overview of Wordsworth's role in the controversy, see John Edwin Wells, "Wordsworth and Railways in 1844-1845," *Modern Language Quarterly* 6.1 (1945): 35-50; James Mulvihill, "Consuming nature: Wordsworth and the Kendal and Windermere Railway Controversy," *Modern Language Quarterly* 56.3 (1995): 305-327.

calls Wordsworth's "environmental protest" of the expansion of the railway is widely considered to mark the nineteenth century origins of the environmental movement.[300] If a few critics have noted in passing that Wordsworth is not opposed to the railway, Wordsworth's protest of the expansion of the Windermere railway remains widely conflated with a reflexive anti-industrialism.[301] Romantic ecocriticism has entirely overlooked how Wordsworth develops a specific ecological critique of railway capitalism rather than the railway as a whole in pioneering an alternative ecologically sustainable form of industry. Wordsworth's railway poetry and writings are best understood in the context of his close engagement with railway engineering and enthusiasm for the Romantic potentials of the railway. Wordsworth ends his final letter protesting the expansion of the Windermere Railway with "Steamboats, Viaducts, and Railways," writing that "The utility [of the railway], especially as expediting the communication between England and Ireland, more than justifies the labours of the Engineer…Once for all let me declare that it is not against Railways but against the abuse of them that I am contending. How far I am from undervaluing the benefit to be expected from railways in their legitimate application will appear from the following lines published in 1837."[302] In 1844, Wordsworth at once protested the "superabundance of capital in railway mania" exemplified by the expansion of the Kendall and Windermere Railway into the Lake District and enthusiastically supported how "Railways and all the mechanical achievements of this day are doing wonders for the next generation; indeed, it is the appropriate work of this age and this country, and it is doing it gloriously. That anxious money-getting spirit which is a ruling principle in England, and a passion and a law in America, is doing much by exhausting itself; we may therefore look forward with hopeful trust."[303]

Wordsworth's protest of the expansion of the Windermere Railway into the Lake District began in a critically overlooked railway engineering context that marked the rise of railway capitalism. On October 15, 1844, Wordsworth wrote letters to William Gladstone, The President of the Board of Trade, who was in charge of approving the construction of new railways, and to the prominent engineer Charles William Pasley, Gladstone's Inspector General of Railways. In his letter to Gladstone, Wordsworth included his poem "On the Projected Kendal and

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[300] Jonathan Bate argues that with the railway, "Wordsworthian ecology" gave rise to "a broader – and indeed an explicitly political – nineteenth-century environmental tradition… Wordsworth in his letters on the projected Kendal and Windermere Railway" explored the environmental effects of railway excursions" in *Wordsworth and the Environmental Tradition*, 51. Scott Hess calls Wordsworth's "opposition to the railways in the name of landscape aesthetics" the "world's first environmental protest" that "provided an important precedent for various defense of the Lake District that would follow and for the development of an environmental movement overall." *William Wordsworth and the Ecology of Authorship: The Roots of Environmentalism in Nineteenth-Century Culture* (University of Virginia Press, 2012), 116. Other ecocritical readings of Wordsworth's role in the controversy include Kate Rigby, *Topographies of the Sacred: The Poetics of Place in European Romanticism* (University of Virginia Press, 2004), 88 and James McKusick, *Green Writing: Romanticism and Ecology* (New York: St Martin's Press, 2000), 74-76.

[301] McKusick, for instance, asserts that Wordsworth "deplores the introduction of industrial machinery" and is flatly "against the railway" as a whole in *Green Writing*, 74; Hess likewise reads Wordsworth's environmental protest as opposing a monolithic "industrial progress" that he conflates with industrial "capitalists" in *William Wordsworth and the Ecology of Authorship*, 116, 121.

[302] Wordsworth, Letter to the Editor of the *Morning Post*, December 20, 1854, in *The Prose Works of William Wordsworth*, vol. 3., eds. W.J.B. Owen and J.W. Smyser (Oxford, 1974), 355.

[303] Wordsworth, October 6, 1844, quoted in Caroline Fox's *Memories of Old Friends,* vol 1. (London: 1882), 194-95, in *The Letters of William and Dorothy Wordsworth*, vol. 7, 616.

Windermere Railway."[304] "Pleading the cause of the Lake Scenery against the proposed Kendal and Windermere Railway, and sending a sonnet on the subject," in the letter's title, Wordsworth traces the problem with the expansion of the railway to "the excesses to which the Railway Mania drives people on the present superabundances of capital" that would "destroy the staple of the [Lake] Country," its landscape.[305] The Railway Mania that Wordsworth critiques specifically refers to the exponential expansion of the railways that began with the unprecedented number of railway bills (44 of them) that Gladstone approved in the 1844 session of parliament, authorizing the construction of 890 miles of railway tracks. In 1844-45 alone, the total mileage of railway lines in England doubled. In one year, more railways were built than in the previous thirty combined.[306] The projected Kendal and Windermere Railway was proposed in 1844 amidst this Railway Mania, though not yet approved. Henry Tuck's 1845 *Railway Shareholder's Manual; Or Practical Guide to All the Railways in the World, Completed, in Progress, and Projected* charted the rise of the 1844-45 railway capitalism to which Wordsworth refers in precisely the language that Wordsworth deploys. Marveling how "the superabundance of capital that has shown itself so prominently in this country within the last few years, and has at length sought employment in new sources of industry, is the fruit of the extension of the railway system," Tuck reflects that the "The astonishing number of projected railways which have been recently brought before the public...will render the year 1845 unparalleled in the history of railway enterprise." By Tuck's count, one year alone saw the formation of "1263 railway companies requiring for construction a capital of 563,000,000*l*."[307] The Railway Mania of 1844-45 that Wordsworth critiques marked the formation of the first major railway corporations, which rapidly became the largest corporations in Great Britain and the world, at precisely the historical moment that railway historians have identified as the rise of railway capitalism that marked the turning point between the railway as a public works project and the rapid expansion of corporate railways, as thousands of miles of earthworks proliferated with new railway projects.[308]

While the Kendall and Windermere Railway had not yet been approved, Wordsworth requested Gladstone's support in opposing the proposed extension of the railway into the Lake District. Despite approving many new railway lines in 1844, Gladstone shared Wordsworth's critique of railway capitalism. In fact, shortly before Wordsworth's letter, Gladstone's Railway Regulation Act had just passed in the August 1844 session of Parliament, the first major railway

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[304] Critical accounts of Wordsworth's railway protest have entirely overlooked the railway engineering context of Wordsworth's initial letters and typically begin with Wordsworth's railway sonnets or letters to the *Morning Post*.
[305] Wordsworth to Gladstone, October 15, 1844; Wordsworth to Charles William Pasley, October 15, 1844, *The Letters of William and Dorothy Wordsworth*, vol. 7, 615-618.
[306] For these statistics, and background on Gladstone's Railway Regulation Act, See P.J.G. Ransom, "The Railway Mania, and After," in *The Victorian Railway and How it Evolved* (London: 1990), 79-111, especially 81-85.
[307] Henry Tuck, *The Railway Shareholder's Manual; Or Practical Guide to All the Railways in the World, Completed, in Progress, and Projected* (London: 1845), iii; 1846 edition, xvii, xx.
[308] The centrality of railway corporations in the rise of industrial capitalism cannot be overstated. As economic historian Geoffrey Channon sums up, railway companies were the first large corporations and the largest private corporations in the nineteenth century that marked the formation of the "corporate economy." The sheer statistics are overwhelming. By 1850, there were "very few companies in the manufacturing and extractive sectors with assets of more than 500,00 pounds. In the British railway industry, by contrast, 19 companies had raised more than 3 million by 1850." The Midland Railway and London and Northwestern Railway were two of the world's three largest corporations at the time. By 1850, railway companies were "the most heavily capitalized businesses in the United States and in Britain." Geoffrey Channon, *Railways in Britain and the United States, 1830-1940: Studies in Economic and Business History* (Ashgate: 2001), 24-25.

regulation bill that sought to check the rise of railway capitalism.[309] Surprisingly radical, the initial version of the Railway Regulation Act that Gladstone proposed in Parliament called for the state purchase of railways that would have effectively nationalized railway corporations out of existence and rendered railways a public works project. This provision was too radical for Parliament, which deleted it. The final version of the bill that passed shortly before Wordsworth's letter had a mixed impact. On the one hand, Gladstone's Act required that all railway companies run regular third-class parliamentary trains that met certain minimum standards, which significantly improved travel conditions for working class passengers. Yet in the defeat of the initial bill's attempts to nationalize railways as public works projects, railway historians have shown how it at once paved the way for "wild speculation in railway proposals…and for construction of the nation's railway system on principles of laissez-faire."[310]

From his very first correspondence with Gladstone and the engineer and Inspector General of Railways Charles Pasley on the subject, Wordsworth framed his environmental protest of the expansion of the Windermere Railway as a critique of the ecological effects of the rise of railway capitalism, what he called "the superabundances of capital" invested in "Railway Mania."[311] From the outset, Wordsworth's and William Gladstone's correspondence was framed in terms of engineering discourse, concerning the figurative logic of railway earthworks. Responding to Wordsworth's October 15 letter, Gladstone replies to Wordsworth:

> It had been my hope that Orrest Head, and other like projections on the earth's surface, would have pleaded for themselves in terms intelligible to engineers and speculators – in other words that the expected traffic between Kendal and Windermere, when compared with the natural obstacles to be overcome, would not have sustained the project of a Railway. You will observe that I do not refer to this as a reason preferable to yours, but as one which would more readily have brought about that practical solution of the question which you desire.[312]

Wordsworth's and Gladstone's letters frame the railway as engineering earthworks, as "projections on the earth's surface" in "the terms of engineers and speculators." The main difference between Wordsworth's and Gladstone's approach to the railway is that while Gladstone hopes that financial and engineering obstacles will be sufficient to halt the expansion of the railway into the Lake District, for Wordsworth, the engineering terms need to be combined not only with the terms of speculators but in the more poetic terms of the formal and figurative impacts that "the superabundance of capital" has on the ecological form of railway projections on the earth's surface. Wordsworth frames his critique in terms of how the unchecked and excessive capitalist expansion of the railway threatens to "disfigure" the face of the earth.

Wordsworth elaborates on this geopoetics in his poem "On the Projected Kendal and Windermere Railway" that he sent to Gladstone and published in the *Morning Post*, entering into the public debate on the Windermere Railway. The *Morning Post* introduced Wordsworth's poem as an inquiry into the ecological effects of the "cutting and blasting" of railway earthworks, adding "that perhaps no living man, except the venerable Poet-Laureate, could have

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[309] Gladstone's Railway Regulation Act passed and was published on August 9, 1844.
[310] P.J.G. Ransom, *The Victorian Railway and How it Evolved*, 85.
[311] Wordsworth to Charles Pasley, October 15, 1844, *Letters of William and Dorothy Wordsworth*, vol. 7, 617.
[312] William Gladstone to Wordsworth, October 19, 1844, in *The Letters of William and Dorothy Wordsworth*, vol. 7 1840-1853 ed. Alan Hill (Oxford, 1988), 616.

infused the spirit of poetry into so unromantic a subject as a railroad" (a judgment quickly belied by the many railway poems that would soon answer Wordsworth's):

> Is there no nook of English ground secure
> From rash assault? Schemes of retirement sown
> In youth, and mid the busy world kept pure
> As when the earliest flowers of hope were blown
> Must perish; – how can they this blight endure?
> And must he too the ruthless change bemoan
> Who scorns a false utilitarian lure
> Mid his paternal fields at random thrown?
> Baffle the threat, bright Scene, from Orrest-head
> Given to the pausing traveller's rapturous glance:
> Plead for thy peace, thou beautiful romance
> Of nature; and, if human hearts be dead,
> Speak, passing winds; ye torrents, with your strong
> And constant voice, protest against the wrong.[313]

The papers in which "On the Projected Kendal and Windermere Railway" was published were saturated with countless notices for new projected railway projects approved in 1844. Imagining the earth's surface terraformed by railway earthworks, Wordsworth projects an image of every inch of English ground disfigured, as the new railway lines approved for construction in 1844 threaten to leave "no nook of English ground secure / From rash assault" including Orrest Head, the proposed site of the extension of the railway into the Lake District. Urging that the poem is no mere "poetic effusion" for those who "enter into the strength of the feeling," Wordsworth elaborates on the ecological effects of railway capitalism in the note accompanying the poem that imagines the loss of a "magnificent tree" that railway corporations force a local yeoman to "fell for profit's sake" in clearing the land for railway earthworks. Yet Wordsworth protests not the railway but the ecological effects of the "ruthless change" of the "rash assault" of railway capitalism whose unchecked, excessive expansion in the railway mania of 1844 cuts through "fields at random," disfiguring the "beautiful Romance of nature" and in turn threatening the railway tourist's "rapturous glance" of "the bright scene," in one of the first uses of scenery in English. Railway earthworks for Wordsworth are not incompatible with natural beauty but rather their unchecked capitalist expansion that disfigures the "beautiful Romance of Nature."[314] In fact, a few days before composing the poem, Wordsworth wrote the publisher Edward Moxon urging him to publish a railway guide that would enable railway passengers to appreciate the natural beauty of the landscape from the railway line. Wordsworth writes Moxon: "Is there in existence a railway guide, to answer the purpose of Paterson's Book of Roads? if not, I think it might answer for you to publish one. I have long wished that you had some book or Books like Murray's hand-books for regular and constant Sale...It ought to express by small drawings the object signified...a conspicuous hill, brook or river, or any other prominent object, marking its

[313] Wordsworth, *Morning Post*, October 16, 1844.

[314] Jonathan Bate rightly notes in passing of this line that "it was to the rash assault that Wordsworth objected" rather than the railway itself. Yet Bates reads the rash assault in terms of mass tourism rather than the ecological effects of industrial capitalism on the earth itself. *Wordsworth and the Environmental Tradition*, 50.

distance from the line."[315] As Scott Hess rightly observes of "There is no nook," Wordsworth's protest is mediated through landscape aesthetics, if we understand landscape aesthetics in more capacious terms than Hess does to include engineering earthworks. Wordsworth frames his protest in the language of natural beauty and its disfiguration (the "bright scene" of "the beautiful Romance of nature"). Yet against Hess's contention that Wordsworth's environmental protest is "aesthetic rather than ecological," the aesthetic – specifically, the form that earthworks take – for Wordsworth mediates ecological critique. The form and figure of the earth become the grounds for a critique of the ecological damage of industrial capitalism.

"On the Projected Kendal and Windermere Railway" was widely reprinted and elicited many responses in newspapers around the country in October and November 1844.[316] Initial responses to Wordsworth with titles like "Poetry vs Railways" and "Poetry versus Engineers" were highly polarized along industrial and environmental lines, situating Wordsworth in the middle of a critically overlooked debate regarding the ecological effects of the terraforming of the earth that anticipates the chasm in Romantic ecocriticism between industry and ecology that Wordsworth's green industry bridges. On October 24, *The Bradfield Observer* reprinted what it called Wordsworth's "opposition in verse" to the projected railway with the header "Poetry and Poets v. Engineers and Railways."[317] The October 26 reply to Wordsworth in the *Northampton Mercury* titled "Poetry versus Railways" began by reprinting "On the Projected Kendal and Windermere Railway" and reflecting that "Mr. Wordsworth is not the only poet who feels that the mighty 'motions and means' of late years 'war with old poetic feeling,'" (referencing the opening of "Steamboats, Viaducts, and Railways" yet overlooking its ecological hopes), reprinting a railway poem by Leigh Hunt that took a more aggressively anti-industrial stance towards the ecological impacts of the railway than Wordsworth's poem:

> Far be the railroads from this quiet spot,
> Cutting its heart through; – far that anti-farness;
> Trampling all peaceful places into forced
> And iron neighborhood; making all towns
> O'ertake all country with their shoes of swiftness
> That stamp their tyranneous tracks in steel for ever;
> Killing the green, the loneliness, the poetry.
> Oh leave us some small solitude, Improvement;
> Improve us not into extremes that make
> Anti-improvement; nor for earth's fair body
> Bring up the dry bones of its iron skeleton,

[315] Wordsworth to Edward Moxon, September 30, 1844, in *The Letters of William and Dorothy Wordsworth*, vol. 7 1840-1853 ed. Alan Hill (Oxford, 1988), 607. Railway and steamboat guidebooks rapidly proliferated in the 1830s-40s, including *The Railway Companion* (1833) and the *Steamboat and Railway Companion* (1847).

[316] Shortly after its publication in the October 16, 1844 *Morning Post*, "On the Projected Kendal and Windermere Railway" was widely reprinted in newspapers around the nation, including the *Morning Chronicle* on October 17, the *Westmorland Gazette* on October 19 and the *Leeds Mercury* and *Sheffield Independent* on October 26. Over October through December, responses to Wordsworth's poem (and subsequent letters) proliferated in newspapers around the country, including the *Northampton Mercury, Bradford Observer, Hereford Journal, Westmoreland Gazette, Preston Chronicle,* and *Hull Packet*.

[317] "Poetry and Poets v. Engineers and Railways," *The Bradfield Observer*, October 24, 1844, 7.

Till all be a machine and a hollow heart.[318]

Hunt's poem imagines how the railway disfigures the earth, "killing the green" and "the poetry" with its tracks stamped in steel that turn the "earth's fair body" into "a machine and a hollow heart."[319] Harvey Coleridge defended Wordsworth's ecological concern for rocks and stones and trees in his railway poems in a letter to the *Kendal Mercury*. For Coleridge, Wordsworth protested the expansion of the railway into the Lake District "not for himself, but for nature," "for the stones, and the trees" and the "rock which must be blasted" in forming railway earthworks.[320] At the opposite extreme, a response to Wordsworth in the *Morning Chronicle* titled "Poetry against the World" ridiculed how "The Poet Laureate has written a sonnet to prevent the Windermere Railway! A line of fourteen miles is to be stopped by fourteen lines of metre! And science must yield to sentimentality. Trains of people are not to interfere with trains of thought…Hills are before human hearts, and streams of water before streams of intelligence. Trees are divinities, before which it is fitting that men should fall down and worship them." Weaponizing Wordsworth's note on the deforestation prompted by railway earthworks, the author castigates the "the lake-school" as "tree-worshipers." Dismissing the ecological defense against railway earthworks as the pure poetic effusions of tree-worshipers, the author calls for achieving Wordsworth's "beautiful romance of nature" through more terraforming: "If lakes and mountain scenery be really necessary to elevate the mind of man, and draw him from his grosser indulgences, let the 'sons of art' [engineers] raise artificial hills and make their mill-ponds into lakes," building artificial lakes and mountains so that the "*true* romance of nature may be reserved for the truly romantic," suggesting that Wordsworth's concern for the purity of the landscape emanates from a sentimental position of class privilege rather than ecological concern. We can glimpse an emerging dichotomy between utilitarian reason and poetic feeling (the "poetic effusions" of "tree-worshipers") that Wordsworth himself soon rejects at the center of the debate regarding the industrial benefits and ecological effects of terraforming the earth.[321]

Wordsworth's railway sonnet sparked a series of railway poems for and against the Windermere Railway with titles like "The Poet and the Railroad." Remarking on how the "effusion of Wordsworth…had created quite a poetical controversy," papers printed railway poems in reply to Wordsworth.[322] Like Leigh Hunt's railway poem, one "Sonnet to William Wordsworth" defended the poet's ecological mobilization of "mountain, stream, and glen," against "a proud world enslaved to gain."[323] Other railway poems opposed Wordsworth's railway sonnet, which one paper mobilizing its own lines of railway verse against "On the Projected Railway" called "an effusion of an overstrained sentimentality" better "confined to the rhymes of dandy poetasters" than one of the "great luminaries of our generation."[324] One railway

[318] "Poetry versus Railways," *Northampton Mercury*, October 26, 1844, 4. The lines quoted in the *Mercury* are from Leigh Hunt's "Rustic Walk and Dinner," first published in *The Monthly Magazine* (1841), 240.
[319] Yet the *Mercury* concedes that "there is much to be said…even by poetry, on the other side of the question," noting that the railway at once provides access to what Wordsworth calls the "beautiful Romance of nature" and allows for poetry while disfiguring the landscape less than poem suggests.
[320] Hartley Coleridge, "Windermere Railway," *Kendal Mercury*, November 20, 1844.
[321] "Kendal and Windermere Railway. Poetry Against the World," *Morning Chronicle*, October 23, 1844, 3. Emphasis in original.
[322] "The Poet Laureate and the Windermere Railway," *Hull Packet*, November 15, 1844.
[323] "Sonnet to William Wordsworth, Occasioned by his Letter on the Contemplated Lake Railroad." *Morning Post*, December 18, 1844.
[324] "The Poet and the Railroad," *Preston Chronicle*, October 19, 1844.

sonnet responding to Wordsworth argued that even though "the poet's feeling should bewail the change" with the railway, "art must pursue the triumphs of its might" even if every "sequestered nook" is "torn from nature's book" by forming earthworks. Another striking railway poem opened, "O thought unworthy of the poet-sage! / Can the most lovely of terrestrial scenes / Be marred, when human science intervenes / To place the marvels of a recent age, By God's old grandeurs?" Such railway poems that naturalized how the earth cannot be marred by industry – as its newfound mechanical powers unlocks "earth's full glories" as the "long-tameless elements of nature" serve "as man wills / To bear him mighty loads" on "thought-swift" railway trains – at once mark the rise of an emerging line of railway poetry that Wordsworth contributes to and measure the distance between Wordsworth's green industry and any productivist naturalization of industry.[325]

