

Introduction:

Dilemmas of a Modern Machine-Man

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[working draft]

If you are like many people, you likely hold two seemingly quite contradictory convictions about yourself: first, that you are essentially an organic machine, a fully material entity composed of myriad complex moving parts; and second, that your essence, your individual personhood, is something definitively irreducible to any mechanical system. Although these two convictions seem diametrically opposed, this book shows that they are in fact deeply, historically and philosophically connected to one another. The machinery conception of life and intelligence and the not-machinery conception emerged together, in mutual dependence, in the seventeenth century; they have developed together in dialectical engagement; and they are by now as profoundly and thoroughly entangled as two such seemingly opposite ideas could get.

This book, in other words, presents the history of a modern contradiction. Ever since the Scientific Revolution of the seventeenth century, the sciences have cast living creatures, including human beings, as both *machines* and *not-machines*. We continue to view human beings in both ways simultaneously, without explicitly noticing the contradiction. This contradiction has therefore acted (often fruitfully, for contradictions can be fruitful) at the very heart of modern thinking about what life is, what a human being is, and what a scientific explanation of these should look like.

To be a *machine* has meant to be made up of a system of material parts and, as such, to be fully explicable in the same terms that a clock or harpsichord or steam engine is explicable. This model of a living being is tightly connected with a core ideal of modern science, namely that a scientific explanation must not attribute will or agency to natural phenomena. For example, this rule would disallow explaining the falling weight that drives a clock by saying that the weight wants to move closer to the center of the earth, or explaining the expansion of steam in a steam engine by saying that the steam intends to move upward toward the heavens. This ideal of modern science, in other words, assumes a passive machine-world devoid of agency. Assuming that living beings are part of nature, according to this model, they, too, must be rationally explicable without appeal to intentions or desires, agency or will.

One core argument of this book is that this mechanist model of science, with its accompanying mechanical model of living creatures, relied crucially, as it was developing between the seventeenth and nineteenth centuries, upon an accompanying *theology*: the argument from design. A purely passive artifact-world devoid of agency, after all, cannot stand on its own as a plausible account of living nature. It only makes sense if one outsources perception, will and purposeful action to a divine Designer. A central principle of modern science, to reduce natural phenomena to interactions of material parts, which generated the most reductively machine-like accounts of living beings, depended fundamentally upon a theological notion, the divine Engineer. This mode of science, let us call it theological mechanism, gave rise in turn to a core principle of modern biology, the notion of physiological adaptation or fitness, examples of which provided the main evidence for authors of arguments from design.

At the same time, however, practitioners of the sciences were laboring to redefine science as essentially distinct from theology. If one wanted to disallow appeals to a supernatural god, and make the sciences rigorously independent of theology, then passive machinery would not work as a model of living nature. One needed a different model, one that would naturalize the very things that the argument from design outsourced: perception, will, purpose, agency. These all had to be integral to the natural world and its creatures.

Hence, the model of living beings as *not-machines*. Or better, as a *different kind of machine*: an essentially and intrinsically active, purposeful, sentient, perceptive machine. Those who rejected the argument from design, and believed agency and perception must have natural rather than supernatural origins, viewed not only living creatures but the entire machinery of nature as *active machinery*. The title of this book and of Chapter Four, “The Restless Clock,” comes from a passage that epitomizes this active view of machinery, both natural and artificial. The German philosopher, mathematician and inventor Gottfried Wilhelm Leibniz wrote this passage as he was struggling to find a different model for nature and science than the passive machinery of his contemporaries. He described clockwork and, by analogy, human beings in surprising terms: “In German,” he wrote, “the word for the balance of a clock is *Unruhe* – which also means disquiet; and one can take that for a model of how it is in our bodies, which can never be perfectly at their ease.” The balance of

a clock was in a constant state of agitated motion, as Leibniz saw it, and so too were human bodies.

To be an *active machine*, then, has meant to be essentially and intrinsically forceful, restless, purposeful, sentient, perceptive. During the same period that saw the establishment of materialist, mechanist principles in science, which excluded appeals to agency, scientific accounts of living beings in fact increasingly represented these as defined by their agency. Scientific accounts of life, in other words, were in a productive state of contradiction with a governing principle of natural science. A living being became, essentially, an agent: an entity capable of perception, intention and purposeful action.

A crucial part of this scientific picture of living beings as active machines, restless clocks, was that life had to be self-creating: its structures had to emerge genetically, in the root sense of being self-generating, from within rather than being imposed from outside. Thus the first developmental accounts of living nature, describing species as emerging and transforming themselves over time, arose in the context of this struggle to naturalize agency, making it a part of nature's machinery, rather than outsourcing it to a divine designer.

In sum, we have two competing models of life attached to two competing models of science. These developed in dialectical engagement with one another, each defining itself in relation to the other. And both gave rise to foundational concepts in our current scientific understandings of life.

Our story begins before this contradictory state of affairs, when people regarded machinery – both nature's machinery and artificial machines such as clocks – in very different terms. **Chapter One, Machines in the Garden**, tours the surprising world of lifelike machines of late medieval and early modern Europe. These *automata* (mechanical figures of people and animals, literally “self-moving machines”) started in churches and cathedrals. The Catholic church was the leading sponsor of a sort of artisanal ancestor to robotics. The modern idea of animals and humans as machinery also originated in Catholic writings of this period. These writings assumed a continuity of matter and spirit, so that machinery – whether natural or artificial – was at once material and inspirited, with no opposition between the two. From churches and cathedrals, automata spread to the palaces and gardens of wealthy estate-owners. These machines were anything but “robotic” in the current

sense: they were responsive, spiritual, surprising, funny, bawdy, messy. It was a culture, in other words, of lively machines and an accompanying philosophical notion of animal- and human machinery as intrinsically active.

This was the background against which the French philosopher and mathematician René Descartes wrought his philosophical revolution. **Chapter Two, Descartes in the Grottoes**, follows how Descartes acted upon this older culture of machinery, in which machines were active, responsive, even sentient things. Hoping to achieve a newly exhaustive, rational account of nature – including living bodies – Descartes drained soul from matter. Henceforth, he said, we must consider the natural world simply as bits of matter in motion. These bits of matter move only when they are moved by other bits: they have no intrinsic tendencies, desires, will or purpose. Descartes's goal was to achieve a kind of complete intelligibility: to make all of nature fully explicable. The result, though, was to leave a passive machine-world on one side of the divide and a spiritual realm of pure agency – absolute, infinite, immaterial souls – on the other.

Evacuating spirit and agency from nature's machinery left a brute world: rote, inert, passive. Descartes drew the line straight down the middle of human beings: their bodies occupied the world of brute machinery, while their selves – their rational souls – were immaterial, transcendent things in the realm of spirit. **Chapter Three, Me and My Machine**, examines how the passive-machine model of human bodies and the infinite, transcendent model of human selfhood arose together, each defined in relation to the other. A mostly Protestant theological program, the argument from design, propelled the evacuation of agency to a supernatural position outside the material world. The result was a kind of marionette-mechanism, which could only work if one was willing to posit a Puppeteer. The modern biological concept of physiological adaptation – a mechanical fitness of parts – emerged in this theological-scientific tradition.

Some, however, were not willing to endorse a model of life, and of science, that relied upon appeals to a supernatural god. They are the protagonists of **Chapter Four, The Restless Clock**. Leibniz and others in physiology and natural philosophy struggled to hold mechanism and agency together, to describe a purposeful machinery of nature that could encompass life and mind, and to establish modern science on a different path. This alternative model of science would be fully naturalist in the sense that it would not rely upon a supernatural god and would leave nothing – neither

mind, nor force, nor agency – out of nature. Living creatures, including human beings, on this model were not made of passive machinery attached to infinite immaterial souls, but rather of intrinsically active and purposeful machinery.

The first androids – automata that closely simulated the movements and functions of living creatures – arose in the midst of this struggle between competing models of life and scientific explanation. **Chapter Five, The Birth of the Android**, examines the emergence and culture of androids (the word “android” was coined in the seventeenth century but came into common usage with the actual androids of the mid-eighteenth) and the ways in which this culture reflected the two competing models of living machinery. The androids of the mid-eighteenth century walked, talked, breathed, bled, played musical instruments, wrote messages, drew pictures, ate, digested, even shat. They dramatized the increasingly fraught scientific and philosophical question regarding the relations of agency to machinery and what could count as a scientific theory of life.

These androids fueled a further phase of the conflict. The French philosopher and maverick Julien Offray de La Mettrie, author of the bestselling manifesto *Man a Machine*, and others of his generation prominently invoked the androids in their efforts to defeat the reigning model of human beings as passive bodily machinery attached to infinite, immaterial souls. **Chapter Six, The Adventures of Mr. Machine**, examines La Mettrie’s mission to re-embodiment the human soul, to drag it down to the very “mud.” Getting himself in trouble with the French court, and then again in the relatively tolerant Netherlands, La Mettrie finally took refuge at the court of the materialist-loving Emperor Frederick the Great of Prussia before dying prematurely of poisoning. All the while, La Mettrie was out to persuade his contemporaries that every feature of mind or soul was a purely a function of bodily machinery. His reasons, and those of his fellow-travelers, were primarily moral: to humble the Cartesian, imperial self by showing that human beings were integral to the material continuum of nature. In so doing, this generation of active-mechanists produced some of the first theories of transmutation of species, treating living forms as developing and changing over time.

The Enlightenment man-machine was a humble part of the greater machinery of nature. At the same time, he was so powerful as to be capable of self-constitution: he was his own creator. The android-human was rationally intelligible on the model of mechanist science, but also intrinsically active and sentient. He was, in short,

essentially contradictory: a passive machine whose essence was agency. This paradoxical creature had momentous moral and social implications, which are the subject of **Ch. 7, The Morals of Mr. Machine**. The man-machine model provided a basis for new classifications of human beings into social and moral categories, and new understandings of human essence and variety. It also became a core point of reference for theories of how human creatures develop into members of civil society and how to shape this process through education.

At the turn of the nineteenth century, human- and animal-machines remained abroad in the land, ubiquitous in literary, philosophical and scientific writing, but with an important difference. The Enlightenment man-machine now gave way to a moving corpse. A macabre preoccupation with androids, cast repeatedly in Romantic writing as deathlike monsters, represented a core feature of the Romantic movement. These ghastly creatures were the literary and aesthetic coming-to-a-head of the intensifying contradiction between competing models of life and science. **Chapter Eight, The Death of the Android**, treats the scientific, literary and aesthetic response to this crisis. The Romantic period was characterized by a remarkable intimacy between poetry and science. While poets did electrical experiments and attended chemistry lectures, physiologists and physicists wrote poetry and, indeed, often presented their scientific findings in poetic form. Poets and physiologists were driven together by a shared sense that the established rules of science were in deep conflict with the developing sciences, especially the sciences of life. Out of this struggle and the poetic science it generated came a genetic (again, in the root sense of “self-generating”) approach to understanding the mechanisms of life

Charles Darwin incorporated both contradictory models of living creatures – as adapted systems of material parts and as self-creating and self-transforming agents – into his theory evolution. But he did not do so by resolving the contradiction. Rather, he did so by anguishing over it. **Chapter Nine: Darwin’s Fertile Dilemma** is about his tremendously productive process of anguishing. While Darwin adopted the notion of mechanical fitness of parts, he rejected the divine designer on naturalist principles. And while he adopted the notion that living forms transformed themselves over time, he rejected the ascription of agency or will to these forms on mechanist principles: a scientific explanation did not ascribe purposeful action to the phenomena it was meant to explain.

If evolutionary biologists today continue to be at daggers drawn over the question of purpose – if and when one can explain living structures in terms of purposes, and what constitutes an unscientific ascription of agency to natural phenomena – it is for good reason. The contradiction is built right into the foundation of their discipline: living creatures as passive machines in the notion of physiological fitness, and living creatures as agents in the notion that their forms emerge from within rather than being imposed by an external designer. The **Epilogue, Legacy of a Contradiction**, examines how the dialectical engagement we have followed between two opposing models of life continues to shape biological, philosophical and cybernetic discussions of the nature of life and mind.

Along the *Route de l'Horlogerie* (The Clockmaker's Way) through the Jura Mountains in Switzerland, mechanical creatures two and three centuries old remain in the alpine villages where they were first created, attended by curators and watchmakers who are often the direct descendants of the original builders. I traveled there in the course of writing this book. Among the clockwork beings I encountered is a peasant teaching his pig to hunt truffles.¹ Holding a truffle in one hand, and his pig on his opposite knee, the peasant is apparently in the midst of explaining that one finds a truffle by its smell. Raising the truffle to his nose, he inhales, shakes his head from side to side, and simultaneously closes his eyes, giving an irresistible display of sentience. Watching this and other machines, I have been struck by their sheer *persuasiveness*. They seem, astonishingly, to reduce consciousness to a combination of movements. But, of course, they don't.

At home at the Massachusetts Institute of Technology, and later at Stanford, I began to visit the Truffle-hunter's modern descendants: Cog and Kismet, Rodney Brooks's and Cynthia Breazeal's creations at the MIT Robotics Lab; Romeo and Juliet, Oussama Khatib's creatures at the Stanford Robotics Lab. They too have an unsettling aura: Cog swivels to seek out a new voice in the room; Kismet projects happiness and sadness, amusement and interest, by means of exaggerated, cartoon-like facial expressions. If such artificial creatures ever do have life and consciousness, Brooks says, it will be by means of an imposed design, but rather

¹ Gustave Vichy, *Le Paysan et son Cochon*, circa 1890. On Vichy, see Christian Bailly, *L'Age d'or des automates, 1848-1914* (Paris: Editions Scala, 1987), 63-112.

through a process mechanical evolution, which will generate an as-yet unknown “new stuff,” he also refers to it as “the juice,” something emergent that will explain perception, evolution, cognition and consciousness.

