*Modern Intellectual History*, 12, 2 (2015), pp. 443–451 
doi:10.1017/S1479244314000432

# THE EARLY MODERN MACHINE: DIVINE, SENTIMENTAL, ROMANTIC

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Justin E. H. Smith, *Divine Machines: Leibniz and the Sciences of Life* (Princeton, NJ: Princeton University Press, 2011)

Adelheid Voskuhl, *Androids in the Enlightenment: Mechanics, Artisans, and Cultures of the Self* (Chicago: The University of Chicago Press, 2013)

John Tresch, *The Romantic Machine: Utopian Science and Technology after Napoleon* (Chicago: The University of Chicago Press, 2012)

It is easy, especially for a generation of students who entered kindergarten in the age of Google, to think that machines, before the advent of electronic computers (and smart phones and iPads), were heavy, clunky, stupid things—big, industrial, hissing with steam and clanking their gears. Or if they weren't heavy and hissing, at least they were rigid and rote: a clock inexorably ticking its way around the dial, an automaton executing brittle motions in stiff sequence.

But no: a series of recent books reveals that machines during the seventeenth to nineteenth centuries were divine, sentimental, and romantic, in that order, though not in a neat series, since the periods and styles overlapped. Moreover, the divinity, sentimentalism and romanticism of early modern machines had consequences, not just for how people understood machines, but also for how they understood the whole cosmos, animate and inanimate, natural and artificial.

Consider how the German rationalist philosopher and designer of one of the first mechanical calculators, G. W. Leibniz, described clocks. He saw these not as rigid but as "restless," striving, responsive, in "perpetual conflict," and as such, analogous to living bodies.[1] How very different a model of clockwork this

[1] Gottfried Wilhelm Leibniz, *Nouveaux essais*, in Leibniz, *Die philosophischen Schriften*, ed. Carl Immanuel Gerhardt, 7 vols. (Berlin, 1875–90) (hereafter *PS*), 5: book 2, chap. 20, 153.

is—and of living bodies as clocklike entities—from the traditional understanding of the early modern clockwork cosmos, a regular, constrained and fundamentally passive artifact.[2]

In a revisionist new reading whose elegance and rigor tend to camouflage its radicalism, Justin Smith writes that Leibniz saw all the mechanisms of the world, including the inanimate ones, even including the artificial ones, in "biological" terms. A "living force" set everything in Leibniz's cosmos, not just living things, in motion (4–5).[3] To be sure, as Smith emphasizes, there was an important difference between human-made machines and "divine" ones, i.e. living things, according to Leibniz. The difference was that God's machines were even more mechanical than human-made devices. This was because living beings were irreducibly mechanical down to their "smallest distinguishable parts."[4] "I define the Organism, or the natural Machine," Leibniz wrote to the English philosopher Lady Damaris Masham in 1704, as "a machine in which each part is a machine, and consequently the subtlety of its artifice goes to infinity, nothing being small enough to be neglected, whereas the parts of our artificial machines are not machines. That is the difference between Nature and Art."[5]

In the first years of the eighteenth century, Leibniz developed a theory of organisms that would shape discussion of living beings over the following decades.[6] His central principle was the one announced above, that living things were more thoroughly mechanical than any device created by human beings.

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2 I discuss this passage, and Leibniz's view of machines, both living and artificial, more fully in Jessica Riskin, "The Restless Clock," in Paula Findlen, ed., *Early Modern Things: Objects and Their Histories, 1500–1800* (New York, 2012), 84–101, and in a forthcoming book by the same title.

3 See also Daniel Garber, "Leibniz and the Foundations of Physics: The Middle Years," in K. Okruhlik and J. R. Brown, eds., *The Natural Philosophy of Leibniz* (Dordrecht, 1985), 27–130.

4 Gottfried Wilhelm Leibniz, "Principles of Nature and Grace, Based on Reason" (1714), in Leibniz, *Philosophical Essays*, ed. Roger Ariew and Daniel Garber (Indianapolis, 1989) (hereafter *PE*), 206–13, 207. See also Leibniz, *Système nouveau de la nature et de la communication des substances et autres textes, 1690–1703*, ed. Christiane Frémont (Paris, 1994), 70–71: "A natural machine still remains a machine in its least parts"; and Leibniz, *Nouveaux essais*, in *PS*, 5: book 3, chap. 6, section 39.