The highly polarized nature of the initial responses to "Is there no nook" that oversimplify the poem's environmental protest cast the distinctiveness of Wordsworth's own position between such poles into relief. Wordsworth's friends Barron Field, Hartley Coleridge, and Henry Crabb Robinson were some of the few that grasped how the ecocritical drive of Wordsworth's poetics could not be reduced to either of these anti-industrialist or productivist extremes. Hartley Coleridge noted how Wordsworth's ecological concern for rocks and stones and trees did not amount to a rejection of the railway as a whole. In a letter to Henry Crabb

[325] "The Poet and the Railroad," *Preston Chronicle*, November 9, 1844. Following up on its October article with the same title, the Chronicle printed "the following sonnets…in reply to that of Mr. Wordsworth, which we published and commented on the 19th of October." Like Wordsworth's own railway poetry, many of the often untitled and anonymous railway poems were widely reprinted in papers around the nation. Some of the most striking responses to Wordsworth pushed back against the notion that the natural beauty of the Lake District was disfigured by the "rude features" of the railway. One railway poem opened: "The hour may come, nay must in these our days / When the harsh steam-car with the cataract's shout /Shall mingle its swift roll, and motley rout / Of multitudes these mountain echoes raise." Monckton Milnes, "Projected Railways in Westmoreland, in Answer to Mr. Wordsworth's Late Sonnet," *Whitehaven Herald*, November 30, 1844. Drilling holes in the aesthetic category of natural beauty, the railway sonnet contends that "the rude features" of the railway "steam-car" and its working-class passengers would harmonize with rather than disfigure the Lake District's rude cataracts and mountains. The Lake District's scenery could no more be corralled into the aesthetics of the picturesque than the railway itself. Some took the opposite approach of elevating the railway as an aesthetic object and object of poetry. The notion that effect of "the railway into the Lake District will be to alter its character and deform it…seems to me hardly fair. To many, a railway through a hilly country is a highly interesting object, as an exhibition of human skill, and with its bridges and viaducts even picturesque…This country combines a bold rudeness of scenery with finished beauty; the one exhibited, in the highest grounds, the fells, the mountain ridges, and in the lower valleys" so that a railway through the mountains "could hardly fail being...a sublime object, and eminently picturesque." "Kendal and Windermere Railway," *Westmoreland Gazette*, November 23, 1844. Another asked, "Even as a picturesque object, in what is a locomotive inferior to a stage wagon" or "a cultivated farm to a barren morass?...We would put it to Mr. Wordsworth himself in his more practical moods, whether the romantic beauties of his own region would be injured by the railway," which is no less poetic than "the rocks of untouched wilderness. "The Poet and the Railroad," *Preston Chronicle,* Oct 19, 1844.Wordsworth himself would grant as much, and not only in his more practical-mechanical moods. While these responses do much to open up the poetics of the railway, and are theoretically sound insofar as the railway is regarded merely as a conventional aesthetic object, their aesthetics remain phenomenological and fail to grasp the materiality of Wordsworth's natural beauty. Wordsworth objects not to the railway as an aesthetic object – as these responses suppose – but to the effects of its industrial capitalist application on the aesthetic form of the landscape itself. It is not that for Wordsworth the railway inherently disfigures the beauty of the Lake District by its mere presence (since Wordsworth promotes the railway as a means of access to natural beauty in his letter to Moxon and maintains that the "harsh features" of steamboats and railways can harmonize with nature), but rather that in physically deforming the environment through tunnels, embankments, viaducts, and railway lines, the industrial capitalist mode of forming railway earthworks threatens to materially disfigure the landscape.

Robinson on Oct 21, 1844, Barron Field registered his preference for the 'philosophy' of "Steamboats, Viaducts Railways," over that of 'Is there no nook,' suggesting that the former had to be read in the larger context of Wordsworth's attempt to reconcile industry and nature in the latter. Robinson then wrote to Mary Wordsworth on Nov 6, 1844: "I admire this Sonnet ["Is there no nook"] too, but it is not so wise as the philosophical 'motions & means on Land & Sea at war.'"[326] Expressing a preference for the more nuanced green industry of Wordsworth's "Steamboats, Viaducts, Railways" that Wordsworth's readers had overlooked, Field and Robinson both insisted that Wordsworth's verse protest of the railway had to be read in the larger context of the ecocritical drive of his poetics towards an ecologically sustainable form of industry, which Wordsworth himself would soon call for in redeploying "Steamboats, Viaducts, and Railways" in his letters protesting the expansion of the Kendal and Windermere Railway.

Firing back against how his railway poetry had been misread as "Poetry v. Railways" or "Poetry v. Engineers," Wordsworth responded to his critics in two letters in the December 11 and December 20 *Morning Post,* exploding any such binary logic in clarifying his position on the railway and advancing a fuller critique of railway capitalism made possible by what he identifies as an ecocritical view of nature new to Romantic poetry. Wordsworth elaborates on what he calls the "beautiful Romance of nature" in "Is there no nook" as a "romantic" view of ecology of "recent origin" with Romantic poetry. Much like many the railway sonnets responding to "Is there no nook," pre-Romantic poetry had often depicted nature only as an industrial resource without any poetic feeling for the "beauty" of "romantic scenery" "undisfigured" by industry that leads to an ecological view of nature. [327] Particularly striking is Wordsworth's self-conscious periodization of Romantic poetry. Mobilizing this new figurative logic of Romantic poetics, Wordsworth advances an ecological critique of how railways built solely for the "the profit of the shareholders" of "railway companies" increasingly "disfigured" the surface of the earth, with "the beauty" of the "Lake District" defaced by railway earthworks as other districts were disfigured by "mines" and "quarries."[328] The "intrusion of a railway with its scarifications, its intersections, its noisy machinery, its smoke," Wordsworth writes, "in some places greatly impair the characteristic beauty of the country," disfiguring the face of the earth. [329] Yet rather than opposing Romantic poetry to the railway, Wordsworth overturns the binary logic of many of his critics by conjoining the two in an ecological view of industry over against the narrow utilitarianism of railway capitalism that sacrifices nature for industrial development regardless of ecological cost. While the "utility" of railways "especially as expediting the communication between England and Ireland, more than justifies the labours of the Engineer," Wordsworth concludes that "not so would it be with the Lake District" because railway lines in sufficient proximity already exist and further railways would only disfigure the region's beauty.[330] Wordsworth concludes the letter by insisting that he is not against the railway or insensitive to its utopian potentials: "Once for all let me declare that it is not against Railways but against the

[326] Barron Field to Henry Crabb Robinson, October 21, 1844; Henry Crabb Robinson to Mary Wordsworth, November 6, 1844, in *The Prose Works of William Wordsworth*, vol. 3, eds. W.J.B. Owen and Jane Worthington Smyser (Oxford University Press, 1974), 366.
[327] Wordsworth, December 11, 1844 Letter to the Editor of the *Morning Post*, *Prose Works*, 341-342.
[328] Railway developers sometimes used the presence of mineral resources as a justification for new railway projects. Hence, much as in his note the *Excursion*, Wordsworth argues that "in this district the manufactures are trifling; mines it has none, and its quarries are either wrought out or superseded" and that the "main staple of this country is its beauty," 340-341.
[329] Wordsworth to the Editor of the *Morning Post*, Dec 16 and Dec 20, 1854, *Prose Works*, 340, 346, 353, 356.
[330] Wordsworth to the Editor of the *Morning Post*, Dec 20, 1854, *Prose Works*, 355.

abuse of them that I am contending…How far I am from undervaluing the benefit to be expected from railways in their legitimate application will appear from the following lines published in 1837," including "Steamboats, Viaducts, and Railways" in the letter, a benefit that ultimately extends to the hope of a green technology in a commensalist or congruent relation to the earth.[331]

What exactly does Wordsworth consider to be the abuse of the railway, and the potential benefits of its legitimate application? Wordsworth clearly identifies what he calls the "abuse" of the railways with its industrial capitalist application in the Railway Mania of 1844: railways built solely in the "interests of trade" and "in the pursuit of wealth, without regard to the good or happiness of others" that exist merely to increase the "wealth…accumulating by trade and manufactures," disfiguring the earth solely for the maximization of profit.[332] Wordsworth includes one more railway poem in his letter critiquing the ecological damages of the "thirst for gold" in railway capitalism that "rules over Britain like a baneful star":

> Proud were ye, Mountains, when in times of old,
> Your patriot sons, to stem invasive war,
> Intrenched your brows; ye gloried in each scar:
> Now, for your shame, a Power, the Thirst for Gold,
> That rules over Britain like a baneful star,
> Wills that your peace, your beauty, shall be sold,
> And clear way made for her triumphal car
> Through the beloved retreats your arms unfold!
> Her ye that Whistle? As her long-linked Train
> Swept onwards, did the vision cross your view?
> Yes, ye were startled; – and in balance true,
> Weighing the mischief with the promised gain,
> Mountains, and Vales, and Floods, I call on you
> To share the passion of a just disdain.[333]

In his late railway poetry, Wordsworth diagnoses the environmental crises precipitated by the industrial capitalist form of railway earthworks. The railroad makes "clear way" for the "triumphal car" of the "long-linked Train" cutting and blasting through mountains, disfiguring the landscape to maximize profit. Here the spatial extension of the straight line of the long-linked Train cuts through the landscape solely "in pursuit of wealth without regard for the good or happiness of others." The "beauty" of the mountains is "sold" by the cutting and clearing of the land for railway embankments to make way for the railway car. Weighing the "promised gain" of the railway "in the balance" against its ecological costs, the poem apostrophizes the Lake District's Mountains, and Vales, and Floods to testify against the proposed railway earthworks that would cut through them. Wordsworth envisions how "the profit of the shareholders" of "railway companies" can lead "in many places to a destruction of the beauty of the country, which the parties are in search of" with the "the molestation of cheap trains pouring out their hundreds at a time along the margin of Windermere."[334] These cheap trains refer not merely to

[331] Wordsworth to the Editor of the *Morning Post*, Dec 20, 1854, *Prose Works*, 355.
[332] Wordsworth to the Editor of the *Morning Post*, Dec 16 and Dec 20, 1854, *Prose Works*, 346, 353, 356.
[333] Wordsworth to the Editor of the *Morning Post*, Dec 20, 1844, 356.
[334] Wordsworth to the Editor of the *Morning Post*, December 16 and December 20, 1854, in *The Prose Works of William Wordsworth*, vol 3., eds. W.J.B. Owen and J.W. Smyser (Oxford, 1974), 346, 353, 356.

third class cars but to a specific capitalist form of railway earthworks. With the railway mania that began in 1844, railway design cheapened along many lines, so that railway earthworks that were previously built of local earth and rocks that were minimally ecologically disruptive were increasingly replaced with cheaper imported building materials that were far more aesthetically and ecologically disruptive to the local environment.[335] In fact, Charles Pasley, the Inspector General of Railways whom Wordsworth petitions in protesting the expansion of the Kendall and Windermere Railway into the Lake District, at the time had a reputation for ensuring that railway earthworks were soundly constructed, but would later lose his position in 1846 because of his cheap and unsound earthworks hastily constructed during the Railway Mania.[336]

These "cheap trains" at once relied on a figurative logic that Wordsworth calls "straight-lined progress," which became a point of contention between ecologically conscious engineers and those solely interested in maximizing the railway's profit. Over the early 19th century, railway engineers and industrial capitalists quickly came to realize that the shortest distance between two points on the railway was a straight line.[337] "Progress" was the term that Romantic engineers used to refer to the spatial extension of the railway line. A railway that progressed in a straight line maximized its commercial efficiency by minimizing the distance travelled, so that hundreds of cheap trains could transport commodities to produce the maximum surplus value. Narrowly applied for industrial capitalist ends, this figurative logic literally disfigured the surface of the earth. As one Romantic engineer wrote, "we have excavated, and even embowelled the earth...in multiplying or improving these latter channels of communication." "We double head-lands, and take large offings in our progress from one spot to another, as though the earth was an element which could be traversed only, subject to the same endless windings and reduplications of our course as the ocean." "Instead of toiling up, or winding round hill, we should force ourselves a way through them," boring tunnels through the earth for rail lines.[338] In his letters to the editors of the *Morning Post*, Wordsworth praises railway engineers who resisted straight-lined progress by forming railways according to an alternative figurative logic of machinery that minimized the railway's environmental impact. As Wordsworth writes of one railway engineer, "the hint" of avoiding destruction by railway "produced its due effect upon the engineer" when "some one point[ed] out how easily a deviation [in the railway line] might be made" from straight-line progress so that the railway's form is instead eco-mimetically adapted to minimize its environmental impact, taking its form from the surrounding earth.[339] Wordsworth sides with Romantic engineers who built railways that were instead "adapted to local nature." Wordsworth may have been familiar with this strain of railway engineering from Tegg's *Practical Mechanics*, an arts and engineering encyclopedia that Wordsworth owned and

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[335] See Gordon Biddle, "Railways, their Builders, and the Environment," in *The Impact of the Railway on Society in Britain: Essays in Honor of Jack Simmons*, ed. A.K.B. Evans and J.V. Gough (Ashgate: 2003), 117-128. Biddle notes how many railway builders before the Railway Mania favored "good design" practices that involved the "use of local building materials" in earthworks such as red stones in the Midlands and local stone for embankments that not only harmonized with (and took their form from) local ecologies but even were often covered with vegetation to "provide new habitats" for local wildlife. Railway design harshened in the 1840s-50s with the railway mania as many building materials for earthworks were made of cheap imported materials. 122, 125.

[336] See "The Uses of General Pasley," *Morning Post*, November 10, 1846, 3. Pasley came under for fire for the unsound earthworks of the Northern British Railway, which opened in 1846.

[337] Wordsworth, *SS*, 622; Wordsworth to the Editor of the *Morning Post*, December 16, 1844, in *The Prose Works of William Wordsworth*, vol. 3, 341.

[338] William Wickens, in Thomas Gray, *Observations on a General Iron Rail-way* (1825), 134, 138.

[339] Wordsworth to the Editor of the *Morning Post*, December 20, 1844, in *Prose Works*, vol 3, 352-53.

expressed enthusiasm for. Tegg's article on "Railways" advised forming railways with rocks and earth adapted to local nature.[340]

While some railway companies interested in maximizing profit derided the method of "forming rail-ways" that is "adapted to the natural declivity of the country through which they passed," other engineers insisted that railway form should be adapted to fit the local environment, shaped by the "rugged and uneven" terrain arising "from the irregularities of a mountainous country," and "formed in such a direction, and with such a declivity as may best suit the nature of the ground through which it passes.[341] For Wordsworth, this ecological imperative does not entail ruling out all tunnels and viaducts – after all, he singles out for praise in his railway letter the largest and most ambitious railway projects then in existence spanning Britain and Ireland that entailed viaducts, tunnels, and other earthworks of an unprecedented scale as "more than justifying the labor of the engineer" – but rather making fewer ones, and adapting those to the earth's form and to terrestrial limits. Protesting attempts to turn capital development into the absolute value of the railway's expansion – and of the maximum possible speed and efficiency of industrial development – Wordsworth instead works toward a world in which technology might move at a slower pace, of industrial development paced to the rhythm of planetary limits. While he shares the utopian-socialist desire for an ecologically sustainable form of industry, unlike the utopian-socialists, Wordsworth does not call for the abolition of industrial capitalism so much as reining in its worst excesses. After all, Wordsworth is quick to note the benefits of railway commerce.[342] Of course, moments like these do not individually articulate a green industrialism in explicit terms. Wordsworth's green industry remains partial and incomplete, an idea which he struggles to articulate, an impulse that consistently makes its forces felt at the core of Wordsworth's poetry yet which he does not yet have the language to fully express in his early industrial moment, when engineering itself only achieved the first flickers of any ecological consciousness. My claim is not that Wordsworth explicitly develops a green industry but rather that taken together, these impulses consistent over Wordsworth's poetic career shadow forth an imperfect and incomplete yet nonetheless deeply felt green industrialism that we are left to reconstruct.

In the wake of the controversy, the public assessed poetry's powers in relation to the railway. On December 25, 1844, an article titled "Poetry and Railways" assessed that Wordsworth's railway "sonnet, it seems...has done good; for the line of railway is not to be carried to Low Wood, near the Head of Windermere," so that the proposed railway would terminate farther than the Lake District.[343] But Wordsworth's twelve lines of verse could not stop twelve miles of railway. The Board of Trade approved the Windermere and Kendall Railway in

[340] Henry Crab Robinson gave Wordsworth a copy of Tegg's *Encyclopedia of Science, Art, Literature, and Practical Mechanics* in 1841. On 18 April 1841, Wordsworth wrote Robinson thanking him for Tegg's *Practical Mechanics,* "what will be to us the most useful present...it is the sort of book which all my life I have wanted."

[341] "To the Committee of the Promoters of the Intended Railway," "Jessop's Report to the Committee of the Proposed Railway," in *Observations on a General Iron-Railway*, 95-97, 104.

[342] It is not necessary for Wordsworth to entirely reject industrial capitalism for him to critique it, nor do his hopes for the railway as a public works project necessarily preclude commercial activity. Hence, if Wordsworth shares the French and German industrial-socialist hopes for the railway, he also pioneers a distinctly British version of this program that, much like Gladstone and British engineers, seeks to reign in the hypertrophic tendencies of railway capitalism and expand the railway as a public works project without ruling out commercial activity altogether.

[343] "Poetry and Railways," *Hereford Journal*, December 25, 1844, 3.

April 1845. Construction began almost immediately, and the new line opened in 1847.[344] By the end of the century, the railway extended all the way through Simplon Pass. The Simplon Tunnel that opened in 1905 became the longest tunnel in the world at the time. Yet Wordsworth was undeterred by this failure, reprinting and revising his railway poems and letters to the *Morning Post* in a Railway Sonnet Pamphlet that he publishes in 1845 to be deployed in future railway projects. This ecocritical application came true: as critics have shown, Wordsworth's railway poems were deployed in a series of protests against railways, including Ruskin's. Wordsworth's railway poems are thus often considered the nineteenth century origins of the environmental movement.[345] While this environmental legacy has been extensively discussed, Wordsworth's railway poetry at once opens up another ecological possibility that has remained largely overlooked. Wordsworth's poetry at once prefigures the possibility that poetic lines might not merely oppose railway lines but engineer them into an ecologically sustainable form, for a green industry spanning poetry and technology in an ecologically sustainable relation with the earth that might check the planetary ecological crises precipitated by industrial capitalism.[346]

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[344] The Board of Trade approved the construction of the Kendall Windermere Line on April 15, 1855 in *Reports of the Railway Department of the Board of Trade on Schemes for Extending Railway Communication* (Westminster: Bigg & Son, 1845), 220-221.

[345] For the impact of Wordsworth's protest of the Windermere railway on the 19th century environmental movement, including Ruskin's protest of the railway, see Hess, *Wordsworth and the Ecology of Authorship,* 116-154.

[346] Even if they shared many of his ecological and anti-capitalist convictions, not all agreed with Wordsworth's assessment of the environmental impacts of the Windermere Railway. Many defended Wordsworth's critique of railway capitalism. An article in the *Morning Post* praised Wordsworth's critique of railway capitalists for whom "it is a thing next to an impossibility to get them to think of any railroad except as an 'investment', or a mode from getting from one place to another with the least expenditure of time…for the gain of money makers merely." Yet many others felt that the railway as a "great public works" project would increase the means of access to the Lake District of those least able to afford it, and questioned rather its environmental damage was as grave as Wordsworth supposed and whether the Windermere Line was as capitalized as other railways. *Morning Post*, Dec, 18, 1844, 5; "Kendal and Windermere Railway," *Westmoreland Gazette*, Dec 14, 1844, 14. Another article summed up that "this line of railway is likely to be a public good." "Kendal and Windermere Railway," *Westmoreland Gazette*, November 23, 1844. In the official report authorizing the construction of the Windermere line, the Board of Trade claimed to approve the new line only on its merits as a public works project without regard for capital interests. The Railway Department of the Board of Trade opened its 1845 report by noting that "the Board are anxious that it should be understood that we arrived at these results" approving all new lines "solely upon public grounds, and to the exclusion of all considerations how far such results might require to be modified by a due regard for private rights and interests." In approving the Windermere Line, the report concluded that "there are no public grounds which ought to be decisive against the Kendal and Windermere proposed railway receiving the sanction of Parliament…the [Lake] scenes should be open alike to all," *Reports of the Railway Department*, 221. One reply to Wordsworth titled "Poetry and Railways" argues that "all possible facility of access" for the "public...should be afforded to this district," so that Wordsworth's poetry can be appreciated, arguing that "the supposed evil effects of the railway, in partially disfiguring the country" were less severe than Wordsworth thought. "Poetry and Railways," *Hereford Journal*, December 25, 1844, 3. By 1849, observers of railway earthworks in the Lake District found that "Engineers have realized the poet's dream [with] the locomotive" of "making matter and the elements" formed from earthen materials serve revolutionary ideals, as "within the last forty years" the railway "may be said, literally, to have revolutionized the world" P.K. Mannex, *History, Topography, and Directory of Westmoreland* (London: 1849), 52. Hudson revised and expanded Wordsworth's own *Guide to the Lake District* in the 1850s to direct travelers to the Lake District via the railway. Harriet Martineau's *Complete Guide to the English Lakes* (1855) reflected that that "The best, as well as the last and greatest change in the Lake District is that which is arising from the introduction of the railroad" in multiplying the quantity and quality of communications between peoples and the natural world (Windermere: 1855), 144. Despite these various assessments of the benefits and environmental costs of the Windermere Railway, Wordsworth's attempt to prefigure an alternative figurative logic of environmental engineering outside of railway capitalism has critical value for ecological thought in the Anthropocene.