These machines and the scientific and philosophical conversation surrounding them have their roots in a centuries-long contradiction that, though never resolved, is continually fruitful. What follows is the genealogy of this productive contradiction at the heart of modern science.

Chapter Six:

The Adventures of Mr. Machine

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With the chattering, sighing and singing of the androids sounding in their ears, a rising generation of writers took up the notion of living machinery. The result of their labors was the Enlightenment man-machine, a hypothetical figure who oriented his century's moral, social and political discussions.

The Enlightenment man-machine represented a kind of climax of attempts to escape the predicament in which Descartes and his fellow travelers had left their successors. They had banished mind and agency, as we have seen in Chapters One and Two, from the natural world. This banishment had made possible the conjoined Cartesian models of science and human selfhood: science as the exhaustive, rational account of a passive, artifact-world; the self as that transcendent, unlimited being who alone could be capable of such an account. These models held a kind of sway even as people increasingly explicitly rejected them. Most people, indeed, during the first decades of the eighteenth century, moved away from the austere mechanism of the previous period, and as we have seen, Descartes's radical disembodiment of the human soul had provoked objections from the first. Nevertheless, the models retained a crucial power.

The first remained as a sort of regulating ideal of intelligibility in science: an abiding sense that agency and purpose should play no role in scientific explanations (except, of course, an external, divine agency) else the result would be not science but occult nonsense. The second model remained as a consuming preoccupation with Descartes's foundational question, "What is it that I am?"ⁱ accompanied by a conviction that, to paraphrase Rousseau's Savoyard vicar, space is not my measure, the whole universe is not big enough for me.ⁱⁱ

In order to coexist in harmony and coherence, these two regulating ideals of science and human selfhood required a dualist world with a supernatural God. Enlightenment heirs to Descartes were unwilling to strike such a bargain. They

wanted to achieve something tantamount to squaring the circle: to make Cartesian selfhood an object of Cartesian science by incorporating the infinite self into a material, mechanical body.

The Enlightenment man-machine was thus a creature of mixed parentage. It took certain key features from Descartes, but radically rearranged these: like Descartes's body-machine, the Enlightenment android was a rigorously material, rationally explicable piece of mechanism; and like Descartes's rational self, the conscious entity associated with it was a limitless and all-encompassing "I"; but the bodily mechanism was now meant somehow to encompass the infinite self. Meanwhile, from Leibniz's restless-clock model of human beings, the Enlightenment android inherited some other crucial characteristics: inner agency, activeness, organization. The result was an unfathomable creature, composed out of oppositions.

Moreover, this creature born of a contradiction was important: androids provided the Enlightenment with core test cases, models and thought experiments for assessing the defining features of humanness and their relations to one another. The axiom that people were constituted of machinery, began life devoid of any ideas or qualities, and became both selves and social beings through bodily sensations alone directed ambitious programs for social and political reform during the second half of the eighteenth century. Revolution-era programs of civic education in France, informed by earlier pedagogical reformers, principally Rousseau, promoted abandoning books and traditional lessons, and instead molding children into citizens by carefully manipulating their senses.ⁱⁱⁱ Moralists such as Benjamin Franklin and David Hume proposed radical educational schemes assuming that a child's moral development was determined by two physical (mechanical) tendencies, namely avoiding pain and seeking pleasure.^{iv} At the hands of the eccentric Londoner, Jeremy Bentham, this principle became the basis of utilitarianism, which made the maximization of pleasure and minimization of pain the ultimate purpose of civil society.^v

Reformist schemes such as these gave the idea of human machinery a radical reputation. And yet, although he cut a flamboyant, polemical figure, the Enlightenment man-machine also expressed a certain reactionary impulse: to tame the imperial, rational self unleashed by Descartes and his contemporaries, to bring it right back down to the ground. In one sense, to be sure, those who embraced and developed the man-machine idea in the eighteenth century continued what Descartes

had begun: they carried the *bête-machine* to its logical extreme, encompassing even the human rational soul.^{vi} These writers cast Descartes as a closet materialist and persuaded their generation of this dubious claim. Odd stories began to circulate, such as the anti-materialist fable that Descartes had built a perfect automaton replica of his dead daughter, Francine. According to the tale, he had been inseparable from it, sleeping with it in a trunk by his bedside, until during a crossing of the Holland Sea in the 1740's a suspicious ship captain had discovered it and thrown it overboard.^{vii}

But in another, at least as important and less explored sense, the Enlightenment authors of the man-machine reversed Descartes, undoing Descartes's more dangerous idea: the stark removal of the human soul from the bodily world.^{viii} Reacting against the disembodiment of the human self, Enlightenment materialists traveled to the opposite extreme. They snatched the soul from the heavens and drove it into the very earth, making of it a "*soul of mud*."^{ix} Their man-machine was a rebuke to the rationalists: a denial of the transcendent and omnipotent intellectual self that rationalists ascribed to humans, above all, themselves.

Perhaps it will sound surprising to suggest that those who most urgently pressed the idea of the human-machine in the eighteenth century were driven by a primarily moral purpose, these polemicists who have appeared in historical writing not only as anti-clerical, but as "immoralist" and "anarchic" hedonists who liked to celebrate in print every sexual possibility from masturbation to bestiality (§1. **Mr. Machine and the Imperial Me**).^x But neither anti-clericalism nor lasciviousness, after all, actually constitutes moral anarchism and, moreover, neither stance was specific to the materialists; deists and other theological moderates shared both.^{xi} A different moral purpose did distinguish the materialist man-machine advocates, however, and that was anti-rationalism (§2. **The Mole-Machine**). They, more decisively than any of their contemporaries, were bent on humbling the Cartesian imperial self, leashing the unmoored "me," curtailing the authority of reason and restoring to Nature her eternal mysteries. In this sense, partisans of the human-machine model in the Enlightenment were not only moralists but also proto-Romantics.

Here, then, is a perhaps counterintuitive argument of this chapter: the view of human beings encapsulated in the Enlightenment man-machine was as much anti-rationalist as rationalist, proto-Romantic in its celebration of sensory and emotional experience and mystery, and also deeply moralized.

A momentous development, moreover, rode onto the scene beneath this surprising creature's flashy cloak. Thrusting the arrogant human "I" into the material continuum of nature, the Enlightenment man-machine opened a new conversation about just where and how it fitted in. Embarking on this conversation, the author of the original, definitive man-machine produced some glimmers of a modern theory of evolution, but one that exhibited dramatic differences from its nineteenth-century successors (§3. **Machine-lets and Little Organizations**). Here was a radically materialist, overtly moralized and starkly non-progressive form of evolutionism.

With its author's checkered tale, our chapter begins.

1. Mr. Machine and the Imperial Me

In the autumn of 1744, in the throes of the War of Austrian Succession, having entered into a secret alliance with Frederick the Great of Prussia, Louis XV laid siege to the city of Freiburg. During the siege, a young medical officer named Julien Offray de La Mettrie, who was attached to a regiment of the Gardes Françaises, contracted a raging fever. As Frederick the Great, soon to become La Mettrie's protector and patron, later told the story, "[f]or a philosopher an illness is a school of physiology." Being of a philosophical bent, the delirious doctor seized the occasion to observe the effects of fever on mental function. "[H]e believed he could see clearly that thought is but a consequence of the organization of the machine, and that the disturbance of the springs has considerable influence on that part of us which the metaphysicians call the soul."^{xii} Perhaps thinking of Descartes's story of the fateful dreams that had revealed his own philosophical destiny while he was a young soldier at war,^{xiii} Frederick related, with or without irony I leave to the reader to judge, that La Mettrie had taken his intellectual direction from this early moment of delirium.^{xiv}

Even in the pink of health, La Mettrie was apparently hot-headed. "Tumultuous and open-mouthed" is how Thomas Carlyle described him, with a "*minimum* quantity" of discretion.^{xv} Born and raised in the port city of Saint-Malo, Brittany, the son of a wealthy textile merchant, La Mettrie was an inveterate polemicist. During his convalescence and afterward, he pursued the idea that machinery was the basis of thought and "found only mechanism where others had supposed an essence superior to matter."^{xvi} Persuaded that thought must be a bodily function, La Mettrie audaciously said so in his first philosophical work, *L'Histoire naturelle de l'âme* (1745). When the Paris Parlement condemned this book to be

burned by the public executioner, La Mettrie prudently left for Leiden. Once there, however, he imprudently went back to work on developing his idea. Illness, after all, was not the only example of the influence of physical upon mental states. La Mettrie compiled a long list that included the mind-altering power of opium, wine, coffee, sleep, pregnancy (with its “frightful schemes”), age, climate, weather, hunger (“The power of a meal!”) and of course lust, “that other frenzy of Man or Woman ... hounded by continence and health.”^{xvii}

Reciprocally, La Mettrie also considered the effects of mental upon physical states. Why, for example, he mused, “does the sight or the mere idea of a beautiful woman cause such singular movements...?” The response of “certain organs” to the simple thought of womanly beauty demonstrated beyond a doubt, La Mettrie reckoned, the intimate connection between the imagination and the muscles. The imagination had the capacity to excite a sequence of springs in the body, he supposed, and “how can this be, if not by the disorder and tumult of the blood and spirits that gallop with extraordinary promptitude and swell the hollow tubes?”^{xviii} Seized thus by the idea of human machinery, La Mettrie ejected his most important work, *L’Homme-machine* (1747). Though no longer ill, he had a feverish style, as even his champion acknowledged: “he wrote his *Man a Machine* or rather,” amended Frederick, “he put on paper some vigorous thoughts about materialism, which he doubtless planned to rewrite.”^{xix}

These vigorous thoughts included the announcement that soul was but “a vain word” signifying “that part that thinks,” namely the brain. This organ, in turn, had “muscles for thinking as do the legs for walking.”^{xx} With his customary mixture of serious and mischievous intentions, and to the great consternation of his beneficiary, La Mettrie dedicated his philosophical hot potato to the Swiss physiologist, poet, novelist, political theorist and theologian, Albrecht von Haller. The two were exact contemporaries and both had studied with Hermaan Boerhaave, botanist, doctor and mechanist philosopher at the University of Leiden.^{xxi} But, in contrast with La Mettrie’s ostentatious materialism, Haller was a Calvinist and a temperamental as well as a doctrinal moderate.^{xxii} The two intellectual offspring struggled over the legacy of their carefully ambiguous father: Haller construed Boerhaave as a devout dualist while La Mettrie made him an unflinching materialist.

At the time, Haller was poised to unleash a controversy by presenting the core idea of his physiology, first in lectures and then in print, which was an identification

of two capacities of animal tissues. The first, “irritability,” was specific to muscle tissues: it was the capacity to contract in response to stimulus, and Haller viewed it as the basis of animal motion. The second capacity, “sensibility,” resided in the nerves.^{xxiii} Irritability and sensibility were versatile ideas: they lent themselves to exploitation by both vitalists, who saw evidence of a special, animating force in living matter, and materialists, who saw support for the explanatory reach of matter alone.^{xxiv} Haller vehemently rejected both camps. Although he called himself a mechanist and saw physiology as the “description of the movements by which the animal machine is activated,”^{xxv} he also believed in an immaterial soul and styled himself a scourge of atheists and materialists. La Mettrie, whose philosophy was a blithe combination of vitalism and materialism, invoked irritability and sensibility in the service of both at once; indeed, he anticipated Haller in his discussion of muscular irritability in *L’Homme-machine*.^{xxvi} In short, while Haller was fending off vitalists on one flank and materialists on the other, La Mettrie, with his dedication of *L’Homme-machine*, neatly planted a thorn in each.

The manifesto was too hot even for Holland, and went the way of its elder sibling, to a ceremonial burning in the city square by the public hangman.^{xxvii} It survived this execution handily, however, provoking one of the defining controversies of the accelerating Enlightenment and becoming a fulcrum of philosophical debate.^{xxviii} The banished author, too, landed on his feet, at Frederick’s court in Berlin. There he played a mixed role, officially the monarch’s reader but equal parts gadfly and fool.^{xxix} He affected a great familiarity with the emperor, not hesitating to “throw himself down and stretch out on the couches. When it was hot, he opened his collar, unbuttoned his vest, and threw his wig on the floor.”^{xxx} Frederick, for his part, hated to be parted from La Mettrie, who played with him and made him laugh,^{xxxi} thereby inspiring much envy. Carlyle’s unflattering characterization, indeed, relies on the accounts of jealous rivals for Frederick’s attention, especially Voltaire.

La Mettrie had discovered the limit of the Voltairean sense of humor with a bit of either oblivious gaucherie or well-aimed malevolence. He had told Voltaire that Frederick had remarked of him, “I will want him another year, at most; you squeeze the orange, you throw away the skin.” The orange-skin affair tormented Voltaire: “should I believe it? is this possible? What! after sixteen years of kindnesses ... I sacrifice everything to serve him ... a king ... who told me that he loved me ... it is beyond me.”^{xxxii} Although he struggled not to believe it, “I am still dreaming of the

orange-skin,” Voltaire lamented, “... I am afraid I am like those cuckolds, who force themselves to think that their wives are very faithful.”^{xxxiii} Voltaire’s orange-skin is representative: by the same quality of outrageous ineptitude or malign cleverness, or likely a potent alchemy of the two, La Mettrie penetrated as deeply La Mettrie penetrated as deeply under the Enlightenment’s collective skin.

