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CHAPTER 5

Designing the Enlightenment Anthropocene

Kevin MacDonnell

On April 28, 1784, James Watt acquired a patent for design improvements to the steam engine.[1] This was not the first patent that Watt and his partner, Matthew Boulton, had been issued for their work on the steam engine, nor would it be the last. It would, however, be the most impactful. Earlier steam engines had been used primarily to pump water out of mines, but the series of improvements that culminated in the 1784 patent converted the machine into a power source that could impel other machinery, a development that would position the engine as the prime mover of Britain's emerging industrial apparatus. Dating back to Karl Marx's claim that industrial capitalist production originates in "the patent that [Watt] took out in April 1784," the historical significance of this document has not been understated.[2] Marx's designation of the patent as the starting point of industrial capitalism has more recently been adopted by scientists and humanists attempting to pinpoint the onset of the Anthropocene, a term coined by the atmospheric chemist Paul Crutzen and the ecologist Eugene Stoermer to denote the current geological epoch in which humanity acts as a geophysical force.[3] And following Crutzen and Stoermer's assertion that the Anthropocene *begins* with the invention of Watt's 1784 model, the environmental philosopher Timothy Morton went a step further, saying, "We can be uncannily precise about the date on which the world ended. . . . It was April 1784, when James Watt patented the steam engine, an act that commenced the depositing of carbon into Earth's crust."[4] Proponents of an eighteenth-century Anthropocene, then, implicitly contend that it is the diagrammatic expression of the steam engine's design—and not the onset of large-scale fossil fuel consumption—that triggers a fundamental shift in the relationship between humans and the natural world.[5]

That such epochal change has been attributed to the publication of a patent rather than, say, the installation of these technologies suggestively foregrounds the role of design in producing the material conditions of the Anthropocene. Patents are, first and foremost, legal documents. But they can also mark the arrival of an

idea or concept as a discursive actor, often representing their first articulation in the public sphere. This is certainly the case with Watt's improvements to the steam engine. Although it would be decades before the machine became ubiquitous in British manufacturing, its key design features were codified in the 1784 patent. As such, the very notion of an eighteenth-century Anthropocene places eighteenth-century intellectual culture firmly at the center of modern environmental history. Or as Alan Mikhail argues in his essay "Enlightenment Anthropocene," the contemporaneity of an eighteenth-century Anthropocene and a major intellectual movement like the Enlightenment is a "coincidence" that necessitates greater investment in efforts to understand the latter's role in producing the former.[6]

This chapter seeks to answer Mikhail's call. In what follows I unpack the sociocultural contexts out of which Watt designed the 1784 patent, which can in turn amplify the conceptual foundations subtending industrial capitalism and the Anthropocene. The key features introduced in the patent, I argue, extend on the artisanal theory of design spearheaded by the publication of William Hogarth's aesthetic treatise *The Analysis of Beauty* (1753). I focus my analysis on how Hogarthian aesthetic and epistemological commitments informed the most important addition to the 1784 patent, an innovative mechanism known as "Watt's linkage," the introduction of which established the steam engine as what Marx calls "an agent universally applicable in industry" (figure 5.1).[7]

Designed to synthesize the linear motion of the engine's piston rod and the curvilinear motion of its working beam, Watt's linkage allowed the steam engine to produce a steady supply of mechanical force by translating these competing trajectories into what would become the machine's signature reciprocating flow. The linkage achieved this synthesis by tracing an undulating line that one nineteenth-century historian of the steam engine characterized as "a species of S-curve."[8] I contend that the distinctive S-curve generated by Watt's linkage is born out of the same epistemological foundations that underpin the serpentine "line of beauty," the aesthetic principle at the heart of Hogarth's philosophy of design. While the morphological affinity between the two is striking, their superficial resemblance means little in itself. The serpentine figures expressed by Watt's linkage and Hogarth's line of beauty are, more importantly, representative manifestations of a shared philosophy of design that constituted aesthetic and technological production amid Britain's industrial transition.

During the second half of the eighteenth century, the serpentine line emerged as a potent symbol of artisanal efforts to navigate the limitations of classical geometrical design. Euclidean geometry had long been employed as the dominant conceptual framework for both the fine arts and mechanical arts, but its dependence on metaphysical abstractions as the grounds for design came under assault as British epistemology became increasingly committed to empirical analysis throughout the period.[9] The precipitous rise of empiricism brought with it a set of design practices that privileged material application over abstract formulation. If the straight line and the circle reflect the ideal figures of classical geometry, then the serpentine line embodies something wholly different, capturing the organic