3. After Geoengineering

What work can this Romantic possibility of a green industry do now in the Anthropocene? We now recognize railway and steamboat earthworks that date to the Romantic era as early forms of terraforming or geoengineering projects, the rise of human mechanical powers as a geomorphic force that marks the Romantic origins of the Anthropocene. Today, geoengineering is often freighted with negative connotations in ecocriticism, or closely identified with the planetary damages, that, since the onset of industrial modernity over the Romantic era, have precipitated our current ecological crises, or with large-scale climate engineering projects such as carbon capture and storage and solar radiation management often rejected by contemporary ecocriticism. For many critics, we have been geoengineering the planet through earthworks since the late 18th century, often for the worse. We already live in a world after geoengineering, on an earth reshaped for hundreds of years by industrial technology, often through capitalist projects that valorize economic growth regardless of ecological cost. Yet some form of geoengineering may now be necessary: as many earth system scientists and climate scientists now argue, some of the worst possible ecological futures are the result of a failure to implement ecologically viable forms of geoengineering to counter the crises that their industrial capitalist application is already precipitating.[347]

Critics increasingly take geoengineering to refer to any such modification of the earth by industrial technology, from capitalist to eco-socialist.[348] As Holly Jean Buck points out in *After Geoengineering*, "it has been difficult for environmentalists and the left to engage with either carbon removal or solar geoengineering in a forward-thinking way."[349] There remains an "abyss in contemporary thinking" such that ecocriticism is still often defined in negation to such engineering projects or industrial technology as a whole, which remains widely conflated with capitalism. "Binary thinking about climate engineering," Buck observes, "has made it difficult for progressives to create a dialogue about how engaging with these emerging approaches might be done." Yet some sort of engineering, which could be led by civil society, is increasingly necessary to combat our planetary ecological crisis. As Buck demonstrates, "Sticking rigidly to these binaries" that have historically structured ecological thought "keeps us from seeing possible futures: it gives the terrain for shaping climate engineering over to the few."[350] Buck suggests that thinking about a world after geoengineering is "an invitation to think about the ends goals of geoengineering" to create a habitable world that comes after geoengineering, which could be a means to radically different ecologically sustainable ends: what one ecosocialist manifesto for the Green New Deal calls an opportunity to "reimagine the world freed from the imperatives of market fetishism." Hence, geoengineering needs to be understood not just as an

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[347] For recent radical and eco-socialist arguments for geoengineering, see *Has It Come to This? The Promises and Perils of Geoengineering on the Brink*, eds. and J.P. Sapinski, Andreas Malm, and Holly Jean Buck (New Brunswick, NJ: Rutgers University Press, 2020).

[348] For some of these senses of terraforming or geoengineering, see the recent special issue of *Diacritics* 47.3 on terraforming, especially Derek Woods and Amanda Goldstein's contributions to the volume. As Karen Pinkus and Derek Woods rightly in their introduction, geoengineering's significations range from the capitalist to the eco-socialist: "terraforming can refer to the colonial inscription of the earth in globalizing grids of capital accumulation and environmental destruction, or to utopian visions of earth greened by socialist revolution. The term can name a dream of the future, an ongoing project of the present or a historical process that has already taken place." "Terraforming," *Diacritics* 47.3 (2020): 4.

[349] Holly Jean Buck, *After Geoengineering: Climate Tragedy, Repair, and Restoration* (Verso, 2019), 28.

[350] Buck, *After Geoengineering*, 34, 40.

abstract noun or one-off event but "as a temporarily extended process" that is "directed not just into the future, but into the past as well" in the nineteenth century origins of geoengineering projects that Wordsworth began to confront.[351]

The ecocritical drive of Wordsworth's poetics towards a sustainable form of industry outside of capitalism moves beyond the emerging binaries of the 19th century environmental movement and industrial development that continue to limit ecological thought today. Wordsworth's attempt in his late steamboat and railway poetry to work towards an ecologically sustainable relation between industrial technology and the earth, however imperfect and incomplete, now has critical value in our moment in Anthropocene history. In imagining alternative forms of industrial development within planetary limits that counter what he calls the "ill-regulated and excessive application" of earthworks for unchecked capitalist growth – "the superabundances of capital" in capitalist railway corporations fueling the unchecked expansion of engineering projects terraforming the earth solely "for the profit of the shareholders" regardless of ecological cost – Wordsworth begins to imagine an ecologically sustainable form of railway engineering earthworks adapted to nature, and of geoengineering more broadly, holding up the possibility of a future of railways as "public works" projects after that "money-getting spirit" of industrial capitalism is "exhausted." These earthworks would no longer "mar nature" and thus prefigure Buck's call for a third way "beyond the boxes of capitalist economics, on the one hand, and binary formulations on the other" for a "view of technology that is collective or cooperative, or that works with nature."[352]

Of course, this early form of geoengineering that dates to the time of Romanticism is not perfectly ecologically sustainable. Nor is the proto-ecological form of Anthropocene consciousness that Wordsworth and Romantic engineers develop fully ecologically sustainable, particularly as long as industrial technology remains powered by fossil fuels. Yet this figurative logic that emerges out of Romantic poetry and engineering is now integral to any hope of a commensalist relation between industrial technology and the earth in our own moment in Anthropocene history, when combating the planetary ecological crises of industrial capitalism demands that public infrastructure projects such as renewably powered railways have to be scaled up exponentially, now the eco-socialist ambition of the Green New Deal.[353] The ecological possibility that Wordsworth and Romantic engineers anticipate now includes geoengineering technologies ranging from carbon sequestration – from biochar embankments

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[351] Buck, *After Geoengineering*, 24, 27. Alyssa Battistoni, Kate Aronoff, Daniel Aldana Cohen, Thea Riofrancos, *A Planet to Win: Why We Need a Green New Deal* (Verso, 2019), 161. Much like Buck, Battistoni et al. call for a need to think "beyond bad dichotomies" of technology v. ecology that have long plagued ecological thought.. "Prospects for climate action tend to rouse sharp debate around old dichotomies, especially on the Left… Polemicists charge that you're either…an eco-modernist or a neo-Luddite…Instead of fetishizing or demonizing technologies, we call for evaluating them the way we would any other political project… We also shouldn't let the military or Silicon Valley own or define 'tech' – literally or metaphorically. Science and technology can help us understand, and live with, the planet we share." *A Planet to Win*, 27-28.

[352] Wordsworth, *Excursion*, 8.111-12n; Wordsworth to Charles Pasley, October 15, 1844; Wordsworth, December 11, 1844 Letter to the Editor of the *Morning Post*, *Prose Works*, 340-41; Wordsworth, October 6, 1844, *The Letters of William and Dorothy Wordsworth*, vol. 7, 616.; Buck, *After Geoengineering*, 35.

[353] Alyssa Battistoni and Thea Riofrancos, for instance, call for "building green infrastructures" or earthworks as part of any Green New Deal, as "the politics of climate change and the transformation of the built environment are the same." Like Buck, they emphasize the need for engineering earthworks as public infrastructure projects to "reshape our built environment in ways that decarbonize, make us safer, and abolish inequalities," from "laying tracks for efficient new trains" for "speedy trains, and verdant landscapes of public renewable power" to "roadways and streams to help cities absorb floodwaters and keep their sewage systems clean" (*A Planet to Win*, 137, 173-74).

and geological sequestration in earthworks that convert carbon to stone – to earthworks like renewably-powered trains and public transportation infrastructures adapted to planetary limits, figurative possibilities not limited to a pre-industrial past but that persist in industrial technologies. This is not to say that any technology can provide all solutions in Wordsworth's time or our own but rather that it would be the beginning of the ongoing work to poetically reshape the ecological relation between technology and the earth. As Buck notes, if we take literally the meaning of 'geoengineering' as a present participle, it becomes a project, a work-in-progress as a form of "infrastructure" that "refer[s] to specific goals and projects" that is "not a closure, not a moving-on, but the beginning of long work ahead."[354] The ecological potentials of the figurative logic of machinery that emerges over the Romantic era may now provide the figurative tools necessary for any hope of achieving an ecologically sustainable relation to the earth in our own time of planetary ecological crisis.

[354] Buck, *After Geoengineering*, 40, 245.

Chapter 3:

THE RISE OF THERMODYNAMICS: MECHANICAL ENGINEERING AND BYRON'S POETRY MACHINERY

From Garrard to Turner, the path is very simple. It is the same path that runs from Lagrange to Carnot, from simple machines to steam engines, from mechanics to thermodynamics – by way of the Industrial Revolution.

– Michel Serres, "Turner Translates Carnot"

"If it is necessary to find a virtue in technology," Paul de Man remarks in "The Temptation of Permanence," "it is that it is too rude to offer even a simulacrum of appeasement." As it "burns history without leaving material residue, technology forces us to rid ourselves of what is only after all a false serenity," the temptation of permanence.[355] If de Man's tropic language turns away from technology – too rude – it at once turns towards its mechanical power to burn through any illusion of material permanence, with or without residue. As will become clear, de Man's notion of technology "burning history" implies a historical consciousness of the thermodynamic logic of machinery that emerges out of the steam engine and is now burnt into Anthropocene history, often dated to Watt's 1784 patent of the steam engine, also known in Byron's time as the fire engine.[356] Thermodynamics arises out of late 18th and early 19th century mechanical engineering – leading up to Carnot's 1824 reflections on the fire engine – as a figure for the dissipation of human mechanical power and the impermanence of the material universe.[357] Much recent work in Victorian studies has attended to the figurative resources of thermodynamics. Yet its Romantic origins and impact on Romantic aesthetics have received little attention. I begin by recovering the thermodynamic logic of machinery in Romantic era engineering and painting over the 1810s-20s, culminating in the work of J.M.W. Turner and Sadi Carnot. Next, taking a closer look at the rise of thermodynamics in Romantic poetics, I turn to Byron as a case study to recover the engineering poetics that he develops around 1820 as he pioneers a new thermodynamic logic of poetic machinery. I close by reflecting on the critical value of Byron's thermodynamic logic of machinery for Anthropocene thought today. One aim of this chapter, then, is to recover a neglected history of the emergence of modern engineering in the Romantic period, and its thermodynamic aesthetics. Another aim is to demonstrate how the rise of modern engineering (in a much more pragmatic form than the Newtonian science it displaced) directly influenced Byron's poetics, as he came to define his poetic vocation as "my post as an engineer."[358] Romantic poetry and engineering shared a thermodynamic aesthetics fueled by a mutual question: what work can we realistically expect material forms to achieve when they operate under strict constraints of perpetual energy loss and unavoidable physical attrition? That question continues to bear on how we approach poetry and machinery today, and what we might

[355] Paul de Man, "The Temptation of Permanence," in *Critical Writings, 1953-1978,* ed. Lindsay Waters (Minneapolis: University of Minnesota Press, 1989), 30-31.
[356] Paul Crutzen, "Geology of Mankind," *Nature* 415.23 (2012): 23. While the dating (and term) Anthropocene are hotly debated, James Watt's 1784 steam engine design has substantial traction.
[357] Mechanical power in Romantic era mechanical engineering and culture referred at once to the elementary parts of machines (the nut, screw, etc.), machines or engines themselves, and the human powers that machines produce.
[358] Byron to John Murray, Nov 29, 1813; in *Letters and Journals*, v 3. ed. Leslie Marchand (Cambridge, MA: Harvard University Press, 1973).

anticipate from aesthetics and engineering in the Anthropogenic age that we share with Romanticism.

1. Turner / Carnot

Mechanical engineering marks the transition between simple mechanics and thermodynamics: between the perfect world of Newtonian mechanics ordered by rational principles of motion and a world in which nothing is permanent except for change itself. While thermodynamics is formalized in the 1850s, its core principles arise over the time of British Romanticism with the emergence of engineering.[359] Michel Serres writes, "As soon as one can build them and theorize about…steam or combustion engines…the notion of time changes. The second law of thermodynamics accounts for the impossibility of perpetual motion…Energy dissipates, and entropy increases."[360] With the engine, force passes from the "rationalized" or "mathematical real" of Newtonian mechanics – which abstracted from matter to treat the motion of figures as perpetually reversible, unchanged by friction – to matter itself, in which the production and dissipation of mechanical power by friction is evidence of "an unceasing mutual interchange of figure," as one engineer put it in the 1810s.[361] No more transcendence, only material finitude. Engineers over the time of Romanticism discovered what became the first law of thermodynamics, which formalizes the conservation of energy: that energy is neither created or destroyed but translated.[362] The energy concept depends upon the mechanical theory of heat: that all force is materially equivalent to heat or motion. Heat is not a separate substance but simply the effect of motion. Over the late 18th and early 19th century, engineers also discovered what became the second law of thermodynamics, entropy. As Helmut Müller-Sievers sums up, for the "Newtonians, [friction] was a negligible factor, to be analyzed away," while in steam

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[359] If the energy concept has an extensive prehistory, with many genealogies, thermodynamics itself – especially entropy – arises out of 18th and early 19th century mechanical engineering leading up to Carnot's 1824 *Reflections*. For classic studies of the rise of thermodynamics, see D.S.L. Cardwell, *From Watt to Clausius*: *The Rise of Thermodynamics in the Early Industrial Age* (Ithaca: Cornell University Press, 1971); Crosbie Smith, *The Science of Energy: A Cultural History of Energy Physics in Victorian Britain* (Chicago: University of Chicago Press, 1998). Ted Underwood's *Work of the Sun: Literature, Science and Political Economy, 1760-1860* (Palgrave, 2005) is the single major Romantic study to date, and, as entropy occurs only once in a footnote, more on energy than thermodynamics. Tobias Menely in passing dates the transition to a thermodynamic energy regime to the Romantic era, though he does not consider its engineering origins or impact on Romantic aesthetics at any length. See "Late Holocene Poetics: Genre and Geohistory in Beachy Head," *European Romantic Review* 28.3 (2017): 307-314. For major studies of thermodynamics in 19th century literature, see Bruce Clarke, *Energy Forms: Allegory and Science in the Era of Classic Thermodynamics* (Michigan: University of Michigan Press, 2001); Allen Macduffie, *Victorian Literature, Energy, and the Ecological Imagination* (Cambridge, UK: Cambridge University Press, 2014); Barri J. Gold, *ThermoPoetics: Energy in Victorian Literature and Science* (Cambridge, MA: MIT Press, 2010).

[360] Michel Serres, *Hermes: Literature, Science, Philosophy*, eds. J. Harari and D. Bell (Baltimore, MA: Johns Hopkins University Press, 1982), 71.

[361] "Friction," in *Rees's Cyclopædia or Universal Dictionary of the Arts, Science and Literature*, *by Abraham Rees, with the assistance of eminent professional gentlemen*. vol. 15 (London: 1819): 369. Mechanical engineers wrote the entries on machinery. Not to be conflated with Chambers' *Cyclopædia.* For more on Rees's *Cyclopædia*, see Celina Fox, *The Arts of Industry in the Age of Enlightenment* (New Haven, NY: Yale University Press, 2009).

[362] As Helmut Müller-Sievers puts it, "What engineers had tacitly presupposed since the middle of the eighteenth century found its basic expression in the first law of thermodynamics." *The Cylinder: Kinematics of the Nineteenth Century* (Berkeley, CA: University of California Press, 2013), 21; For accounts of the phase shifts from Newtonian mechanics to mechanical engineering, see also Helmut Müller-Sievers, "A Doctrine of Transmission Devices: On the Classification of Machines around 1800," in *The Science of Literature: Essays on an Incalculable Difference* (De Gruyter, 2015), 176-194; Schaffer, "Machine Philosophy: Demonstration Devices in Georgian Mechanics"; Bryan Lawton, *The Early History of Mechanical Engineering* (Brill, 2004).

engines, "the production and dissipation of heat through friction became a first step toward a comprehensive theory of thermodynamics." Every motion is frictive, losing heat, leading ultimately to "the inevitable descent of all organization into undifferentiated matter." Heat is not destroyed, but it is nevertheless irreversibly lost through friction: energy becomes more and more dissipated, until the end of all motion. The best that engineering – or any art – can do is struggle against where it all must end, deferring entropy for a time through mechanical power.[363]

Mechanical engineering arises as a profession and discipline in Britain in the early nineteenth-century with the steam engine.[364] Yet the Romantic era engineers who developed the thermodynamic logic of machinery have been neglected, their voices lost along with their aesthetics. How did engineers themselves figure the rise of thermodynamics? Engineering, as one member of the rising class defined it in the 1810s, is the art of "mak[ing] of any kind of useful engines or machines," also called "practical mechanics" or "operative mechanics."[365] Engineers were working mechanics with little formal education whose trade was not taught in universities until the 1890s; Newtonians were mathematicians, scientists, and theorists, not machine-builders. Intellectuals with university chairs, Newtonians built no working machines of any kind.[366] The Newtonians' and engineers' approach to mechanics were at war from the start. While Newtonians privileged rational, mathematical principles of force abstracted from friction, engineers valued the variable maker's knowledge of building working engines that generate mechanical power – force or energy – over theory. Mechanics, as one engineer defined it in 1815, "treats of the energy of machines."[367] Due to the "variations of force," "an engineer must not be tied down by too many maxims" because the engine's power is "extremely variable."[368] Newtonian's rational mechanics triumphed over working mechanics until the late 18th century, consolidating their social power. The *Principia*, Newton insisted, was "not a treatise on mechanics" but rather designed to found "rational mechanics" as the "science of motion" on invariable principles that then applied to machinery.[369] For Newtonians, the power dynamic was only supposed to flow one way: Newtonian theorists dismissed the vulgar mechanics of engineers as too materially variable to ever impact the rationally ordered Newtonian universe.

Force itself was melting away the Newtonians' rational principles. Anti-theoretical and anti-philosophical, engineers in the 1810s waged war on rational mechanics through the mechanical power of the engine. The engineer Robert Stuart's *Descriptive History of the Steam Engine*, which he delivered to engineers in the Mechanics' Institute in 1824, is representative.[370] Stuart pointedly notes how the fact that "the little which has been done by learned men on this subject is of no practical mark or likelihood" in machinery demands "the exclusion of merely theoretic disquisition or inference" by Newtonians from his history of the engine. "No 'philosopher' or 'theoretic men,'" Stuart insists, can claim "any part of the honor of being instrumental, even indirectly, in the perfecting of the steam engine." In fact, "There is no

[363] Müller-Sievers, *The Cylinder,* 20-22; Serres, *Hermes*, 73.
[364] For the professional history of mechanical engineering, see R.A. Buchanan, *The Engineers: A History of Engineering Profession in Britain 1750-1914* (London: 1989).
[365] "Engineer," in *RC*, vol. 13 (1819), 160. "Machinery," *RC*, vol. 21 (1819), 764, 766.
[366] On the class dynamics of the emerging profession of engineering in the late 18th and early 19th century, lack of institutional presence, and war with the Newtonians, see Schaffer, "Demonstration Devices in Georgian Mechanics."
[367] Olinthus Gregory, *A Treatise of Mechanics,* 3 vols. (London: 1815): 2:1.
[368] "Machinery," *RC*, vol. 21 (1819), 766; "Steam Engine," *RC*, vol. 34 (1819), 110.
[369] Newton, "Preface to the Principia," in *Newton*, eds. Bernard Cohen and R. Westfall (Norton, 1995), 224-226.
[370] The Mechanics' Institute was a workers' institution founded by mechanics with radical political ambitions. See Kyoko Takanashi, "The Romantic Origins of the Mechanics' Institute," NASSR, Providence, RI, June 2018.

machine or mechanism in which the little that [Newtonian] theorists have done is more useless. It arose, was improved and perfected by working mechanics – and by them only." Stuart points to the "fact of Savery having begun life as a working miner; Newcomen was a blacksmith...Don Ricardo Trevithick was also an operative mechanic."[371] Stuart is right: no Newtonian "theorists" or "philosophers" had any part in the rise of the engine, the work of engineers. Mechanical power ran directly counter to Newtonian's class interests buttressed by rational mechanics.[372] "No machine" better showed the powerlessness of Newtonian "theorists." As Stuart reflects in 1824, 'Twenty years ago, [the engineer] Hornblower remarked, 'that the most vulgar stoker may turn up his nose at the acutest mathematician in the world, for, (in the action and construction of Steam Engines,)…the higher powers of the human mind must bend to mere mechanical instinct;' and the observation applies with greater force now than it did then." [373]