In his three short years at Frederick’s Berlin court, La Mettrie was a whirlwind of activity. He elaborated his polemical philosophy in eight or ten more works and, at Frederick’s behest and to the chagrin of many of its members, secured election to the Prussian Royal Academy of Sciences.^{xxxiv} Meanwhile he cheerfully stoked the fires of controversy, joining in the fun *incognito* on his detractors’ side as well. A philosophy professor at Göttingen gave La Mettrie an opening by suggesting that the author of *L’Homme-machine*, if he were correct in his claims, would himself be a machine and therefore not responsible for the gibberish he produced.^{xxxv} La Mettrie delightedly accepted the soubriquet “Mr. Machine” and dashed out an anonymous, self-satirizing pamphlet describing the life and, more saliently, the death of this personage.

Having decided that opium was the secret to a machine’s happiness, Mr. Machine had met an untimely end by indulging in a good dose of rat poison. But one must not blame a creature equivalent to “the ducks of Mr. *Vaucanson* in *Paris*”: “Remind yourself, if you would, that this is *Mr. Machine*. A machine does not act as it likes, but rather as it must.”^{xxxvi} This mischievous piece of mystification contained a certain poignant clairvoyance and perhaps also an undercurrent of sorrow.

Despite his official jollity, the philosophical jester appears to have felt his exile keenly. “Reader to the king of Prussia though he may be,” Voltaire reported, “he burns to return to France. This man so gay, who passes for someone who laughs at everything, sometimes cries like a baby to be here.”^{xxxvii} Voltaire, who evidently would not have been opposed to La Mettrie’s repatriation, enclosed a letter from La Mettrie to Richelieu, asking that Richelieu obtain a pardon for him to return to France. But before the matter could be pursued, La Mettrie made an abrupt and suitably dramatic exit from history’s stage. “Our crazy La Métrie,” Voltaire wrote with ill-disguised satisfaction, “has just made up his mind to die.... I cannot get over my astonishment.”^{xxxviii}

La Mettrie had gone to visit the Irish Jacobite, Lord Tyrconnel, who acted as Louis XV’s ambassador in Berlin. Tyrconnel was unwell and had requested the

presence of the monarch's reader-*qua*-fool to cheer him. Arriving just as Madame Tyrconnel was sitting down to eat, La Mettrie, according to Voltaire, "eats and drinks, and talks, and laughs more than all the others; when he is full to the gills, they bring a pâté of eagle disguised as pheasant, sent from the North, and well mixed with bad lard, chopped pork and ginger. My man eats the whole pâté and dies the next day."^{xxxix} Contemporaries called it "indigestion"; historians have agreed upon "food poisoning"; but if Voltaire's account is accurate, then poisoning, *tout court*, seems as good a name as any. "Voilà, my hero, one of our farces carried out," was Voltaire's punning verdict to Richelieu, a *farce* being both a farce and a stuffing.^{xl} (Farcical too is that Voltaire was even still thinking of peeled fruit: "I would have liked to ask La Métrie, at death's door, for news of the *orange skin*. This good soul, on the verge of appearing before God, would not have been able to lie."^{xli})

The manner of the materialist's death instantly became a test of his principles. "There is now a great dispute," reported Voltaire, "to know whether he died as a christian or as a doctor." La Mettrie had been a good atheist to the end, according to Voltaire, begging to be buried in Tyrconnel's garden, but had been denied this final courtesy: "His body, swollen and big as a barrel, was carried, willy-nilly, into the catholic church, where it was astonished to find itself."^{xlii} La Mettrie's death by pâté allowed his delighted enemies to equate materialism with gluttony.^{xliii} On the other side, his supporters too were keen to attach their own moral to the parable. Frederick, in particular, scrupulously verified La Mettrie's steadfastness *in extremis* before undertaking to write his eulogy:

The king inquired very exactly about the manner of his death, whether he had gone through all the catholic rites, if he had had some sort of edification; finally he satisfied himself that the gourmand had died as a philosopher: *I am much relieved*, the king told us, *for the peace of his soul*; we started laughing, and he did too.^{xliv}

Another chronicler of Frederick's court, the bookseller and writer Christoph Friedrich Nicolai, told the story of La Mettrie's fabled demise rather more poignantly. According to Nicolai, Tyrconnel's chaplain, urged on by some enemies of La Mettrie who wanted to render him "contemptible" in Frederick's eyes, had "pushed into the sickroom." In this version of the story, too, the materialist moralist held fast and achieved, indeed, a form of heroism:

La Mettrie would have nothing to do with this Priest and his talk; who, however, still sat and waited. La Mettrie, in a twinge of agony, cried out ‘JESUS MARIE!’ ‘AH, VOUS VOILA ENFIN RETOURNE A CES NOMS CONSOLATEURS!’ exclaimed the Irishman. To which La Mettrie answered (in polite language, to the effect), ‘Bother you!’ and expired a few minutes later.^{xlv}

The stance to which La Mettrie apparently remained committed even to his death was not merely anti-Christian but also, I have been suggesting, constituted a positive moral program.

Let us now examine the core idea of this program: the inseparable implicitness of order, importantly including a moral order, and the individual human self to which it applied, within the material machinery of the world.

2. The Mole-Machine

An admirer of Vaucanson, La Mettrie flamboyantly described the body as “a clock,” and a “machine that winds itself.” He lingered over the “springs of the human Machine”: the spring of the entire body backwards in terror from the edge of a cliff; the blink of an eye at the threat of a blow; the expansions and contractions of the pupils, the pores of the skin, the heart, the lungs, and the sphincters of the bladder and rectum; and the heaving of the stomach when poisoned. He also considered admiringly how “the erector muscles raise up the Rod in man”: “there is a singular spring in this member,” La Mettrie marvelled, whose study had been shamefully neglected even in the present age of enlightened anatomy.^{xlvi}

Despite this talk of winding and springs, the living machinery that La Mettrie described was importantly different from the inanimate kind. Indeed, a considerable sleight of hand supported his insistence that humans were machinery to the core. With the audience distracted by talk of clockwork and rods on springs, La Mettrie deftly inserted a special “principle,” never found in any clock, and which made the whole thing go: “Grant me only that organized Matter is endowed with a motive principle,” he coaxed, “... eh! could one refuse that most incontestable Observation?” This motive principle lent living matter not only movement but also “sentiment,” a mix of sensation and feeling, which La Mettrie took to be essentially the same as movement.^{xlvii} This idea quickly and firmly took hold. Several decades later, Diderot

affirmed in his *Eléments de physiologie* (1784) that animal machinery was of another sort altogether from artificial machinery: “the laws of motion of sensible, animated, organized, living bodies have not even been sketched,” he maintained, and above all, these relied upon a property specific to animal machinery: “*sensibility*.”^{xlvi}

The man-machine was hence an erotic and passionate creature, coursing with sensations and emotions. “To be a machine,” La Mettrie wrote: “to feel, think, know how to distinguish good from evil like blue from yellow.” Emotions, moral instincts, an aesthetic sense: the man-machine had all of these and also, by the same token and no less mysteriously, a sex life: “who would ever have divined *a priori* that a drop of the liqueur that shoots forth during coupling would make one feel divine pleasures?”^{xlix} Even a rudimentary living machine could experience this last universal boon: La Mettrie extended the joys of sex right down to plants.^l

His libertinism was not amoral: on the contrary, it constituted a moral scheme of its own. “Natural Law” operated through the machinery as an “intimate feeling” for integrity, humanity and virtue over their opposites. To treat others as one would want to be treated, La Mettrie claimed, was not a principle but a feeling built right into the machinery.^{li} (Diderot would later make a similar argument for another traditional virtue, industry: “idleness is always contrary to a living machine!”^{lii})

The greatest vice in La Mettrie’s moral universe was therefore rational reflection: the doomed attempt to transcend one’s bodily mechanism. La Mettrie’s overriding project was to deflate the imperial self of Descartes and his fellow rationalists. Study, he therefore scolded, was “a catalepsy, or immobility of the Mind, so deliciously inebriated ... that it seems detached by abstraction from its own body.” Learning was an “abuse of our faculties.” Philosophers trying to understand the world *a priori* using “the wings of the Mind” were doomed to failure. Worse, they were “Do-nothings” and “vain Pedants” whose “Balloon” brains were swollen with heaps of words and figures – which were, after all, only so much stuff, physical imprints on the “medullar canvas.”^{liii}

The finiteness and materiality of the human-machine constituted the central moral truth in La Mettrie’s deliberately Epicurean philosophy: “Man in his first Principle is nothing but a Worm.” Viewing the material world from within rather than above or beyond, the man-machine enjoyed the perspective of a “Mole”. Therefore, La Mettrie urged, “Let us not lose ourselves in the infinite, we are not made to have the least idea of it; it is absolutely impossible for us to go back to the

origins of things.” With human knowledge necessarily limited and provisional, the worst pretenders were those “proud and vain beings” who claimed access to a larger, more transcendent kind of truth: rationalist philosophers and, of course, theologians. “However much they want to elevate themselves, [they] are at bottom nothing but Animals, and perpendicularly crawling Machines.”^{liv}

While the negative component of La Mettrie’s moral program was an extended rebuke to both rationalists and theologians, its positive element was a proto-Romantic celebration of feeling, emotion, experience and mystery. Thought itself, the materialist moralist insisted, was only a property of matter “like Electricity” or the “motive Faculty” and, as such, a “faculty of feeling.” Moreover, neither the mechanism of thought (i.e. feeling) nor any other mechanism could ever be fully explained. This was because the essential nature of matter and motion themselves, along with all that was not immediately visible, was ultimately “an impenetrable mystery.” La Mettrie therefore ostentatiously reconciled himself to the “incomprehensible Marvels of Nature.” To embrace the ultimate ignorance of an essentially material creature – a worm, a mole, a perpendicularly crawling machine – was to live a good, just and happy life.

What do we know of our destiny, any more than of our origin? Let us submit ourselves therefore to an invincible ignorance upon which our happiness depends. Whoever thinks this way will be wise, just, and tranquil about his fate, and consequently happy. He will await death neither fearing nor desiring it.

Such a creature would cherish life, be “full of respect for Nature; full of gratitude, attachment and tenderness.” He would be grateful to partake in the “charming Spectacle of the Universe.” He would “pity the vicious without hating them; in his eyes they will be but deformed Men.”^{lv} A materialist would regard all human failings with the tolerant comprehension of a “Physician”: “Do you know why I still make something of Men? It is because I seriously believe them to be *Machines*. Under the contrary hypothesis, I know few whose society I would value. Materialism is the antidote to Misanthropy.”^{lvi} To realize that humans were nothing but more or less imperfect machines, Diderot later affirmed, was to embrace the following credo: “There is only one virtue, justice; one duty, to be happy; one corollary, not to overrate life, and not to fear death.”^{lvii}

Through the pump-like lungs of the passionate, sensitive, moral man-machine breathed some of the first approximations of a modern theory of evolution.^{lviii} If man was a worm and a mole, La Mettrie observed, then no sharp discontinuity separated humans from animals. Indeed, the great ape “resembles us so strongly” that it seemed perfectly possible one could teach it a language.^{lix} Denis Diderot, whose philosophy imbibed much of the tone and substance of *L’Homme-Machine*,^{lx} made a similar point in relation to the orang-outan at the Jardin du Roi in Paris: “Cardinal Polignac said to him one day, ‘speak, and I will baptise you.’”^{lxi}

Even more significantly, neither human- nor animal- machines were rationally designed. Flamboyantly pressing his atheist cause, La Mettrie rejected the argument from design also because of its celebration of the power of reason. He ridiculed the “tedious repetitions of zealous Writers” with their endless “verbiage” and great “volume of proofs.” The eye might well work like a telescope, but that did not mean someone had constructed it to do so. “Nature no more thought of making an eye to see than water to serve as a mirror for the simple Shepherd.” Water just so happened to reflect images, as other substances happened to reflect sound, and likewise the eye “sees only because it happens to be organized and placed as it is.” Eyes and ears required “no greater artifice” than the “the fabrication of an echo.”^{lxii} Thus the optics of vision, that most beloved example to authors of arguments from design, which would later shake the resolve of Darwin himself, was to La Mettrie a bit of happenstance. Against the power of human reason to discern a machine-like order in nature, La Mettrie invoked the principle of human ignorance, which he deemed unanswerable: ultimately, “[w]e do not know anything about Nature.”^{lxiii}

Scorning a rational account of living machinery, La Mettrie adopted a different approach. Human machinery had not been designed. It was the result of some other kind of process. Perhaps it had been mechanical, something like the gradual buffing of a stone: human beings were animals in whom the “raw Diamond” of the mind had been “polished” by language and culture. Or maybe, instead, it was an organic development: the human brain was a “fertile ground perfectly seeded,” yielding a hundred-fold what it received. Or, again, the working of the brain’s imaginative faculty might have brought about “the generation” of mind. However it had happened, La Mettrie was sure no artifice had been involved. There was no absurdity in imagining that “an intelligent Being could come from a blind Cause,” just as it required no genius on the part of parents to produce intelligent children. As a

woman's womb, "from one drop of liqueur, makes a child," so a part of the machinery of human beings had simply turned out to be suited to retaining and producing ideas. "Having made, without seeing, eyes that see, [Nature] made, without thinking, a machine that thinks."^{lxiv} The resulting human-machine, La Mettrie said, was like a vessel constructed to sail on its own, but also constantly pulled this way and that by the wind and the currents: "a ship without a pilot in the middle of the sea."^{lxv}

Acting as a "blind Cause," Nature must have produced people and animals only "little by little," La Mettrie surmised, from the smallest and humblest beginnings. Matter would have had to pass through an "infinity of combinations" before arriving at the one that produced "a perfect Animal." Strikingly, La Mettrie anticipated Darwinian natural selection in imagining that less perfect animals would die before reproducing, while more perfect animals would survive for longer:

[t]he first Generations must have been very imperfect. Here the Esophagus would have been missing; there the Stomach, the Vulva, the Intestines etc. It is evident that the only Animals that could have lived, survived and perpetuated their species, would have been those finding themselves equipped with all the necessary Pieces for generation, and in which, in a word, no essential part would be missing. Reciprocally those who would have been deprived of some absolutely necessary part would be dead either soon after their birth, or at least without having reproduced. Perfection has no more been the work of a day for Nature than it is for Art.^{lxvi}

In the thought that humanness might not be constructed but rather buffed or grown or generated or otherwise arrived at over indefinitely many imperfect generations, La Mettrie found an alternative to both "Chance" and "God," namely "Nature."^{lxvii}

Here were two principal ingredients of the evolutionary theories that were to emerge over the next century: the idea that humans might be the result of a gradual process and the possibility that nature could be orderly without being designed. Both arose through La Mettrie's energetic attempts to describe a kind of machinery that was not rationally designed.