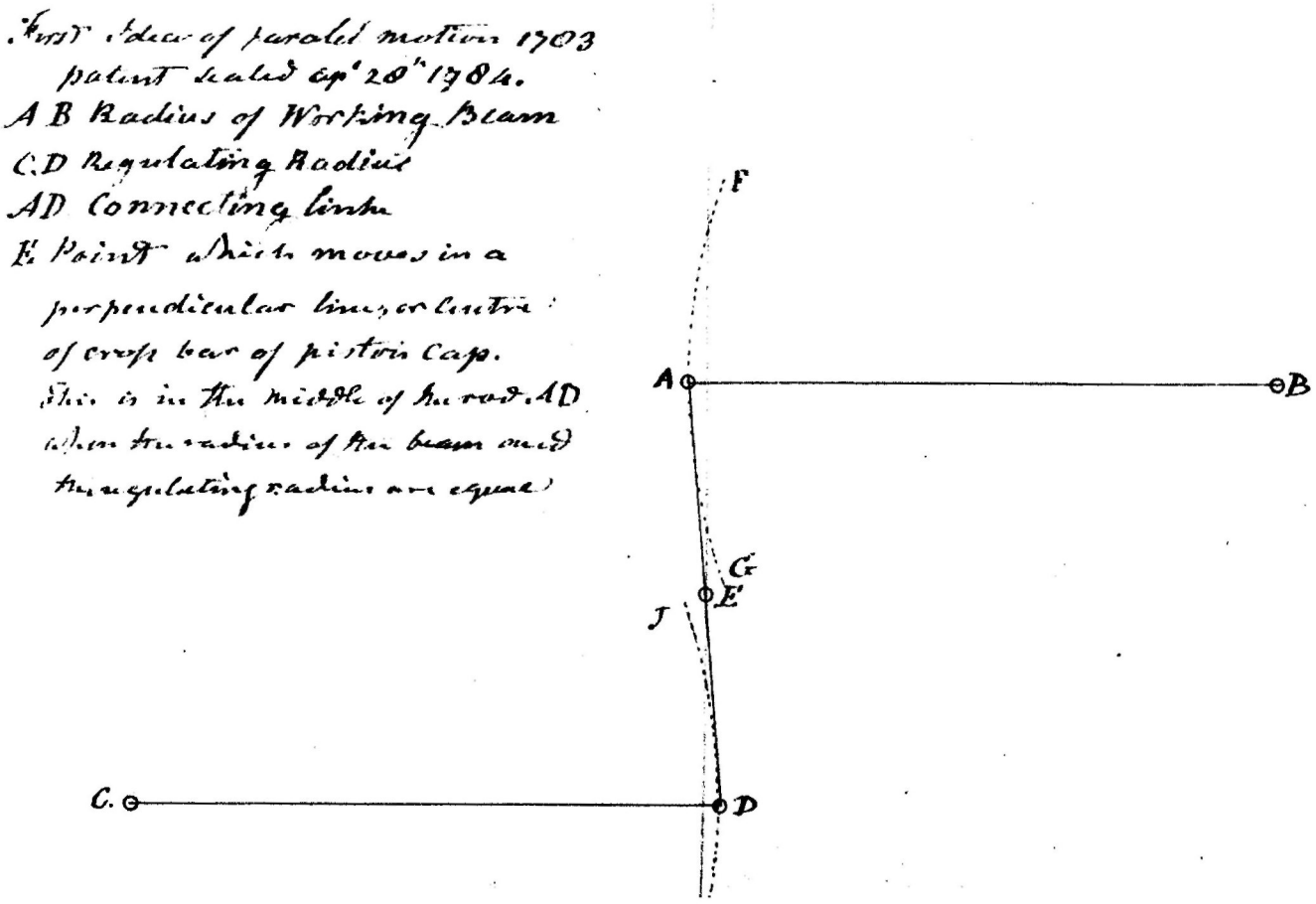

Figure 5.1. Sketch of Watt's linkage, James Watt to Matthew Boulton (1784). Reprinted from *The Selected Papers of Boulton and Watt*, vol. 1, *The Engine Partnership, 1775–1825* (Cambridge, MA: MIT Press, 1981).

fluidity that constitutes material form. This turn toward more empirical design practices that is reflected in the irregular form of the S-curve proved critical to the success of industrialization efforts. By attending to material rather than metaphysical notions of formal design, engineers like Watt and artists like Hogarth were able to effectively harness a natural world that exceeded linear calculation.

Given the position of the steam engine within the historiography of the Anthropocene, my discussion of the shared principles of design found in Watt's linkage and Hogarth's line of beauty inevitably complicates the legacies of the latter. If it is indeed the diagrammatic expression of these design principles that marks the onset of the Anthropocene, then it follows that their manifestation in contemporary aesthetic forms played a part in the sociocultural transformation that accompanied this new geological epoch. However, lest we too quickly indict eighteenth-century aesthetic philosophy for aiding and abetting the onset of the Anthropocene, I conclude this chapter by considering the application of these design principles in ways that undermine the instrumental logic of the industrial era. To do so, I examine Laurence Sterne's novel *Tristram Shandy* (1759–1767), a text that identifies itself as a "machine" and does not shy away from its indebtedness to Hogarthian aesthetics and whose serpentine narrative offers an alternative iteration of the innovation in question. By centering my inquiry around a set of common practices applied within engineering, art, and literature, I therefore track the role of Enlightenment-era design not only in shaping and expressing the Anthropocene's dominant modes of knowing and making but also in challenging their implementation.

The serpentine style had been incorporated into artistic practice dating back to the Renaissance-era *figura serpentinata*, but it was during the middle decades of the eighteenth century that the undulating S-curve rose to prominence within Britain's arts establishment, assuming a central position in the artisanal design practices that opposed the abstract conventions of high art.[10] Up until midcentury, architectural and artistic design had largely conformed to the neoclassical theory formalized by Francis Hutcheson and Lord Shaftesbury, who equated "the Beautiful" with the ideal figures of classical geometry.[11] The formal integrity that Hutcheson ascribes to hexagons, octagons, or decagons, for instance, is derived from their correspondence to conceptual figurations explicitly divorced from material reality. Straight lines and perfect circles do not, after all, appear in nature. This unnatural quality of geometrical form stood out as a testament to the brilliance of human artifice, with the straight line appearing as what Tim Ingold describes as "an index of the triumph of rational, purposeful design over the vicissitudes of the natural world."[12] Significantly, the basis for such thinking was decidedly abstract, centralizing metaphysical form as the grounds for aesthetic design.

The subsequent resurgence of the serpentine style occurred in response to this glowing appraisal of classical geometrical form within high art. W.J.T. Mitchell concedes that the S-curve is itself a geometrical figure—a member of the vortex family—though he is quick to note that its divergence from "pure" geometrical forms like the straight line and circle in late eighteenth-century aesthetic and mathematical theory is "emblematic of the historic shift from classic to modern geom-

etry."[13] Whereas Britain's early eighteenth-century aestheticians endorsed the regularity of straight lines and circles, those who worked in more artisanal fields like furniture and landscape design began to "show," in William Shenstone's words, "to the pupils of Design, / The triumphs of the waving line."[14] The figure initially appeared as a central component of the rococo style imported from France around midcentury, visible in the Rocaille's utilization of serpentine lines to portray what Siegfried Giedion calls the "meeting of reason with the richness of organic form."[15] The serpentine style ultimately achieved influence within British aesthetics in landscape and garden design, the practitioners of which sought to imitate the flexibility of natural form as a counterbalance to the stifling formality of neoclassicism. This contrast is evident in the work of William Kent, whose approach to landscape design stems from the position that "Nature abhors a straight line," even as his contributions to architecture adopt the linear Palladian style.[16] Likewise, the asymmetrical S-curve was notably a preferred feature in the elaborate gardens designed by Capability Brown, whose use of the serpentine style was widely adopted by his contemporaries and successors throughout the eighteenth century.[17]

After initially gaining traction in the domain of landscape architecture, the serpentine line would receive its most elaborate theorization as a design principle in Hogarth's *The Analysis of Beauty*, in which the waving "line of beauty" is declared to be the cornerstone feature of aesthetic value (figure 5.2). Conceived by Hogarth as a challenge to the precision of academic design theory, he crafts a system of design around the line of beauty, to which, as he has it, "all mathematical schemes are foreign."[18] A fundamentally empirical treatise, the *Analysis* rejects the geometrical aesthetics of Shaftesbury and Hutcheson on the basis of Hogarth's observation of the striking dissonance between the mathematical calculability of neoclassical design and the "variety" and "intricacy" of form that has a "real foundation in nature" (33).[19] Hogarth, who posits the human body as the quintessential figure of "native beauty," recognizes that the body does not align with neoclassical conventions: "no exact mathematical measurement by lines can be given for the true proportions of a human body" (39). Moreover, attempts to contort the body to "mimic such very straight or round motions" would be "incompatible with the human form" and "therefore ridiculous" (106). Individual body parts like bones and organs might be rigid or visually unappealing, but Hogarth contends that our "elastic skin" connects these components into a smooth, curving body (56). Michael Baridon has argued that the scientific associations with Hogarth's use of "elastic" here inherently challenge the "omnipotence" of geometry, "for the expansible character of gases made it impossible to represent them by geometric shapes."[20] From gaseous substances to human bodies, empirical inquiry was revealing the surrounding world to be fluid and amorphous, leading Hogarth to suspect that contemporary design was hampered by a fundamental misapprehension of reality. Or as Baridon says, "Geometrical figures were too rigid to express the flexibility of living forms."[21] Hogarth's argument in the *Analysis* follows from this insight, as he goes on to articulate a system of design that is attuned to the elasticity of nature rather than the "mean lines" of abstract forms (106).

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THE

ANALYSIS

OF

BEAUTY.

Written with a view of fixing the fluctuating IDEAS of TASTE.

BY *WILLIAM HOGARTH.*

So vary'd he, and of his tortuous train
Curl'd many a wanton wreath, in sight of Eve,
To lure her eye.-------- Milton.

