5

Enlightened Automata

Simon Schaffer

> While justly respecting great geniuses for their enlightenment, society ought not to degrade the hands by which it is served.
>
> Jean d'Alembert, *Preliminary Discourse to the Encyclopaedia of Diderot* (1751)

Automata figure in the sciences of the Enlightenment as machines in the form of humans and as humans who perform like machines. Some of these sciences proposed the organization of productive bodies in disciplined settings, then understood production in terms of the workings of automata. In 1757, the Royal Academy of Sciences in Paris was presented with representatives of just such enterprises during a contest for its post of associate mechanician. Backed by court patronage and celebrated for his designs of automata and his work in the silk mills, the engineer Jacques Vaucanson was appointed to the post. Vaucanson's automata, first put on show in Paris and London, provided matter for catchpenny theatrics, materialist theorizing, and industrial management. The loser in 1757 was the editor of the *Encyclopédie,* Denis Diderot. His accounts and images of a vast range of machines and labor processes have long been taken as a key to the Enlightenment's attitude to mechanical work. Diderot's handling of the mechanical arts was no less embroiled in the puzzles of automatism. As Ken Alder points out in this book, the *Encyclopédie* repeatedly announced its aim to free the mechanical arts from the condescension and ignorance of the noble and the literate, yet did so in the name of an ideal of rationalized labor processes under the guidance of enlightened managers. Jean Ehrard has sagely observed that "the Encyclopedist apologia for labour is an apologia for capital."[1] Laborers were there judged too secretive, incapable of fully expressing the true principles on which labor processes relied. By making techniques perfectly visible, they could apparently be reproduced anywhere and everywhere. In general, as William Sewell has argued, "the workers of the

1. Doyon and Liaigre, *Vaucanson,* 308; Ehrard, "La main du travailleur," 53.

Encyclopédie are docile automatons who carry out their scientifically determined tasks with the efficiency and joylessness of machines."[2] The figure of the automaton thus had major epistemic and economic consequences. Because Diderot and his collaborators reckoned that active gestures were a fundamental source of knowledge, it was clear to them that valuable knowledge was locked up in the operations of mechanical workers. That knowledge could only be freed, reformed, and rendered efficient by the gaze of the enlightened, whose faith held that automatic machinery could displace these gestures. This belief legitimated the new devices representing working human bodies.[3]

The focus of this chapter is the relation that some Enlightenment savants developed between machinery viewed as human and humans managed as machines. Its immediate inspiration is a celebrated and tragic image employed by Walter Benjamin in his very final notes on "the problem of memory and forgetting," penned as a refugee from Fascism in 1940. The previous decade had understandably witnessed an efflorescence of studies, from Ernst Cassirer not least, of the Enlightenment. Meditating on the relation between the Enlightenment's two great Germanic legacies, idealist metaphysics and historical materialism, Benjamin invoked "an automaton constructed in such a way that it could play a winning game of chess." He found the automaton described in an essay by one of his favorite authors, Edgar Allan Poe, who had in turn plagiarized accounts of a late-eighteenth-century machine, fashioned in the form of a Turk, that seemed to possess unrivaled skill at chess though worked by a hidden (and human) virtuoso. Benjamin imagined "a philosophical counterpart" to this "puppet in Turkish attire" and to its "little hunchback who was an expert chess player seated inside." He wrote that "the winner, if it is up to me, will be the Turkish puppet, for whom the philosopher's name is materialism. It can easily be a match for anyone if assured of the services of theology, which today, however, is small and ugly and nowhere to be seen." The ugly theology to which Benjamin referred relied on the Romantic metaphysics of early-nineteenth-century Germany; the puppet of materialism embodied Benjamin's attitude to Marxism. Since Jürgen Habermas, at least, commentators have sought to define the relative power of the dwarf and the puppet, of theology and materialism. Responding to conservative attacks on the Enlightenment's legacy, Habermas has recently insisted that "it is of the very nature of the Enlightenment to enlighten itself about itself, and about the harm that it

2. For Diderot and workmen as automata, see Koepp, "Alphabetical Order," 243, 251, 255, and Sewell, "Visions of Labor," 277.