5 Leibniz to Lady Damaris Masham, 30 June 1704, in *PS*, 3: 356.

6 On Leibniz's distinctive form of mechanism as applied to the phenomena of life see also François Duchesneau, *Les modèles du vivant de Descartes à Leibniz* (Paris, 1998), chap. 10; and Duchesneau, "Leibniz's Model for Organizing Organic Phenomena," in *Perspectives on Science*, 11/4 (2003), 378–409, 398. Duchesneau argues that Leibniz's theory of organisms grew out of his understanding of dynamics, a "science of power and action," which he developed in the last decade of the seventeenth century.

Nature was machinery all the way down.[7] To describe Leibniz's mechanics of divine, living machines, Smith coins the term "organics," specifying that organics did not constitute an alternative or contrasting approach to mechanics, but quite the contrary. Organics was a branch of mechanics, or, better yet, it was mechanics at its most exhaustive and pure (19, 58, 98–101). The science of living beings was the fundamental mechanist science, and provided the basis for the physics of inanimate things rather than (as we have since become accustomed to thinking) the other way around.[8]

Witnessing the android figure of a man run across the surface of the Seine in 1675, Smith recounts, Leibniz was greatly excited and inspired (59). Such machines fascinated him, the self-playing musical instruments and artificial horses and others of their kind. Leibniz's own teacher, Erhard Weigel, a professor of mathematics at Jena University, built a spring-driven bronze horse covered with real horse-skin, which had "a movement strong and continuous enough to make it go in one autumn day four German miles; that is to say, 8 French leagues, providing it is in a flat Country."[9] According to Smith, Leibniz found such machines philosophically salient because they tested the limits of ontological distinctions, in particular the distinction between the natural and the artificial. An android or artificial horse dramatized the possibility that living things might provide the key to understanding the whole cosmos, including its inanimate parts.

Leibniz's "organics" (to use Smith's term) undermined other, related commonplace distinctions as well, for example the distinctions between divine and mechanical, preestablished and spontaneous. Leibniz's living machines were "divine, because initially generable only by God," but they were also machines in the sense that one could fully explain their functioning without "recourse to God's constant concourse, nor to some subordinate God-like principle within the machine" (135–6). The living machines' developments and operations were preestablished but they were also spontaneous "in the original Latin sense of 'spontaneus,' as equivalent to the Greek 'automatos,' that is, the state of being determined only by one's intrinsic properties" (230).

7 Gottfried Wilhelm Leibniz, "On Nature Itself, Or, on the Inherent Force and Actions of Created Things, Toward Confirming and Illustrating Their Dynamics" (1698), in *PE*, 155–67, 156. See also Leibniz, "Against Barbaric Physics: Toward a Philosophy of What There Actually Is and against the Revival of the Qualities of the Scholastics and Chimerical Intelligences" (1710–16?), in *PE*, 312–20, 319: "everything happens mechanically in nature, but that the principles of mechanism are metaphysical."

8 See also Garber, "Leibniz and the Foundations of Physics."

9 *Journal des sçavans* (Paris, 1665–1792), 1680, 12.

Restless, spontaneous, self-determining machines within machines within machines all the way down: here was Leibniz's model of life, the cosmos itself and scientific explanation. He had a "philosophy of biology," Smith delightfully explains,

> in the same sense in which Molière wrote "comedies of manners": in both cases we are dealing with a genitive of description. Leibniz has a philosophy that, by and large, is "of biology," focused upon biological phenomena and concerned to demonstrate their relevance to our understanding of nature as a whole. (21)

Smith seems fully bilingual in history and philosophy. As a rule, historians and philosophers read very differently, so that a figure such as Leibniz appears strikingly different in historical and philosophical writing. This has to do with the different purposes of history and philosophy. Philosophers' general purpose is to arrive at a philosophically correct view of the problems that interest them. When they read Leibniz (or any other historical figure), they therefore seek coherence: a view that both is internally consistent and also concurs with their own intuitions and manners of thinking. Accordingly, philosophers tend to look for ways to eliminate (resolve, correct, filter out) those elements of historical texts that seem to them ambiguous, contradictory, inconsistent or otherwise mistaken. Historians, in contrast, want to understand the ideas in their original context: the concerns that motivated them, the forces that shaped them, the implications that flowed from them. In their efforts to understand ideas in their original context, historians catch at the very things that philosophers try to eliminate: anything that seems unfamiliar, contradictory or inconsistent. These things, which get in the way of a philosophical reading, are essential to a historical reading: they are the jagged edges and fault lines that reveal the contours of the original context, and the forces at work in it. Smith's bilingualism allows him to combine the best of both, employing the relatively exotic elements of Leibniz's thinking to reveal new philosophical possibilities.