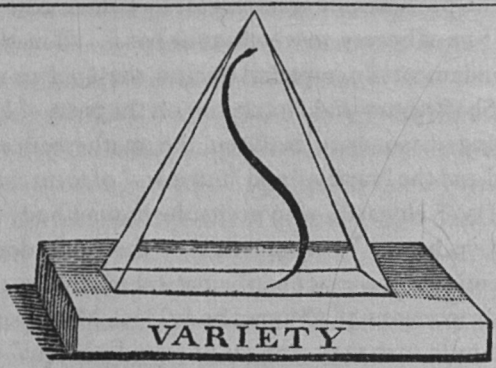

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Figure 5.2. Frontispiece from William Hogarth's *The Analysis of Beauty* (London, 1753). Courtesy of the University of Wisconsin Digital Collections Library.

Although Hogarth's critique is primarily directed at the fine arts, his diagnosis of the misguided commitment to such abstractions extends to his views on the mechanical and industrial arts as well. Hogarth's perspective on technological design can be gleaned from the work of one of his disciples, Jean Andre Rouquet, whose *The Present State of the Arts in England* (1755) has been treated as a recapitulation of the artist's own views.[22] Based on his examination of the production methods used within skilled labor enterprises ranging from painting and architecture to silk manufacture and steel work, Rouquet's treatise concludes that the English, while valuing design, were hampered by a "geometrical rigour" that restricts the potential of material production.[23] This approach, Rouquet argues, "must surely contribute to the improvement of our reason: but everything may be abused; we may reason too much; thence may be too vain, and come to despise everything that does not appear exactly reasonable."[24] Machines and instruments built according to strict mathematical laws thus reflect, for both Rouquet and Hogarth, a fundamental incommensurability with the material world. In the *Analysis*, clockwork mechanisms like John Harrison's chronometer and Jacques Vaucanson's mechanical duck are characterized as "confused" and "displeasingly shaped" because of the unnatural movement of their rigid components (62). These machines, like the geometrical figures endorsed by Hutcheson, achieve their desired ends yet fail to consolidate their internal motion into the fluid regularity found in nature. Hogarth's vocal critique of contemporary technology notwithstanding, he does not go so far as to claim that the arts could not construct a figure with both graceful motion and practical application—"variety" *and* "fitness"—only that within Britain's contemporary regime of material production, they largely had not. Hogarth's primary aim in the *Analysis*, then, is to cultivate the design principles that could be employed to build such "machines."

In response to Hogarth's dissatisfaction with the geometrical straitjacket of contemporary design, he conceives the line of beauty as a technique that posits "variety" of motion as the founding principle of material production. The basis of his valuation of the line of beauty lay in its application outside the strictures of geometrical form, appearing instead as a founding example of what Scott MacKenzie calls the "post-classicist line" that was "no longer determined and explicable, *a priori* by geometrical principle."[25] Whereas motion had long been taken as a direct product of linear composition, Hogarth flips the script and identifies linear form as a by-product of motion. On the basis of this assumption, he offers the continuous undulating motion of the line of beauty as the central component of aesthetic beauty. By forcing the viewer's eye to physically mimic the reciprocating trajectory of an S-curve, the line of beauty appeals to the mind's "love of pursuit" by "*lead*[ing] *the eye a wanton kind of chace*, and from the pleasure that gives the mind, intitles it to the name of beautiful" (33). As such, the line of beauty challenges the systematicity of geometrical design by mobilizing the indeterminacy of empirical reality, representing an aesthetics that is, as Timothy Erwin describes it, "obstinately of this world."[26]

Hogarth's attention to variety, however, does not come at the cost of legibility. Conceding that "variety uncomposed, and without design, is confusion and deformity," he advocates for a "composed variety" that is embodied in the line of beauty's irregular S-curve (28). Proper design requires a degree of uniformity to accompany variety, so rather than letting variety run amok, "Simplicity is call'd in to restrain its superfluities" (39). The line of beauty, a figure composed of any "two curves contrasted," appears at the intersection of classical and modern geometrical form, representing for Hogarth the mediation of the regularity of artifice and the elasticity of experience (42). This mediating quality is invoked by Ronald Paulson, who describes the artist's approach to design as a "middle way," sitting firmly "between the static Beautiful of Shaftesbury and Hutcheson and the uncontrollable chaos of the Sublime."[27] Echoing Paulson, Mitchell refers to Hogarth's "balancing of antithetical values," while Frédéric Ogée describes the line of beauty as "halfway between abstinence and excess, between the rigid straight line of dogmatism and the excessively curved line of hedonism."[28] This strategic retention of discipline to balance—or, as Paulson says, "regulate"—the flexible nature of material reality is where Hogarth most radically diverges from his predecessors and what gives the line of beauty its distinctive character.[29]

Despite Hogarth's own conflicting attitudes toward the mechanical arts, the design principles he establishes in the *Analysis* were received warmly among craftsmen.[30] In fact, the relegation of the *Analysis* to mere "art theory" is more a historiographical misconception based on Hogarth's success as a painter than an accurate appraisal of the text. That Hogarth saw the wider application of his design theory is evident in his decision to send a copy of the *Analysis* to the Royal Society, Britain's premier scientific institution, along with his rejection of the line of beauty's association with objects that are "no way applied, nor of any manner of use, but merely to entertain the eye" (60). Unlike the serpentine lines used within rococo aesthetics, Hogarth's line of beauty "covered much more territory," emerging as a general-purpose principle of material production that could be adopted by mechanics as well as painters.[31] Indeed, long after Romantic treatises on aesthetics had supplanted Hogarth's work, the line of beauty remained a useful design principle within nineteenth-century engineering. An 1833 issue of *Mechanics Magazine*, for instance, invokes the line of beauty as evidence of the superior design of the latest stagecoach model. Unlike older models, the axle in these new stagecoaches implements a "return curve (Hogarth's line of beauty)," which "is a tolerable evidence that the builders are not totally ignorant of the rules by which beauty is produced."[32] Likewise, in an account of the *Brougham* and *Lowther* steam locomotives, the British railway writer C. Hamilton Ellis describes the "sweep" of the engine's cylinder as "that *Line of Beauty and Grace* which Hogarth drew on the palette of his self-portrait in 1745."[33] The line of beauty's versatility in this respect can be attributed to what Ruth Mack identifies as Hogarth's "practical aesthetics." Having "straddled the role of artist and artisan for his entire career," Hogarth derives his theory of design from "the artisanal domain of habitual action," grounding his notions of form, function, and beauty in practice.[34] Although the scholarly

conversation regarding the line of beauty's application has largely been restricted to its use as a principle of artistic production, reading Hogarth artisanally, as Mack does, allows us to reorient the line of beauty in relation to contemporary developments in technological design.