3. Puymèges, "Les machines dans l'*Encyclopédie*"; Proust, "L'image du peuple"; Picon, "Gestes ouvriers."

does." Some forms of automatic machinery—especially the amazing Turk—can be used to explore this kind of self-enlightenment and its ills.[4]

The automatic chess player was first designed in the 1760s by an ingenious Habsburg courtier to match his own virtues against the vulgar and the merely skillful. In the opening section of this chapter, it is argued that the status of enlightened philosophers was often supposed to depend on their capacity to comprehend the mechanical principles of nature and society alike. Once shown at court, the Turk became a major attraction of the fairs and theaters. The second section of the chapter therefore describes how such automata became captivating commodities, their meanings established in the market and their value assigned through commerce. Automata were never merely metaphors of social order. As commodity fetishes they played a significant role in the manufacturing economy and the mercantile system. The third section of this chapter connects major works of Enlightenment materialism with actively interventionist projects of Enlightenment engineering to indicate how such devices changed the management of industry and the workforce. Examples include Vaucanson's early theatrical automata, which then helped him establish systems of manufacture in the silk industry in the midcentury, and Lavoisier's chemical analysis of the animal economy, which let him evaluate the mechanical effects of both intellectual and manual labor. By the apparent mechanization of rational analysis, the show of the Turkish automaton then broached the issues of determinism and free will, obsessions of Enlightenment philosophy. The chess player appeared in the German lands at the same time as Kant's celebrated essay on Enlightenment. Late-eighteenth-century accounts of political order such as those of Kant, or Bentham, explicitly used automata as apt emblems of subjection and government. The fourth section of this chapter thus traces these arguments to emphasize how governmentality was worked out through the philosophy of automatic machinery. It at last becomes apparent why Benjamin was right to see in this exotic device a rich motif of Enlightenment philosophy and its legacies. In his survey of these legacies, Jean Starobinski has associated the end of the Enlightenment with "a technical expansion of the human will." Humanity's new knowledge of nature's mechanically determined laws enabled large-scale intervention in and command over the world defined by those laws. He picks out two aspects of this technical expansion—anthropogeny (the artificial production of humans) and utopianism (projects for ideal societies). This chapter thus examines connections between the Enlightenment construction of automata and of its idealized social order.[5]

4. Benjamin, "Theses on the Philosophy of History," in *Illuminations*, 253; Nietzhammer, *Posthistoire*, 104–8 (citing Benjamin's revision of the Turkish image); Habermas, *New Conservatism*, 201. For Benjamin's theology see Roberts, *Walter Benjamin*, 210, 216.

Visible Technicians and Productive Labor

Some historians still deny that enlightened natural philosophies "fed the fires of the industrial revolution." Others more convincingly indicate the intimate connection between the machinery of natural philosophers' concerns and that of the new entrepreneurs and projectors. The lettered savants who plied their trade in a culture dominated by interests in economic improvement and civic sensibility were in fact noteworthy analysts of and contributors to mechanization and its consequences.[6] Enlightened philosophers tried to build for themselves a position from which they could describe the mechanisms that governed nature and humanity. We can see this process in exemplary sites of enlightened sciences such as Lowland Scotland and absolutist France. Diderot invited his bourgeois readers to admire the workings of an automated silk loom, in which "a machine makes hundreds of stitches at once . . . and all without the worker who moves the machine understanding anything, knowing anything or even dreaming of it." Workers resembled the very machine they managed. This is how the Scottish philosophic historian Adam Ferguson saw things in 1767:

> Many mechanical arts require no capacity. They succeed best under a total suppression of sentiment and reason, and ignorance is the mother of industry as well as of superstition. Reflection and fancy are subject to err, but a habit of moving the hand, or the foot, is independent of either. Manufactures, accordingly, prosper most, where the mind is least consulted, and where the workshop may, without any great effort of imagination, be considered as an engine, the parts of which are men.[7]

From the elevated viewpoint of the Edinburgh chair of moral philosophy, Ferguson here managed "without any great effort of imagination" to identify laborers with the machines they used. This identity, the disciplined productive body as automaton, played a salient role in the formation of enlightened culture. Automata were supposedly produced by rational design and modeled both the celestial system and the animal economy. Their history had taken them from religious and courtly ceremonies to eighteenth-century markets,

5. Starobinski, *Invention of Liberty*, 207–8.

6. Compare Jacob, "Scientific Culture," 136, and Stewart, *Rise of Public Science*, 29–30, with the response in Sutton, *Science for a Polite Society*, 211–12.

7. *Encyclopédie*, 2:98 ("Bas"); Ferguson, *An Essay*, 182–83.

squares, and theaters, a transition quite comparable with that of the enlightened themselves. In Ferguson's conjectural history, the division of labor purchased social progress at a price that limited the scope of laborers' interests to their immediate concerns. Thence arose "in this age of separations" a hierarchy defined in terms of the scope of individual attention: sympathy sustained the solidarity of intellectual elites; the laboring class was barely capable of refined feeling. According to Ferguson, "even in manufacture, the genius of the master, perhaps, is cultivated, while that of the inferior workman lies waste. The statesman may have a wide comprehension of human affairs, while the tools he employs are ignorant of the system in which they are themselves combined." This systematic overview defined the philosopher's place too: "thinking may become a peculiar craft."[8] Son of a Calvinist minister and grandson of a Perthshire artisan, Ferguson's own craft of thinking required careful specification. The efforts of laborers might benefit from progressive division and mechanization, but the social hierarchy did not. Discipline should be based on moral order, not on the mechanical relations found in manufactures. The effects of separation, which bred surplus value and leisured classes, would compensate for those of subordination. The workshops' inmates could be seen as automata, but the denizens of the enlightened academy must forge a crucial alliance of "the citizen and the statesman," which could compensate for the effects of "the subdivision of arts and professions." These hybrid citizen-statesmen were to be the privileged bearers of rational philosophy.[9]

In the same decade, Ferguson's opposite number at Glasgow, Adam Smith, drafted similar arguments for his planned treatise on political economy. "It was the division of labour," he wrote, "which probably gave occasion to the invention of the greater part of those machines by which labour is so much facilitated and abridged." But according to Smith, the key technical innovations could not be credited to confined workers but to those possessed of a much wider view. Water- and windmills were due to "no work man of any kind, but a philosopher or meer man of speculation; one of those people whose trade it is not to do any thing but to observe every thing, and who are upon that account capable of combining together the powers of the most opposite and distant objects." For the enlightened professors, spokesmen of a self-confident elite of improving landlords and civic humanists, philosophers' role was to exploit their relative leisure to coordinate powers sundered by the division of labor. The development of steam engines and mill wheels, "the application of new powers which are altogether unknown and which have never before been applied to any similar purpose, belongs to those only who have a greater range of thought and more extensive views of things." Smith's Glasgow colleague the eminent chemist William Cullen voiced the same view about the subordination of arts and the superintendence of the enlightened philosopher. For Smith, philosophy itself became "a particular business, which is carried on by very few people who furnish the public with all the thought and reason possessed by the vast multitudes that labour."[10]