Much as Stuart sketches, over the early 19th century, mechanical engineering eclipses Newton's rational mechanics to give rise to the new thermodynamic logic of machinery. The reason for the eclipse is simple. Building working engines that efficiently generate mechanical power demanded that the practical reality of friction take precedence over theoretical insight, the logic of machinery thermomechanically abrading the fixed lines of rational mechanics from the inside out.[374] While Newtonians dismissed the effects of friction as a "vulgar error," engineers used machinery to publicly challenge rational mechanics, exposing how the Newtonian's demonstration devices failed in practice to predict the mechanical power of working engines – or of any figures in motion – due to thermomechanical friction. By working with their tools, engineers over the Romantic era discover the material dissipation of force through friction that turns into the basis for the second law of thermodynamics. As one engineer put it, "the subject of friction is of such importance in relation to the construction and use of various machines" that "no engineer" will fail to account for the "loss of power by friction" in "any engine." [375] Friction, as engineers came to define it, is "the act of rubbing or grating the surface of one body against that of another, also called attrition": "Friction arises from the roughness or asperity of the surface of the body moved on, for such surfaces consisting alternately of eminences and cavities," which "must be both broke and worn off" by thermomechanical abrasion.[376] No motion is without friction, loss of heat: "neither [force nor the loss of it] can happen without motion, nor can motion be produced without a force impressed. The force applied to move the body is either wholly or partly spent on this effect; and consequently, there arises a resistance, or friction." Fueled by the motive power of fire, the engine made evident friction's role in the production and exhaustion of force by heat: how "all bodies by friction are brought to conceive heat."[377] The rubbing or grating of all figures colliding against one another broke them down to release heat energy. Part of the heat energy released could be used to power machinery. Friction

[371] Thomas Savery, Thomas Newcomen, and Richard Trevithick were all engineers who improved the steam engine's design. Savery invented the first non-rotary steam engine used to pump water from mines, Newcomen built the "atmospheric engine," and Trevithick designed the first high-pressure steam engine.
[372] Schaffer also notes this power dynamic: "Historians of otherwise differing views have alleged that [Newtonians] of the Georgian university exhibited little interest in mechanic arts because the colleges depended upon the traditional regime of landed wealth" that engineers' mechanical power threatened. "Demonstration Devices," 172.
[373] Robert Stuart, *A Descriptive History of the Steam Engine* (London, 1824), v-vi.
[374] On Newton's "frictionless" mechanics see Schaffer, "Demonstration Devices in Georgian Mechanics,"180; Müller-Sievers, *The Cylinder*, 22.
[375] "Friction," *RC*, vol. 15 (1819), 367-368.
[376] Gregory, *TM*, 252; "Friction," *RC*, vol. 15 (1819), 365.
[377] "Friction," in *RC*, vol. 15 (London: 1819), 364. Olinthus Gregory, *Treatise of Mechanics*, vol 2. (1815), 252.

produced heat energy by combustion or burning required to power the engine. The "strength of the fire" in the engine cylinder heated water vapour into steam, the "force applied to move" the piston upward and convert heat energy into mechanical power that could be used to move machinery.[378]

Romantic era engineers discovered that friction dissipated any mechanical power, force forever lost. As one summed up in 1819, "engineers expect in practice" to "lose part of the advantage of their force by the friction, but how much...nothing but practice can determine."[379] Faced with the rude truth that a great part of the power of any engine is expended in friction, engineers sought to reduce the waste of force. Since friction arises from figures in motion roughly wearing against one another, engineers discovered that friction diminishes as figures become smoother and more polished. Rough motion was more frictive; smooth motion, less. "Hence it follows," one engineer remarked, "that the surfaces of the parts of machines that touch each other should be as smooth and polished as possible."[380] Lubrication was key to reducing the friction as machine parts abraded one another. Engineers thus used vulgar materials like oils, wax, resinous bodies and tallow in engines to lessen the friction.[381] The engine "should be fitted, and kept in contact" with oil to reduce "burning or heating by friction, when in rapid motion."[382]

Yet ultimately, the loss of mechanical power by friction was inescapable. As one engineer put it: "There is no such thing as a perfect smoothness in bodies, no machine can move without a mutual rubbing of its parts." "No body can be so much polished" to "take away all [friction]": "witness those numerous ridges discovered by the microscope on the smoothest surfaces."[383] Every motion was frictive: "Nor could motion be produced without a force impressed" by thermomechanical abrasion, "the force applied to move the body was either wholly or in part spent on this effect." Even if "fit as perfectly as art and industry can make them," all bodies will "wear one another:" "constant friction will tend to enlarge the cylinder, and diminish the diameter of the ring, the piston, after some time, would cease to fit." No more Newtonian permanence of figure: all figures thermomechanically abrade one another in motion, breaking down in releasing heat. "Friction subsists [even] after the contiguous surfaces are worked down as regular and smooth as possible...Its existence demonstrates an unceasing mutual change of figure" by the "minute and accidental risks of contact," a ruder, rougher materiality of thermomechanical force and its dissipation that could never be reasoned away.[384] The thermodynamic logic of machinery that engineers discovered by working with their tools was too rude to offer any temptation of permanence: even if engines were fit as perfectly as art could make them, any mechanical power would ultimately dissipate by the very force that fueled it. Engineers discovered the loss of force due to friction and other "accidental risks of contact" renders perpetual motion impossible.[385] Due to friction, perpetual motion was "beyond the utmost effects mechanical powers can produce."[386] In 1776, the Paris Academy of Sciences declared that it would no longer consider proposals for perpetual motion, awarding the Academy

[378] *Gregory*, Treatise of Mechanics, vol 2., 252; "Friction," in *Rees's Cyclopædia*, 365.
[379] "Friction," *RC*, 364-5.
[380] "Friction," *RC*, 364-65; "Machinery," *RC*, vol. 21 (1819), 764.
[381] Stuart, *Descriptive History of the Steam Engine*, 113; "Machinery," *RC*, vol. 21 (1819), 764.
[382] Stuart, *Descriptive History of the Steam Engine*, 113; "Machinery," *RC*, vol. 21, 764.
[383] Gregory, *Treatise of Mechanics*, 2:88, 2:167; "Friction," *RC* (1819), 365.
[384] "Friction," *RC*, vol. 15 (1819), 364-65, 369; "Steam-Engine," *RC*, vol. 34 (1819), 114.
[385] Other accidental risks of contact included evaporation, cooling, and boiler explosions.
[386] The Academy's proclamation is in *Histoire de l'Académie Royale des Sciences* (1775), Paris, 1778, 61-6; Thomas Reid to Richard Price, 1772, in *Correspondence of Richard Price*, ed. W. Peach (Durham, 1983), 1:153-4.

Prize instead to the topic of friction; less than fifty years later, the engineer Sadi Carnot's 1824 *Reflections* on the loss of the horsepower of 1810s engines turns into the founding text of thermodynamics.[387] As Carnot observes, perpetual motion is the state of a perfect engine that can never be reached but only approached; engine design doesn't deny consciousness of loss but rather forcefully struggles against loss for a passing time. Engineering renounces the "transcendence and divine intervention" of a Newtonian God as the Prime Mover "who could intervene to stop irregularities of planetary motion, to wind the universe back up."[388] No longer made in the image of power divine, human mechanical powers become the only prime movers. Emptied of triumph, machinery critically internalizes a catastrophist logic of struggling to defer dissipation by the "disasters" and "accidental risks of contact" built into engineers' definitions of machinery by the 1810s.[389] Machines, as one Romantic engineer put it, struggle to "balance or overcome another power or obstacle whose intensity or resistance is greater," namely friction, and other catastrophic wear that can only ever be temporarily overcome by any moving power.[390]

In "Turner Translates Carnot," Michel Serres tropes on the rise of thermodynamics in Romantic aesthetics in the passage from simple machines to the steam engine, from the straight lines of the simple machines of the painter George Garrard's advertising sign for the shipyard warehouse of Samuel Whitbread (1784) to Turner's entry into the boilers of steam engines. For Serres, "From Garrard to Turner, the path is very simple. It is the same path that runs from Lagrange to Carnot, from simple machines to steam engines, from mechanics to thermodynamics – by way of the Industrial Revolution." Garrard's shipyard delineates the perfect world of Lagrange's *Analytical Mechanics* (which extended Newton's rational mechanics) on the brink of its dissolution, the "recapitulation of a perfect world soon to disappear." The equipment stands out: "flawless timberwork," "ships, hawsers tied to the mooring posts, sails at rest, rigging free and in place," "a world that is drawn, drawable." The pulleys, slings, winches, ropes, and weights of Gerrard's ship sum up the simple mechanics of Newton's world, a world of lines that heroically triumph over matter: the machinery as orderly as the Newtonian universe, human mechanical power as invariable as the divine power it resembles. A ship of the line – with its hawsers, cranes, and mechanical powers – static, at rest, perfectly in order.[391]

Turner, in Serres's account, "change[s] ships": Turner stops painting the wooden "ship of the line" – the simple machinery of Newton's and Gerrard's world – and starts painting steam boats. Garrard's shipyard burns up in fire with Turner, who enters into the boiler of the steam boat, into the fire of the engine cylinder. With Turner's steam boats, the art of drawing explodes into fiery color: "For a moment the engine dissolves into the world that resembles it…He passes from the rationalized real, from the abstract or mathematical real, to the burgeoning real that

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[387] The Academy's proclamation ruled that "the construction of a perpetual motion is impossible." *Histoire de l'Académie Royale des Sciences* (1775), Paris, 1778, 61-6. For more on the proclamation, see Schaffer, "The Show That Never Ends," 160. Thomas Reid to Richard Price, 1772, in *Correspondence of Richard Price* (ed. W. Bernard Peach and D.O. Thomas), 2 vols., Durham, 1983, i, 153-4. See Sadi Carnot, *Réflexions sur la Puissance Motrice du Feu* (Paris: 1824). For the standard accounts of Carnot's contributions to thermodynamics, which formalized what engineers already established in the 1810-20s, see Cardwell, *Watt to Clausius*; Smith, *The Science of Energy*; Müller-Sievers, *The Cylinder*.

[388] Müller-Sievers, *The Cylinder*, 21-2.

[389] Gregory, *Treatise of Mechanics*, vol. 2., 167; "Friction," 367; "Machinery" in RC. Note also the quasi-militant, agonistic quality of the logic of machinery defined by a struggle to "overcome" or "counterbalance" the resistances or obstacles to its power, the catastrophic forces of dissipation such as "friction, or resistance."

[390] Gregory, *TM*, vol 2, 1. "Overcome," like "counterbalance," as engineers defined it, is not triumphalist. Machinery "overcomes" an obstacle or opposing force when it has sufficient power to move despite the resistance to its motion.

[391] Michel Serres, "Turner Translates Carnot," in *Hermes*, 54-57.

radiates from the furnace where edges collapse." [392] Turner enters into incandescence "without theoretical detours," by using some of the same materials in his painting – metals, oils, and resins – that engineers did in the engine. Freed from the statics of Newton's world, engineering and Romantic painting explode into fiery motion. "Matter and color triumph over line, geometry, and form…Turner sees the world in terms of water and fire, as Gerrard saw it in terms of figures and motion." Yet figures in motion don't, as Serres contends, go away but rather are materialized by the painter's and engineer's lines, renouncing any Newtonian claim to formal transcendence, their straightness and regularity abraded from the inside out by thermomechanical friction. Turner's lines are "the height of disorder": the foundry's roof is askew; its equipment unevenly squared; the plumb line has "melted in front of the furnace"; even the engine is made of imperfectly machined parts. No less striking are the implications for Romantic aesthetics: Turner translates the rise of thermodynamics into painting not by reading Carnot but by his own mechanical power: through Romantic painting as vehicle for the thermodynamics of figures in motion with the fire engine.[393] No more mechanical powers made in the image of power divine. No more formal transcendence, only the material immanence of thermomechanical force.

George Gerrard, *Mr. Whitbread's Wharf* (1784)

[392] Serres, "Turner Translates Carnot," 58-60.
[393] Serres, "Turner Translates Carnot," 58, 60-62.

J.M.W. Turner, *An Iron Foundry (1797/98),* www.tate.org.uk

J.M.W. Turner, *Fingal's Cave (1832/33)*, Yale Center for British Art, britishart.yale.edu

In spite of the radiance of Serres's vision, his reading of Romantic painter J.M.W. Turner's fire engines that marks the transition between Newtonian mechanics and engineering from *An Iron Foundry* (1797) to *Rain, Steam, and Speed – The Great Western Railway* (1844) forces us to reckon with the same thermodynamic world of de Man's figure of technology burning history, particularly in an age of anthropogenic climate change often dated to Watt's 1784 steam engine. The new thermodynamic world that emerges out of the engine gives rise to the material condition of the Anthropocene. As a neo-catastrophist concept, the Anthropocene confronts the material relation between the dissipation of human mechanical power – machinery – and thermodynamic and energy systems.[394] One chapter in Anthropocene history is the emergence of the thermodynamic logic of machinery over the Romantic era, in which the combustion of the perfect world of Newton and Gerard in the fire of the engine cylinder forces us to reckon with the rude truth that thermodynamic logic emerges not as an external critique of engineering but from it: the power of machinery that burns down the Newtonian universe.

2. Byron's Engineering Poetics

If Serres's passing sketch focuses on the sea change in visual representation between Turner and Carnot, how might Romantic poetry take part in the rise of thermodynamics? The same path that runs from Newton to Carnot, from Garrard to Turner, runs from Pope to Byron, by way of the combustion of the engine. A sense of constant, perpetual motion – or of unstoppable "strength" or "force" – heroically struggling to overcome opposing forces is often taken to be the heat signature of Byron's poetics.[395] If Romantic criticism has long recognized Byron's metaphors taken from mechanics, it has at once obscured its importance in the rise of thermodynamics.[396] I argue that Byron develops an engineering poetics that is best understood in the context of the end of perpetual motion and dissipation of human mechanical power that marks the transition between Newtonian mechanics and mechanical engineering in the early 19th century. Byron's "force" – far from anti-empirical – is best understood as thermomechanical force.[397] Byron's new poetic machinery struggles with the production and dissipation of energy that marks the rise of thermodynamics over the 1810s-20s. Much like Turner and Carnot,

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[394] For this relation as definitive of the Anthropocene, as Tobias Menely and Jesse Oak Taylor remark, see *Anthropocene Reading: Literary History in Geologic Times* (Penn UP, 2017). For the Anthropocene as a neo-catastrophist concept, see Jeremy Davies, *The Birth of the Anthropocene* (University of California Press, 2018).

[395] On the critical trope of Byron's strength or force, see Jerome Christensen, "Romantic Strength v. Empirical Force," in *Lord Byron's Strength: Romantic Writing and Commercial Society* (Baltimore, MA: Johns Hopkins University Press, 1993), 4; Jerome McGann, "Byron and the Force of Circumstance," *Don Juan in Context* (Chicago: University of Chicago Press, 1976), 1-10; Emily Rohrbach, *Modernity's Mist: Romanticism and the Poetics of Anticipation* (New York: Fordham University Press, 2015), 134-61. On Byron's force as a heroic, agonistic struggle, see Susan Wolfson, "Byron's Heroic Form," *Formal Charges: The Shaping of Poetry in British Romanticism* (Palo Alto: Stanford UP, 1997), 133-63; McGann, "The Paradoxes of Heroicism" and "Byron Agonistes," *Don Juan in Context*, 11-50; Gerard Cohen-Vrignaud, "Rhyme's Crimes," *ELH* 82.3 (2015): 987-1012.

[396] See James Chandler, "Byron's Causes: The Moral Mechanics of *Don Juan*," in *England in 1819*: *The Politics of Literary Culture and the Case of Romantic Historicism* (University of Chicago Press, 1999), in which Chandler notes "Byron's emphatic resort to metaphors drawn from mechanics," 358; McGann, "Byron and the Force of Circumstance," 1-10; Christensen, "The Circumstantial Gravity of *Don Juan*," in *Lord Byron's Strength*, 214-57. By "mechanics," Chandler, McGann, and Christensen refer to Newtonian mechanics rather than engineering on the level of generality at which Newton's and Hume's "mechanics" are interchangeable.

[397] My argument runs directly counter to Jerome Christensen's identification of Byron's strength with his "lordship" over against empirical force in "Romantic Strength v. Empirical Force," in *LBS*, 4.

Byron's poetic machinery burns through the temptations of permanence of the divinely ordered universe of Newton and Pope for the thermodynamic universe of energy and its perpetual loss that emerges with the engine.

Byron's engineering poetics stretch over his entire poetic career. As early as 1813, Byron explicitly refers to his poetic vocation as "my post as an engineer" with enough poetic force to "displace all the stars in the Newtonian system."[398] Byron's theoretical identification of his poetic vocation with the emerging profession of engineering applies the power of his poetic machinery to displace the static Newtonian universe precisely as engineers were in the 1810s-20s. Byron's engineering poetics shares the core features of engineers' definitions of machinery: machines struggled to "balance or overcome another power or obstacle" that threatened to catastrophically dissipate it, whether friction or the transcendental principles of Newtonian mechanics.[399] Far from anti-empirical or aristocratic, Byron's engineering poetics critically aligns his poetic vocation with his political sympathies for working mechanics – and the human totality – that develops over his poetic career, from his defense of working mechanics in Parliament to his 1824 death in combat fighting alongside a group of engineers struggling for human emancipation. If the critical power of Byron's engineering poetics is impersonally material as thermomechanical force, it at once aligns with the totality of human mechanical power on a historical materialist scale.[400]

If Byron's engineering poetics span his entire poetic career, it develops most fully with his new poetic machinery in *Don Juan* in the context of the rise of thermodynamics over the late 1810s and early 1820s between Newtonian mechanics and engineering. We can already glimpse the core features of Byron's engineering poetics in the Pope Controversy that flared up in the early days of *Don Juan*.[401] A "ship of the line" (this time Pope's, not Gerrard's) became the flash point of the dispute on the role of mechanical artifice in poetry. William Bowles had argued for a naturalistic poetics based in "invariable principles of nature." For Bowles, the natural forces of the wind and the waves are poetic, not the ship (for "the ship is all art"). The machinery of the ship is too rude to be poetic, mechanical powers made of vulgar materials: the sail, stripped down to its rude materiality, is nothing more than "coarse canvas," blue bunting," and "three tall polls." Byron defends mechanical artifice, articulating the core logic of his engineering poetics. Painting a Turneresque picture, Byron reenvisions the simple machinery of Pope's and Newton's world with a poet-engineer's sensibility to the new thermodynamic logic of machinery:

> B[owles] asserts that [the] Ship of the Line derives all its poetry not from art, but from Nature…Take away the waves, the winds, the sun, etc. etc., etc., one will become a stripe of blue bunting; and the other a piece of coarse canvas on three tall poles….But the 'poetry of the ship' does not depend on the 'waves,' etc.; on the contrary, the 'Ship of the Line' confers its own poetry upon the waters, and heightens theirs...But what seemed the most poetical of all at the moment, were the numbers (about two hundred) of Greek and

[398] Byron to John Murray, Nov 29, 1813; Dec 7, 1813, *Letters and Journals*, v 3. ed. Leslie Marchand (Cambridge, MA: Harvard University Press, 1973).
[399] Gregory, *Treatise of Mechanics*, 2:1.
[400] Byron's default historical-material poetic scale of the human totality combines elements of Pope's and Marx's historical materialism. What Chandler calls Byron's "cosmopolitanism" similarly points to Byron's insistent recourse to the human totality as his default poetic scale over against national identities or class distinctions. If totality is also the epic, heroic scale par excellence, then Byron's scale aligns with his diminished heroic logic.
[401] For more on the historical context of the Pope Controversy, see James Chandler, "The Pope Controversy: Romantic Poetics and the English Canon," *Critical Inquiry* 10 (1984): 481-509.

> Turkish craft, which were obliged to 'cut and run' before the wind, from their unsafe anchorage...The sight of these little scudding vessels, darting over the foam in the twilight… their reduction to fluttering specks in the distance...their littleness, as contending with the giant element; their aspect and their motion, all struck me as something far more poetical than the mere broad, brawling, shipless sea, and the sullen winds, could possibly have been without them.[402]

For Byron (as for Gerrard or Turner), the equipment or machinery is what stands out: the ship "conveys its own poetry upon the waters." Most poetic, Byron counters, turning Bowles's terms against him, are precisely its mechanical powers that Bowles considers too rude to be poetic, the "admirable application of the terms" of his "art": the "blue bunting," "coarse canvas," "three tall polls." Byron deconstructs Bowles's naturalistic poetics by dismantling the premise that poetry can ever be natural: "Nature will make no great artist of any kind, least of all a poet…the poet is the most artificial, perhaps of all artists." Poetic artifice is irreducibly mechanical: "art" for Byron is the application of human labor power to make something that would not otherwise exist in nature. What's striking is the base materiality of "art" for Byron, who takes the mechanical powers of the ship – the "coarse canvas" of the sail – as most poetic. Art or machinery (materially equivalent for Byron, who refers to anything built by human mechanical power as art) doesn't exist outside of materiality but is immanent to the motion of "matter," which is "always changing."[403] The sail derives its mechanical power from the wind and waves. In fact, without the ocean, "there would be no ship at all." Mechanical powers are not static or fixed but finite concessionaries of larger forces. "Most poetical of all" is "their aspect and their motion in contending with the giant element," struggling to defer material dissipation: "far more poetic than the mere broad, brawling, shipless sea could possibly have been without them": without the human presence. For Byron, art has no transcendent outside or Newtonian exteriority to materiality, no static or fixed line, just material immanence, pure finitude. All of this is Byron reading the world of Pope or Newton through the eyes of a Turner or Carnot.