Considered as a feature of technological as well as aesthetic design, the line of beauty's manipulation of empirical reality reflects the governing logic of modern technology, as defined by Martin Heidegger. The "revealing" of essence that "holds sway" in modern technology occurs through what Heidegger calls a "challenging," which means "to call forth" or "to demand positively."[35] Whereas a Dutch windmill's ability to perform work is passively "left entirely to the wind's blowing," a hydroelectric plant "sets upon" a river by appropriating its energetic potential and then directing it toward something else.[36] Pre-industrial machines, like Vaucanson's clockwork duck, operate irrespective of existing physical forms, manifesting themselves as material representations of strictly abstract principles. "Modern" technology, on the other hand, departs from its predecessors by actively exploiting the material world. In this sense, the line of beauty *behaves* like a feature of modern technology, manipulating the intricate world of experience—empirical reality—to construct culturally legible forms. If employed properly, or "artfully," argues Hogarth, the line of beauty has the ability to "set native beauty off to more advantage" (39). Its mediating or regulatory approach to design attends to the unwieldy variety of nature and strategically formalizes this quality rather than surrendering to it. Insofar as the line of beauty approaches empirical reality as a dynamic force that can be molded into a coherent figure, the system of design that Hogarth lays out participates in the same will to regulate or control nature that has come to define technology in the Anthropocene. Different in degree only, the extraction and assimilation that characterizes technological activity in the Anthropocene is visibly at work in Hogarth's articulation of the line of beauty. This is certainly not to say that the art created by Hogarth or inspired by the *Analysis* is any way responsible for the environmental destruction brought about by industrial capitalism amid the Anthropocene. I am, however, suggesting that the cultivation and reification of strategies and practices within the realm of the aesthetic should be accounted for in any analysis of the conceptual foundations of the Anthropocene.

It is against the backdrop of Hogarth's ranging influence on design that we can situate the steam engine that Watt patented in 1784, itself one of Heidegger's core examples of modern technology and a machine whose invention has been directly tied to the onset of industrial capitalism and the Anthropocene. Like Hogarth, Watt was successor to a mathematical system of design founded on the abstract principles of Euclidean geometry. Watt, moreover, similarly responds to the inherent constraints of this framework by adopting a serpentine motion into the mechanism at the center of the 1784 patent, a technical feature that reflects his own empirical approach to design. Whether Watt was directly familiar with Hogarth's work is not only unclear but ultimately outside the scope of this study. It is rather my aim to identify their shared approaches to design as "open techniques," a term that Liliane

Hilaire-Perez and other historians of technology have used to describe the skilled practices that both technical and nontechnical actors develop and circulate throughout society. "The techniques of production," Hilaire-Perez and Catherine Verna point out, "were not only of interest to producers, but also to merchants, shopkeepers, artists, consumers, local authorities, princes, political writers, and others. Thus the actors involved in technical dissemination should not be limited to the technicians."[37] Visual culture emerged as an important site for such interchange, offering techniques and technologies that could be used by artists and engineers alike. Pamela Smith tracks this interdisciplinary application of visual culture back to the use of images in early modern science, arguing that artists and artisans "helped constitute the aims and methods" of empirical scientific inquiry.[38] Nor is Smith alone in this regard. Eileen Reeves and Dániel Margócsy, among others, have offered similar assessments of the relationship between visual culture and technoscience, presenting compelling evidence of the reciprocal influence that these knowledge systems have had on each other.[39] Following the emergence of the public sphere but before the erection of firm disciplinary boundaries, eighteenth-century Britain's knowledge culture was well suited to foster such conceptual transmission. The serpentine motion that appeared as an open technique at this time can thus be positioned as a shared strategy for responding to similar epistemological challenges faced across the fine arts and mechanical arts.

In the decades that followed the invention of the steam engine, it shuttled into popular consciousness as an object whose allure extended beyond technicians and manufacturers. The dissemination of the machine initiated what Ben Russell calls a "new machine aesthetic," in which the steam engine came to exert "a continued imaginative effect on those who saw it work."[40] Within modern scholarship, the aesthetic quality of the steam engine has typically been discussed in these terms, as a phenomenon that proceeds from, rather than informing, the machine's design.[41] The aestheticized perceptions of the steam engine, according to such accounts, merely extend from its function, engendered by the recognition of how serviceable the machine could be to capitalist production. But while these analyses deliver important insights into how nineteenth-century aesthetics was shaped by the invention of the steam engine, they do not consider how the steam engine may have been shaped by eighteenth-century aesthetics. As Russell reminds us, "The engine was as much a cultural machine as a scientific one," and it is therefore imperative that we remain attentive to the discursive formations embedded within its design.[42]

The groundbreaking design improvement at the center of the 1784 patent appeared in the form of a diagram for the unassuming mechanical contraption that became known as "Watt's linkage" (figure 5.3).[43] The unimpeded reciprocating motion generated by the linkage could be used to power any machine driven by a wheel, providing a source of mechanical force more reliable and consistent than animals, wind, or water. Two years prior, Watt had taken out a patent for the sun-and-planet gears—a device attached to the flywheel that drove the piston both up and down, making the engine "double-acting"—which had begun the process of bringing the engine out of the mine and into the factory. But without the addition of

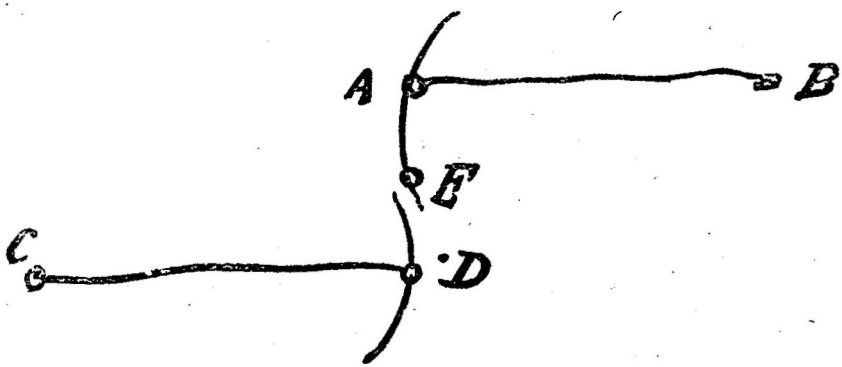

Figure 5.3. Sketch of Watt's linkage, James Watt to his son, James Watt Jr. (1808). Reprinted from Franz Reaulaux, *The Kinematics of Machinery: Outlines of a Theory of Machines*, ed. and trans. Alex B. W. Kennedy (London: Macmillan, 1876).

the linkage introduced in 1784, the engine's signature reciprocating motion would remain imperfect, severely delimiting the machine's maximum output and prohibiting its use as a prime mover.[44] Watt's linkage worked by incorporating a flexible joint that could accommodate both the angular motion of the working beam and the perpendicular motion of the piston. The joint was composed by a three-bar linkage that connected the two contrasting motions and converted them into a unified reciprocating motion. According to Helmut Müller-Sievers, synthesizing "translation" (straight-line motion) and "rotation" (circular motion) into a singular motion had long been considered a contradictory proposition within Western metaphysics. Watt's linkage, however, "forced a compromise between rotation and translation."[45] The mechanism achieved this compromise by attaching parallel bars to both the piston rod and working beam that would each trace a curvilinear line and then connecting these with a third bar. This third bar converted the two semicircles into an undulating line that produced the linkage's signature S-curve.