In place of design or structure, accordingly, La Mettrie substituted Leibniz's notion of "organization." Leibniz, as we saw in Chapter 4, had described living

bodies as organized rather than designed, their structures emerging through a kind of prearranged unfolding from within rather than being imposed from without. This unfolding took place across as well as within generations, since an organized being, in Leibniz's view, could not intelligibly come into being without having existed in other, simpler forms since the beginning of time.^{lxviii} La Mettrie adopted this notion of "organization" even while disparaging Leibniz for having "spiritualized matter" and produced an "unintelligible" system. Even La Mettrie, in other words, bent on describing nature's machinery as intrinsically active and even sentient, found Leibniz's fusion of matter and perception to be fundamentally contradictory. Thus, while he adopted core Leibnizian concepts such as "moving force" and organization, he rendered these as purely material phenomena.^{lxix} To render Leibniz's living force and organizational unfolding as purely material phenomena, while disallowing what La Mettrie called the "spiritualization" of matter, was a rather contradictory business, to be sure.

"Organization" was an initially Aristotelian idea with an interesting twist at its core: an "organized" body, as Aristotle had described it, was one with the potential for life (the greater the degree of organization, the higher the form of life), and one in which all the parts were arranged just as they would have been "if they had come to be for an end."^{lxx} Organization was specific to living beings and was the quality of being arranged *as if* for a purpose: here was a kind of design that, in keeping with Aristotle's Craftsman-less cosmology, invoked no demiurge Designer.

"Organization" had appeared occasionally in seventeenth-century writing on life, matter and spirit, but carrying different meanings. Authors of arguments from design occasionally used the word "organization" as synonymous with "design." The English philosopher and theologian John Ray, for instance, found the greatest demonstration that nature was guided "by Mind for Ends" in the varied and intricate "Organization of the Bodies of Animals."^{lxxi} It was "absurd and ridiculous," concurred the Cambridge Platonist Ralph Cudworth, to suppose that the "organization" of animal bodies – the brain here and the heart there, with its many valves, the intricate machinery of bones and tendons – could take place fortuitously, without any "final or intending causality."^{lxxii} To think that a "jumbling of Atoms" could produce the "Organization of a Flower or a fly," chimed in the Irish philosopher John Toland, one might as well imagine that "by tumbling together the letters of a

Printer a million times, they shou'd ever fall at last into such a Position, as to make the *Aeneis* of VIRGIL, or the *Ilias* of HOMER....^{lxxiii}

A different, landmark usage of “organization” figured in John Locke’s understanding of the identity of a living thing: that which made it the same living thing over time despite the continual transformation of its material parts. The momentous chapter of Locke’s *Essay Concerning Human Understanding* in which he considers this problem, “Of Identity and Diversity,” makes organization its core idea. An oak tree, for example, derived its identity over time from its “Organization of Parts in one coherent Body.” New “Particles of matter” were continually being “virally united” to it, but since these preserved “a like continued Organization,” the tree remained the same plant. The same was true of an animal: it was “a living organized body” that preserved its sameness over time as a result of its organization, into which new parts of matter incorporated themselves and, as a result, partook in the “same continued life.”^{lxxiv}

The “identity of a man,” finally, consisted in nothing else according to Locke: a man was a particular, ongoing “organization” of ever-renewing material parts. Locke applied “organization” to artificial as well as natural machines, although he also used the idea to distinguish the two. He explained, for example, that an artificial “organization or construction” such as a watch had an external source of both organization and motion, and could therefore be organized but motionless. In contrast, “in an animal the fitness of the organization, and the motion wherein life consists, begin together, the motion coming from within.”^{lxxv} As in the Aristotelian sense of “organization,” which Leibniz and La Mettrie later picked up, Locke assumed that the order and motion of living organized bodies originated within themselves. But to Locke, the salient feature of animal organization was not an intrinsic purposefulness but rather sameness over time.

The Aristotelian notion of organization, a kind of immanent purposiveness specific to living creatures, figured in some early eighteenth-century theories of life and mind in addition to Leibniz’s. Boerhaave, La Mettrie’s mentor, defined an organic or organized body as one “consisting of different parts, which jointly concur to the exercise of the same function.” Here again organization was an internal affair, a concurrence of parts. Boerhaave also described organization as something that became evident in the process of growth.^{lxxvi} Organization appeared in moralist and aesthetic writing in the same period, preserving the sense of an animate order that was

internally generated rather than externally imposed. “Organization,” defined as the “Form and Nature of the Solids and Fluids of the Body,” starred in a 1714 moralist tract claiming to demonstrate how a “wrong or different Formation may affect our WISDOM, JUDGMENT, OR REASON.”^{lxxvii} The organization of the body – the eyes, the heart – figured at intervals in the historian and critic Jean-Baptiste Dubos’s history of the arts.^{lxxviii} Differences in organization between men and women acted in early theories of the novel.^{lxxix} Diderot used the word in his *Essai sur mérite et vertu* (1745) to refer to the “moral architecture” of animals, a crucial apparatus composed of their “social affections.”^{lxxx} Organization in these settings also retained its ancient connotation of hierarchy, as when Voltaire alleged that those with the “liveliest passions” were the ones “best organized.”^{lxxxii}

Organization did appear at least once before mid-century as an alternative to design. Yn-Che-Chan, a correspondent in the marquis d’Argens’s epistolary novel *Lettres chinoises*, writes to his friend in Paris, the materialist traveller Sioeu-Tcheou,

How can intelligent Beings, such as Men are, flow from a material Principle How comes it then, that we don’t see intelligent Trees and Stones, and that Chance only grants Perception to organis’d Matter, such as that which forms human Bodies? Is it this Organisation which is the Cause of Intelligence? But if so ... how is it possible, that in this vast Universe, every thing should be so just, so balanc’d, so beautiful and exact, and yet this Order not be produced by an intelligent Being.^{lxxxii}

D’Argens, like La Mettrie, was a flamboyant materialist moralist and protégé of Frederick the Great; among his most notorious moralist writings was the pornographic *Thérèse philosophe*, which appeared the year after *L’Homme-machine*.

Organization was thus a burgeoning concept by the late 1740’s,^{lxxxiii} but it received its first extended treatment in La Mettrie’s attention-grabbing manifesto. Here, organization became something new under the sun: the basis for a rigorously materialist, non-rational moral scheme. Organization in La Mettrie’s usage retained its original aspects of specificity to living creatures and intrinsic purposiveness. From these ingredients, the materialist moralist derived a perfect melding of physical and moral purposes. “Organization,” La Mettrie wrote, “is the first merit of Man” and the source of all the others. Rhetorically, he demanded, does organization “suffice for

everything?” His answer was an emphatic “yes.” Every faculty that had been attributed to mind or soul came down in the end to “Organization itself; *voilà* a well-enlightened Machine!”^{lxxxiv}

3. Machine-lets and Little Organizations

In the wake of La Mettrie’s bestseller, and even following his controversial end, “organization” in La Mettrie’s sense of the word proliferated rapidly in natural history. The concept immediately permeated another landmark bestseller, this one by the director of the Jardin du Roi in Paris, Georges Buffon. The opening volumes of his *Histoire naturelle, générale et particulière* were published in 1749, two years after La Mettrie’s *L’Homme-machine*. Here, Buffon identified Nature’s chief business as the production of life by “organization.” Nature in general, he wrote, “seems to me to tend much more toward life than death, she seems to try to organize bodies as much as possible.” Pointing out that one could seemingly augment the world’s quantity of living beings indefinitely, whereas one could not do the same with “rocks or other brute matter,” Buffon concluded that “the most ordinary work of Nature is the production of the organic, that this is her most familiar action, and that her power is not limited in this regard.”^{lxxxv}

Organization also provided the key to Buffon’s understanding of an individual, which he defined as “a whole uniformly organized in all its interior parts.” These parts, in turn, he supposed to be made up of “an infinity of little organized beings,” or “organic molecules.” An “internal mold” brought these organic molecules together in generation and nutrition (and they came apart again after death).^{lxxxvi} Haller, a partisan of design over organization, argued that such a “mold” could never accomplish the task: it required a “building master” to ensure that “never could an eye become attached to a knee, or an ear to a forehead.”^{lxxxvii} To Buffon, however, a living creature was an organized conglomeration of organized beings: organization all the way down.

Like La Mettrie, Buffon emphasized that organized bodies worked differently from artificially built contraptions. The “organic machine” of the sense organs and brain, for example, differed from artificial machines in that it was not only capable of “resistance and reaction,” but was “itself active.”^{lxxxviii} The “true springs” of animal motion, Buffon reckoned, were not the visible muscles, veins, arteries and nerves, but rather the “interior forces” that clearly resided in organized bodies. These forces did

not follow the “laws of gross mechanics ... to which we would like to reduce everything.” After all, why must the very few properties of matter admitted by Descartes and other 17th-century mechanists – extension, impenetrability, movement, shape, divisibility – be the only ones? A naturalist, Buffon urged, must work to increase rather than restricting the number of causes. Thus in his theory of nutrition, he invoked a new sort of “active power”: the “penetrating” tendency of living, organic matter to organize itself. Like gravity, this self-organizing power bore no relation to the external features of an object, but only to its “interior,” acting upon the “most intimate parts and penetrating them at every point.” Such forces would remain forever essentially mysterious, since they acted on the interior of matter and “in a word they escape our eyes.” Buffon promised, “we will never reach them by reasoning.”^{xxxix}

Buffon’s theory of the human constitution as an organic rather than a designed machine, like La Mettrie’s, thus constituted a rebuke to rationalists with their hubristic arguments from design. “Who in fact has the greater idea of the Supreme Being,” Buffon demanded: he who perceives him as the source of a divinely ordained, general order in nature, or “he who seeks and finds him attentively conducting a republic of flies, and greatly occupied with how a beetle’s wing should fold?”^{xc} The sneer was directed at Buffon’s rival, the natural historian and natural theologian René Antoine Ferchault de Réaumur, who offered his voluminous, minute descriptions of insects as so many demonstrations of God’s skill. Rationalists were misguided, Buffon argued, both in believing that they could explain everything and, relatedly, in setting humans apart from the rest of the natural world. In contrast, Buffon promised his readers a “serious examination of Nature.” Reading this examination was to be a bracing experience, the moral equivalent of a cold bath, for the first truth to be learned was a “humiliating” one: man was an animal. Worse yet, he occupied the same continuum as “the most unformed matter” and “the most brute mineral”: never mind moles and worms, no sharp discontinuity separated humans even from rocks.^{xcii}

Another person who quickly and influentially took up the Leibnizian concept of “organization” was a friend and protector of La Mettrie’s, the French mathematician and philosopher Pierre-Louis Moreau de Maupertuis. Like La Mettrie, Maupertuis was a native of Saint-Malo and a protégé of Frederick the Great, for whom the monarch had several years earlier secured the presidency of the Prussian Royal Academy of Sciences. It was Maupertuis, indeed, who had devised the rescue

plan of bringing La Mettrie to Berlin in 1748 after the publication of *L'Homme-machine*.^{xcii}

Organized bodies, Maupertuis announced in 1754, in agreement with both Buffon and La Mettrie, were inexplicable by means of the mechanical principles of the inanimate world. A “uniform and blind attraction spread through all the parts of matter,” such as gravity, could never explain how the elements of a living creature came together: how, for example, some parts formed an eye while others made up an ear. To account for such a thing, Maupertuis argued, the very elements of matter must contain “some principle of intelligence ... something similar to what we call *desire, aversion, memory*.” Perception was an elementary property of matter; indeed, Maupertuis wrote, one might equally well call these elements “animals” in their own right.^{xciii}

After all was said and done, Maupertuis judged, there were only three possibilities for how the world of living beings had come to exist. Either it had come together randomly out of brute and unintelligent parts; or God had composed it out of such parts the way an architect builds with stones; or, finally, “the elements themselves, endowed with intelligence, arranged and united themselves to carry out the vision of the Creator.” Maupertuis chose the last as the only compelling possibility to account for living beings: no externally imposed construction of blocks or stones but a confluence of sentient participants. The intelligent, sentient action of the parts of matter in forming animal bodies also accounted, according to Maupertuis, for the proliferation of species. If these elementary parts combined themselves too readily or forgot the order of the father and mother animals,

each degree of error would have made a new species; & by means of these repeated divergences would have come the infinite diversity of animals that we see today, that will perhaps grow more with time, but to which perhaps the succession of centuries would bring only imperceptible increases.^{xciv}

By the mid-1750's, “organization” was everywhere, first in France but soon proliferating in the writings of Swiss, German and English naturalists. It was possible, for example, in a treatise on reproduction in plants and animals, to refer to the mammalian fetus as a “little organization.”^{xcv} Diderot identified “organization” as the difference between living and dead matter in his *De l'interpretation de la nature*

(1754)^{xcvi} and the concept is ubiquitous in the naturalist Jean-Baptiste Robinet's monumental *De la nature* (1761-1768).^{xcvii} Delisles de Sales, who sharply rejected La Mettrie's man-machine manifesto, nevertheless filled his clandestine bestseller *De la philosophie de la nature* (1769) with references to animals and humans as greater and lesser "organized machines."^{xcviii}

Organized machines were importantly unlike the rigidly deterministic clockwork described by both natural theologians and some polemical materialists. The materialist provocateur, the baron d'Holbach, for example, described human beings as purely passive, puppet-like devices acted upon by unknown mechanical causes.^{xcix} Organized machines, in contrast, derived their order from within their own workings. Thus Philo, the skeptical debunker of arguments from design in David Hume's *Dialogues concerning natural religion* (1779), answered "design" with "organization," a kind of order that did not arise from "reason or contrivance."^c To Hume, the argument from design was its own undoing, and the trouble was not those questions about blind spots and other imperfections featured in Chapter Three. The argument's downfall did not lie in imperfections of contrivance, but in *contrivance itself* as an argument for an omnipotent being. Any contrivance, after all, is a particular and limited affair.^{ci} It might be a good thing, as Boyle had pointed out, that flies, not being able to move their eyes, have compound eyes to compensate for it. But why can't they move their eyes? Boyle waved the question aside, leaving it between parentheses,^{cii} whence it stubbornly continued to indicate the same core problem that Hume identified: one could not get from a particular and limited contrivance to an absolute power. Design was thus a fatally contradictory notion; Hume found in "organization" a more compelling sort of order.