Byron articulates the core logic of his engineering poetics in relation to the mechanical power of machinery that engineers develop over the 1810s and 20s, defined by machinery struggling against the catastrophic dissipation of human mechanical power by larger physical forces.[404] Byron's own experience as a sailor, in which he came into contact with many working mechanics and sailor-engineers, no doubt had an impact.[405] Byron defines the relation between the poet's mechanical power and an unruly nature by struggle: "contend": "to struggle," to "strive in opposition; to engage in conflict or fight."[406] The poet's and the engineer's force is not natural but rather artificial, like the sail struggling with the forces that threaten to dissipate it. As one engineer described sail-cloth as a mechanical power in 1816: a "canvas" "made of sail-cloth" must have "very considerable strength" to withstand the counterforce of both "air and

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[402] Byron to Murray, February, 7, 1821, in *Lord Byron, The Complete Works, vol. 12, Letters and Journals*, ed. Peter Cochran, 13 vols. (Cambridge, UK: Cambridge University Press, 2009), 12:297-98. Hereafter cited *Letters and Journals*. Unless otherwise noted, all references to Byron's works refer to this edition.
[403] Byron, *Letters and Journals*, 12:267.
[404] Many of the engineers who developed the steam engine were also sailors. At first, the engine was initially applied for "raising water" from mines and "pumping water from ships." For instance, see Captain Savery, a "sailor-engineer" whom Robert Stuart, like many engineers, includes in his *Descriptive History of the Steam Engine*, 29, 40.
[405] On Byron's maritime experience, see Talissa Ford, *Radical Romantics* (Edinburgh: Edinburgh University Press, 2016).
[406] "Contend, v.2." *OED*. July 2018.

water." Any machinery of the ship must be made in "point of strength" to bear the "strain on each part" by the counterforce of the wind and water that wear against it, threatening to dissipate its form and force.[407] Emptied of any triumph, the logic of machinery diminishes human power, "reduced to littleness" contending with the "giant" element. Yet even in diminishing human mechanical power, Byron locks it in the crosshairs, defining his engineering poetics with the terms engineers used to defined machines: most poetic is the "admirable application of the terms" of his "art": "a good workman" – whether a poet or engineer – "will not find fault with his tools."[408] As one engineer wrote in 1815, "Machines are nothing more" than "tools interposed between the workman" and the human struggle to "counterbalance or overcome another power or obstacle" such as friction and catastrophic wear by the elements that threatened to destroy it.[409] By attributing the "infinite superiority" of the ship over Bowles's sea for poetry to the "admirable application of the terms of" human "art," Byron likens his engineering poetics to the technical language of working mechanics – what he calls "engineering slang" or "cant" – and to "the application of art" as engineers applied the term: the "application of the force" of machinery – human mechanical power – to build or make something not otherwise in nature. [410] The terms of art mark the site of the struggle of human mechanical powers with the elements. [411]

At the heart of the Pope Controversy is Byron's articulation of a dynamic view of the material universe that fuels his engineering poetics precisely to the extent that it is anti-philosophical or materialist in character.[412] Like engineers at the time, Byron turns energy and its exhaustion by the practical application of mechanical power against the static mechanics of Newton and Pope's world to break down any transcendental principles that triumph over matter. Byron concludes, "I now come to Bowles's 'invariable principles of poetry…' I do hate that word *invariable*. What is there of *human* things, be it in poetry…matter, life, or death, which is '*invariable*? Of course, I put things divine out of the question." [413] Nothing human is invariable – like the mechanical power of the sail – because human things are material, cut off from divine power. Freed from transcendental determination, matter for Byron is not static but dynamic: "always changing" with the frictive "jar of atoms," like the sail at once energized and worn away by the wind and water. Just as Byron does, engineers in the 1810s took the "coarse cloth" of the

[407] Gregory, *Treatise of Mechanics*, 2:316-317. See also "On the Strength and Stress of Materials," in Gregory, *A Treatise of Mechanics*, 107. Against Christensen's anti-empirical sense of Byron's strength, Byron's strength is as impersonally material as engineer's sense of mechanical power's ability to withstand the elements.

[408] "Application" was itself an engineering term. For instance, in a *Treatise of Mechanics*, Gregory writes of "the application of practical engineers"; the "application of the steam-engine" for "giving motion," 2:233, 2:390, 2:384.
[409] Gregory, "Remarks on Machinery in General," in *A Treatise of Mechanics*, 2:1.
[410] For technical slang and jargon in 18th and 19th century literature, see Janet Sorensen, *Strange Vernaculars: How Eighteenth-Century Slang, Cant, Provincial Languages, and Nautical Jargon Became English* (Princeton: Princeton University Press, 2017); Elaine Freedgood and Cannot Schmitt, "Denotatively, Technically, Literally," *Representations* 125 (2014): 1-14. Both identify maritime technical language as a major site of technical language.
[411] Byron attributes the "infinite superiority of Falconer's *Shipwreck*," a long poem famous for translating working mechanic's cant into poetry, to the "admirable application" of the "terms" of "his art": as Falconer put it, "in ornamental verse / To dress, the harshest sounds mechanic arts express." Falconer, *The Shipwreck*, 204-5. Note the rough, "harsh" sounds of mechanics. Between the 1762 and 1764 editions, Falconer toggled between "the harshest sounds mechanic arts express" and "terms of art express" (Byron's phrasing verbatim). On Falconer's reputation for mechanic's slang, see Sorensen, *Strange Vernaculars*, 231-38.
[412] Chandler observes how Byron's poetics are "anti-philosophical, or materialist" in *England in 1819*, 363.
[413] Byron to Murray, February 7, 1821, in *Letters and Journals*, 12:297-302.

sail to exemplify "Variable Motion."[414] No more powers that triumph over matter, only human mechanical powers contending with unruly physical forces.[415] For Byron, nothing but dynamic motion persists in a universe in which the only constant is the unceasing mutual interchange of figures. Ending the Pope Controversy with the remark that "a good workman will not find fault with his tools" (and workmen in the 1810s are working mechanics or engineers), Byron burns through any notion that poetic making can ever escape from its rude mechanical powers.[416]

What matters about the Pope Controversy is how Byron's engineering poetics emerges in opposition not only to naturalist poetics – from Bowles to Wordsworth – but also the pre-industrial, pre-thermodynamic logic of machinery of Pope's or Garrard's world, all too static in its triumph over matter.[417] Poetic machinery for Pope imitated divine powers in moving the poem forward, an epic trope. The poet's machinery thus resembled power divine: transcendental forces exterior to materiality like Newton's Prime Mover. If it exerted its force over late 18th century poetry, the machinery of Pope's and Newton's world was on the brink of its dissipation by the time of the Pope Controversy. The 1819 *Cyclopaedia* article on "Machinery" in Poetry (next to the entry by an engineer) defined machinery as "when a poet brings" in some "divine power" to "solve some difficulty out of the reach of human power." The epic poet "does nothing but by machines": "there must be machines" in "every part" as the "gods are both good, bad, or indifferent."[418] In 1819, the same year as the "Machinery" article, Byron writes to Murray with his plans for *Don Juan*'s new poetic machinery: "You have so many divine poems, is it nothing to have written a human one? Without any of your worn-out machinery." Rather, "human" mechanical powers, "good or bad, must serve for the machinery" of "*Don Juan*."[419] Ruling out "divine poems," any machinery of Newton or Pope's world, Byron turns to "human" things: to the variable force of machinery itself. Chandler is right: Byron saves Pope for the poetry of the past, not for Romantic poetry. [420] "Pardon the engineering slang," Byron remarks, measuring his poetic force by the "metaphor taken from the forty-horse-power of the steam engine," the first use of the engineer's measure of mechanical power in the *OED* outside an engineering treatise.[421] Much like Turner, Byron changes machinery. Rhyme, the rude "tool that good workmen never quarrel with" in Canto 1 – retooling his Pope Controversy line – soon turns into "the steam-boat that keeps verses moving." Byron's poetic machinery cannot be reduced to

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[414] See Gregory, "Variable Motion," in *Treatise of Mechanics*, 181. Gregory takes "the wind on the sails" as his primary example of variable motion. ("When a moving body is subjected to the energy of a force which acts on it....in a different manner at each instant, the motion is called in general, variable motion"), 181.

[415] Byron, *Don Juan*, 2.1696*; Letters and Journals*, 12:267-68, 12:297-302.

[416] Engineering treatises in the 1810-20s are filled with markers of mechanic's slang denoted by the phrase "as the workmen call it," the same term Byron uses. See Gregory, *A Treatise of Mechanics*, 2:53, 2:179, 2:453, 2:461.

[417] If Pope's machinery is largely outside the scope of this chapter, the 18th century epic trope of poetic machinery traces to the *Rape of the Lock* (and back to Aristotle's *deus ex machina*). For this genealogy, see Joseph Drury, *Novel Machines: Technology and Narrative Form in Enlightenment Britain* (Oxford: Oxford University Press, 2017), 27.

[418] "Machinery," *RC*, vol. 21 (1819), 754-56.

[419] Byron to Murray, April 6, 1819, in in *Medwin's Conversations of Lord Byron*, ed. Ernest Lovell (Princeton: Princeton University Press, 2016), 165.

[420] See Chandler, "The Pope Controversy," 481-509. While he rightly notes that Byron "saves Pope for not for the history of the future but for the history of the past," Chandler only links this to Byron's rejection of Pope's invariable principles of nature rather than to his poetic machinery. As I've just shown, however, there's quite a lot of heat and light on Byron's poetic machinery generated by the Controversy against the backdrop of the rise of thermodynamics.

[421] "Horsepower, n." *OED*. October 2019.

Pope's, which he radically rejects in a poem of "only materials."[422] Rather, it emerges out of the thermodynamic logic of machinery itself: early nineteenth-century engineering.

In *Don Juan*, Byron applies to practice the core logic of his engineering poetics that he articulates in the Pope Controversy: "good workmen never find fault with their tools" turns into the machinery or "tool" of "rhyme" that "good workmen never quarrel with" in Canto I over against the blank verse of Bowles or Wordsworth's nature poetry or Pope's machinery. If Byron's "fondness for rhyme" spans his entire poetic career from his "post as an engineer," it is because it is the mode of language power self-conscious of its mechanical artifice. Over his poetic career, Byron rejects the blank verse of nature poetry as a "rough and barren rock": matter not worked upon by mechanical artifice, without human mechanical power struggling with the elements to defer its dissipation.[423] The machinery of "rhyme" for Byron is metonymic for the mode of poetic language power self-conscious of its mechanical artifice, as the application of the poet's labor power to make something that would not otherwise exist in nature, the "tool" or "machinery" of "workmen".[424] With his poetic machinery, Byron develops a thermodynamic logic of poetic language power in which the dynamic motion of poetic language cannot be decoupled from its dissipation. For Byron, the mechanical power of poetic language is energy artificially perpetuated by human means that struggles against forces that threaten to dissipate it. From the Dedication, Byron's machinery "turns and turns to give the world a notion / of endless torments and perpetual motion."[425] Just as the horsepower of the engine is forced, artificial motion that would not exist in nature, so rhyme turns into the engine that "*keeps* verses moving," artificially perpetuated by the poet's mechanical artifice. Yet for Byron, as for engineers, dynamic motion cannot be decoupled from its dissipation through friction: "where it all must end."

By working with their tools, engineers over the early 19th century discovered the irreversible loss of force that turns into entropy. Engineers fit together machine parts called "couplings" to maximize the engine's power by reducing the force lost by friction. To an extent, machine parts had to be tightly fit together – "force-paired" – by screw-nut couplings to reduce friction. Yet fitting machine parts together too tightly in fact increased friction, as their figures would wear against one another. Engineers thus lubricated machinery to couple the parts together less tightly, rendering motion freer and less frictive. As one engineer put it, machinery "should be fitted, and kept in contact" with oil to reduce "burning or heating by friction, when in rapid motion." The "nut[s] of the female screw" coupling the engine together were lubricated to reduce the "very great friction in the [male] screw" slipping inside it.[426] Particularly critical was reducing the force lost by the engine coupler, the engine's central linkage that translated the piston's rise and fall into the torque that powered machinery. As Helmut Müller-Sievers notes, "engineers used Schillerian terms like *play* and *tolerance* to mark this contradiction, and in German the sealing gasket that was supposed to fill and leave open this space…was even

[422] Byron to Murray, August 12, 1819.
[423] Byron, *The Corsair*, in *Poetical Works*, 3:149. It is not the roughness of the "rough and barren rock" of mere nature that Byron opposes but rather as poetry that passively copies nature unmarked by the rough struggle of mechanical artifice with the elements. For Byron, nature poetry like Bowles that emphasizes nature's serenity and dynamic vitality risks papering over the roughness of inhuman nature like the "brawling sea."
[424] Olinthus Gregory, "Remarks on Machinery in General," in *A Treatise of Mechanics*, vol. 2 (London: 1815), 1.
[425] Byron, *Don Juan*, "Dedication," 103-4. As Christensen notes, the poem's "indefinite continuation is a sufficient 'notion' of 'torments and perpetual motion'…the poem "turns in order to keep turning…to turn into mere trope," in *Lord Byron's Strength*, 218.
[426] "Friction," in *RC*, vol. 15, 369; Gregory, *A Treatise of Mechanics*, vol 2., 29, 299; "Machinery" in *RC*, vol. 21.

bestowed the sacred term for poetry."[427] Against Bowles, the logic of machinery demanded keeping a space open for free motion that was called poetic. Lubricating the parts let them "play up and down without rubbing on the sides, which would quickly wear it out." As one engineer put it, machinery should be "supplied with oil" to prevent "obstructing its free play" so that the piston would have "sufficient freedom of motion" to "play freely" and move "at pleasure," without "slippage."[428] Reducing the friction from the slippage of the "paired couplings" of parts demanded freedom of motion to maximize the power of the engine.

Engineers developed a thermodynamic aesthetics of freedom out of the logic of machinery. Rough, frictive motion and the loss of force was aesthetic displeasure, like the screw abrading the nut. Novalis, a mining engineer, called frictive motion displeasure.[429] "Pleasure," as engineers termed it, corresponded to dynamic, "free" motion unimpeded by rough friction. Fluid, lubricated machine parts could "play freely" and "varied at the engineer's pleasure," just as smooth, unimpeded motion was pleasurable. Pleasure was thus the feeling of mechanical power increasing or friction, or resistance to motion overcome.[430] With the masculine and feminine endings of machine parts, the physiological correlates were part of material experience: "pleasures unredeemed by transcendence that debase a human essence."[431] Anti-transcendental, aesthetic freedom lay not in the Kantian free play of the faculties but in the dynamic motion of thermomechanical force relatively unimpeded by friction and freed from any static fit of parts too tight for free motion, like Byron's "fire and motion of the soul" that burns through "every fitting medium of desire" like the motive power of his new poetic machinery.[432]

Byron's poetic machinery turns precisely this free, dynamic motion of thermomechanical force into the engine of poetry. As opposed to machinery in general, thermodynamics takes a distinctly semiotic form with poetic language in the form of signifying force and its dissipation. In translating how Byron's engineering poetics turn "extreme suspicion" – critical consciousness – and "playful mischief" – semiotic dissipation – into the engine of poetry, Walter Scott compares Byron's "imaginative force" to the thermodynamics of machinery.[433] As Scott observes, Byron's poetic "force" is fueled by the engineering principle that "the wheels of a machine to play rapidly must not fit with the utmost exactness else the attrition diminishes the impetus." "Minimizing the attrition" – the friction produced by the parts fitting too tightly – by "playful" yet "suspicious" ironic labilities of language – frees up Byron's "imaginative power" so that it can "play more rapidly."[434] Byron's playful yet suspicious labilities of language are the lubricants that free up the dynamic force of his poetics. By fitting together poetic language with room for semiotic dissipation, Byron frees the dynamic yet dissipate power of poetic language. Like the engineer's suspicion of fixed principles, the "extreme suspicion" of Byron's imaginative power is anti-transcendental and materialist, turning against the statics of Newton's world. Scott

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[427] Müller-Sievers, *The Cylinder*, 60.
[428] Olinthus Gregory, *A Treatise of Mechanics*, vol 2. (London: 1819); 299, 118, 349, 411.
[429] On Novalis's mining engineering, see Bryan Norton, "Novalis's Perpetuum Mobile: Towards a Thermodynamic *Naturphilosophie*," NASSR, Providence, RI, June 2018.
[430] Gregory, *Treatise of Mechanics*, vol. 2, 1, 349.
[431] To repurpose Cohen-Vrignaud's apt phrase for Byron's rhyme in "Rhyme's Crimes," 992.
[432] *Childe Harolde's Pilgrimage*, 3.371, 3.374. Byron also glosses "my spirits" as the fuel of his "machinery," a felt sense of mechanical power. See Byron to Murray, April 6, 1819; *Medwin's Conversations of Lord Byron*, 165.
[433] Walter Scott, Nov 20, 1825, *The Journal of Walter Scott* ed. Burt Franklin (New York: 1890).
[434] "Force of impetus," as engineers defined it, "is the mechanical power" of machines "exerted upon any obstacles which occasion a diminution of their velocity," such as friction. John Farey, *A Treatise on the Steam Engine: Historical Practical Descriptive* (London: Longman, 1827), 19.

makes no mention of prosody: for Scott, Byron's machinery is more fundamentally semiotic than prosodic, extending to all poetic language rather than limited to any verse form like *ottava rima*. If Scott is ultimately right, he overlooks how Byron articulates his engineering poetics in relation to rhyme. Byron uses rhyme metonymically for his machinery as the form of poetic making self-conscious of its mechanical power that makes use of rhyme as a tool but is not limited to it.

In retooling Romantic poetry, Byron re-engineers rhyme's mechanical reputation. "Rhyme" turns into the "steam-boat" that "keeps verses moving" coupled into "faithful pairs," the force-paired couplings of lines that defer dissipation by perpetuating the power of poetic language. "Couplet" itself etymologically derives from two pieces of iron riveted together by screws, the fundamental mechanical couplings that maximized the engine's power.[435] In another engineering metaphor, Byron reflects on how the "engineer's" machinery dissipates "for the same cause which makes a verse want feet," the "haste or waste" by which it is fit together. Like attrition, "waste" is engineering slang for frictive dissipation. Yet rather than over-identify his poetic machinery with prosody, Byron uses rhyme metonymically to re-engineer the more fundamental semiotic dynamic of rhyme's mechanical reputation critiqued by proponents of the rational freedoms of blank verse for semiotically decoupling "sound" from "sense" – or, more to the point, language's material motion from its rational content.[436] Rather than force "rhyme to reason" – as rhyme's defenders often did – Byron critically turns the motion of poetic language against its rational content. For Byron, the engine of rhyme "keeps verses moving / Against reason." If for Chandler, Byron's materialist tendency is undone by the "ironic labilities" of his language,[437] my claim is that such labilities are the most radical expression of it. The labilities of Byron's poetic language – much as Scott saw – are the lubricants that fuel the dynamic motion of his poetic machinery that can't be decoupled from its frictive dissipation:

> Of faithful pairs (I needs must rhyme with dove,
> That good old steam-boat which keeps verses moving
> 'Gainst reason—Reason ne'er was hand-and-glove
> With rhyme, but always leant less to improving
> The sound than sense), beside all these pretences
> To love, there are those things which words name senses
> Those movements, those improvements in our bodies.[438]

How exactly does Byron's machinery "keep verses moving against reason"? The "senses" of the mechanical vehicularity of poetic language – its mechanical power as a finite mechanism to defer dissipation – are at stake. On one level, language defers dissipation to the

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[435] See "Couplet, n." *OED*. October 2019.

[436] On rhyme's "mechanical reputation," see Cohen-Vrignaud, "Rhyme's Crimes," 987-1012. In recovering how rhyme's crimes over the 19th century arose from a preference for the rational and expressive freedoms of blank verse, Gerard Cohen-Vrignaud notes how many of "rhyme's defenders have internalized the anti-sensualist bias against the practice...the 'cut between the sensorious and the logical'... in which the critic makes rhyme reason either by consolidating or modulating the semantic content of the heroic couplet." 992-3, 997. Likewise, Byron re-engineering of rhyme burns through Pope's notion of rhyme's reason: that "sound" and "sense" should perfectly fit together so that the poet's machinery is made in the image of the divinely ordered Newtonian universe. See Hugh Kenner, "Pope's Reasonable Rhymes." *ELH* 41.1 (1974): 74-88.

[437] For Chandler, despite Byron's "materialist orientation," the "lability of the ironies" of his language ultimately "make it difficult to conduct a materialist analysis of his project." *England in 1819*, 363-65.

[438] Byron, *DJ*, 9.587-592.

extent of its communicative rationality: the extent to which its motion is a vehicle of "sense" or rational content, and entropic to the extent that its fails to transport its tenor to a definite referent. Just as friction is produced by the "slippage" of figures abrading one another in motion, so for Byron friction is semiotic slippage that ironically dissipates the rationality of poetic language. Yet in a ruder sense, for Byron, poetry's power to "keeping verses moving" defers dissipation to the extent that it perpetuates the motion of poetic language, keeping language moving line by material line. "Dove"– which the engine of the couplet "needs must rhyme" with "love" – is an empty signifier with no meaning other than to keep verses moving. Burning through the communicative rationality of poetic language, the engine of rhyme forces "dove" to pair with "glove" and "love" purely to perpetuate the motion of poetry by line. Combusting language's referential content,[439] Byron's verse turns reference into the raw fuel for perpetuating the motion of language. Not only does the engine of rhyme "lean less to improving" the sound than the "sense" but its mechanical force ironically dissipates language's rational content, unfixing the motion of poetic tropes from any pretense to "things which words name." The sense of "sense" itself is subjected to a series of frictive slippages in the lines by the "movements" in "our bodies" that dissipate its rational content.[440] The engine of rhyme thermomechanically abrades the sense of reason itself, moving the referent of "sense" – initially "reason" – from "senses" to "pretences" to "improvement" and "movement." The referent of sense slips from "reason" to "movements in our bodies," which in turn slips into the lubricious movements of the screwlike "loving" of the "pairs" of force-paired couplets. The force-paired screws of the masculine and feminine endings of the engine of rhyme – coupling together "dove" and "love" and "moving" and "improving" – at once perpetuate the motion of poetic language and frictively dissipates it. Byron takes us into the engine cylinder of verse, into the mechanical force of tropes behind "all these pretenses" to "things which words name." Ironically, perpetuating the rude mechanical motion of poetic language frees up the motion of poetry from any rational mechanics of fixed or definite reference. At stake is a thermodynamic logic of poetry and machinery in all its material impermanence, autonomous from any transcendental principle outside of matter itself.