The serpentine line traced by Watt's linkage emerged as the central feature of the machine's aforementioned aesthetic appeal. In an address to the French Académie des sciences, François Arago's technical description of the steam engine devolves into aesthetic admiration when he arrives at the linkage: "At each reciprocation of the stroke, it opens and closes, with the smoothness—I had almost said with the grace,—which charms us in the gestures of an accomplished actor."[46] While technological design is often considered antithetical to aesthetic taste, the "grace" of the linkage's motion leads Arago to position the steam engine as evidence of his stated belief that "the useful arts may often exhibit the same beauty and greatness which are displayed in the fine."[47] Boulton and Watt clearly recognized the hypnotic appeal of the engine's smooth reciprocating motion, taking advantage of this effect by showcasing the first of these models in prominent London locations where it would be visible to the public.[48] After witnessing the mechanism in motion for the first

time, Watt remarked to Boulton on his "surprise at the perfection of its action": "in looking at it for the first time, I had all the pleasure of novelty which could have arisen had it been invented by another person."[49] Though Watt's suggestion here is probably a rhetorical flourish, the steam engine's application of the reciprocating flow of the S-curve to power Britain's industrial transition is nevertheless notable given its well-established position within eighteenth-century aesthetic discourse.

In addition to the morphological affinity between Hogarth's line of beauty and Watt's linkage, Watt arrives at the serpentine line by way of the same challenge to contemporary design practices that had catalyzed its appearance elsewhere. His linkage would revolutionize manufacturing in the coming decades, but more immediately, it signaled a departure from the "geometrical rigour" that Rouquet had diagnosed within the arts. As Michel Serres notes in his account of the major conceptual paradigms before and after the Industrial Revolution, Euclidean geometry influenced the direction of pre-industrial technological design as much as it had informed pre-industrial aesthetic philosophy. As a result, the force generated by pre-industrial machines was taken to correspond directly to "their form, their lines, their geometry."[50] The world of machines before the Industrial Revolution was, in other words, "a world that is drawn, drawable. It is a world in which chains trace motion."[51] Until the 1780s, steam-engine design had reflected this prevailing logic, producing limited force through the machine's assemblage of geometrical components and thus wasting most of the energy produced in the engine's boiler. So entrenched was this approach to mechanical design that Watt's stated intent to replace the rigid contraptions used in earlier engines with the flexible linkage he devised was initially received by Boulton as "quite incomprehensible."[52] Watt's challenge to this system came in the linkage he patented in 1784, which attended to the "elastic force" of steam into the machine's technical design.[53] Against the prevailing "mechanical" theory of heat, Watt and his mentor, Joseph Black, had devised a "chemical" theory that conceived of heat as a substance that combined with other substances. On the basis of this theory, Watt concluded that steam was an "elastic fluid" that expanded when combined with heat. Such expansion, though, would "not follow a Geometrical progression," leading Watt to opt for a flexible linkage that accommodated steam's bounding movement.[54] Though the mechanism itself was rigid, composed of three metal rods, the "bewildering variety" of its serpentine motion could not be charted "algebraically or in any other form of abstraction."[55] Its motion was consistent but exceeded linear calculation. Watt's linkage thus successfully mediated the engine's rigid mechanical principles and steam's elasticity, manifesting in the mechanism's trademark serpentine motion. While his earlier improvements had effectively contained and redirected steam power, the unbroken reciprocating motion produced by the 1784 linkage allowed steam's expansive principle to produce a level of force that exceeded the limits of the machine's linear components. As such, the design of the linkage reflects the "irreducible empiricism and pragmatism" underlying Watt's work on the steam engine, a feature that is embodied in the mechanism's winding S-curve.[56]

My aim thus far has been to contextualize the "species" of motion produced by Watt's linkage by situating it in relation to the serpentine style articulated within Enlightenment-era aesthetic discourse. The shared epistemological foundations of these artifacts of eighteenth-century design do, however, complicate the historical legacies of Hogarthian design. What, exactly, happens to our understanding of eighteenth-century aesthetics once we locate its design principles within the discursive and material formations responsible for initiating industrial capitalism and, by extension, the Anthropocene? Jesse Oak Taylor has tackled this question as it pertains to the "rise of the novel," a literary-historical phenomenon that "dovetails" with the onset of industrialization, an alignment, he argues, that is "not coincidental, but constitutive."[57] As he explains, the novel's representational conventions, which centralize the individual human subject against a static environment, are built on dangerous anthropocentric notions of command over the natural world. Accordingly, he concludes, "The novel form is at once a product and a participant in the social, historic, economic, and ecological forces responsible for bringing the Holocene to an end."[58] Having identified the genre's problematic role in this regard, Taylor contends that alternative representational forms are needed to undermine the governing logics of the Anthropocene.[59] But before I condemn the *Analysis* on similar grounds for advancing techniques that would be replicated by the engines of industrialism, it is important to briefly consider the manifestation of these principles in a slightly different context. To do so, I would like to conclude by turning here to Laurence Sterne's *Tristram Shandy*, a text whose frequent appraisal of itself as a Hogarthian "machine" represents an alternative response to the limits of geometrical design heretofore not considered.

Writing in the wake of the highly systematic approaches to language issued by David Hartley, Robert Hooke, and numerous early novelists, Sterne perceived contemporary representational frameworks to be fundamentally at odds with the limitless variety of experience.[60] To paint a full picture of a "life," as *Tristram Shandy* attempts to do, exposes the limits of such enterprises. Tristram grapples with the inherent challenges of linear representation when his attempt to recount the day of his birth, which is frequently sidetracked by a number of contextual and conversational digressions, takes over a year: "at this rate I should just live 364 times faster than I should write—It must follow, an' please your worships, that the more I write, the more I shall have to write. . . . I shall never overtake myself."[61] This is after taking two chapters to recount "what passed in going down one pair of stairs."[62] Experience is presented here and elsewhere in the text in "elastic" terms, with each moment possessing the capacity to expand into any number of backstories or digressions. "To write a linear narrative is morally impossible for Tristram," argues Joseph Drury, "because to do so requires placing abusive constraints on human nature."[63] Plotting Tristram's life within a linear narrative structure would, Sterne admits, necessitate the elimination of the text's digressions, which are "the sunshine—they are the life, the soul of reading."[64] He therefore sets out to assemble a text that incorporates as central structural components the asides, tangents, and digressions that constitute experience.

Sterne embraces the unpredictable variety of experience in this regard, but he does not abandon linearity altogether. Rather, his adoption of Hogarth's principles of design appear in the very mechanism of the narrative, which embodies the line of beauty's "composed variety." In this sense, the novel is presented not as an undifferentiated collection of digressions but as a well-oiled "machine" that mediates or "reconcile[s]" the "contrary motions" of linear narrative and elastic experience into something of a serpentine trajectory. "In a word," Shandy summarizes, "the machinery of my work . . . is digressive, and it is progressive too,—and *at the same time.*"[65] The degree to which he accomplishes this mediation is illustrated in the impossibility of distinguishing between linear and nonlinear moments in the text, even, as Victor Shklovsky points out, in the scenes that seem overtly digressive: "Sterne's inset material does not play a merely peripheral role in the novel. On the contrary, every passage belongs to one of the novel's compositional lines."[66] Christina Lupton has argued that the ability to recognize the novel's digressions *as* digressions requires that Sterne "first posits his work as a book," citing the linear succession of text in the material book as a precondition for *Tristram Shandy*'s nonlinear appearance.[67] The text's representation of the variety of experience is, in other words, dependent on a certain degree of regulation and control, most evident in the simultaneously linear and nonlinear plotlines Sterne provides at the end of the fifth volume. Even as Tristram facetiously scolds himself here for failing to tell any part of the story "in a tolerable straight line," his comments throughout the novel imply that he was very much pleased with the mediation of progressive and digressive elements reflected in these irregular lines.[68]