Philosophers' "particular business" was hard to define in this scheme of productive labor. In the 1760s, Smith met the protagonists of enlightened philosophy, notably physiocratic economists such as Turgot and Quesnay, during his visit to their capital, Paris. While he sought to demolish the physiocrats' claim that manufacturers and merchants were necessarily unproductive, a "humiliating appelation," Smith nevertheless assigned significant social groups to the "the barren or unproductive class." Magistrates and the military, plus "churchmen, lawyers, physicians, men of letters of all kinds; players, buffoons, musicians, opera-singers, opera-dancers etc." were all "unproductive of any value."[11] The most elevated and mercenary were among those social agents whose enterprises might be represented mechanically. Performance worked through entertaining artifice, armies behaved like well-ordered mechanisms, clerks were depicted as cogs in the machinery of state, the government itself was supposed to emulate the order of the world machine. But it was puzzling for Smith and his allies to specify how intellectual labor might be understood in the mechanical system. This was why Marx recorded the complaint that "Adam Smith invented the category of unproductive labourers out of pure malice, so that he could put the Protestant parsons in it." Marx observed that "Milton who wrote *Paradise Lost* was an unproductive worker. On the other hand, a writer who turns out work for his publisher in factory style is a productive worker." Smith's epoch was just when this style of literary production emerged and, it has been argued, came to dominate the business of enlightenment. Writers looked like automata. As Roger Chartier tells us, the commercial mechanization of print culture accompanied the ideology of "the urgency and absolute freedom of creative power," and this perverse relation between

8. Ferguson, *An Essay*, 181–84. For Ferguson's politics, see Burchell, "Peculiar Interests," 119–50. For elitist sympathy, see Lawrence, "The Nervous System," 29.

9. Ferguson, *An Essay*, 230; on the militia and discipline, see Sher, *Church and University*, 220.

10. Smith, "Early draft of part of *The Wealth of Nations*," in *Lectures on Jurisprudence*, 569–72. For Cullen, see Christie, "Ether," 95, and for Smith's comparable remarks on the chemistry laboratory, see Golinski, *Science as Public Culture*, 30–31; for Scottish improvement and enlightenment, see Christie, "Scottish Scientific Community"; Phillipson, "Scottish Enlightenment."

11. Smith, *Wealth of Nations*, 1:330–31, 2:664.

subjection to the market and intellectual liberty was characteristic of the predicament of Enlightenment philosophers, Diderot and Smith alike.[12]

Better to understand the valorization of intellectuals' literary labor both as inspiration and merchandise, these philosophers could establish their power through their view of the machine. Smith's favored example of the division of labor, the pin factory, was taken from an article on a Normandy workshop he read in the *Encyclopédie,* the first volumes of which he bought for Glasgow University Library. The plates there illustrating the pin factory were made by the civil engineer Jean-Rodolphe Perronet, an expert on the disaggregation of the labor process keen to regiment piecework so as to subordinate production to the management of the enlightened engineer. The article on pin making was immediately followed by Diderot's editorial reflection on the virtues of enlightened authors. He there claimed the entry on pin making "will prove that a good mind can sometimes, with the same success, both raise itself to the highest contemplations of philosophy and descend to the minutest details of mechanics." Encyclopedists could "pass without disdain from a search for the general laws of nature to the least important use of its products."[13] Equable philosophy depended on the careful construction of the laws that governed the cosmos and primitive superstition on ignorance of their mechanics. However different their perspectives on civic society and rural virtue, Ferguson and Smith both shared this view. Ferguson attributed the "ignorance and mystery" of irrational superstition to subjects' perplexity when faced with "strange and uncommon situations." Truly enlightened social order hinged on "the study of nature by which we are led to substitute a wise providence operating by physical causes in the place of phantoms that terrify or amuse the ignorant." Smith argued similarly that "the lowest and most pusillanimous superstition" was spawned by "every object of nature . . . whose operations are not perfectly regular," and that were therefore "supposed to act by the direction of some invisible and designing power." Struck by David Hume's critique of innate causal powers, Scottish philosophers claimed that the progress of machine philosophy calmed these fears and wonders by imaginatively connecting phenomena under lawlike regularities. In a posthumously published essay edited by his literary executor, the chemist Joseph Black, Smith explained that "a machine is a little system created to perform as well as to connect together in reality those different movements and effects which the artist has occasion for. A system is an imaginary machine invented to connect together in fancy those different movements and effects which are already in reality performed." And in the same work, he stipulated that the audience of any superior artwork was moved by "a very high intellectual pleasure not unlike that which it derives from the contemplation of a great system in any other science"—spectators of the *theatrum mundi* were moved by the same systematic pleasures as those of any other playhouse. In the mechanisms to which Diderot and Smith appealed, these systems switched the sources of power from invisible and capricious agents to the regular operations of predictable constructs.[14]