What's critical about the dynamic motion of poetic language for Byron is that it moves "Gainst reason": against any triumph of the line over matter. It is not that the Byron's engine of verse uniformly burns through all rational content in a post-semiotic sense, so much as rational content is shown to be an effect of mechanical motion. Poetic tropes are variably dissipate: not all are as entropic as "dove." "Dove" figures a limit case of dissipation, at once universal and materially variable. "Sense" or reference is shown to emerge ex machina as an effect of mechanical motion, of keeping verses moving. Byron's couplet is anti-philosophical in that it immanently measures the mechanical power of poetic tropes by means of motion rather rational principles. If Byron's engine of verse translates larger thermomechanical forces into the motion of tropes, like any mechanical power, it does so imperfectly. The playful dissipation of Byron's lines suggests that any "pair" of lines will not stay perpetually coupled together but are imperfectly fit, like any force-pair, like the "motion, or fire in the soul / That burns through any fitting medium of desire." "Burns through" in the double sense of by means of and burning out: Byron's machinery, like the engine, is frictively dissipated the very thermodynamic forces by which it burns onward, burning through reason's very "pretense" to fixity, to any perfect fit or pair-bond that can't materially exist. The motion of the line imperfectly perpetuates the motion

[439] See *DJ,* 14.430, "My Muse despises reference," which Christensen takes as his study's epigraph. *LBS,* 3.
[440] Susan Wolfson notes how the series of displacements of "sense" in the lines culminating in the "movements" render the "the exact sense of sense allusive," in *Formal Charges,* 141.

of poetry for a passing time. Byron empties poetic language power of all triumph, of all but the most diminished heroicism. As an immanent materialist critique of any temptation of permanence, Byron's poetic machinery burns through any "invariable principles of poetry" – any fixed principle exterior to materiality – to the exact degree of its non-correspondence with frictive mechanical force. The critical, anti-ideological value of poetic language that turns "against reason" is fueled by its mechanical force. The pleasure produced by Byron's poetic language derives from overcoming the resistances to its motion to perpetuate the free dynamic motion of poetic language. At stake is an autonomous logic of poetry and machinery in all its material impermanence, decoupled from any fixed principle outside of materiality itself.

On the other side of the energy spectrum, frictive displeasure for Byron, as for engineers at the time, rudely thermomechanically abrades even the height of poetic language power from the inside out. In a letter at around the same time, Byron envisions what the rude mechanical force underneath poetic tropes and metaphors looks like. Even "at the very height of desire and human pleasure" – the human pleasure of the free play of the dynamic motion of the engine of rhyme -- there "mingles a certain sense of doubt." "From whatever place we commence, we know where it all must end.... I feel most things, but I know nothing, except":

— — — — — — — — —
— — — — — — — — —
— — — — — — — — — .[441]

Hard to imagine a more brutal material vision of thermodynamic loss than Byron's reflection on the passing mechanical force of the line, except for which he knows nothing. Note Byron's recourse to a material knowledge of the mechanical dissipation of motion, a materialism that is too unflinching in its rude mechanicity to be swayed by any skepticism. "Doubt" is not Pyrrhonian skepticism but the material knowledge of the exhaustion of mechanical force – "that every body must lie still" – that persists even at the height of human pleasure, the "feeling" of the "motion or fire in the soul that burns quenchless evermore." The line is emptied not only of all referential content, but of poetic language itself, of "any pretenses to things which words name." All that remains is the base mechanical motion of the line. And that motion is soon over. Force spent, the line perpetuates its motion for a brief three lines – like poetic lines evacuated of language – before its motion ceases where it "all must end," the total dissipation of motion. No more couplet. No more concourse of atoms. As a negative representation that empties out everything from the poetic line except for its passing mechanical force, the force of poetic tropes is shown for what it is: a material epiphenomenon on the base mechanical motion of the engine of rhyme, of "keeping verses moving": and of passing mechanical force itself. Moving to where it all must end – all things in the material universe – the line perpetuates its frictive mechanical motion for a passing time, as the mechanical force underneath all tropes, irreversibly moving to its dissipation. For Byron, force struggles to defer the end for a passing time: "in all human affairs" – material – there is a "desire" to struggle to defer "where it all must end." The end of the line is what the engine of rhyme defers in "keeping verses moving" for a passing time. Byron ends with a question regarding the implications of where it all must end for human futurity: "And if it were not for Hope, where would be future be? In all human affairs, it is Hope – Hope – Hope?" Byron struggles with the question that engineers grappled with in the 1810s with the end

[441] Byron, Jan 28, 1821, *Letters and Journals*, 115.

of perpetual motion that emerges out of the logic of machinery: what vision of human history is still possible with the catastrophic dissipation of energy through thermomechanical friction?

3. Out of Steam

The machine is that through which man fights against the death of the universe; it slows down the degradation of energy.

– Simondon, *On the Mode of Existence of Technical Objects*

Progress today really does mean simply the prevention and avoidance of total catastrophe.

– Adorno, *History and Freedom*

If the machines of geoengineering are one day rolled out in an attempt to cool the earth, surely their strings will be pulled by ordinary mortals…Humans of the classical type are the only ones who could possibly rise up and shake off fossil fuels.

– Andreas Malm, *The Progress of this Storm*

There is no alternative to continuing to struggle.

– Kim Stanley Robinson, *2312*

What critical value, however, can the thermodynamic logic of machinery still have in a time of anthropogenic climate change dated to the engine? It has recently become popular to assert that thermodynamics fueled fossil capitalism's progressive visions of limitless steam power.[442] Yet this claim proves unsustainable. Over the 1810s-20s, engineers developed a historical consciousness out of the engine that radically diminished any ideal of human progress. With friction, any progress fueled by the engine dissipated with it. Far from triumphalist, machinery became defined by the struggle against the catastrophic dissipation of energy.[443] As it leads to a historical consciousness of the dissipation of energy systems, rendering human power a finite concessionary of the planet's resources, thermodynamics is increasingly recognized as foundational for ecological thought in the Anthropocene. As Macduffie observes, "Despite its commitments…to industrial development, thermodynamic writing contained within it the seeds of an ecologically conscious discourse" about human energy practices.[444] Macduffie's remarks typify the critical tendency to recognize both the critical value of thermodynamics and the tension with its emergence out of steam. To recover the critical value of the thermodynamic logic of machinery for Anthropocene thought, we must grasp how it at once emerges from the steam engine but is not reducible to it in order to negotiate the particular and universal forms of dissipation on a planetary scale. Universal dissipation has doubled in Anthropocene history,

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[442] See, for instance, Cara New Daggett, *The Birth of Energy: Fossil Fuels, Thermodynamics, and the Politics of Work* (Duke University Press, 2019).

[443] For Romantic engineers, friction abraded any concept of technological progress from the inside out. As Carnot put it, the "possible improvements" to the "motive power" of "steam engines have an assignable limit" that "cannot be exceeded by any means." With perpetual motion "beyond the reach of any mechanical power," any progress of human history based on the power of the engine dissipated with it.[443] Far from triumphalist, the "progress" of machinery was defined by the struggle to perpetuate motion to counterbalance the forces of dissipation that threatened to catastrophically destroy it. Sadi Carnot, *Reflections on the Motive Power of Fire* (Paris: 1824), 4; Gregory, *A Treatise of Mechanics*, vol 2, (London: 1805), 358. First edition.

[444] Macduffie, *Victorian Literature, Energy, and the Ecological Imagination*, 14, 82. On the ecological potentials of thermodynamics, see also Paul Ehrlich, Anne Ehrlich, and John P. Holdren "Availability Entropy and the Laws of Thermodynamics." In *Valuing the Earth: Economics, Ecology Ethics,* ed. Herman Daly and Kenneth Townsend (Cambridge, MA: MIT Press, 1993). 72-73.

planetary climate catastrophe caused by the dissipation of the steam engine supervening upon the heat death of the sun.[445] Paul Crutzen has recently argued that geoengineering may be necessary to fight planetary scale dissipation, as merely renouncing it may no longer be sufficient.[446] Yet one need not accept geoengineering to admit that some form of machinery – such as renewable energy technology – may be necessary to get out of steam.[447] Byron's engineering poetics prefigures such a mode of Anthropocene response to the dissipation of energy systems: applying the thermodynamics of machinery to fight against dissipation on a terrestrial scale.

As a "prophet of ecocide," Byron has often been taken to prefigure a pessimistic form of ecological response to universal dissipation.[448] Yet the critical strength of Byron's poetics – and the thermodynamic logic of machinery from the time of Romanticism to the present – ultimately lies not in renunciation but in militant struggle. If Byron's view of history is rightly taken to be catastrophist, this is only half of his historical consciousness that emerges out of machinery: [449]

> When Newton saw an apple fall, he found
> In that slight startle from his contemplation –
> 'Tis said (for I'll not answer above ground)
> For any sage's creed or calculation) –
> A mode of proving that the earth turned round
> In a most natural whirl called 'Gravitation,'
> And this is the sole mortal who could grapple,
> Since Adam, with a fall, or with an apple.
>
> Man fell with apples, and with apples rose,
> If this be true; for we must deem the mode
> In which Sir Isaac Newton could disclose
> Through the then unpaved stars the turnpike road,
> A thing to counterbalance human woes;
> For ever since immortal man hath glowed
> With all kinds of mechanics, and full soon
> Steam-engines will conduct him to the Moon.
>
> And wherefore this exordium? – Why just now,

[445] To be clear, the CO2 emitted by the steam engine is the particular form of dissipation, entropy the general. On the heat signatures of anthropogenic climate change in late eighteenth and nineteenth-century literary history, see Tobias Menely, "Anthropocene Air," *Minnesota Review* 83 (2014): 93-101; "'The Present Obfuscation': Cowper's *Task* and the Time of Climate Change," *PMLA* 127.3 (2012): 477-492**;** Jesse Oak Taylor, *The Sky of our Manufacture: The London Fog in British Fiction from Dickens to Woolf* (University of Virginia Press, 2016).

[446] Crutzen, "Geology of Mankind," 23; Geoengineering is hotly debated. For a good critical overview, see Clive Hamilton, *Earthmasters: The Dawn of the Age of Climate Engineering* (New Haven: Yale University Press, 2013); Holly Jean Buck, *After Geoengineering: Climate Tragedy, Repair, and Restoration* (New York: Verso, 2019); "Terraforming," Karen Pinkus and Derek Woods, *Diacritics* 47.3 (2019): 4-5.

[447] On the exhaustion of critique in the Anthropocene, see also Bruno Latour, "Why Has Critique Run out of Steam? From Matters of Fact to Matters of Concern," *Critical Inquiry* 30.2 (2014): 225-248. If Latour rightly acknowledges the need for new tools, my argument is very different from Latour's and not an endorsement.

[448] See Jonathan Bate, "Living with the Weather," *Studies in Romanticism* 35.3 (1996): 437. See also David Higgins, *British Romanticism, Climate Change, and the Anthropocene: Writing Tambora* (Palgrave, 2017).

[449] On Byron's catastrophism, see Chandler, *England in 1819*, 381-82; Noah Heringman, "The Anthropocene Reads Buffon (or, Reading Like Geology)" in *Anthropocene Reading*, 59-77.

In taking up this paltry sheet of paper,
My bosom underwent a glorious glow,
And my internal Spirit cut a caper
And though so much inferior, as I know,
To those who, by the dint of glass and vapour,
Discover stars, and sail in the wind's eye,
I wish to do as much by Poesy.[450]

Canto X of *Don Juan* represents Byron's most explicit reflection on the rise of the steam engine.[451] The lines translate the rise of mechanical power from Newton to steam engines, from simple mechanics to engineering into the planetary scale power that has come to define the Anthropocene. In fact, Byron composed Canto X shortly after he received a letter from an engineer who requested his support in developing steam engines capable of air travel. Byron responded enthusiastically. Medwin was skeptical of the engineer's proposal. But Byron counters Medwin's skepticism: "There is not so much folly as you might suppose, and a vast deal of poetry, in the idea." "I suppose we shall soon travel by air vessels …and at length find our way to the moon, in spite of the want of atmosphere." Canto X, as Thomas Medwin already saw in 1824, is Byron's attempt to realize the poetry in the engineer's idea through the force of his engineering poetics, here "to do as much by Poesy" as steam-engines to the moon, rivaling the engine's planetary scale mechanical power that has come to define the Anthropocene.[452] Byron's measure of poetry's and the engine's power cuts two ways: if on the one hand, the engine fuels the motion of the poem, and the energy of the poetic language in Canto X – just as Byron finds "a vast deal of poetry" in the rise of the engine's power on a terrestrial scale that persists despite Medwin's skepticism – Byron's poetic machinery at once frictively abrades the engine's power and any progressive view of history it fuels, though it does so without exhausting that power completely. On one level, the motion of Byron's poetic machinery might be called progressivist insofar as it fights to defer dissipation or "counterbalance human woes" by keeping verses moving with every new canto of *Don Juan*. Yet any such progressive energy is at once diminished by the semiotic frictions that can't be decoupled from the motion of the poem, frictions internal to the combustible energy that at once fuels and dissipates the signifying power of poetic language. The very excessive, overheated energy of the language "full soon / Steam-engines will conduct him to the Moon," for instance, at once fuels and frictively abrades its own power to signify that progressive trajectory. When Byron refuses to measure how far the engine will rise while "above ground," his poetic language also reminds the reader of coal's origins below ground and of the planetary limits of energy. Byron prefigures a catastrophic fall back to the planet's surface once that finite energy source runs out of steam.[453]

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[450] Byron, *DJ,* 10.1-24.

[451] Chandler calls the exordium Byron's most explicit reflection on mechanics raised to a "version of history" in *England in 1819,* 366, a phrase he borrows from Peter Manning*, Byron and His Fictions*, 214-16.

[452] Byron, in *Medwin's Conversations of Lord Byron*, 187-88.

[453] How then does the energy of Byron's poetic language measure the rise of the engine? Some measure of progressive energy, however diminished, seems irreducible. Byron's "wish to do as much by poesy" – to realize the "vast deal of poetry in the idea" – measures his irreducible sense of the poetry in the rise of human mechanical power that his engineering poetics in turn puts into practice. Rendering poetic motion more thermodynamic, Byron works the engineer's slang for mechanical power into energetic, playfully labile language. The force-paired couplets ("full soon / to the moon" and "caper / vapour") heighten the rising mechanical energy that they at once signify. "Rotation" in Byron's first draft – full of fricatives – turns into a labile "whirl" to heighten the energy of the poetic

The effect of the thermodynamic engine of the poem itself is to reduce human power to a catastrophic struggle to "counterbalance human woes" on a planetary scale through machinery, poetic or otherwise, a diminished heroic struggle made even more explicit in Byron's letter to the engineer fueling Canto X. Byron continues: "Might not the fables of Prometheus, and his stealing the fire…be but traditions of steam and its machinery? Who knows whether, when a comet shall approach this globe to destroy it, as it has often been destroyed, men" might not stop it "by means of steam" or another engine? Contending with the giant element, Byron's machinery fights to defer global catastrophe. On a planetary scale in which human mechanical power is reduced to a fluttering speck in the distance of universal dissipation, the struggle is at once diminished and rendered more critical. That other species went extinct despite their advanced machinery frictively abrades any hope in human technological progress. Yet even in diminishing human power, Byron sees "a vast deal of poetry" in its struggle. Faced with global catastrophe, Byron keeps fighting against dissipation on a planetary scale. Battling alongside engineers in his last days in 1823-24, participating in the cause for Greek liberation, Byron directly applies his poetic "post as an engineer" to a global struggle, personally ordering the latest armored steam-boats to be directly applied to the fight. Befriending the six engineers in his battalion, "fine rough fellows," Byron praises their cutting edge "factory" as a "model" of applying machinery "only for the public benefit."[454] While the struggle in this case is very different from climate change, the same logic of machinery fuels Byron's engineering poetics in fighting to avert catastrophic dissipation on a planetary scale.

Byron would likely be the first to appreciate that the globe is now all the more likely to destroyed than saved by "steam and its machinery," and that other machinery might at once combat such a planetary scale catastrophe. If Byron could not yet fully anticipate the particular planetary damage of carbon emissions – an additional friction present in reading Byron in a time

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language. The same thermodynamic principle applies to "glow" and "caper," labile terms for force. The fiery "spirit" with which Byron glows perpetuates the motion of poetic language to do as much as the rising power of the engine over the early 19th century. The vast deal of poetry in the rise of machinery for Byron lies the potential to progressively defer dissipation through mechanical power. The force of Byron's poetic language rises with the fiery "glow" of the engine, counterbalancing the forces of dissipation. Yet the mechanical power of Byron's poetic language can't be decoupled from its frictive dissipation. To an extent, the playful energy of the tropic language heightens the critique of Newtonian mechanics: Newtonian gravitation turns into a "sage's creed or calculation" while the frictive collision of the "slight startle from his contemplation" ironizes the excessive rationalism of Newtonian mechanics, and its valorization of rational theory over the energy of machinery. The frictive slippage of the tropes – also immanent to the friction of the imperfectly rhymed couplet of "eye / Poesy" – suggest that the rise of human mechanical power with the engine is temporary, and that a fall will follow it. Even at the "height of human pleasure" for Byron, there is a "fear" of "falling." If primarily a critique of Newtonian mechanics, "I won't answer for any sage's creed or calculation / Above ground" – the conditional phrase on which the rise hinges – threatens to dissipate the mechanical power of the rise of the engine through the ironic dissipation of tropic language. Why "above ground"? Given that the entire action of the Exordium, the rise of the engine, takes place above ground – the steam engines to the moon allegorizing the rise of human power – the tropic language "above ground" is particularly semiotically frictive. Byron insists that he can in fact "answer for" the power of the engine not above ground but rather on or below it, anticipating a fall back down to the planetary surface that precedes any rising motion in the lines. What then is below ground? The dissipation of motion, lying still in the stratigraphy of the earth: where "every body must one day / lie still" or "where it all must end." Steam power, traced back to its fossilized source in the earth: mining coals, the finite measure of how high the engine can ascend. The dissipate motion of Byron's tropes suggests that the engine and poetry will not perpetually rise, once it runs out of fuel and fall back down to earth.

[454] Byron, *Letters and Journals*, ed. Leslie Marchand, 11:79, 105-106. Byron's radical militancy has fared very well in recent critical race theory and global studies scholarship reappraising his cosmopolitanism. On Byron's contributions to global class struggle, see Jared Hickman, "Byronic Abolitionism," in *Black Prometheus: Race and Radicalism in the Age of Atlantic Slavery* (Oxford UP, 2016).

of anthropogenic climate change – his engineering poetics may now provide critical tools for combating it, although they would have to be more explicitly turned against rather than fueled by steam to be useful today. Andreas Malm has shown the critical necessity of the thermodynamic logic of machinery for fighting catastrophic dissipation on the planetary scale that Byron envisions.[455] As Malm observes, "Progress today really does mean simply the prevention and avoidance of total catastrophe" in "opposition to the forces of this storm."[456] Rather than rejecting mechanical power, any chance of avoiding catastrophe will involve repurposing machinery to "fight" against catastrophic dissipation on a planetary scale. Advocating a path to eco-militancy, Malm insists that human powers must "commit to the most militant opposition" to the "forces of this storm" to "make this little planet habitable": critically, through negative emissions technologies and renewable energy technologies. As Malm shows, such mechanical powers are now aligned with global class struggle, and the interests of the planet itself.