Leibniz was not alone in his fascination with androids and automata, which were a leading preoccupation of the age and one that escalated over the course of the eighteenth century. Adelheid Voskuhl's *Androids in the Enlightenment* takes a close look at two Swiss androids that drew much attention during the 1770s. Both represent young ladies playing keyboard instruments. The first is a harpsichordist designed by a clockmaker named Pierre Jaquet-Droz. With the help of his son, Henri-Louis, and his adopted son, Pierre Leschot, Jaquet-Droz built the Musicienne and two other machines, a Writer and a Draughtsman, in his workshop in La Chaux-de-Fonds in 1774, using springs to drive them and gears and cams to program them.[10] The inventors employed lifelike materials such as

10 Alfred Chapuis and Edouard Gélis, *Le monde des automates*, 2 vols. (Paris, 1928), 2: 270–78; Alfred Chapuis and Edmond Droz, *Automata: A Historical and Technological Study*, trans.

leather, cork, and papier mâché to give their machines the softness, lightness, and pliancy of living things. With the likely help of the village surgeon, they also designed the machines' hands, modeling their skeletal structures on real human hands.[11]

The Jaquet-Droz automata, like their predecessors, went on to tour the cities and courts of Europe; they had an audience with Louis XVI and Marie-Antoinette, whose portrait the Draughtsman obligingly sketched.[12] (According to another version of the story, the Draughtsman was supposed to sketch the profile of the late Louis XV, but Leschot in his nervousness set up the machine wrong, so that it sketched "mon toutou," a little dog, instead.)[13]

The second automaton featured in Voskuhl's book is a dulcimer player built in the principality of Neuwied, not far from Cologne, by a cabinetmaker named David Roentgen together with a clockmaker named Peter Kintzing. Roentgen gave the automaton as a gift to Marie-Antoinette in 1785 and it is now at the Musée des arts et métiers in Paris. Voskuhl selected the two automata to write about, she explains, in order to examine a host of relations, including those among the mechanical arts, early industrialism, the "human–machine boundary," music making and associated "techniques of representation, expression, and subject-formation"; the "culture of sentimentality"; an Enlightenment "practice of self-reflexivity in which feeling subjects were supposed to find and experience themselves"; and more generally efforts "to constitute new types of selfhood in a new type of society" (5, 7, 13).

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Alec Reid (Geneva, 1958), 280–81; and Pierre Jaquet-Droz, *Les oeuvres des Jaquet-Droz: Montres, pendules et automates* (La Chaux-de-Fonds, 1971). On the Jaquet-Droz family see also Charles Perregaux and François-Louis Perrot, *Les Jaquet-Droz et Leschot* (Neuchâtel, 1916); Chapuis and Droz, *The Jaquet-Droz Mechanical Puppets* (Neuchâtel, 1956); and Roland Carrera, Dominique Loiseau, and Olivier Roux, *Androïdes: Les automates des Jaquet-Droz* (Lausanne, 1979).

11 See Perregaux and Perrot, *Les Jaquet-Droz*, 31–4. On the Musicienne's performance see also Richard Daniel Altick, *The Shows of London* (Cambridge, 1978); Simon Schaffer, "Enlightened Automata," in William Clark, Jan Golinski, and Simon Schaffer, eds., *The Sciences in Enlightened Europe* (Chicago, 1999), 126–64, 138; and Chapuis and Droz, *Automata*, 280–82. I have discussed the Jaquet-Droz automata in Jessica Riskin, "The Defecating Duck," *Critical Inquiry*, 20/4 (Summer 2003), 599–633; and in Riskin, "Eighteenth-Century Wetware," in *Representations*, 83 (Summer 2003), 97–125.

12 Louis Petit de Bachaumont, *Mémoires secrets pour server à l'histoire de la république des lettres en France depuis MDCCLXII jusqu'à nos jours*, 36 vols. (London, 1777–89), 7: 323; Chapuis and Gélis, *Le monde des automates*, 2:192; and Paul Metzner, *Crescendo of the Virtuoso: Spectacle, Skill, and Self-Promotion in Paris during the Age of Revolution* (Berkeley, 1998), 171.