12. Marx, *Capital,* 1:768 n. 6 (on Smith) and 1044 ("Results of the Immediate Process of Production," 1863, on Milton). For literary production, see Darnton, *Business of Enlightenment;* Kernan, *Printing Technology;* and Chartier, *Order of Books,* 37.

13. Picon, "Gestes ouvriers," 135, on Perronet; Vidler, *Writing of the Walls,* 26, on workshops' depiction in the *Encyclopédie;* on the division of labor, see *Encyclopédie,* 1:717 ("Art"), and 5:807 ("Epingle"). See Smith, *Wealth of Nations,* 15 n. 3 and 17 n. 10, for his use of this source; Scott, *Adam Smith,* 179, for his purchase of it; and Alder, *Engineering the Revolution,* for the engineering concept of skilled work.

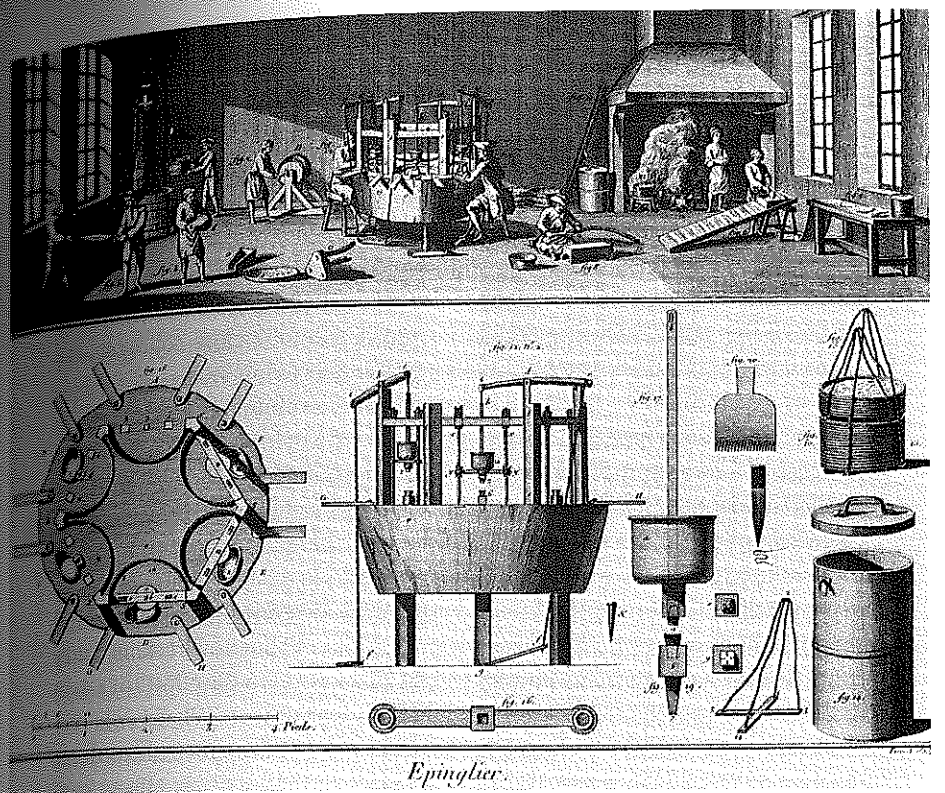

Fig. 5.1. The division of labor in a Normandy pin factory as Adam Smith saw it represented in the *Encyclopédie* in 1765. From Denis Diderot and Jean d'Alembert, eds., *Encyclopédie: Receuil des planches* (1765), vol. 21, plate 3, "Epinglier."