A tree bestows order and organization on that tree, which springs from it, without knowing the order: an animal, in the same manner, on its offspring: a bird, on its nest: and instances of this kind are even more frequent in the world than those of order, which arise from reason and contrivance. To say that all this order in animals and vegetables proceeds ultimately from design, is begging the question; nor can that great point be ascertained otherwise than by proving a priori, both that order is, from its nature, inseparably attached to thought, and that it can never, of itself, or from original unknown principles, belong to matter.^{ciii}

In literature and the arts, too, “organization” became a keyword after 1750. It appeared regularly, for example, in Jean-François Marmontel’s *Poétique française* (1763): the object of poetry, as Marmontel defined it, encompassed all that entered into the “organization of living, animate, sensible beings.”^{civ}

“Of all the modifications of nature,” mused the Genevan Calvinist Charles Bonnet in 1763, “the most excellent is *organization*.”^{cv} Here was a principle to account for the workings of “animal machines” which, though they contained wondrous arrays of “levers, counterweights, diversely calibrated tubes, curves and bypasses,” could never be explained by traditional mechanical principles.^{cvi} Organized bodies, or “organic machines,” instead contained “a secret mechanics” of their own, which allowed them to proliferate, grow, and heal.^{cvii}

Bonnet described organized bodies both as “*looms*” that assimilated and incorporated materials into themselves and also as “cloths, networks, sorts of fabrics in which the warp itself forms the woof.” Each fiber, each “fibrilla” of these loom/fabrics was itself a miniature machine and the “entire machine is in a sense nothing but a repetition of all the *machinelets* whose forces conspire to the same general end.”^{cviii} Forever weaving itself, an organized body was in constant flux, never remaining the same for a single instant.^{cix}

The concept of organization would hereafter often appear clad in weaving metaphors. The Italian physiologist Lazzaro Spallanzani, for example, writing a decade later, likewise characterized the “delicate organization of living beings” as a woven structure and celebrated the extraordinary “fabric of organized bodies.”^{cx} In the same year, Diderot described an animal as a “machine that is born from a point, from a churned fluid,” whose development depends upon “a bundle of thin, separate and flexible threads, a sort of skein in which the least strand cannot be broken, worn out, [or] displaced.”^{cxii} Meanwhile, through this continual process of self-constitution from the world’s ingredients, according to Bonnet, each organized body became a burgeoning mix of all the others: “a little earth, where I perceive in miniature all the species of plants and animals ... an oak seems to me composed of *plants, insects, shells, reptiles, fishes, birds, quadrupeds, even men*.” The earth itself, with its air and water and soil, appeared to Bonnet as “but a mass of seeds, a vast organic whole.”^{cxiii}

Extending indefinitely outward to encompass the world itself and indefinitely inward into the microscopic workings of organic bodies, organization was all-

pervasive: “We do not know where organization finishes, what is its smallest term.”^{cxiii} Perhaps it would be an exaggeration “to *organize* or to *animalize* everything,” Bonnet allowed, but he nevertheless urged his readers not to assume that what appeared unorganized or inanimate was really so. There was “no good philosophical reason,” he reckoned, to “limit the scale of animality to this or that production”: the world might well be fully permeated “with life and sentiment.”^{cxiv}

A sentient cosmos thrumming with feeling traveled thus arm-in-arm with Mr. Machine, paired expressions of rigorous materialism and the elimination of Descartes’s disjuncture between self and world. Diderot was the first in La Mettrie’s wake to describe with deliberate scandalousness this titillating duo, world-creature and human-machine. Devilishly, for he had more than materialism in common with La Mettrie, Diderot chose not only to present his worldview in the traditional form of a dialogue but to cast his estranged friend and former collaborator on the *Encyclopédie*, Jean d’Alembert, in the starring role. Differences in philosophical temperament and doctrine, as well as the usual sorts of vanity and rivalry, had led to d’Alembert’s departure from the *Encyclopédie* and a rift between the friends. The long-suffering mathematician was accustomed to serving as Diderot’s rationalist foil.^{cxv}

The “D’Alembert” character in the dialogues composing *D’Alembert’s Dream* lapses in and out of a feverish philosophic dream during which, his misguided rational faculty for once suspended, he discerns and rantingly announces the truths of the cosmos as Diderot deemed them (an earlier conversation with Diderot prepares the momentous night of dreaming). To play the part of d’Alembert’s doctor and irreverent materialist sage, Diderot thought of casting our hero La Mettrie, who co-stars in a manuscript version of the piece,^{cxvi} although he later assigned the role to the Montpellier doctor Théophile Bordeu, student of the nervous and glandular systems and author of the article on medical “crisis” for Diderot’s *Encyclopédie*. The fictional d’Alembert is also attended by Julie de Lespinasse, with whom the actual d’Alembert lived, and who had indeed recently nursed him through a dangerous illness.^{cxvii}

The core truth that “d’Alembert” perceives is simple: sensitivity is a universal property of matter extending to every stone or speck in nature, corresponding with its “organization,” and this universal sensibility accounts for everything else.^{cxviii} The difference between a canary and a bird-organ automaton? Just organization and degree of sensitivity. Our nerves are “sensitive vibrating strings” and the difference

between “the philosopher-instrument and the clavichord-instrument” is only, once again, the greater sensitivity of the philosopher-instrument and its ability to play itself. A philosopher is essentially a keenly sensitive, self-playing clavichord. Imagine that such a clavichord “organized like you and me” really existed and then grant it the power to reproduce itself, say, with the help of a female clavichord. The result would be little clavichords, no less “alive and resonant” than newborn humans (or baby philosophers) produced in the equivalent way.^{cxix} Everything in nature from rocks to birds to clavichords to philosophers was simply variously organized, hence more or less sensitive matter.

Immanuel Kant took up “organization” at the end of the century and made it the basis of his understanding of living beings. Nature, he observed, “displays itself in its beautiful productions as Art.” Natural and artistic productions alike were beautiful because they appeared to be designed rather than haphazard. Yet, insofar as their design pertained just to their “external aspect,” it was “purposiveness without purpose.” The only true natural purposes, Kant wrote, were those with “internal” perfection and beauty, namely “organised beings.” Their internal perfection, beauty and purpose was “not thinkable or explicable by means of any exactly fitting analogy to human art.” Strictly speaking, Kant concluded, “the organisation of nature has nothing analogous to any causality we know.”^{cxx} Organised beings were nature’s purposes, the highest form of beauty and perfection, and by definition inexplicable in the terms by which one understands artificial mechanisms. They contained their purposiveness and causality within themselves.

This organic view of living machinery was, once again, deeply moralized. Organic machinery, embedded in a material world permeated by life and sentiment, responded continually to a “*Combination of Moral and Physical Causes*.”^{cxxi} Morality itself, that peculiar feature of human beings, Bonnet wrote, arose from humans’ particular “organization”^{cxxii} and likewise for animal societies: beavers and “republican bees,” for example, were “organized” to live in society and could not function in solitude.^{cxxiii} In Diderot’s view, the diaphragm was the part of the machinery responsible for moral sentiments: “the head makes men wise, the diaphragm makes them compassionate, and moral. These are the two great springs of the human machine.”^{cxxiv}

To defy one’s material organization was the greatest folly of all. Thus there could be no purported virtue “as childish, as ridiculous, as absurd, as harmful, as

contemptible” as chastity and continence, pseudo-Bordeu insists to a blushing “Mlle. de Lespinasse” in the aftermath of pseudo-d’Alembert’s (at its climax evidently wet) dream. Masturbation, homosexuality, bestiality, even a frankly lascivious doctor’s discreet attentions to sexually frustrated young girls among his patients ... all these were preferable.^{cxxxv} The greatest moral imperative was never to deny one’s organization, one’s machinery, or its place in the material continuum of nature.

Thus uniting physical composition with social and moral attributes, the notion of organization assumed a prominent role in contemporary moral sciences, precursors to the modern social sciences, particularly economics. The French school of *Economistes*, some of the earliest proponents of (limited versions of) free trade, who re-named their science “Physiocracy” during the 1760’s for “rule of nature,”^{cxxxvi} were particularly fond of invoking “organization” as the basis for the social arrangements they recommended. Pierre-Paul le Mercier de la Rivière, a core member of the *Economistes’* circle, claimed that humans were “organized” to live in society, and moreover, in a particular kind of society: one ruled according to the dictates of nature (i.e. without “arbitrary” taxes on grain). “We are organized to know evidence,” such as the annual agricultural surplus, Mercier argued, “and to allow ourselves to be governed by it.” People living in a society governed by such natural “evidence” would tend perpetually to improve themselves: the guarantee, once again, was the “way in which we are organized.”^{cxxxvii}

By the early 1770’s, the notion that the human body was an “organized machine” had become so very stylish that Jean-Paul Marat, who had an insatiable fondness for popular science and considerable success at mobilizing its flashier components for political purposes, took up the idea as his own.^{cxxxviii} Evidence of its popularity, indeed, is that it caught on across the political and philosophical spectrum. At the opposite end from Marat, to be sure, there were also those, such as the writer and *philosophe* Jacques-Henri Bernardin de Saint Pierre, who grafted the new notion of “organization” to an older tradition of arguments from design.^{cxxxix} But such adaptations were exceptional.

More typical was the usage of the British experimentalist, natural philosopher theologian and dissenting minister Joseph Priestley, who adopted the notion of organization directly from La Mettrie. Sensation and thought resulted from “the organization of the brain” in the same way, Priestley reckoned, that an attractive power resulted from magnetized iron.^{cxxx} The concept of organization became the

basis of Priestley's materialism, something other than substance that was yet attributable to a purely physical entity. The notion of a strictly immaterial soul, Priestley argued, was a modern perversion, the work of Descartes and especially his followers, driven by an unreasonable "dread of materialism." It had roots too in "the vain imaginations of men, flattering themselves with a higher origin than they had any proper claim to."^{cxxxix}

Here again is the moral impulse that animated La Mettrie's man-machine: a drive to lash the human mind tightly into the material continuum of nature. Priestley applied the principle unreservedly: "What I call *myself*," he insisted, "is an organized system of matter."^{cxxxix} This philosophical self-demotion did not necessarily correspond to a worldly one: the devout monists included the atheist-loving emperor who had so carefully scrutinized the circumstances of Mr. Machine's deathbed refusal to convert. "If the soul of your nerves is in a state of quietude," Frederick wrote to Voltaire in response to Voltaire's *Dictionnaire philosophique* article on the soul [*Ame*]:

I would be charmed to see you this evening; if not, I believe it will take vengeance on your body for the wrong your mind is doing it. What is certain, is that I do not believe I or anyone could be double. Great people, in speaking of themselves, say we; but this does not make them multiplied. Let us put our hand on our conscience and speak frankly; we will admit in good faith that thought and movement, of which our body has the faculty, are attributes of the animated machine, formed and organized as man.^{cxxxix}

This materialist moralist impulse and the accompanying notion of "organization" found expression in the work of a growing class of people who renounced the doctrine of special creation for the conviction that species changed over time: what the anatomist and anthropologist Paul Broca would retrospectively dub "transformism."^{cxxxix} (In what follows, I will adopt Broca's term in order to avoid reading aspects of later, "evolutionary" theories back into these early ideas about species-change.) Jean-Baptiste Lamarck, the person whom Broca, and subsequently tradition, designated as the original "transformist," scrutinized the many varieties and gradations in the ongoing composition of the "animal organization" to

assert that reason itself was no peculiar capacity of humans but a function of the nervous system and therefore common in lesser or greater degrees to all animals.^{cxxxv} In Lamarck's view, God was only indirectly the creator of the observable world, acting through the intermediary force of Nature itself. Nature, Lamarck judged, was "certainly not a reasonable being," but rather a "blind power, everywhere limited and constrained." He argued that it was mistaken to attribute intentions or goals to such a power.^{cxxxvi}

But, as we have been seeing, Lamarck was by no means the first *transformiste-avant-la-lettre*.^{cxxxvii} Rather, ideas about the ongoing transformation of living forms emerged with active mechanism: Leibniz's and others' attempts to build the agency responsible for structuring animate machines into the machines themselves. Thus La Mettrie, adopting Leibniz's notion of "organization," had described the man-machine in 1747 as emerging "little by little" from the "smallest beginnings," and had inspired a host of self-transforming organic machines. Buffon, in the fourth volume of his *Histoire naturelle*, in which he undertook a general description of the "animal machine," perceived similarities joining even the most apparently divergent models. On the basis of these similarities, Buffon observed that one might even believe all animals had originated from just a single one by means of a continual "mixing," a "successive variation," and processes of perfection and degeneration. (One might believe it, that is, if Revelation had not specified that all animals participated equally in the grace of Creation.)^{cxxxviii} Maupertuis, also working on the basis of Leibnizian "organization" rather than design, had attributed the proliferation of species to over-eager combinations or lapses of memory on the part of the sentient, intelligent elements of matter.