Not only does the form of the novel reflect this mediation of linear and nonlinear elements; so, too, does the composition of the Shandy family.[69] In order for Tristram to illustrate his claim that Shandy-hall constitutes a "complex" rather than a "simple machine," he describes its inner workings as resembling "the inside of a *Dutch* silk-mill." He explains this comparison by referring to the "parallel" forms of "motion, debate, harangue, dialogue, project, or dissertation" that occur simultaneously in the house's separate quarters and remain interconnected by way of "the rule to leave the door, not absolutely shut, but somewhat a-jar." This rule is enabled by "the covert of the bad hinge, (and that possibly might be one of the many reasons why it was never mended)." Information travels back and forth through the cracked door, which was "wide enough, for all that, to carry . . . this windward trade," keeping the residents of Shandy-hall on the same page. Though the household is composed of a range of actors who are "contrasted by nature and education," the door hinge mediates their incommensurable "motions," synthesizing these perspectives into a single collective experience. Sterne uses the death of Bobby Shandy to illustrate how this "family-machine" worked, presenting the different ways in which the Shandys and their servants process the tragic news as it circulates across either side of the open door. As Walter's address to the parlor attempts to rationalize the loss by recounting a linear history of the philosophical interpretation of death, "proceeding from period to period, by metaphor and allusion," Trim provides a less structured and more emotional response to the tragedy. His

oration in the kitchen is "without wit or antithesis, or point, or turn, this way or that; but leaving the images on one side, and the pictures on the other, going straight forwards as nature could lead him, to the heart." Sterne's depiction of the "complex" Shandy family-machine here implies that Bobby's death could only be conceptually approached by balancing these alternative forms of expression, requiring neither Walter's rigid logos nor Trim's disjointed pathos alone. Some combination of the two, however, mediated by the mechanical hinge between them, begins to register the immensity of such an experience.[70]

Sterne's use of the language of machinery to stage his critique of the limits of representation speaks to the common structural limitations faced by mechanical production and artistic representation alike. That Sterne packages the novel as a "machine" is often read metaphorically, but Drury usefully points out that during the eighteenth century, "the novel was understood to be a kind of technology." As a result, "critical reflection on its uses and effects was necessarily implicated in contemporary discourses about the uses and effects of the Enlightenment's other machines."[71] As such, pulling apart Sterne's ideas concerning the limitations of narrative from those about technological design writ large becomes impossible. And while Roy Caldwell has argued that Sterne's machine "belongs not to the family of modern industrial machinery, but is rather the heir of the archaic machines of the seventeenth century," the text's incorporation of the stochastic power of digression as the source of its literal and figurative motion is distinctly modern.[72] Unlike the rigid mechanisms constructed by Sterne's contemporaries in the domains of literary and technological production, *Tristram Shandy* mediates linear progression and nonlinear digression to generate his machine's motive force. The middle way that the text inhabits aligns Sterne's project with those techniques employed by Hogarth and Watt insofar as it attempts to practically negotiate the systematizing nature of design with the elastic quality of empirical reality.[73]

The novel, however, puts these mediating techniques to very different ends, conceiving of itself as a machine that, while certainly functional, does not actually do or create anything. The novel is rather, as Yorick announces in the text's closing line, but "a COCK and a BULL."[74] Take the aforementioned door hinge, which importantly performs its mediating role by *not* working properly. Though classified as a "bad hinge," its dysfunction as a simple machine proves to be critical to its function as part of Sterne's complex machine. The hinge, in other words, acquires its value outside of the parameters of conventional technological design, operating irrespective of the rules established within that system. Moreover, the family-machine made possible by this broken machine does not itself function in a way that could be deemed "productive" or "progressive." The circulation of the news of Bobby's passing between the parlor and the kitchen, while allowing the characters on either side of the cracked door to begin processing the death in their own ways, nevertheless culminates in a miscommunication between Walter and Mrs. Shandy. Standing outside the door, Mrs. Shandy mistakes Walter's recitation of Socrates's statement "I have friends—I have relations,—I have three desolate children" as an admission of infidelity, prompting her to charge into the parlor to confront her husband.

> —Then, cried my mother, opening the door,—you have one more, Mr. *Shandy*, than I know of.
>
> By heaven! I have one less,—said my father, getting up and walking out of the room.[75]

Rather than facilitating clear communication between the separate rooms in the house, the door hinge here obstructs communication. By concluding the account of Bobby's death with such a farcical denouement, Sterne reveals the "complex" machine that is Shandy-hall to be inherently unproductive. Though capable of mediating the characters' contrary "motions" into a generative collectivity—Mrs. Shandy is eventually informed of her son's death—in the end, the family-machine only generates a comical moment of misunderstanding.

Against the instrumental turn that defined technological development within Enlightenment Britain, Sterne imagines the novel to be a perfect machine that cannot be incorporated into contemporary systems of production.[76] His text-machine thus comes to function as an antimachine, effectively mobilizing the elastic quality of empirical reality, but to no end that would be deemed "productive." *Tristram Shandy* simultaneously replicates and disavows the conceptual schema it had adopted from contemporary design, offering a compelling instance of Enlightenment self-critique. Consider for a moment the account of Trim's failed attempts to tell Toby "The story of the king of Bohemia and his seven castles." Every time Trim begins, Toby interjects with an irrelevant question or comment, resulting in a temporary digression away from the story. Trim begins the story from scratch five times, each beginning represented by an interruption in the text itself: "The story of the king of Bohemia and his seven castles, continued."[77] With every new attempt, Toby finds a way to derail what is presumably Trim's conventionally linear story. Sterne includes scenes like this as a way to maintain his formal balance between digression and progression, reinforcing their mediation in the text by repeatedly proceeding with the story, only to return each time to the beginning. There is no product or payoff produced by Sterne's machine here; rather, the value lies simply in witnessing its motion.

The de-instrumentalization of Hogarth's principles achieved in Sterne's text-machine suggests that such techniques are not inherently exploitative, nor must they necessarily be abandoned to challenge the conceptual underpinnings of industrial capitalism and the Anthropocene. The decline of classical geometry within aesthetics and engineering ushered in a way of knowing and making that replaced abstractions with empirical reality as its animating subject, yet the emanations of this new epistemological paradigm differed greatly across the fine arts and industrial arts, if not in theory than in application. According to Gilbert Simondon, the often-nefarious reorientation of technical practices is a common, if not constitutive, occurrence in the history of technology. "There appears to be a singular law of transformation of human thought," he argues, "according to which any ethical, technical, and scientific invention, which sets out as a means of liberation and rediscovery of man, becomes through its historical evolution an instrument that

turns against its liberation and enslaves man by limiting him."[78] Eighteenth-century design theory did not set out to develop skilled practices and techniques that could be exploited by bourgeois manufacturers. These individuals were merely responding to a rigid conceptual framework by attending to the capacities of empirical reality in their efforts to cultivate practical knowledge. As Siegfried Giedion reminds us, "Mechanization is neutral. What matters is how one uses mechanization."[79] That industrial capitalism would repurpose the contributions of eighteenth-century aesthetic discourse is clear, but this process would not be absolute. Despite the violent legacies of industrial technologies like Watt's steam engine, the discursive formations embedded within such machines remained persistently malleable, capable of disrupting the very systems they constituted.