14. Ferguson, *Essay,* 90–91; Smith, *Essays,* 48–50, 66, 205.

The sciences of labor were integrated with laboratory techniques. As Lissa Roberts has argued, enlightened modernity viewed the body as a machine—and in chemistry as in industrial production surrounded it with ever more complex systems of human-built technologies. These technologies, she points out, then helped change the polity. After managing military works in the French West Indies in the 1760s, the eminent engineer and academician Charles Coulomb tried to evaluate the maximum effect extractable from labor. Coulomb's political economy taught him that work that commanded the same wage must involve the same amount of fatigue. Field trials allowed him to measure the effects of this labor.[15] During the early 1790s, Coulomb's close colleague, the chemist and economist Antoine Lavoisier, was involved in studies of the balance of profit and loss in the national agrarian economy and of means to reform the French political machine. At just the same time, he managed to develop a technique for the precise evaluation of the mechanical worth of intellectual labor. He reported at once on these techniques to his eminent chemical colleague Black, another authority on the animal economy and its thermal mechanics.[16] Lavoisier's laboratory methods treated all humans as so many machines absorbing vital air and nutriment. By evaluating pulse rate and air consumption, the prudent academician and his collaborators reckoned they could determine "how many pounds weight correspond to the efforts of a man who recites a speech, a musician who plays an instrument. Whatever is mechanical can similarly be evaluated in the work of the philosopher who reflects, the man of letters who writes, the musician who composes. These effects, considered as purely moral, have something physical and material which allows them, through this relationship, to be compared with those which a labourer performs." Lavoisier's chemical technology understood all humans as automata laboring in closed exchange systems. "It is therefore not without justice that the French tongue mixes together under the common name 'work' *[travail]* the efforts of the mind as well as those of the body, the work of the study and the work of the hireling." In the very months during which Lavoisier was preoccupied with evaluating agricultural productivity for the National Assembly, he here explained how the enlightened natural philosopher could "organize and regenerate" the careful balance of social, human, and natural machines. "In the silence of his laboratory and his study, the natural philosopher *[physicien]* can also exercise patriotic functions. . . . He can also aspire to the glorious title of benefactor of humanity." By constructing, displaying, and imagining such self-governing machine systems, the enlightened supposed

15. Roberts, "Death of the Sensuous Chemist," 507–8, 521; Coulomb, "Mémoire sur la force des hommes," 260. See Gillmor, *Coulomb*, 23–24, and Vatin, *Le travail*, 42–43.

16. Holmes, *Lavoisier*, 444–46, for Lavoisier and Black.

they could make their own social order and secure a powerful place within it. So automata had a political function in "the technologies of rationalism."[17]

Automata and the Parliament of Monsters

Histories of automata, drawing on the classical texts of Hero and Vitruvius, chronicled their hieratic role in ancient temples, where they could be used to impress the faithful, then traced the development of ingenuity in cathedral timekeepers and courtly entertainments. Such clockwork and hydraulic devices linked the workings of the cosmos, the state, and the human body. Renaissance horology allowed the construction of purely mechanical devices, and these typically involved shows that mixed celestial with mundane figures in planetaria or dances. Thus the automata installed by Tomaso Francini for the French monarch at Saint-Germain-en-Laye around 1600 included a Grotto of Perseus, in which alongside a set of smiths, weavers, and other artisans working steadily at their trades the eponymous hero slew his dragon. Francini's devices and their imitators at Fontainebleau were a plausible source of notorious Cartesian accounts of the animal machine. Baroque princes commissioned a host of similar devices, which mechanized the deeds of gods and heroes or else the labors of servants and workmen.[18] Automata were apt images of the newly disciplined bodies of the military systems of early modern Europe. In Golden Age Netherlands and absolutist Prussia, drill masters worked out systems to turn soldiers into machines. Automata as models of the well-regulated workshop also proliferated. Dan Christensen has recently described a remarkable eighteenth-century automaton built to represent the workings of the Kongsberg silver mine in Norway and its royal Danish administrators—there, for example, mercantilist management saw mineworkers as so many mechanical elements of a centrally driven automatic system. These projects ingeniously connected a culture that viewed laborers as machines with one that saw machines as sources of power. Access to the inwards of these machines was at least as vital as the display of their marvelous performance. Automata were both arguments and entertainments, designed seductively to place craft skill within the setting of power, and to allow the selective entry by that power to the inner workings of