Transformism was an idea that traveled through the eighteenth century hand-in-hand with rejections of the argument from design, with its brute-mechanist picture of living beings. Thus Hume reasoned that the world was much more like an animal or a vegetable than it was like any "artificial machine," such as a watch or a loom. "The cause, therefore, of the world, we may infer to be something similar or analogous to generation or vegetation," a growth or emergence or development over time.^{cxxxix} "If faith had not taught us," Diderot urged, "that animals left the hands of the creator just as we seem them," would we not begin to suspect that the "elements" of "animality" had come together differently? Could we not imagine that these elements had started out "separate and confused in the mass of matter":

that these elements came to reunite, because it was possible for that to happen; that the embryo formed by these elements passed through an infinity of organizations and developments; that it had, successively, movement, sensation, ideas, thought, reflection, conscience, sentiments, passions, signs, gestures, sounds, articulate sounds, a language, laws, sciences, and arts; that millions of years ran by between each of these developments; that there are perhaps other developments to come and other expansions to undergo, that are unknown to us ... that [life] would disappear forever from nature, or rather it will continue to exist, but in a different form, and with faculties altogether different from those we remark at this instant in time.^{cxl}

“You suppose animals were originally what they are at present,” Diderot chastises “d’Alembert” in their pre-dream dialogue. “How silly! We no more know what they have been than what they will become.”^{cxli} The sleeping “d’Alembert” next witnesses race upon race of animals coming into and passing out of existence in unending succession. Our own present moment, the dreamer perceives, represents but an instant “in the succession of these animal generations.”^{cxlii}

Diderot’s eternally transforming sensitive clavichords constituted a strikingly non-progressive view of species-change. Here is a critical way in which the early transformism of La Mettrie, Diderot, Buffon and Maupertuis differed from later evolutionary ideas. “The imperceptible worm that wriggles in the mire” might be on its way to becoming a great and fearsome beast; but likewise, today’s enormous and terrifying animals were likely tending into worms.^{cxliii} Diderot’s vision of natural history was also startlingly indeterminist. Remote and indifferent, the sun was the cause of all. Extinguish it and everything would perish; re-light it and the resulting “infinity of new generations” might never include our own plants and animals.^{cxliv} Let “the current race of existing animals pass; let the great, inert sediment act several million centuries,” and there was no telling what sort of beings might result.^{cxlv}

Above all, humans represented but a brief and haphazard moment, and no kind of culmination. Indeed, we might not even be the protagonists of our own moment. Being made up of infinite “animacules,” themselves in constant flux, we might be but the “breeding-ground of a second generation of beings, separated from this one by an inconceivable interval of centuries and successive developments?”^{cxlvi}

Another early transformist, Erasmus Darwin, author of the talking head featured in Chapter Five, was one of Priestley's fellows in the Birmingham philosophical dinner club, the Lunar Society. He represents the culmination of the trajectory this section has been tracing from man-machine toward human evolution via the moral rejection of transcendent reason. Intellectual as well as biological grandfather to Charles Darwin, Erasmus Darwin, like La Mettrie, was a rhapsodist of the sex lives of plants, an enthusiastic believer in the co-extension of sensation and sentiment with living matter and the material oneness of all living things.^{cxlvii} Like Lamarck, he understood animals as ever-burgeoning forms of the same basic "organization," and drew the same implication too, though with greater drama.

"Go, proud reasoner," Darwin charged, "and call the worm thy sister!"^{cxlviii}

ⁱ René Descartes, in *Méditations touchant la première philosophie*, "Méditation seconde" [1641], in *Oeuvres complètes de Descartes*, Connaught Descartes Project, André Gombay, ed. (Charlottesville: Intelix, 2001), IXa, 22. For recent scholarly treatments of Enlightenment musings on the "self," see Dror Wahrman, *The Making of the Modern Self: Identity and Culture in Eighteenth-Century England* (New Haven: Yale University Press, 2004); Jan Goldstein, *The Post-Revolutionary Self: Politics and Psyche in France, 1750-1850* (Cambridge: Harvard University Press, 2005); Charles Taylor, *Sources of the Self: The Making of Modern Identity* (Cambridge: Harvard University Press, 1992).

ⁱⁱ Rousseau, *Emile* [1762], 585.

ⁱⁱⁱ Jean-Jacques Rousseau, *Emile, ou, De L'Education* (1762), in *Oeuvres completes*, Bernard Gagnebin and Marcel Raymond, eds. (Paris: Pléiade, 1959-1995), 298, 311.

^{iv} Benjamin Franklin, "Dissertation on Liberty and Necessity" (1725), in *Papers of Benjamin Franklin* (1959—), 1: 57-71; David Hume, *A Treatise of Human Nature* (1762), L.A. Selby-Bigge, ed. (Oxford: Clarendon, 1978), see especially Part 3, §1.

^v Jeremy Bentham, *Introduction to the Principles of Morals and Legislation* (Oxford: Clarendon, 1907 [1789]), Ch. 1.

^{vi} For this aspect of the story, see Leonora Cohen Rosenfield, *From Beast-Machine to Man-Machine: Animal Soul in French Letters from Descartes to La Mettrie* (Oxford: Oxford University Press, 1941).

^{vii} Stephen Gaukroger, *Descartes: An Intellectual Biography* (Oxford: Clarendon, 1995), 1-2 and 418, n. 1; and Rosenfield, *From Beast-Machine to Man-Machine* (1941), [PP].

^{viii} On La Mettrie as an anti-Cartesian, see Kathleen Wellman, *La Mettrie: Medicine, Philosophy and Enlightenment* (Durham and London: Duke University Press, 1992), 177-186.

^{ix} Julien Offray de la Mettrie, *L'Homme-Machine* (1747), in Aram Vartanian, ed., *La Mettrie's L'Homme-machine, A Study in the Origins of an Idea* (Princeton: Princeton University Press, 1960), 150. "Soul of mud" was a paraphrase of the abbé Pluche's characterization of John Locke's view of the soul. See abbé Noël Antoine Pluche, *Le Spectacle de la nature, ou Entretiens sur les particularités de l'histoire naturelle*, (Paris, 1732-1750), Vol. 5: 176-177.

^x See for example Jonathan Israel, *Enlightenment Contested: Philosophy, Modernity and the Emancipation of Man, 1670-1752* (New York: Oxford University Press, 2006), 803, 809, 810. “La Mettrie’s immoralism threw up an insuperable barrier between him and the maturing Radical Enlightenment. Ultimately at issue was La Mettrie’s abandonment of Spinoza’s moral naturalism. Morality is a fiction, a “fruit arbitraire de la politique.” Men are determined in what they do by natural impulse, we are no more criminal in following our basic drives ... than is the Nile in inundating precious farmland. ... Pleasure is the essence of life and of man. This was totally unacceptable to Diderot, Dorthous de Mairan, d’Argens and the other modern Spinozists.” pp. 804-805

^{xi} For instance: Voltaire, Rousseau, Diderot.

^{xii} Frederick the Great, “Eulogy on Julien Offray de La Mettrie” (1751), in La Mettrie, *Man a Machine*, ed. Gertrude Carman Bussey (La Salle, Illinois: Open Court, 1912), 1-10, on p. 6.

^{xiii} Adrien Baillet, *La Vie de M. Des-Cartes* (Paris, 1691), Bk. 2, Ch. 1. On Descartes’s dreams, see also Gregor Sebba and Richard A. Watson, *The Dream of Descartes* (Southern Illinois University Press, 1987).

^{xiv} Frederick the Great, “Eulogy of La Mettrie” (1751), 6.

^{xv} Thomas Carlyle, *History of Friedrich II of Prussia, Called Frederick the Great*, Vol. 4 of 6 (London: Chapman and Hall, 1864), Bk. 16: *The Ten Years of Peace. 1746-1756*, p. 386.

^{xvi} Frederick the Great, “Eulogy of La Mettrie” (1751), 6.

^{xvii} La Mettrie, *L’Homme-Machine* (1747), 152-156.

^{xviii} La Mettrie, *L’Homme-Machine* (1747), 183.

^{xix} Frederick the Great, “Eulogy of La Mettrie” (1751), 8.

^{xx} La Mettrie, *L’Homme-Machine* (1747), 180, 183.

^{xxi} On La Mettrie, Haller and Boerhaave, see Vartanian, “The Historical Background of L’Homme-Machine,” in Vartanian, ed., *La Mettrie’s L’Homme-machine* (1960), Ch. 4, pp. 75-89. Despite his policy of ambiguity and overt criticisms of Spinoza, Boerhaave was reputed to be a Spinozist, a charge against which Samuel Johnson defended him. See Samuel Johnson, “Hermann Boerhaave,” *The Gentleman’s Magazine*, Jan. – Apr. 1739, reprinted in *The Works of Samuel Johnson*, Vol. 14 (Troy, NY: Pafraets Company, 1903), 154-184, [PP]; and Israel, *Radical Enlightenment: Philosophy and the Making of Modernity 1650-1750* (Oxford: Oxford University Press, 2001), [PP].

^{xxii} See Israel, *Radical Enlightenment* (2001), 704.

^{xxiii} On Haller’s physiology, see François Duchesneau, *La Physiologie des Lumières: empirisme, modèles, théories* (The Hague: Nijhoff, 1982), Chs. 5 and 6; Shirley Roe, “Anatomia Animata: The Newtonian Physiology of Albrecht von Haller,” in Everett Mendelsohn, ed., *Transformation and Tradition in the Sciences: Essays in Honor of I. Bernard Cohen* (Cambridge: Cambridge University Press, 1984), 273-300; and Hubert Steinke, *Irritating Experiments: Haller’s Concept and the European Controversy on Irritability and Sensibility, 1750-90* (Amsterdam: Rodopi, 2005). On the distinction between irritability and sensibility, see Dominique Boury, “Irritability and Sensibility: Key Concepts in Assessing the Medical Doctrines of Haller and

Bordeu,” *Science in Context* 21 (4), 521-535 (2008).

^{xxiv} Indeed the line between vitalism and materialism was often very blurry in this period, has historians of the 18th and early 19th centuries have noted. I have taken up this blurriness in “Eighteenth-Century Wetware,” *Representations*, Summer 2003, No. 83: 97-125.

^{xxv} Albrecht von Haller, *Elementa physiologiae corporis humani* (1757), Preface, p. v, cited in translation in Shirley Roe, *The Natural Philosophy of Albrecht von Haller* (Manchester, NH: Ayer, 1981), “Introduction.”

^{xxvi} Vartanian, “Trembley’s Polyp, La Mettrie and Eighteenth-Century French Materialism,” in *Journal of the History of Ideas*, Vol. 11, No. 3 (June 1950), 259-286, on p. 271.

^{xxvii} Carlyle, *History of Friedrich II* (1864), p. 387.

^{xxviii} On La Mettrie’s influence on his contemporaries, see Vartanian, “Trembley’s Polyp” (1950) and Israel, *Radical Enlightenment* (2001), Ch. 37.

^{xxix} Carlyle writes of Frederick: “It is certain he could, especially in his younger years, put up with a great deal of zanyism, ingenious foolery and rough tumbling, if it had any basis to tumble on.... By far his chief Artist in this kind, indeed properly the only one, was La Mettrie,” in *History of Friedrich II* (1864), pp. 385-386.

^{xxx} Dieudonné Thibault, *Mes souvenirs de vingt ans to séjour à Berlin: ou Frédéric le Grand, sa famille, sa cour, son gouvernement, son académie, ses écoles, et ses amis littérateurs et philosophes*, Vol. 5 (Paris: F. Buisson, 1805 [2nd ed.]), p. 405.

^{xxxi} See Voltaire – Mme. Denis, in 14 November 1751, in *Oeuvres de Voltaire*, ed. Adrien-Jean-Quentin Beuchot, Vol. 55 (Paris: Firmin Didot, 1831), no. 1785, pp. 688-689.

^{xxxii} Voltaire’s report of La Mettrie’s account of Frederick’s remark, and Voltaire’s initial reaction, are in a letter to his niece: Voltaire – Mme. Denis, 2 September 1751, in *Oeuvres de Voltaire*, ed. Beuchot, Vol. 55 (1831), no. 1755, pp. 657-660. Carlyle recounts the story in *History of Friedrich II* (1864), 396. The orange-skin affair has been retold by generation after generation of Voltaire biographers. For 19th-century examples, see John Morley, *Voltaire* (London: MacMillan, 1886), 194-195; and Edward Bruce Hamley, *Voltaire* (Edinburgh and London: William Blackwood & Sons, 1877), 154-155.