NOTES

1. James Watt, Fire and Steam Engines, &c., U.K. Patent 1432, issued April 28, 1784.

2. Karl Marx, *Capital*, vol. 1, trans. Ben Fowkes (London: Penguin, 1990), 499.

3. Paul Crutzen and Eugene Stoermer, "The 'Anthropocene,'" *IGBP Newsletter* 41 (2000): 17–18. The specific dating of the Anthropocene has, of course, become a major point of contention among humanists and social scientists. For further discussion of the Anthropocene starting date, see Jeremy Davies, *The Birth of the Anthropocene* (Berkeley: University of California Press, 2016), 41–68; Simon L. Lewis and Mark A. Maslin, *The Human Planet: How We Created the Anthropocene* (New Haven, CT: Yale University Press, 2018); Christophe Bonneuil, "The Geological Turn: Narratives of the Anthropocene," in *The Anthropocene and the Global Environmental Crisis: Rethinking Modernity in a New Epoch*, ed. Clive Hamilton, Christophe Bonneuil, and François Gemenne (Abingdon, UK: Routledge, 2015), 17–31; J. R. McNeill and Peter Engelke, *The Great Acceleration: An Environmental History of the Anthropocene since 1945* (Cambridge MA: Harvard University Press, 2016); Bruce D. Smith and Melinda A. Zeder, "The Onset of the Anthropocene," *Anthropocene* 4 (2013): 8–13.

4. Timothy Morton, *Hyperobjects: Philosophy and Ecology after the End of the World* (Minneapolis: University of Minnesota Press, 2013), 7.

5. Marxist historiography has operated on similar assumptions. G. A. Cohen, for example, identifies the locus of industrial capitalist society in "technical knowledge" above and beyond the physical embodiment of the machine itself. As Cohen argues, "Destroy all steam engines but preserve knowledge of how to make and use them and, with a bit of luck in the matter of raw materials, you can soon return to the status quo ante. Destroy the knowledge and preserve the engine and you have a useless ensemble of metal, a material surd, a relic of the future." Cohen, *Karl Marx's Theory of History: A Defence* (Princeton, NJ: Princeton University Press, 2000), 41.

6. Alan Mikhail, "Enlightenment Anthropocene," *Eighteenth-Century Studies* 49, no. 2 (Winter 2016), 211–231.

7. Marx, *Capital*, 499.

8. John Bourne, *A Treatise on the Steam Engine in Its Application to Mines, Mills, Steam Navigation, and Railways* (London, 1846), 211.

9. See Bonnie Blackwell, "The Pleasures of Geometry: Math and Melancholia in Rousseau's *La Nouvelle Heloïse*," *European Romantic Review* 15, no. 1 (March 2004): 89–112; Laura Søvsø Thomasen and Henrik Kragh Sørensen, "The Irony of Romantic Mathematics: Bridging the Historiographies of Literature and Mathematics," *Configurations* 24, no. 1 (Winter 2016): 53–70; Matthew Wickman, *Literature after Euclid: The Geometric Imagination in the Long Scottish Enlightenment* (Philadelphia: University of Pennsylvania Press, 2016).

10. For more on the history of the serpentine line, see James Bunn, *Wave Forms: A Natural Syntax for Rhythmic Language* (Stanford, CA: Stanford University Press, 2002); Miranda Stanyon, "Serpentine Sighs: De Quincey's *Suspiria de Profundis* and the Serpentine Line,"

Studies in Romanticism 53, no. 1 (Spring 2014): 31–58; David Summers, "*Maniera* and Movement: The *Figura Serpentinata*," *Art Quarterly* 35 (1972): 269–273.

11. See Francis Hutcheson, *An Inquiry into the Original of Our Ideas of Beauty and Virtue* (London, 1726). For a discussion of the mathematical nature of the "Shaftesbury-Hutcheson Beautiful," see Ronald Paulson, *Hogarth*, vol. 3, *Art and Politics, 1750–1764* (New Brunswick, NJ: Rutgers University Press, 1993), 65–76.

12. Tim Ingold, *Lines: A Brief History* (London: Routledge, 2007), 152.

13. W.J.T. Mitchell, *Articulate Images: The Sister Arts from Hogarth to Tennyson* (Minneapolis: University of Minnesota Press, 1983), 127.

14. William Shenstone, "Verses Written in the Garden of William Shenstone, Esq.," in *The Poetical Works of William Shenstone*, vol. 1 (London, 1780), 58.

15. Siegfried Giedion, *Mechanization Takes Command: A Contribution to Anonymous History* (Minneapolis: University of Minnesota Press, 2013), 312.

16. Quoted in Ingold, *Lines*, 159.

17. See Tom Turner, *English Garden Design: History and Styles since 1650* (Suffolk, UK: Antique Collectors' Club, 1986).

18. William Hogarth, *The Analysis of Beauty* (New Haven, CT: Yale University Press, 1997), 65; hereafter cited parenthetically in the text.

19. See Rosamaria Loretelli, "The Aesthetics of Empiricism and the Origin of the Novel," *The Eighteenth Century* 41, no. 2 (Summer 2000): 83–109.

20. Michel Baridon, "Hogarth's 'Living Machines of Nature' and the Theorisation of Aesthetics," in *Hogarth: Representing Nature's Machines*, ed. David Bindman, Frédéric Ogée, and Peter Wagner (Manchester: Manchester University Press, 2001), 92.

21. Ibid., 94.

22. For a discussion of Hogarth's influence on Rouquet, see Paulson, *Hogarth*, 193–196.

23. Jean Andre Rouquet, *The Present State of the Arts in England* (London, 1755), 7.

24. Ibid., 9.

25. Scott R. MacKenzie, "My Chapter upon Lines: Motion, Deviation, and Lineation in Eighteenth-Century British Aesthetics," *Criticism* 61, no. 1 (2019): 6.

26. Timothy Erwin, "William Hogarth and the Aesthetics of Nationalism," *Huntington Library Quarterly* 64, no. 3 (2001): 393.

27. Paulson, *Hogarth*, 97.

28. Mitchell, *Articulate Images*, 131; Frédéric Ogée, "From Text to Image: William Hogarth and the Emergence of a Visual Culture in Eighteenth-Century England," in Bindman, Ogée, and Wagner, *Hogarth*, 10.

29. Paulson, *Hogarth*, 73.

30. See Anne Puetz, "Design Instructions for Artisans in Eighteenth-Century Britain," *Journal of Design History* 12, no. 3 (1999): 217–239.

31. Paulson, *Hogarth*, 122.

32. "Defence of Coach-Building, and a Few Words on Steam-Carriages," *Mechanics Magazine* 18 (1833): 209.

33. Quoted in Ian Carter, *Railways and Culture in Britain: The Epitome of Modernity* (Manchester: Manchester University Press, 2001), 264.

34. Ruth Mack, "Hogarth's Practical Aesthetics," in *Mind, Body, Motion, Matter: Eighteenth-Century British and French Literary Perspectives*, ed. Mary Helen McMurray and Alison Conway (Toronto: University of Toronto Press, 2016), 22, 29. See also Abigail Zitin, *Practical Form: Abstraction, Technique, and Beauty in Eighteenth-Century Aesthetics* (New Haven, CT: Yale University Press, 2020).