13 Perregaux and Perrot, *Les Jaquet-Droz*, 110–11.

Voskuhl's approach is to raise questions about the relations among these many features of the later eighteenth century rather than to offer answers. She presents the argument of the book as a series of related questions, for example: "I argue based on my readings that piano-playing women automata raised questions not only about whether humans had become 'like' machines in the modern age, but also about whether the initial formation of the modern subject—the one preceding its mechanization—was a real and reliable process" (13). Refraining from answering the unanswerable, Voskuhl concludes her study with the same question rephrased: "The women automata's performance thus asks whether the process of subject-formation is 'real' or merely 'mechanical' and fake" (192).

Voskuhl makes an exception to this general stance of questioning rather than answering, by at intervals pressing a particular answer, namely that despite a tendency she identifies among historians to represent eighteenth-century automata as serving "primarily epistemic functions," in fact these machines were meant instead "to perform a specific cultural body technique." Moreover, Voskuhl argues, the notion that the automata served epistemic functions is undermined by her findings that the "manufacture and display of androids was a strenuous mechanical, economic, and cultural affair in the eighteenth century. The automata had to be produced with considerable investment of time, money, and skill, often for capricious and obscure markets" (17, 21 n.). But, assuming that "epistemic" means roughly "scientific," wasn't the same thing true of all early modern scientific endeavors? They all required investments of time, money, and skill and they all relied upon a market of one kind or another. One could even say the same of present-day science.

Moreover, as historians of science of the past couple of generations have documented extensively, scientific endeavors in the early modern period were inseparably blended with all other forms of cultural activity—artistic, literary, dramatic, musical, popular, courtly—and vice versa. Voskuhl's androids embody precisely the inseparability of the various elements of Enlightenment society and culture that she canvasses: machinery, music and music making, cultural assumptions about women, the economics of early industrialism, patronage and commerce, philosophical worries about what constitutes a human self, popular science, anatomy and physiology, acoustics . . . and the list could go on. To insist upon a cultural rather than epistemic (scientific?) purpose for the automata—isn't this to assume, with the old-school intellectual historians, that the two categories are perfectly distinct, and that any project must fall squarely into one or the other? It seems an old-fashioned assumption and one undermined, in fact, by Voskuhl's skillful and comprehensive portrait of these two complicated and dynamic machines.

False dichotomies (nature/artifice, organic/mechanical, cultural/epistemic) are a running theme throughout these works. They recur in John Tresch's

https://doi.org/10.1017/S1479244314000432 Published online by Cambridge University Press

*The Romantic Machine* from its title onward. The book presents the world of "romantic mechanism" that flourished during the first half of the nineteenth century, centrally in France. Tresch introduces the "romantic machine" by its contrast with the "classical machine." Whereas a classical machine, for example a clock, lever or balance, was but a "passive transmitter of external forces," romantic machines moved by means of internal forces such as steam, electricity or magnetism (12).

Here one might note that the source of power and motion in a machine, the decision about whether it is internal or external, depends largely on how you look at it. Leibniz's view of a clock, described above, assigned the clock an internal agency. Conversely, one could, and people certainly did, describe steam engines and electromagnetic devices as passive instruments of externally determined forces. (Moreover, if some saw classical machines in romantic terms and vice versa, it also means that the two forms of mechanism—classical and romantic—existed in dialectic from the start, from the mid-seventeenth century onward, succeeding one another in periods of greater dominance.) But this observation I think ultimately strengthens rather than undermines Tresch's essential contrast, which is between romantic and classical mechanism rather than between a clock and a steam engine. Advocates of classical mechanism favored clocks and telescopes while proponents of Tresch's romantic mechanism preferred steam-driven and electromagnetic devices, but their basic difference was one of philosophical outlook.

Why, for example, Tresch asks, did the physicist and mathematician André-Marie Ampère, author of devices to demonstrate the equivalence of electricity and magnetism and to measure their force, consider electromagnetism a material phenomenon and not an immaterial form of mind or soul (31)? One answer: Ampère had a romantic commitment, Tresch shows, to the idea that all things in nature were fundamentally united, and that the unity of nature had a material basis. Ampère's stance was a form of "transcendental materialism," in Anson Rabinbach's aptly oxymoronic phrase.[14] Ampère was further convinced that electricity would provide such a material substrate for nature's unity. This romantic materialism meant that force, action, and agency must be integral to the material world rather than something apart (chap. 2).