^{xxxiii} Voltaire – Mme. Denis, 29 October 1751, in *Oeuvres de Voltaire*, ed. Beuchot, Vol. 55 (1831), no. 1781, pp. 681-683.

^{xxxiv} See Vartanian, “Biographical Sketch of La Mettrie,” in Vartanian, ed., *La Mettrie’s L’Homme Machine* (1960), Ch. 1, on pp. 8-9; Israel, *Radical Enlightenment* (2001), 574. See also p. 671: “If La Mettrie was detested by the rest of the Berlin Academy, he was nevertheless, at the wish of the Prussian monarch, made a full member”; and p. 722: “Much to the chagrin of almost the entire Prussian Royal Academy, Frederick ... required them in July 1748 to adopt La Mettrie as a full member of their body.” See also Israel, *The Enlightenment Contested* (2006), 803.

^{xxxv} Samuel Christian Hollmann, in *Göttingen Zeitungen von gelehrten Sachen* 1748, p. 411; see Vartanian, “The Critical Reaction of La Mettrie’s Contemporaries,” in Vartanian, ed., *La Mettrie’s L’Homme-Machine* (1960), Ch. 5, on p. 101-102 and fns. 18, 19.

^{xxxvi} *Epître à Mlle. A.C.P. ou la ‘Machine terrassée* (1749), in Francine Markovits, ed., *La Mettrie: Oeuvres philosophiques* (Rennes: Fayard, 1987), Vol. 2: 213-222, on pp. 215-216. This *Epître* was one of three anonymous, self-satirizing pamphlets, all of which appeared in 1749. The others were *Epître à mon Esprit, ou l’Anonyme persiflé* and *Réponse à l’auteur de la Machine terrassée*. See Vartanian, “The Critical Reaction of La Mettrie’s Contemporaries,” in Vartanian, ed., *La Mettrie’s L’Homme-Machine* (1960), Ch. 5, p. 102, fn. 20; and Pierre Lemée, *Julien Offray de La Mettrie, médecin, philosophe, polémiste; sa vie, son oeuvre* (Mortain: Editions Mortainais, 1954), 205-219.

^{xxxvii} Voltaire – Mme. Denis, 2 September 1751, in *Oeuvres de Voltaire*, ed. Beuchot, Vol. 55 (1831), no. 1755, pp. 657-660.

^{xxxviii} Voltaire – Mme. Denis, 14 November 1751, in *Oeuvres de Voltaire*, ed. Beuchot, Vol. 55 (1831), no. 1785, pp. 688-689. For the dramatic – indeed, farcical – story of La Mettrie’s death, see also Frederick – Wilhelmina, 21 November 1751 and Christoph Friedrich Nicolai, *Anekdoten*, vi. 197-227 both reproduced by Carlyle in *History of Friedrich II* (1864), 399-400. For an analysis of the various versions of this story, see Theodore Dressler, “La Mettrie’s Death: Or, The Nonsense of an Anecdote,” *Neophilologus* (1991), 194-199.

^{xxxix} Voltaire – Mme. Denis, 14 November 1751, in *Oeuvres de Voltaire*, (1831), no. 1785.

^{xl} Voltaire – Richelieu, 13 November 1751, in *Oeuvres de Voltaire*, ed. Beuchot, Vol. 55 (1831), no. 1783, pp. 684-685. The two meanings of “farce” may in fact be related, their common ancestry being the medieval comic performances that were stuffed in between religious presentations to entertain the *hoi polloi*.

^{xli} Voltaire – Mme. Denis, 24 December 1751, in *Oeuvres de Voltaire*, ed. Beuchot, Vol. 55 (1831), no. 1789, pp. 696-699.

^{xlii} Voltaire – Mme. Denis, 14 November 1751, in *Oeuvres de Voltaire*, ed. Beuchot, Vol. 55 (1831), no. 1785, pp. 688-689.

^{xliii} See for example Thibault, *Mes souvenirs* (1805), p. 407. Thibault also reports that La Mettrie had an uncontrolled imagination, that as an “absolute and pronounced materialist” he was “afraid of almost everything,” p. 406.

^{xliv} Voltaire – Mme. Denis, 24 December 1751, in *Oeuvres de Voltaire*, ed. Beuchot, Vol. 55 (1831), no. 1789, pp. 696-699.

^{xlv} Christoph Friedrich Nicolai, *Anekdoten von König Friedrich dem Zweyten von Preußen und von einigen Personen, die um ihn waren*, 6 vols. (Berlin und Stettin, 1788-1792), Vol. 1: 20, as recounted in Carlyle, *History of Friedrich II* (1864), pp. 399-400.

^{xlvi} La Mettrie, *L’Homme-Machine* (1747), 154, 182-183, 186, 190. Vaucanson appears on p. 190.

^{xlvii} La Mettrie, *L’Homme-Machine* (1747), 189-190. On La Mettrie and

^{xlviii} Diderot, *Eléments de physiologie* (Paris: Didier, 1964 (1784)), 20-21.

^{xlix} La Mettrie, *L’Homme-Machine* (1747), 192.

^l La Mettrie, *L’Homme-Plante* (1748), in La Mettrie, *Oeuvres philosophiques* (Paris: Fayard, 1984), Vol. 1, pp. 281-306.

^{li} La Mettrie, *L’Homme-Machine* (1747), 173-175, 196.

^{lii} Diderot, *Eléments de physiologie* (1784), 32.

^{liii} La Mettrie, *L’Homme-Machine* (1747), 145, 152, 164-165, 175.

^{liv} La Mettrie, *L’Homme-Machine* (1747), 176, 191-192, 194.

^{lv} La Mettrie, *L’Homme-Machine* (1747), 189, 192, 194, 196.

^{lvi} La Mettrie, *Système d’Epicure* (1750), ¶XLVI, in La Mettrie, *Oeuvres philosophiques* (Paris: Fayard, 1984), Vol. 1, pp. 353-386, on pp. 369-370.

^{lvii} Diderot, *Eléments de physiologie* (1784), 308.

^{lviii} For discussion of La Mettrie's proto-evolutionism, see Robert J. Richards, *Darwin and the Emergence of Evolutionary Theories of Mind and Behavior* (Chicago: University of Chicago Press, 1987), 25, 30, 32; Richards, *The Meaning of Evolution: The Morphological Construction and Ideological Reconstruction of Darwin's Theory* (Chicago: University of Chicago Press, 1993), 64; and Richards, "The Emergence of Evolutionary Biology of Behaviour in the Early Nineteenth Century," *British Journal for the History of Science*, Vol. 15, No. 3 (Nov., 1982), 241-280.

^{lix} La Mettrie, *L'Homme-Machine* (1747), 160. For an in-depth discussion of what La Mettrie had in mind when he spoke of "le grand Singe" and where he got his information on these animals, see Vartanian's commentary in fns. 45-48, pp. 213-216.

^{lx} On La Mettrie's influence Diderot, see Vartanian, "Trembley's Polyp" (1950). Vartanian attributes Diderot's about-face between the deistic *Pensées philosophiques* (1746) and the materialistic *Pensées sur l'interprétation de la nature* (1754) importantly to La Mettrie's *L'Homme machine*, p. 274.

^{lxi} Diderot, *Suite* (1784), 385.

^{lxii} La Mettrie, *Système d'Epicure* (1750), ¶s XVIII and XXI, pp. 353-386, *L'Homme-Machine* (1747), 359-360.

^{lxiii} La Mettrie, *L'Homme-Machine* (1747), 177.

^{lxiv} La Mettrie, *L'Homme-Machine* (1747), 162, 167; La Mettrie, *Système d'Epicure* (1750), ¶s XXVII and XXVIII, pp. 361-362.

^{lxv} La Mettrie, *L'Histoire naturelle de l'âme* (La Haye: Jean Neaulme, 1745), 151. La Mettrie attributed the image of man as a ship without a pilot to Spinoza, but in fact it came from a repudiation of Spinoza by Thémisuel de Saint-Hyacinthe [Hyacinthe Cordonnier]. See Israel, *Radical Enlightenment* (2001), 723.

^{lxvi} La Mettrie, *L'Homme-Machine* (1747), 163; Mettrie, *Système d'Epicure* (1750), ¶s XVI and XIII, pp. 357-358.

^{lxvii} La Mettrie, *L'Homme-Machine* (1747), 178. See Vartanian, "Interpretation of L'Homme-Machine," in Vartanian, ed., *La Mettrie's L'Homme-machine* (1960), Ch. 2, on p. 25.

^{lxviii} Gottfried Wilhelm Leibniz, *Essais de théodicée: sur la bonté de Dieu, la liberté de l'homme et l'origine du mal* [1710] (Paris: Aubier, 1962), 161, 189, 247, 365.

^{lxix} La Mettrie, *L'Homme-Machine* (1747), 149, 188.

^{lxx} Aristotle, *Physics*, Bk. 2 198b17-198b33 and 199b10-199b13; *On the Soul*, Bk. 2, 412a27-412b9.

^{lxxi} John Ray, *The wisdom of God manifested in the works of the creation* (London: Sam Smith, 1701 [3rd edition] [1st 1660]), 48-49.

^{lxxii} Ralph Cudworth, *The true intellectual system of the universe: the first part; wherein all the reason and philosophy of atheism is confuted...* (2nd edition, London, 1743. 1st published 1678) Vol. 1: 149.

^{lxxiii} John Toland, *Letters to Serena* (London: Bernard Lintot, 1704), 235. See also Nehemiah Grew, *Cosmologia sacra: or a discourse of the universe as it is the creature and kingdom of God* (London, 1701), Ch. V; and Pierre de La Touche Boesnier, *Préservatif contre l'irréligion, ou démonstrations des vérités fondamentales de la religion chrétienne* (La Haye, 1707).

^{lxxiv} Locke, *An Essay Concerning Human Understanding* [1690], Bk. 2, Ch. 27, §§ 6, 8 [Nidditch p. 330-332].

^{lxxv} Locke, *Essay* [1690], Bk. 2, Ch. 27, §§5, 6 [Nidditch p. 330-332].

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- ^{lxxvi} Hermann Boerhaave, *A new method of chemistry* (London, 1727), 142, 150.
- ^{lxxvii} Anon., *Wisdom and Reason; Or, Human Understanding Consider'd, with the Organization: Or, with the Form and Nature of the Solids and Fluids of the Body* (London: John Hooke, 1714).
- ^{lxxviii} Abbé Jean-Baptiste Dubos, *Réflexions critiques sur la poésie et sur la peinture* (Paris: P-J Mariette, 1733), Part 1, §49; Part 2, §7; Part 3, §10.
- ^{lxxix} See for example François-Alexandre Aubert de la Chesnaye-Debois, *Lettre sur les romans* (Paris: Gisse, 1743), 227-229.
- ^{lxxx} Denis Diderot, *Essai sur mérite et vertu* (1745), in *Oeuvres complètes*, Vol. 1 (Paris: Garnier, 1875), 98. See also pp. 32, 44, 66 on organized beings and organized bodies.
- ^{lxxxi} Voltaire, *Lettres philosophiques* [1734] (Paris: Hachette, 1915-1917), 188.
- ^{lxxxii} Marquis d'Argens, *Chinese Letters. Being a philosophical, historical, and critical correspondence between a Chinese traveller at Paris, and his countrymen* (London, 1741, 1st published 1739-1742).
- ^{lxxxiii} In addition to the instances listed above, see Jacques Bénigne Bossuet, *De la connoissance de Dieu et de soi-même* (1704), in *Oeuvres complètes*, Vol. 23 (Paris: L. Vives, 1864), 235, 242; and Etienne Bonnot de Condillac, *Essai sur l'origine des connaissances humaines* (Amsterdam: P. Mortier, 1746), 77.
- ^{lxxxiv} La Mettrie, *L'Homme-Machine* (1747), 166-67, 180.
- ^{lxxxv} Georges Buffon, *Histoire naturelle, générale et particulière*, Vol. 2 (Paris: Imprimerie royale, 1749), 37.
- ^{lxxxvi} Buffon, *Histoire naturelle*, Vol. 2 (1749), 19, 24; "organic molecules" and "interior mold" are presented in Ch. 3.
- ^{lxxxvii} Haller, preface to the second volume of the German translation of Buffon *Histoire naturelle*, 30 March 1752, quoted in translation in Roe, *The Natural Philosophy of Haller* (1981), "Introduction."
- ^{lxxxviii} Buffon, *Histoire naturelle*, Vol. 4 (1753), 40.
- ^{lxxxix} Buffon, *Histoire naturelle*, Vol. 2 (1749), 44-46, 51-53, 486-87.
- ^{xc} Buffon, "Discours sur les animaux" (1753), in *Histoire naturelle, générale et particulière, avec la description du Cabinet du Roy* (Paris: Impr. Royale, 1749-1778), t. 4: 94-95.
- ^{xc} Buffon, *Histoire naturelle*, Vol. 1 (1749), 12.
- ^{xcii} On La Mettrie and Maupertuis, see Vartanian, "Biographical Sketch of La Mettrie" (1960), 5, 7-8. On Maupertuis's presidency of the Prussian Royal Academy of Sciences, see Mary Terrall, *The Man Who Flattened the Earth: Maupertuis and the Sciences in the Enlightenment* (Chicago: University of Chicago Press, 2002), Ch. 8.
- ^{xciii} Pierre-Louis Moreau de Maupertuis, *Essai sur la formation des corps organisés* (Berlin, 1754), §§14, 51, 57 (see also §§52, 59, 63).
- ^{xciv} Maupertuis, *Essai* (1754), §§39, 44, 64. On Maupertuis's transformism and Leibnizianism, see Georges Canguilhem, "Note sur les rapports de la théorie cellulaire et de la philosophie de Leibniz," Appendix II in *La connaissance de la vie* (Paris: J. Vrin, 2003 [1965]); Jacques Roger, *Les sciences de la vie dans la pensée française au XVIIIe siècle* (Paris: Albin Michel, 1993), 484; Charles T. Wolfe,

“Endowed Molecules and Emergent Organization: The Maupertuis-Diderot Debate,” in *Early Science and Medicine* 15 (2010), 38-65.