35. Martin Heidegger, "The Question Concerning Technology," in *The Question Concerning Technology and Other Essays*, ed. and trans. William Lovitt (New York: Garland Publishing, 1977), 14.

36. Ibid., 14, 16.

37. Liliane Hilaire-Pérez and Catherine Verna, "Dissemination of Technical Knowledge in the Middle Ages and the Early Modern Era," *Technology and Culture* 47 (July 2006): 539.

38. Pamela H. Smith, "Art, Science, and Visual Culture in Early Modern Europe," *Isis* 97 (March 2006): 95. See also Smith, *The Body of the Artisan: Art and Experience in the Scientific Revolution* (Chicago: University of Chicago Press, 2004).

39. Dániel Margócsy, *Commercial Visions: Science, Trade, and Visual Culture in the Dutch Golden Age* (Chicago: University of Chicago Press, 2014); Eileen Reeves, *Painting the Heavens: Art and Science in the Age of Galileo* (Princeton, NJ: Princeton University Press, 1997). See also Anita Guerrini, *The Courtiers' Anatomists: Animals and Humans in Louis XIV's Paris* (Chicago: University of Chicago Press, 2015); Harold J. Cook, *Matters of Exchange: Commerce, Medicine, and Science in the Dutch Golden Age* (New Haven, CT: Yale University Press, 2007).

40. Ben Russell, *James Watt: Making the World Anew* (London: Reaktion, 2014), 197, 201.

41. See Peter Brooks, *Reading for the Plot: Design and Intention in Narrative* (New York: Knopf, 1984), 41–44; Tamara S. Ketabgian, *The Lives of Machines: The Industrial Imaginary in Victorian Literature and Culture* (Ann Arbor: University of Michigan Press, 2011); Andreas Malm, *Fossil Capital: The Rise of Steam Power and the Roots of Global Warming* (London: Verso, 2016), 194–222; Anson Rabinbach, *The Human Motor: Energy, Fatigue, and the Origins of Modernity* (Berkeley: University of California Press, 1992); Russell, *James Watt*, 170–202.

42. Russell, *James Watt*, 9.

43. I refer to Watt's linkage and the parallel motion device he developed shortly after the 1784 patent was issued interchangeably throughout. The parallel motion device used the exact same mechanism that we see in the 1784 patent, but it added a fourth bar to the contraption to save space.

44. For more on the technical history of Watt's linkage, see Ben Marsden, *Watt's Perfect Engine: Steam and the Age of Invention* (New York: Columbia University Press, 2002); James Patrick Muirhead, *The Origin and Progress of the Mechanical Inventions of James Watt* (London: John Murray, 1854); William Rosen, *The Most Powerful Idea in the World: A Story of Steam, Industry, and Invention* (New York: Random House, 2010).

45. Helmut Müller-Sievers, *The Cylinder: Kinematics of the Nineteenth Century* (Berkeley: University of California Press, 2012), 43.

46. François Arago, *Historical Eloge of James Watt*, trans. James Patrick Muirhead (London: John Murray, 1839), 85.

47. Ibid., 214.

48. Russell, *James Watt*, 167.

49. Robert Stuart, *A Descriptive History of the Steam Engine* (London: Knight and Lacey, 1824), 190–191.

50. Michel Serres, "Turner Translates Carnot," in *Hermes: Literature, Science, Philosophy*, ed. and trans. Josué V. Harari and David F. Bell (Baltimore: Johns Hopkins University Press, 1982), 56.

51. Ibid., 56.

52. Matthew Boulton to James Watt, July 17, 1784, Boulton and Watt Collection, MS 3147/3/8/10, Library of Birmingham, UK.

53. Watt, Fire and Steam Engines, &c.

54. Quoted in David Philip Miller, *James Watt, Chemist: Understanding the Origins of the Steam Age* (London: Pickering and Chatto, 2009), 97.

55. Müller-Sievers, *The Cylinder*, 29.

56. Ibid.

57. Jesse Oak Taylor, "The Novel after Nature, Nature after the Novel: Richard Jefferies's Anthropocene Romance," *Studies in the Novel* 50, no. 1 (Spring 2018): 110.

58. Ibid.

59. Others have offered similar arguments about the ineptitude of traditional literary genres in responding to the ongoing environmental crisis. See Amitav Ghosh, *The Great Derangement: Climate Change and the Unthinkable* (Chicago: University of Chicago Press, 2016); Ursula K. Heise, "Lost Dogs, Last Birds, and Listed Species: Cultures of Extinction," *Configurations* 18, nos. 1–2 (Winter 2010): 49–72; Stephanie LeMenager, "Climate Change and

the Struggle for Genre," in *Anthropocene Reading: Literary History in Geologic Times*, ed. Tobias Menely and Jesse Oak Taylor (University Park: Pennsylvania State University Press, 2017), 220–238.

60. See Rebecca Tierney-Hynes, "Fictional Mechanics: Haywood, Reading, and the Passions," *The Eighteenth Century* 51, nos. 1–2 (Spring–Summer 2010): 153–172.

61. Laurence Sterne, *The Life and Opinions of Tristram Shandy, a Gentleman* (London: Penguin, 2003), 257.

62. Ibid., 253.

63. Joseph Drury, *Novel Machines: Technology and Narrative Form in Enlightenment Britain* (Oxford: Oxford University Press, 2017), 138.

64. Sterne, *Tristram Shandy*, 64.

65. Ibid., 63–64.

66. Viktor Shklovsky, *Theory of Prose*, trans. Benjamin Sher (Champaign, IL: Dalkey Archive, 1990), 165.

67. Christina Lupton, "Contingency, Codex, the Eighteenth-Century Novel," *ELH* 81, no. 4 (Winter 2014): 1180. See also Eric Rothstein, *Systems of Order and Inquiry in Later Eighteenth-Century Fiction* (Berkeley: University of California Press, 1975).

68. Sterne, *Tristram Shandy*, 425.

69. For a discussion of the competing representational systems depicted in the Shandy household, see Alex Solomon, "The Novel and the Bowling Green: Toby Shandy's Diagrammatic Realism," *Philological Quarterly* 95, no. 2 (2016): 269–291.

70. Sterne, *Tristram Shandy*, 323–324.

71. Drury, *Novel Machines*, 4.

72. Roy C. Caldwell, "*Tristram Shandy*, Bachelor Machine," *The Eighteenth Century* 34, no. 2 (Summer 1993): 106. See also Judith Hawley, "*Tristram Shandy*, Learned Wit, and Enlightenment Knowledge," in *The Cambridge Companion to Laurence Sterne*, ed. Thomas Keymer (Cambridge: Cambridge University Press, 2009), 34–48.

73. See also Peter Conrad, *Shandyism: The Character of Romantic Irony* (Oxford: Basil Blackwell, 1978); Martin Meisel, *Chaos Imagined: Literature, Art, Science* (New York: Columbia University Press, 2016), 307–309.

74. Sterne, *Tristram Shandy*, 588.

75. Ibid., 334.

76. See Paul Slack, *The Invention of Improvement: Information and Material Progress in Seventeenth-Century England* (Oxford: Oxford University Press, 2015).

77. Sterne, *Tristram Shandy*, 510.

78. Gilbert Simondon, *On the Mode of Existence of Technical Objects*, trans. Cécile Malaspina and John Rogove (Minneapolis: Univocal, 2017), 18.

79. Giedion, *Mechanization Takes Command*, 345.