If the Anthropocene is not only a techno-scientific problem that, as Crutzen argues, requires scientists and engineers to fight for "environmentally sustainable management" but also, as many now recognize, irreducibly figurative and aesthetic, poetry might play a critical role in forming our historical consciousness of the totality and dissipation of energy systems and mobilizing the affective energy and critical friction to effectively combat planetary catastrophe.[457] Now more than ever, we need Byron's critical diminishment of human power combined with his militant commitment to historical-material struggle, to at once figure out the frictions in proposed techno-fixes without rejecting the real tools at our disposal. Like Bloch's militant optimism, Byron's engineering poetics couples a frictive pessimism of the intellect to an optimism – or heightened energy – of the will. Emptied of any triumph, poetry might retain its power as a form capable of at once thinking totality and dissipation and combating it through

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[455] A similar application of the thermodynamic logic of machinery runs through 20th century and contemporary engineering. Reflecting on the rise of thermodynamics over the early 19th century, Simondon puts the critical strength of the logic of machinery most succinctly: "the machine is that through which man fights against the death of the universe; it slows down the degradation of energy." Simondon, *On the Mode of Existence of Technical Objects* (Minneapolis, MN: University of Minnesota Press, 2017), 21. In "Progress and Entropy," one 20th century engineer, Norbert Wiener, sums up the historical implications of rise of thermodynamics for the logic of machinery. Wiener reflects, as a "locally anti-entropic progress" in a material universe in which "in the long run…maximum entropy will appear to be the most enduring of all" on a planetary scale, "machines" serve to "fight against the increase of entropy." Thermodynamics empties the struggle of any triumph: "The second law of thermodynamics, while it may be a valid statement about the whole of a closed system, is definitely not valid concerning a non-isolated part of it. There are local and temporary islands of decreasing entropy in a world in which the entropy as a whole tends to increase," which allows for the "existence of progress." Framing the energy of machinery as a militant struggle of human mechanical power against entropy, Wiener reflects that "whether to interpret the second law pessimistically or not" depends on the relative importance we assign to the human scale of machinery fighting against entropy. On a cosmic scale, thermodynamics reduces human power to its proper dimensions. "It seems almost as if progress itself and our fight against the increase of entropy" through machinery "intrinsically must end in the downhill path from which we are trying to escape" as "in a very real sense, we are shipwrecked passengers on a doomed planet." Yet "once we become aware of the new needs that a new environment has imposed upon us, as well as the new means of meeting these needs that are at our disposal it may be a long time yet before our civilization and our human race perish." Faced with last things, machinery "fights" against entropy to defer it for a passing time. "Progress and Entropy," *The Human Use of Human Beings,* 32, 38, 40-41, 47.

[456] Andreas Malm, *The Progress of this Storm: Nature and Society in a Warming World* (Verso, 2017), 149, 210. Malm repurposes Adorno's remark on progress in *History and Freedom: Lectures 1964-1965* (Polity, 2008), 143.

[457] Crutzen, "Geology of Mankind," 23. On the Anthropocene aesthetics of totality and dissipation on a planetary scale, see also Benjamin Morgan, "*Fin Du Globe*: On Decadent Planets," *Victorian Studies* 58 (2016): 609-635.

militant struggle.[458] How successfully poetry can contribute to this struggle today is an open question, especially at a time when poetry itself can seem to have run out a steam as a literary form, a notion challenged by the recent flourishing of popular Anthropocene poetry committed to such a militant struggle. One recent poetry and short story collection, *Sunvault,* engineers solar-powered forms of poetry with the explicit goal of combating planetary scale dissipation in the wake of climate change. The planned companion volume *Almanac for the Anthropocene* will relate *Sunvault*'s poetry to engineering blueprints for solar-power technologies to militate against "capitalism and climate disaster."[459] Poetry today might at once renew its own energies as a literary form and fight against climate change in part by retooling and reengineering sustainable, renewable forms of the thermodynamic aesthetics that have fueled it since the Romantic era.

If it is necessary to ascribe a virtue to the thermodynamic logic of machinery that arises over the time of Romanticism, it is how it prefigures a renewed historical materialism that lies in the critical application of science and technology rather than its rejection, one equipped to struggle eco-militantly against the planetary catastrophe of thermodynamic systems to keep this planet habitable.[460] For Byron, nature is not only a sheltering sky or vital presence but an unruly force that we must struggle with, whether in contending with the giant element, whatever comet approaches the globe to destroy us, or now, planetary scale climate catastrophe. Any chance of

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[458] One might also route the work that poetry can now do in the Anthropocene through Byron's radical diminishment of the epic. The Anthropocene forces us to reckon with totality and dissipation of thermodynamic systems on a planetary scale, the heroic, epic scale of totality central to Byron's engineering poetics. In her response to Mark McGurl, Wai Chee Dimock reflects how, "One possible outcome of scaling up is of course a quietism, if not nihilism—a resignation ahead of time—brought on by the near certainty of extinction from the standpoint of a cosmic longue durée. As McGurl points out, when the sun goes out, a spectacular heat-death implosion slated to happen some 4.5 thousand million years from now, the planet will most certainly go out with it." If on a thermodynamic scale, the human is "cosmicomically small," as McGurl finds in rejecting human power, the other response to scaling up – Byron's – is heroic. "The epic," Dimock notes, "is about surviving the gigantic": "instances of the very large" and the littleness of "the human in comparison" represent "the quintessential epic encounter with alien orders of magnitude" on the scale at which "the planet itself comes to an end….It is the human…that allows some such clusters of words to begin a long trek that, with luck, might not end till the long trek of the planet itself comes to an end. It is these reversed proportions that make the catastrophic briefness of human life not quite catastrophic… saving us from the brute fact of large numbers, rendering back to us a numerically demoted but otherwise undiminished sense of ourselves. We could call this the posthuman comedy. We could also call it low epic." Wai Chee Dimock, "Low Epic," *Critical Inquiry* 39.3 (2013): 617, 627, 631. Byron insistently focalizes the littleness of the human totality heroically struggling against catastrophic forces of dissipation. "Reduced to littleness" in "contending with the *giant* element," Byron's engineering poetics struggles to "survive[s] the gigantic." Whether "reduced to littleness" in "contending with the giant element" or "steam and its machinery" fighting against a colossal comet that threatens to destroy the planet, Byron's thermodynamic logic of machinery diminishes human power heroically struggling against the forces of dissipation. If what Dimock calls the scaling down of the epic allows for its "survival" as a literary form, then the diminished heroicism of Byron's engineering poetics follows a parallel logic: the reduction of human power to littleness is the precondition for its historical-material struggle.

[459] See *Sunvault: Stories of Solarpunk and Ecospeculation*, eds. Phoebe Wagner and Brontë Wieland (Upper Rubber Boot Books, 2017), especially Joel Nathaniel's poetry in the volume, and the planned second volume *Almanac for the Anthropocene* (University of West Virginia Press), to relate poetry to engineering blueprints and practical tools to fight "capitalism and climate disaster," announced at http://wagnerwieland.com/2019/06/03/new-project-almanac-for-the-anthropocene-a-compendium-of-solarpunk-futures/.

[460] See Marjorie Levinson's call for a Romanticism that might reject conservative ecocriticism and instead open up a more radical ecocriticism that lies at the completion of science and technology rather than its rejection in "Pre- and Post-Dialectical Materialisms," *Culture Critique* 31 (1995): 111-27. So far, Levinson's project has explored the scientific half of this call. On keeping the planet habitable, see David Wallace-Wells, *The Uninhabitable Earth: Life after Warming* (Tim Duggan Books, 2019).

averting catastrophic dissipation will have to be a struggle fought by mere mortals. Byron's engineering poetics leaves us with no guarantees outside of planetary dissipation, and the determination to struggle against it. A renewed historical materialism that Byron prefigures might take this eco-militant struggle as its ground zero to oppose the forces that now threaten the planet. Only then can we hope to "counterbalance human woes," lest the end of history come with our own "want of atmosphere," in an ironic inversion of Byron's engines to the moon, burnt away without material residue. Otherwise, the end of our mechanical powers will be ruder still. Such an eco-militant engineering poetics now demands to be considered not only because its thermodynamic aesthetics has quietly shaped Anthropocene history since the time of Romanticism and continues to do so, but because it may very well provide critical tools for reconsidering what work poetry can do today to combat our current climate catastrophe.

Coda:

GEOPOETIC FUTURES

What became of the Romantic industrialism of this study? One might readily chart a trajectory of the end of Romanticism culminating in mid- to late- nineteenth century Victorian liberalism. By this familiar narrative, industrial capitalism consolidates its hegemony to reign supreme; the British colonial fossil empire expands around the globe. This fossil empire becomes synonymous with industrial modernity, driving the alternative Romantic possibilities of this study to the brink of extinction. After all, by the end of the nineteenth century, most of these Romantic hopes had been eclipsed by the Victorian consolidation of liberal-capitalist logics.[461] The railway capitalism that Wordsworth hoped would soon exhaust itself reigned supreme, locking in our path-dependency on fossil fuels; Owen's socialist mills were soon superseded by industrial factories materializing Blake's worst fears for the dark satanic mill, while the radical hopes of the Mechanics Institutes' were crushed by venture capital; thermodynamics largely fueled rather than restrained Britain's ceaseless combustion of steam power; industrial technology from railways to steamboats became an engine of the colonial expansion of the British empire from India to Peru, ultimately leading to the planetary ecological crises of industrial capitalism and the combustion of any possible geopoetic future for a planet ravaged by it mechanical powers.

There would of course be much truth to this story, which aligns with familiar narratives of Anthropocene criticism. Yet it would also be a partial and incomplete one that risks unintentionally reduplicating the very liberal-capitalist historiography of industrial modernity that Victorians began to construct to suppress the Romantic geopoetic futures now lost to literary history. However eclipsed, the untimely Romantic possibilities of this study never fully disappeared but lived on in a counter-modernity that extends from Marx and Engel's industrial socialisms to their successors that characterize our own moment in Anthropocene history. Taken together, this forgotten Romantic strain of engineering poetics constitutes a Romanticism that belongs to industrial modernity and prefigures alternative futures for it outside of capitalism.

We can glimpse both the consolidation of liberal-capitalist logics and the suppression of the Romantic geopoetic futures irreducible to it in Samuel Smiles' *Lives of the Engineers*, the most famous Victorian history of engineering, which opened its 1879 edition by celebrating the expansion of the railway to India and Japan fueling the globalization of the British empire.[462] Smiles attempts to corral Romantic engineering into a liberal narrative of global progress fueled by Britain's industrial power, which proceeds by industrial biographies of the Romantic engineers who made industrial modernity. Smiles carefully excises any mention of the Owenites, Mechanics Institutes, or industrial socialists. Featuring prominently in Smiles' history of engineering is the Romantic engineer Thomas Telford – close friends with Romantic poet Robert

[461] On the Victorian "consolidation of liberal-capitalist logics," to repurpose Christopher Taylor's apt phrase in *Empire of Neglect: The West Indies in the Wake of British Liberalism* (Duke University Press, 2018), 6, see Nathan Hensely, *Forms of Empire: The Poetics of Victorian Sovereignty* (Oxford University Press, 2016); Jesse Oak Taylor, *The Sky of our Own Manufacture*; Andres Malm, *Fossil Capital: Steam Power and the Roots of Global Warming*; Elizabeth Miller, *Extraction Ecologies and the Literature of the Long Exhaustion, 1830s-1930s*.

[462] Samuel Smiles, *Lives of the Engineers* (London: Murray, 1879), iv-v. First published in 1861, Smiles' history of engineering went through many editions over the next forty years and spawned many companion volumes. Smiles notes that Edmund Burke's 1783 "reproach" that "were we to be driven out of India this day, nothing would remain to tell that it has been possessed, during the inglorious period of our dominion, by anything better than the ourang-outang or tiger" now "no longer exists" due to the Indian Railways subsidized by "British capital" (iv).

Southey – who built thousands of engineering earthworks from railways to suspension bridges across Scotland. In Smiles's narrative, Telford paves the way for the global geopoetic expansion of Britain. Smiles carefully constructs a narrative of Romantic poetry, engineering and geopolitical expansion by cherry picking from Romantic poet laureate Robert Southey's journals and poetry.

In 1819, Telford took Southey on a six weeks' tour of his engineering projects across Scotland, which Southey recorded in his journals. Much of Southey's journals are spent in "a great measure of an interesting resume of the engineer's operations in harbour-making, road-making, and canal making," [463] which become the basis for three dedicatory poems praising such geopoetic forces inscribed on Telford's largest earthworks. Smiles quotes extensively from the many passages of the journal in which "the poet admired" Telford's engineering earthworks: "I went with Mr. Telford to the harbour, to look at his works, which are of great magnitude and importance: a huge floating dock, and the finest graving dock I ever saw… What they take from the excavations serves to raise ground which was formerly covered by the tide, but will now be of the greatest value for wharfs, yards, &c....Telford's is a happy life; everywhere making roads, building bridges, forming canals, and creating harbours – works of sure, solid, permanent utility; everywhere employing a great number of persons, selecting the most meritorious, and putting them forward in the world in his own way… The pier was a busy scene; hand-carts going to and fro over the railroads, cranes at work charging and discharging, plenty of workmen, and fine masses of red granite from the Peterhead quarries. So much was never done by any Government for the improvement of a country in the same length of time."[464] Southey calls Telford's earthworks Britain's "greatest work of art" responsible for its "state of great and rapid improvement," a "scene of human activity & power [that] exceeds anything which I ever beheld elsewhere."[465] Smiles quotes such passages from Southey's journal at length to construct a progress liberal-capitalist narrative of industrial modernity that he takes Southey's poetry to affirm – collapsing the difference between such Romantic engineering projects that Southey admired as public works projects and Victorian industrial capitalism. Yet Smiles tellingly omits any reference to Southey's and Telford's visit to Owen's New Lanark Mills at the end of his journals and Southey's enthusiasm for industrial socialism and critique of industrial capitalism, suppressing from the history of industrial modernity the alternative Romantic geopoetic futures of this study that would erode his liberal-capitalist narrative.

In Southey's encounter with Owen's industrial socialism we can glimpse both the historical failures and the enduring promise of Romantic geopoetics. Recounting his visit with Telford to Owen's New Lanark Mills, Southey reflects:

> After breakfast we walked to New Lanark, which is about a mile from the town.... I had written to Owen from Inveraray; and he expected us, he said, to stay with him a week, or at the very least three days; it was not without difficulty that we persevered in our purpose of proceeding the same evening to Douglas Mill. He led us thro' the works with great courtesy, and made as full an exhibition as the time allowed. It is needless to say anything more of the Mills than that they are perfect in their kind, according to the

[463] Samuel Smiles, *The Life of Thomas Telford, Civil Engineer* (London: Murray, 1867), 292. Originally published as the third volume of *Lives of the Engineers* (1861), Smiles expanded his *Life of Telford* into a new edition in 1867.
[464] Robert Southey, *Journal of a Tour in Scotland in 1819*, edited by C.H. Hereford (London: Murray, 1929), 53-54.
[465] Robert Southey, *Journal of a Tour*, 203-204; Southey to Grosvenor Charles Bedford, 14 September 1819; Southey to Herbert Hill, 21 September 1819.

> present state of mechanical science, and that they appeared to be under admirable management. Everything required for the machinery is made upon the spot, and the expence of wear and tear is estimated at 8000£ annually. There are stores also from which the people are supplied with all the necessaries of life.

Sympathetic to Owen's industrial socialism, and critical of the emerging industrial-capitalist order, Southey finds that he "rested satisfied with the belief (whether erroneous or not) that the evils incident in such a system" that "took for its foundation the principle of a community of goods" would be "infinitely less than those which stare us in the face under the existing order" of industrial capitalism. Yet while Southey rejects industrial capitalism in favor of Owen's industrial socialism, he also offers a penetrating critique of Romantic industrialism's imperfect implementation and its racial limitations in the British empire that serves as a spur to improve it:

> In the course of going thro' these buildings, [Owen] took us into an apartment where one of his plans, upon a scale larger than any of the Swiss models, was spread upon the floor…Owen in reality deceives himself. He is part-owner and sole Director of a large establishment, differing more in accidents than in essence from a plantation: the persons under him happen to be white, and are at liberty by law to quit his service, but while they remain in it they are as much under his absolute management as so many negro-slaves… But Owen reasons from his Cotton Mills to the whole empire.[466]

To an extent, Southey's response to Owen anticipates Engels half a century later in his genealogy of Romantic industrial socialisms in "Socialism: Utopian and Scientific." Engels dates the first flares of alternatives to industrial capitalism to the moment when "modern industry" had "just arisen in England": "on January 1, 1800," Engels writes, "Robert Owen undertook the direction of New Lanark…Owen, who in the country where capitalist production was most developed…worked out his proposals for the removal of class distinction systematically."[467] Engels observes that Owen achieved his success in the New Lanark Mill from 1800-1829 by putting humans "in conditions worthy of human beings." Like Southey, Engels is sympathetic to this Romantic strain of industrial socialism: "Every social movement, every real advance in England on behalf of the workers links itself on to the name of Robert Owen." Engels continues to cite Owens' labor laws of 1819, pioneering of trade unions, and introduction of "transition measures to the complete communistic organisation of society, on the one hand, co-operative societies for retail and production." Yet "in spite of all this, Owen was not content. The existence which he secured for his workers was, in his eyes, still far from being worthy of human beings. 'The people were slaves at my mercy.' The relatively favorable conditions in which he had placed them were still far from allowing a rational development of the character and of the intellect in all directions, much less of the free exercise of all their faculties."[468] As Owen himself reflects of the failures of New Lanark, "the people were slaves at my mercy; liable at any time to be dismissed." While infinitely happier, they "still [lived] a miserable existence,

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[466] Southey, "New Lanark," in *Journal of a Tour*, 261, 263-65.
[467] Friedrich Engels, "Socialism: Utopian and Scientific," in *The Marx-Engels Reader*, ed. Robert C. Tucker (Princeton, NJ: Princeton University Press, 1978), 685, 687. Like Marx and Bloch, Engels also argues that modern industry, far from inherently capitalist, is exploited and warped by capitalism yet ultimately socialist, and necessary for the coming communist society.
[468] Engels, "Socialism: Utopian and Scientific," 691-93.

compared with that which, with the immense means [of machinery] at the control of all government, might now be created for every population over the world."[469] Southey, Engels, and Owen himself zero in on racial capitalism – the racialized logic of slavery – to describe the failures of Romantic industrialisms. If infinitely better than the industrial capitalist system, Southey notes, Owen's socialism still fell short of its Romantic ideal of emancipation on a global scale. Racial capitalism, as many scholars now recognize, refers to how race has quietly and unconsciously shaped the global history of capitalism itself, not least in the overwhelmingly white and British origins of industrial capitalism that coincide with Romanticism.[470]

Yet beyond this commonality, Southey's response departs from Engels, and goes a step further in invoking not just slavery in general but the plantation form in pointing towards a penetrating critique of the specific racial limits of British industrialism that Southey himself is on the verge of making yet cannot quite articulate. Despite his sympathetic response to Owen, Southey finds New Lanark "differing more in accidents than in essence from a plantation: the persons under him happen to be white, and are at liberty by law to quit his service, but while they remain in it they are as much under his absolute management as so many negro-slaves." Southey confronts the limits of the whiteness of the Romantic industrialism of this study. Even the most utopian socialist of Romantic industrialists is haunted by the capitalist specter of plantation slavery, most notably, the plantation form of the Haitian sugar mill that C.L.R. James has shown was a capitalist form of modern industry produced by the colonial expansion of white European industrial capitalism.[471] Of course, Southey's primary concern is the lingering unfreedoms of Owen's workers rather than racial hubris or white privilege. Yet he also not quite consciously opens up a powerful racial critique of British industrialism. In Southey's vision, the racial capitalism of the plantation constitutes the black other of white British industry that is at once constitutive of and inextricably imbricated in it, as long as industrial capitalism remains, the Plantationocene that forms the constitutive other of the white male Anthropocene exemplified by the Romantic industrialism of this study and continues to haunt it as long as capitalism persists.[472] Despite their greatest possible distance from industrial capitalism, the white Owenites differ more in accident than essence from negro-slaves on a sugar-mill plantation because they

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[469] Robert Owen, *The Revolution in the Mind and Practice of the Human Race* (London: Wilson, 1850), 16-17.

[470] Cedric Robinson first introduced the concept of racial capitalism in *Black Marxism: The Making of the Black Radical Tradition,* ed. Robin D.G. Kelly (Chapel Hill: University of North Carolina Press, 1983), which has gained major critical traction in recent years. For an overview of racial capitalism in contemporary Anthropocene analytics, see *Futures of Black Radicalism,* eds. Gaye Theresa Johnson and Alex Lubin (New York: Verso, 2017).

[471] As C.L.R. James writes, the "dominant industrial structure" of industrial capitalism in the colonies for two-hundred years since British industrialization "has been the plantation." *The Black Jacobins: Toussaint L'Ouverture and the San Domingo Revolution* (Vintage: 1989), 405. As Christopher Taylor notes, James's study "was perhaps the first text to argue that plantation production was functionally a form of industrial production – that enslaved workers in the New World were more or less members of the modern proletariat…that slavery was not an archaic, pre-capitalist residue, but a moment immanent to racial capitalism's history" that generated the "capital required to jumpstart industrial capitalism" in Britain and Europe. "The Black Jacobins: From Great Book to Classic?" *Age of Revolutions,* May 2, 2016, http://ageofrevolutions.com/2016/05/02/the-black-jacobins-from-great-book-to-classic. See also Eric Williams, *Capitalism and Slavery* (Chapel Hill: University of North Carolina Press, 1994). For slave-labor in the sugar mill plantation as constitutive of racial capitalism, see Daniel B. Rood, *The Reinvention of Atlantic Slavery: Labor, Race, and Capitalism in the Greater Caribbean* (Oxford University Press, 2017).