^{xcv} James Parsons, *Philosophical observations on the analogy between the propagation of animals and that of vegetables* (London, 1752), 9.

^{xcvi} Diderot, *De l'interpretation de la nature* [1754], in *Oeuvres philosophiques*, ed. Paul Verniere (Paris: Garnier, 1956), p. 242.

^{xcvii} Jean-Baptiste Robinet, *De la nature* (Amsterdam: E. Van Harrevelt, 1761), see e.g. pp. 395, 399, 402.

^{xcviii} Delisles de Sales [Jean-Baptiste Izouard], *De la philosophie de la nature* (Amsterdam: Arkstee et Merkus, 1770 (1769)). Occurrences are rife, but see for example: Bk. 3, Ch. 2, p. 297; Bk. 3, Ch. 4, p. 414; Bk. 3, Ch. 5, p. 256. The repudiation of La Mettrie is in Bk. 3, Ch. 4, p. 138. On the commercial status of de Sales's book, see Robert Darnton, *The Forbidden Bestsellers of Prerevolutionary France* (New York: Norton, 1996), 48, 49, 70, 397n.

^{xcix} Paul Henri Thiry, baron d'Holbach, *Système de la nature, ou, Des loix du monde physique et du monde moral* [1770] (London, 1771), see e.g. p. 225.

^c David Hume, *Dialogues Concerning Natural Religion* (first publ. 1779, written c. 1751), in *Dialogues Concerning Natural Religion: And Other Writings (Cambridge Texts in the History of Philosophy)* (Cambridge: Cambridge University Press, 2007), Part 7, ¶13.

^{ci} For Hume's case against the argument from design, see Hume, *An Enquiry Concerning Human Understanding* (1748, Section XI; *Dialogues Concerning Natural Religion* (1779/1751); and J.C.A. Gaskin, “Hume on Religion,” in David Fate Norton, ed., *The Cambridge Companion to Hume* (Cambridge: Cambridge University Press, 1993), Ch. 11. Despite the current consensus among philosophers that Hume's argument was devastating, it was not received as such at the time, witness the success of Paley's book a generation later. On the fortunes of Hume's argument against the argument from design, see Andrew Pyle, *Hume's Dialogues Concerning Natural Religion Reader's Guide* (London: Continuum International, 2006), Ch. 5: “The lack of impact of Hume's *Dialogues* in early nineteenth-century Britain is very clear from the immense popularity of Paley's *Natural Theology* (1802),” p. 136. See also Gaskin, “Introduction,” in Hume, *Principle Writings on Religion* (Oxford: Oxford University Press, 1993), ix-x: “William Paley's *Evidences of Christianity* (1794) and *Natural Theology* (1802) had in effect been refuted by Hume in the *Dialogues* (1779) and elsewhere before they were even written; but Paley, not Hume, was the standard reading on religion for students throughout the nineteenth century and into the twentieth. Even when the balance changed in Hume's favour, under the influence of Logical Positivism in the 1930's and philosophical analysis in the post-war decades, the fashion was still to discuss a single argument or section of Hume's work in isolation from the rest.”

^{cii} Boyle, *A Disquisition about the Final Causes of Natural Things* (1688), 55.

^{ciii} Hume, *Dialogues concerning natural religion* (1779/1751), Part 7, ¶13.

^{civ} Jean François Marmontel, *Poétique française* (Paris: Lesclapart, 1763), 316.

^{cv} Charles Bonnet, *Contemplation de la nature* [1764], in *Oeuvres*, Vol. 4 (Neuchatel: S. Fauche, 1781), Part 2, p. 29. See also Bonnet, *La palingénésie philosophique* (Geneva: Philibert et Chirol, 1769), Part 9, p. 320.

^{cvi} Bonnet, *La palingénésie philosophique* (1769), Part 9, p. 321; *Considérations sur les corps organisés* [1762] (Amsterdam: M.M. Rey, 1768), 1, 8, 13; “animal machines”: *Contemplation* [1764], Part 3, Ch. 14.

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- ^{cvii} Bonnet, *La palingénésie philosophique* (1769), Part 9, p. 323; *Considérations* [1762], 13; “organic machines”: *Principes philosophiques* (1755), 344, 380-381, 363; *Considérations* [1762], 13, 139; *Contemplation* [1764], Part 8, p. 368.
- ^{cviii} Bonnet, *Contemplation* [1764], Part 8, pp. 359-361 (*machinules*).
- ^{cix} Bonnet, *Principes philosophiques* (1755), 304, 340.
- ^{cx} Lazzaro Spallanzani, *Nouvelles recherches sur les découvertes microscopiques, et la génération des corps organisés* (London, 1769), ii, 6.
- ^{cxⁱ} Diderot, *Rêve* (1769), 325-326.
- ^{cxⁱⁱ} Bonnet, *Considérations* [1762], 90-91. On the eternal, perpetual and universal “circulation of organized matter,” see also William Smellie, *The philosophy of natural history* (Dublin, 1790), p. 72.
- ^{cxⁱⁱⁱ} Bonnet, *Contemplation* [1764], Part 8, p. 359.
- ^{cx^{iv}} Bonnet, *La palingénésie philosophique* (1769), Part 15, pp. 112-113.
- ^{cx^v} See Thomas L. Hankins, *Jean d’Alembert: Science and the Enlightenment* (Taylor and Francis, 1990), Ch. 4; and Riskin, *Science in the Age of Sensibility* (2002), 56-58, 123.
- ^{cx^{vi}} Emily Jane Cohen, “Enlightenment and the Dirty Philosopher,” *Configurations* 5.3 (1997), 369-424, on p. 408.
- ^{cx^{vii}} On d’Alembert’s much-gossiped-about relations with Julie de Lespinasse, see Hankins, *Jean d’Alembert* (1990), Ch. 6.
- ^{cx^{viii}} Diderot, *Entretien entre d’Alembert et Diderot* (1769) in *Oeuvres Philosophiques*, Ed. P. Verniere (Paris, Garnier, 1961), 258, 276; *Le rêve de d’Alembert* (1769), in *Oeuvres Philosophiques*, Ed. P. Verniere (Paris, Garnier, 1961), 313.
- ^{cx^{ix}} Diderot, *Entretien* (1769), 271-274.
- ^{cx^x} Immanuel Kant, *Kant’s Critique of Judgement*, translated with Introduction and Notes by J.H. Bernard (2nd ed. revised) (London: Macmillan, 1914), §42: Of the intellectual interest in the Beautiful, ¶462; §65: Things regarded as natural purposes are organised beings, ¶670. On Kant’s view of organization, see Evelyn Fox Keller, “Organisms, Machines and Thunderstorms: A History of Self-Organization, Part One,” in *Historical Studies in the Natural Sciences* Vol. 38, No. 1 (Winter 2008), 45-77, on pp. 47-51.
- ^{cx^{xi}} Bonnet, *Principes philosophiques* (1755), 340.
- ^{cx^{xii}} Bonnet, *Essai de psychologie* [1754], in *Collection complète des oeuvres*, Vol. 8 (Neuchatel: S. Fauche, 1783), 107; *Principes philosophiques sur la cause première et sur son effet*, in *Essai de psychologie ... Auxquelles on a ajouté des Principes philosophiques* (London, 1755), 298.
- ^{cx^{xiii}} Bonnet, *Contemplation* [1764], Part 11, p. 293.
- ^{cx^{xiv}} Diderot, *Eléments de physiologie* (1784), 138.
- ^{cx^{xv}} Diderot, *Rêve* (1769), 300; Diderot, *Suite de l’entretien* (1784), in *Oeuvres Philosophiques*, Ed. P. Verniere (Paris, Garnier, 1961), 375-379.
- ^{cx^{xvi}} Pierre Samuel Dupont de Nemours, *De l’origine et des progrès d’une science nouvelle* (1768), in *Oeuvres politiques et économiques* (Nendeln: KTO, 1979), Vol. 1, pp. 525-611, on p. 536.

^{cxxvii} Pierre-Paul Mercier de la Rivière, *L'Ordre naturel et essentiel des sociétés politiques* (London, 1767), 3, 5, 35.

^{cxxviii} Jean-Paul Marat, *A philosophical essay on man* (London, 1773), 33. On Marat, popular science and radical politics, see Robert Darnton, *Mesmerism and the End of the Enlightenment in France* (Cambridge: Harvard University Press, 1968), Ch. 3.

^{cxxix} See especially Jacques-Henri Bernardin de Saint-Pierre, *Etudes de la nature* (1784).

^{cxxxx} Joseph Priestley, *Disquisitions related to matter and spirit* (Birmingham, 1782), Vol. 1, pp. 150, 152; see also pp. iv and 202 (for a reference to La Mettrie).

^{cxxxi} Priestley, *Disquisitions* (1782), Vol. 1, pp. 264-265, 269, 206.

^{cxxxii} Priestley and Richard Price, *A free discussion of the doctrines of materialism, and philosophical necessity, in a correspondence between Dr. Price, and Dr. Priestley* (London, 1778), cited passage on 75-76. See also Priestley, *Disquisitions* (1782), Vol. 1, p. iv: "... what we call mind ... [is] the result of corporeal organization"; and p. 117: "A certain quantity of nervous system is necessary to such complex ideas and affections as belong to the human mind; and the idea of self, or the feeling that corresponds to the pronoun I (which is what some may mean by consciousness)...."

^{cxxxiii} Frederick II – Voltaire, 1751, in *Oeuvres de Voltaire*, ed. Beuchot, Vol. 55 (1831), np. 1773, pp. 675-676.

^{cxxxiv} Paul Broca, *Sur le Transformisme* (Paris: Reinwald, 1871).

^{cxxxv} Jean-Baptiste Lamarck, *Philosophie zoologique, ou, Exposition des considérations relative à l'histoire naturelle des animaux* (Paris: Dentu, 1809), 111, 445-446.

^{cxxxvi} See Lamarck, *Système analytique des connaissances positives de l'homme, restreintes à celles qui proviennent directement ou indirectement de l'observation* (Paris: J.-B. Baillièrre, 1830), 9-10, 12, 33. On the opposition between Lamarckism and the natural theology of Paley's tradition, see Ernst Mayr, "Lamarck Revisited," in *Evolution and the Diversity of Life: Selected Essays* (Cambridge: Belknap, 1997), Ch. 17; Ludmilla Jordanova, "Nature's powers: A reading of Lamarck's distinction between creation and production," in James R. Moore, ed., *History, Humanity and Evolution: Essays for John C. Greene* (Cambridge: Cambridge University Press, 1989), Ch. 2; Peter J. Bowler, *Evolution: The History of an Idea* (Berkeley: University of California Press, 2003), 127; and Aileen Fyfe, *Science and Salvation: Evangelical Popular Science Publishing in Victorian Britain* (Chicago: University of Chicago Press, 2004), Ch. 2, esp. p. 94.

^{cxxxvii} For recent scholarship correcting the misapprehension of Lamarck as first transformist, see Pietro Corsi, "Before Darwin: Transformist Concepts in European Natural History," in *Journal of the History of Biology* (2005) 38: 67–83.

^{cxxxviii} Buffon, *Histoire naturelle*, t. 4 (1753), 18, 382-83. The only sort of species-change that Buffon explicitly avowed in writing was degeneration. See Buffon, "De la dégénération des animaux," in *Histoire naturelle*, Vol. 14 (1766), 311-374; *Epoques de la nature, Histoire naturelle supplément*, t. 5 (1778), 26-27. The secondary literature on Buffon's views about species-change is voluminous, but see for example Philip Sloan, "Buffon, German Biology, and the Historical Transformation of Biological Species," *British Journal for the History of Science* 12 (1979), 109–153; Roger, *Les sciences de la vie* (1993), [PP]; Roger, *Buffon: un philosophe au Jardin du Roi* (Paris: Fayard, 1989), [PP].

^{cxxxix} Hume, *Dialogues Concerning Natural Religion* (1779/1751), Part 7, ¶s3, 7.

^{cxli} Diderot, *De l'interprétation de la nature* (1754), in *Oeuvres philosophiques*, ed. Paul Vernière (Paris: Garnier, 1956), 241-242.

^{cxli} Diderot, *Entretien* (1769), 267-268.

^{cxlii} Diderot, *Rêve* (1769), 299, 302.

^{cxliii} Diderot, *Entretien* (1769), 267-268.

^{cxliv} Diderot, *Entretien* (1769), 268.

^{cxlv} Diderot, *Rêve* (1769), 303.

^{cxlvi} Diderot, *Rêve* (1769), 298.

^{cxlvii} Erasmus Darwin, "The loves of plants," Part II of *The Botanic Garden, A Poem in Two Parts* (Lichfield, 1789).

^{cxlviii} Darwin, *Zoonomia; or, the laws of organic life* (Dublin, 1794-1796), 499, 183. On Darwin's transformism, see Richards, *The Meaning of Evolution* (1993), especially 64-65; Richards, "Influence of Sensationalist Tradition on Early Theories of the Evolution of Behavior," *Journal of the History of Ideas* 40 (1979), 85-105; and Bentley Glass, ed., *The Forerunners of Darwin* (Baltimore: Johns Hopkins University Press, 1968), Chs. 3-5.