Romantic ideas about the material oneness of nature, and the integral part of human beings in this cosmic unity, served the Prussian explorer and naturalist Alexander von Humboldt in his establishment of a new ideal of science as the

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14 Anson Rabinbach, *The Human Motor: Energy, Fatigue, and the Origins of Modernity* (Berkeley, 1992), 92.

https://doi.org/10.1017/S1479244314000432 Published online by Cambridge University Press

basis for national and even global social unity (chap. 3). Humboldt's close friend, the astronomer and politician François Arago, adopted Humboldt's vision of a dynamic and unified cosmos, including human material existence and experience. Like Humboldt, Arago saw scientific knowledge as physical participation in natural processes, an epistemological stance that Tresch dubs the "labor theory of knowledge" (chap. 4). Arago promulgated an instrument that he took to embody this form of knowledge, the daguerreotype (named for its original inventor, L.-J.-M. Daguerre), an early form of photography using a silver-coated copper plate set into a camera obscura. The daguerreotype, as Arago construed it, rendered visible the invisible connections among all things in nature: light, chemicals, silver. It did so by actively participating in the great interaction, allowing the viewer to see not only the objects represented on the plates, but those objects' invisible connections to the cosmos and to the viewer.

The technological antics of popular science, such as Etienne Gaspard Robertson's Fantasmagoria, which included electrical equipment, a glass harmonica, and images projected by a magic lantern, popularized the romantic–mechanist view of scientific instruments. Accordingly, these instruments became a way to participate in the dynamic, invisible, all-encompassing cosmic interaction (chaps. 5–6). In the book's final chapters, Tresch pursues romantic–mechanist ideas about nature, science and human experience into social theory with chapters on Saint-Simonianism, the early socialism of the printer and literary critic Pierre Leroux, and the foundations of sociology in the work of Auguste Comte. In each instance, the romantic–mechanist vision of the cosmic, material unity of nature informed emerging ideas about social unity and its basis in science and technology.

To Tresch's protagonists—philosophers, practitioners of science, social theorists, and innovators of the Romantic era—there was no opposition between sentiment and intellect, knowledge and emotion, machine and nature, objects and subjects, science and humanities. They imagined human beings as participating, body and mind, in a general, progressive transformation of the world. Their romantic mode of mechanist science, as Tresch exhibits it, represents a moment of possibilities, and these possibilities, in turn, a path not taken, or at least a path obscured by the currents of history. The "possible worlds" and "alternative modernities" that Tresch reveals all involve "putting human consciousness back into the world picture" (25–6).

A recurring figure in Tresch's story is Jean-Baptiste Lamarck, author of the term "biology" and of the first full theory of species-change. Although he appears at intervals throughout, Lamarck is not a principal figure in the book, though he really could have been, so perfectly does he embody the path-not-taken of romantic mechanism. In Lamarck's case, it was a path quite deliberately

https://doi.org/10.1017/S1479244314000432 Published online by Cambridge University Press

forbidden by neo-Darwinists around the turn of the twentieth century.[15] Lamarck described living beings as dynamic, vital, organic, self-constituting machines, active participants in the material continuum of nature. Through their active participation, very gradually, over long periods of time, organisms made and remade themselves. Lamarck's vision of living machines not only as self-moving, but also as self-producing and self-transforming, violated the neo-Darwinist model. Neo-Darwinists insisted upon the passivity of organic machinery, having inherited their model from natural theology, as epitomized in William Paley's watch on the heath. In other words, the neo-Darwinist view was classical mechanist, whereas Lamarck's view, in Tresch's terms, was romantic–mechanist.

Indeed, Lamarck is a good place to end, since he epitomizes phenomena at the heart of each of the three books in turn: Leibniz's "philosophy of biology," the material and mechanical constitution of selfhood, and the "alternative modernity" that would have put mind back in nature. These three themes, and the three books they animate, together indicate a possible world: an early modern, scientific, philosophical, and cultural possible world. This world featured the possibility that the cosmos was all made up of living machinery, and that human beings constituted their fully material selves through romantic collaboration in the great, cosmic, mechanical interaction.

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15 I develop these points fully in *The Restless Clock*, forthcoming, and in two forthcoming articles, "How the Mouse Lost Its Tail" and "Lamarck's (More) Dangerous Idea."