[472] For the Plantationocene as *"a proposed alternate name for the human geological epoch often called the Anthropocene,*" see "Plantation Legacies," Sophie Sapp Moore, Monique Allewaert, Palbo F. Gómez, and Gregg Mitman, *Edge Effects,* January 22, 2019, http://edgeeffects.net/plantation-legacies-plantationocene/; Donna Haraway, "Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin," *Environmental Humanities* 6 (2015): 159-165.

cannot fully break free from the traces of the racialized logic of slavery that persist within industrial technology as long as capitalism persists, even at the furthest possible remove from it. Even an Owenite community cannot fully seal itself off from the larger industrial-capitalist order with its plantations, and remains imbricated in it. Like plantation slaves, the Owenites are still forced to work like slaves in a mill in de facto wage-slavery like that Blake also diagnoses.[473] The point is not to equate plantation slavery with the plight of British factory workers, or to elide the very real differences between literal slavery and the metaphorical valences that Southey, Owen, and Engels invoke: rather it is that both are co-produced by and imbricated in the same system of racial capitalism which renders any true freedom is impossible, even at the furthest possible remove, and to identify lines of solidarity between the two in a larger historical-material struggle of the human species whose unfreedom and liberation are ultimately bound up together. Southey thus errs a little in claiming that "Owen in reality deceives himself" in thinking that the white residents of New Lanark are not imbricated in slavery: on the contrary, Owen is fully conscious that his industrial-socialist project is incomplete as long as racial capitalism persists. As Owen reflects, "the people were slaves at my mercy; liable at any time to be dismissed" and thrown out into the larger industrial capitalist order to which New Lanark remains a localized exception.

> Southey continues to elaborate on the promise and limits of Romantic industrialism:
> Nor did I ever disguise from myself the difficulties of a system which took for its foundation the principle of a community of goods. On the contrary I met them fairly, acknowledged them, and rested satisfied with the belief (whether erroneous or not) that the evils incident in such a system would be infinitely less than those which stare us in the face under the existing order. But Owen reasons from his Cotton Mills to the whole empire. He keeps out of sight from others, and perhaps from himself, that his system, instead of aiming at perfect freedom, can only be kept in play by absolute power. Indeed, he never looks beyond one of his own ideal square villages, to the rules and proportions of which he would square the whole human race.[474]

Here Owen's reasoning outward "from his Cotton Mills to the whole empire" – the whole global empire or earth, including the plantation and colonies, to "the whole human race," not just Britain – emerges as both a strength and a weakness of Romantic industrialism.[475] As Owen writes, they still [lived] a miserable existence, compared with that which, with the immense means [of machinery] at the control of all government, might now be created for every population over the world."[476] Like Southey, Engels stresses how Romantic utopian socialists like Owen, Charles Fourier, and the Saint Simonians work to emancipate "all humanity at once."[477] The Romantic promise of Owen's reasoning outward to the whole world is global structural transformation, planetary social justice: the abolition of industrial capitalism and its replacement with an alternative socialist or communist system or form of industrial modernity that Southey affirms as an ideal. Unlike Engels, who sees scientific socialism as the answer to

[473] On the valences of slavery in Blake, see Lily Gurton-Wachter, "Blake's Little Black Thing: Happiness and Injury in the Age of Slavery." *ELH* 87.2 (2020): 519-552.
[474] Southey, *Journal of a Tour*, 264-65.
[475] Expanding outward from the New Lanark, which no longer remains a local exception to industrial capitalism, Owenism displays its larger ambition to replace industrial capitalism altogether, to remake the earth as a whole.
[476] Robert Owen, *The Revolution in the Mind and Practice of the Human Race* (London: Wilson, 1850), 16-17.
[477] Engels, "Socialism: Utopian and Scientific," 685.

the limits of Owens's utopian socialism, which he leaves to the literary historians, the Romantic industrialism of this study instead suggests that freedom can only be achieved by the abolition of plantation slavery and the racialized logic of industrial capitalism, with its constitutive white industrialism and black other. Yet Southey is more concerned with the dangers of Owen's over-reaching in reasoning outward to the entire human race than in the promise of Romantic industrialism's utopian potential for the global revolution. The danger that Southey quickly identifies is that Owen would "square the whole human race" to a particular white British form of Romantic industrialism, and an imperfect implementation of it at that which falls short of "perfect freedom" that it aims for and must be "kept in play by absolute power," the ghost of plantation slavery that still haunts Owenism. Without quite intending to do so, Southey thus opens up a space for us to critically challenge Romantic industrialism, and indeed the Anthropocene concept: can Romantic industrialism – the largely white British poets and engineers of this study – serve as a model for geopoetic futures outside of industrial capitalism that would reason outward to the whole globe or planet? How do we begin to decolonize industrial modernity?

This very operation of figuring outward to reshape the entire planet – to transform the totality of industrial modernity – is the greatest promise of Romantic industrialism. While unevenly distributed between periphery and metropole, between the Global South and Global North like Britain, because the crises precipitated by industrial capitalism are planetary in scale, and affect the entire human species, any solution to them has to be planetary also to achieve real structural transformation. At the same time, this operation must open up to multiple possible geopoetic futures outside of capitalism beyond those that are merely British, a possibility which Southey and Owen begin to think. Rather than kept in place by absolute power, or imposed as the singular vision of what our planetary future should look like, the Romantic geopoetics of this study has renewed critical value today in our own moment in Anthropocene history as one set of blueprints for the future among many in an intersectional global struggle to expand the domain of freedom through abolishing industrial capitalism and fighting for a multitude of geopoetic futures after it: as Kathryn Yusoff proposes, a billion black Anthropocenes or none.[478] We can already see black industrial socialist movements influenced by Romantic industrialism in the nineteenth century, such as George Numa Des Sources' Fourierist colony in Venezuela founded by black West Indians, a form of socialist industry outside the plantation form of racial capitalism, perhaps the first to put into practice C.L.R. James's insistence that "scientists and economists have indicated than an effective industry is possible" with the "abolition of the plantation."[479] If the very British focus of this study allows for a heightened insight into the racial and colonial origins of industrial capitalism that at once marks the onset of the Anthropocene, the Romantic industrialisms of this study also share a Romantic, utopian quality and are in solidarity with all those now fighting for geopoetic futures beyond industrial capitalism by decolonizing human mechanical powers to renew rather than exhaust the planet.

Nothing is easier than to dismiss such a hope as utopian or Romantic. Engels himself comes close to doing so in derisively leaving Romantic industrialisms to the literary historians, as a utopian precursor to Marx's scientific socialism. I am not interested in making a fine

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[478] Kathryn Yusoff, *A Billion Black Anthropocenes or None* (Minneapolis: University of Minnesota Press, 2018). Here I am also thinking that something similar to Elaine Freedgood's approach to decolonizing the nineteenth century British novel in "Decolonizing the Novel," *Worlds Enough: The Invention of Realism in the Victorian Novel* (Princeton University Press, 2019), 134-46 might also extend to how we read Romantic poetry.

[479] James, *The Black Jacobins*, 410. On Des Sources's Fourierist colony, see Taylor, *Empire of Neglect*, 147-86.

distinction between scientific and utopian socialisms. Nor do I claim that the Romantic industrialisms of this study are uniformly socialist or communist in their efforts to remake industrial modernity, which take a variety of forms in their anti-capitalist resistance and attempts to prefigure alternatives to industrial capitalism, from Blake, Wordsworth, Byron, Southey, and Owen to Ada Lovelace. Their most persistent quality is their utopian or Romantic force that is all too readily rejected or dismissed in criticism from Marx and Engels to the present.[480] Yet we do so to our peril.

Just as industrial technology is not inherently white, it is also not inherently male. It is no coincidence that Holly Jean Buck returns to the utopian possibilities of the Romantic era to theorize the confluences between Marxist-feminist thought and ecosocialist projects to engineer a world after fossil capitalism, whose dismissal is the heat signature of an all too male fixation on valorizing only the hard and scientific elements of engineering often gendered as male over the soft, poetic, and literary elements of technology, the technocratic pragmatism that all too readily ossifies into ratifying industrial capitalism as the only possible future:

> Exploring an after-zero society [after fossil capitalism] means playing with utopian possibilities...The usual dismissal of utopian thought is linked to an oppressive politics. Marxist feminist scholar Kathi Weeks observes that 'political realism tends to be associated with a mode of hard-nosed, hard-ball politics,' while 'utopianism can be understood – building on this traditional gender logic – as both softhearted and softheaded, or, more precisely, softheaded because softhearted.' Social relations are stabilized by claims about their natural basis – for example, claims about how women 'naturally' are – and analyses that propose alternatives are often dismissed as unrealistic, Weeks writes. It was for this reason that the eighteenth-century feminist writer Mary Wollstonecraft was forced to say that even her moderate visions of gender equality could be termed Utopian dreams… Whatever its particular form, what's clear is that we need a social imagination to match our technological imagination.[481]

Donna Haraway likewise situates "socialist-feminism" in this "utopian tradition." In dismantling the "'hardest' science" of industrial capitalism with its "domination of male and female gender roles," Haraway argues that "socialist feminism" ultimately "means refusing an antiscience metaphysics, a demonology of technology" in favor of remaking "science and technology as possible means of great human satisfaction" and gender equality.[482] Arguing that "the real emancipatory potential of technology remains unrealized," Laboria Cuboniks asks in her recent *Xenofeminist Manifesto*, "Why is there so little explicit, organized effort to repurpose technologies for progressive gender political ends?" Seeking to "strategically deploy existing technologies to re-engineer the world," Cuboniks contends that the "radical opportunities" of technology "should no longer be put to use in the exclusive interests of capital, which, by design, only benefits the few," urging "feminists to equip themselves with the skills to redeploy existing

[480] While Engels notes how Romantic socialists such as Owen and Fourier were "the first to declare" that "woman's emancipation" is "the most natural measure of the general emancipation," his emphasis on scientific over utopian socialism runs the risk of tacitly re-inscribing masculinist presuppositions. "Socialism: Utopian and Scientific," 690.
[481] Holly Jean Buck, *After Geoengineering*, 160; Buck quotes Kathi Weeks, *The Problem with Work: Feminism, Marxism, Antiwork Politics, and Postwork Imaginaries* (Durham, NC: Duke University Press, 2011), 182.
[482] Donna Haraway, *A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century* (Minneapolis, MN: University of Minnesota Press, 2016), 7, 14, 67.

technologies and invent novel cognitive and material tools in the service of common ends."[483] Calling for a remaking of industrial modernity on a planetary scale, she argues that

> The excess of modesty in feminist agendas of recent decades is not proportionate to the monstrous complexity of our reality, a reality cross-hatched with fiber-optic cables, radio and microwaves, oil and gas pipelines, aerial and shipping routes, and the unrelenting, simultaneous execution of millions of communication protocols with every passing millisecond. Systematic thinking and structural analysis have largely fallen by the wayside in favour of admirable, but insufficient struggles, bound to fixed localities and fragmented insurrections…to secede from or disavow capitalist machinery will not make it disappear. Likewise, suggestions to pull the lever on the emergency brake of embedded velocities, the call to slow down and scale back, is a possibility available only to the few – a violent particularity of exclusivity – ultimately entailing catastrophe for the many…The real emancipatory potential of technology remains unrealized...The ultimate task lies in engineering technologies to combat…environmental cataclysm, economic instability, as well as dangerous forms of unpaid/underpaid labour.[484]

Like the Romantic industrialists of this study – Owens's expanding mechanical powers outward to the entire human species – such anti-capitalist strains of contemporary feminist thought call for planetary scale transformation "to re-engineer the world" outside of industrial capitalism.[485]

We can date the first flares of such feminist projects in the Romantic era. So Ada Lovelace, Byron's daughter and the computing pioneer, re-engineers Romantic poetics in wresting what she calls the "poetical science" of computation from even the most hyper-capitalist and white male origins of computing machinery in her notes on the engineer L.F. Menabrea's *Sketch of the Analytical Engine invented by Charles Babbage* (1843), the most significant proto-computer of the nineteenth century.[486] Her Romantic industrialism resonates with socialist feminist movements in its anti-capitalist force even if it is not overtly socialist or feminist. Charles Babbage's attempt to develop a calculating engine was deeply imbricated in the nineteenth century consolidation of industrial-capitalist logics and crystallized in his *Economy of Machinery and Manufactures* (1831), a text that has become synonymous with industrial capitalism's valorization of the hard and scientific masculinist elements of engineering exemplifies the technocratic pragmatism that ossifies into ratifying industrial capitalism as the only possible future. [487] L.F. Menabrea, the male engineer whose *Sketch of the Analytical Engine* Ada Lovelace translates and annotates, opens by reflecting that Babbage's "Treatise on the Economy of Machinery" "gave rise to the idea of the engine in question."[488] In fact, in the very

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[483] Laboria Cuboniks, *The Xenofeminist Manifesto: A Politics for Alienation* (Verso, 2018), 19, 17, 35, 33.
[484] Cuboniks, *The Xenofeminist Manifesto,* 29, 43, 19.
[485] *Xenofeminist Manifesto,* 2
[486] Ada Lovelace to Lady Byron, Undated Fragment, [Before December 1845] in Forbes-Macphail 148. Ada's notes exceed Menabrea's sketch in both length and significance.
[487] Following Marx, Saree Makdisi and Andreas Malm both take Babbage's *Economy of Machinery* as the one of the foundational texts of industrial capitalism. On the role that his calculating engines play in his consolidation of industrial-capitalist logics, see Simon Schaffer, "Babbage's Intelligence: Calculating Engines and the Factory System." *Critical Inquiry* 21.1 (1994): 203-227. On Babbage's contributions to computing, see Matthew L. Jones, *Reckoning with Matter: Calculating Machines, Innovation, and Thinking about Thinking from Pascal to Babbage* (University of Chicago Press, 2016).
[488] L.F. Menabrea, *Sketch of the Analytical Engine, with Notes by the Translator*, translated and edited by Ada Lovelace (London: 1843), 671.

first sentence of his Preface to *On the Economy of Machinery and Manufactures*, Babbage himself wrote that the "The present volume may be considered as one of the consequences that have resulted from the [idea] for the calculating-engine."[489] Babbage lays out his strictly utilitarian plan for the engine in his section "On the Division of Mental Labor," intending for the early computer to automate intellectual labor by the same "arrangements which ought to regulate the interior economy of a manufactory," strict capitalist principles of scientific management with zero interest for building any world outside its narrowly defined parameters.[490]

Wresting the analytical engine from its narrowly capitalist application imagined by the male engineers who designed it, Ada Lovelace overturns Menabrea's naturalization of Babbage's intentions for the analytical engine as an "unfounded" supposition "naturally and almost unconsciously assumed." Opening her notes by directly refuting Menabrea, Lovelace writes, "no necessary sequence and connexion need exist between two such inventions" – referring to Babbage's capitalist plans for computing machinery in the *Economy of Manufactures* that Menabrea ratifies and the Analytical Engine itself – "that they may be wholly independent."[491] Lovelace devotes the entirety of her Notes to demonstrating how the Analytical Engine can be applied for any purpose whatsoever to "operate" upon and figure any materials in the universe that she calls "poetical science," not just Babbage's narrowly capitalist application.[492] "Not merely adapted for tabulating the results of one particular function," – what she calls the male engineers' "very strictly utilitarian" purpose – Lovelace shows that the engine can be applied for "any function whatever" and "operate on things besides number" so that the "powers and mode of action of the analytical engine" in fact "would include all subjects in the universe."[493]

Breaking down Babbage's masculinist and technocratic separation of the scientific aspects of mechanical power from the poetic, Lovelace's "poetical science" extends the Analytical Engine's application to all of the arts, from "the art of weaving" to music to literature: "the engine might compose elaborate and scientific pieces of music of any degree of complexity" and "can arrange and combine its numerical quantities exactly as if they were letters or any other general symbols," thereby "enabling mechanism to combine together general symbols, in successions of unlimited variety and extent," to produce works of art from music to poetry, anticipating how computers now encode and produce sound and language.[494] Lovelace's "poetical science" conjoins the hard and "scientific" elements of engineering with the poetic and the literary elements of it often gendered as feminine and excluded from Babbage's repressive

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[489] Charles Babbage, *On the Economy of Machinery and Manufactures* (London: Knight, 1832), iii.
[490] Babbage, *On the Economy of Machinery and Manufactures*, 191.
[491] Ada Lovelace, "Notes by the Translator," in *Sketch of the Analytical Engine*, 671.
[492] Likewise, while she does not address industrial capitalism, Imogen Forbes-Macphail also rightly observes how Ada Lovelace's notes on the Analytic Engine "transcend[s] the more limited emphasis that Babbage placed upon its capacity for accurate calculation." As Forbes-Macphail shows, Lovelace realizes her early ambition articulated in a letter to Lady Byron to "in due time be a Poet" equal to Lord Byron through the "poetical science" of computation materialized in the Analytic Engine. "'I shall in due time be a poet': Ada Lovelace's Poetical Science in its Literary Context," in *Ada's Legacy: Cultures of Computing from the Victorian to the Digital Age*, ed. by Andrew Russell and Robin Hammerman (New York: Association for Computing Machinery and Morgan and Claypool, 2015), 155.
[493] Lovelace, "Notes," 691-94.
[494] Lovelace, "Notes," 694, 697, 713. On the "art of weaving," Lovelace continues, "the Analytical Engine weaves algebraical patterns just as the Jacquard-loom weaves flowers and leaves" (696). The expansion of the application of computing machinery that she calls poetical science is widely regarded as a Lovelace's major innovation in the history of computing. See *Ada's Legacy: Cultures of Computing from the Victorian to the Digital Age*, ed. by Andrew Russell and Robin Hammerman (New York: Association for Computing Machinery and Morgan and Claypool, 2015).

analytic. In overturning the male engineers' "very strictly utilitarian" capitalist application of the engine, Lovelace opens up this "poetical science" to all the industrial arts, from weaving to music to poetic language, to all the "practical application for the purposes of mankind than the means hitherto in our possession rendered possible" as an "extension of human power" capable of shaping "the planetary and sidereal world."[495] Even while she does not consciously frame her imaginative expansion of computing machinery as a feminist practice, Lovelace's poetical science materializes what Cuboniks calls the "effort to repurpose technologies" so that they can "no longer be put to use in the exclusive interests of capital" necessary for remaking industrial technology for progressive gender-political ends. In extending the power of poetic making, Ada Lovelace expands the domain of freedom beyond the "hard" industrial capitalist application of her male predecessors to remake industrial modernity on the scale of what she calls the entire "planetary world," opening up geopoetic futures outside of capitalism.

By closing with these two moments in which the Romantic industrialisms of this study persist in Southey's and Owen's to Ada Lovelace's challenges to industrial capitalism's imbrication with white male engineering, and the colonial expansion of the British empire and industrial technology around the globe, even from the heart of the British empire, my purpose is not to suggest that racial or gender equality inevitably follows from the abolition of industrial capitalism but rather that its dismantling is a precondition for it: that these struggles and solidarities have been bound up together from the Romantic onset of Anthropocene history. By neglecting the literary histories of the figurative possibilities of Romantic industrialism, in favor of standard and all too familiar Anthropocene narratives of industrial capitalism that conflate it with industrialization or that dismiss such hopes as utopian or Romantic, we erase the possibility of geopoetic futures outside of it that it is now more than ever critical that we fight for today. Any critique that performs such a foreclosure of poetic and technological making is thus unwittingly complicit with industrial capitalism. The Romantic industrialism of this study takes on new urgency in our own moment of Anthropocene history, characterized by both industrial capitalism's accelerated annihilation of our planet's future – what Wendy Brown calls late capitalism's willingness to destroy the earth rather than relinquish white male rule such that "if white men cannot rule the planet, there will be no planet"[496] – and the present renewal of industrial-socialist movements, the successors to the Romantic industrialism of this study, in current eco-socialist movements fighting for geopoetic futures after it. These movements are not merely white or British but span the globe and are often led by women and indigenous writers, activists, poets, and engineers, from Green New Deal movements in Latin America[497] to organizations like the American Indian Science and Engineering Society. Through new fusions

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[495] Lovelace, "Notes," 693, 697, 699, 722; Lovelace to Woronzow Greig, November 15, 1844.

[496] Wendy Brown, *In the Ruins of Neoliberalism: The Rise of Antidemocratic Politics in the West* (Verso, 2019), 180. See especially Chapter 5, "No Future for White Men: Nihilism, Fatalism and Ressentiment," 161-188. Industrial capitalism thus imposes one geopoetic future that is no future, as opposed to the untimely and insurgent multiplicity of geopoetic futures that Romantic industrialism opens up now central to climate justice movements. Elizabeth Miller brilliantly shows how eco-socialist, eco-feminist, and indigenous climate justice movements fight what Macarena Gómez-Barris calls the "'no future' model that is extraction capitalism" for the sake of "ensuring a future for earthly beings." "Drill, Baby, Drill: Extraction Ecologies, Open Temporalities, and Reproductive Futurity in the Provincial Realist Novel," *Victorian Literature and Culture* 48.1 (2020): 32-33; Macarena Gómez-Barris, *The Extractive Zone: Social Ecologies and Decolonial Perspectives* (Durham: Duke University Press, 2017).

[497] See, for instance, the recent special issue of *NACLA, A Green New Deal for the Americas*, and the introduction by Daniel Aldana Cohen and Thea Riofrancos, "Latin America's Green New Deal," *NACPLA Report on the Americas* 52.2 (2020): 117-121. For a prominent case study, see Thea Riofrancos, *Resource Radicals: From Petro-Nationalism to Post-Extractivism in Ecuador* (Duke University Press, 2020).

of poetry and technology, such industrial-socialist movements hold open the Romantic possibility of critically interrogating and reshaping the worldmaking power of literature and technology,[498] in order to remake the planet by and for those whom industrial capitalism has historically denied or excluded from having any such power to shape the earth in the first place.

[498] On the worldmaking power of literature and science, see Shelley Streeby, *Imagining the Future of Climate Change: World-making Through Science Fiction and Activism* (University of California Press, 2017), especially Chapter 1, "#NoDAPL. Native American and Indigenous Science, Fiction, and Futurisms," 34-35. On the American Indian Science and Engineering Society, see Streeby 34-35.

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