17. Lavoisier and Seguin, "Première mémoire sur la respiration des animaux" (1790), in Lavoisier, *Oeuvres*, 2:697. See Holmes, *Lavoisier*, 454; Bensaude Vincent, *Lavoisier*, 220; Lavoisier, *De la Richesse Territoriale*, 10–11. For "technologies of rationalism" and Lavoisier's balances, see Wise, "Mediations," 220.

18. Useful histories are Brewster, *Letters on Natural Magic;* Chapuis and Droz, *Automata;* Price, "Automata in History"; Bedini, "Automata in the History of Technology"; Heckmann, *Die andere Schöpfung*, 91–106, 170–81; Beaune, "Classical Age of Automata." For Francini, see Chapuis and Droz, *Automata*, 43–47; for Cartesianism, see Jaynes, "Problem of Animate Motion," 224, and Dear, "Mechanical Microcosm," 58–60.

art and nature. Such devices thus played roles in early Enlightenment debates involving both clerics and court philosophers on the puzzles of good government—of the world by the deity, of the state by the prince, of the workshop by the master, and of body by spirit.[19]

In early modern cities, these machines moved from palaces and churches to fairgrounds, showrooms, and salons. The very term "automaton" had already been introduced into French in Rabelais's carnivalesque epics. As Peter Dear has perceptively indicated, the formalization of civility in early modern bourgeois societies helped make Cartesian accounts of mechanization current. By the eighteenth century, automata were not merely common in the shows but occupants of the linked worlds of court, marketplace, and theater. There, it was argued, "artificial men" wound up by internal and occult mechanisms played out their games of passion and interest, privy schemes were brought before the public in the name of commerce and spectacle.[20] Machines commissioned by Friedrich II from the émigré clockmaker Abraham-Louis Hugenin, or by Maria Theresa, for whom the inspector of the imperial physics cabinet Friedrich von Knaus built an automaton that could write its own messages during the 1750s, ended up on tour round European showrooms. In Paris, the automaton market boomed after Vaucanson's celebrated works of the late 1730s, a mechanical drummer, a flute-player, and a duck that could digest and even defecate. The young Grenoble engineer's machines were on show at salons and the great Paris fairs. Pleasure seekers paid 24 sous to see his mechanical flautist give concerts in the Tuilieries in 1738. "At first many people could not believe that the sounds were produced by the flute which the automaton was holding. . . . The spectators were permitted to see even the innermost springs and to follow their movements." Automata soon began dominating the so-called *cabinets de physique* at Saint-Laurent and Saint-Germain. When a consortium of Lyonnais businessmen bought the three automata in 1742, the machines were taken to London, put on show at the Haymarket Theatre, and publicized with a translation of Vaucanson's pamphlets produced by the doyen of London engineers and demonstrators, John Desaguliers.[21]

19. For military discipline, see McNeill, *Pursuit of Power,* 125; Flesher, "Repetitive Order," 468–70; for philosophical automata, see Sutter, *Göttliche Maschinen,* 94–98; Robinet, "Leibniz, l'automate, et la pensée"; Gabbey, "Cudworth, More, and the Mechanical Analogy"; Giglioni, "Automata Compared." For Kongsberg, see Christensen, *Det modern Projekt,* 74.

20. Heckmann, *Die andere Schöpfung,* 208–10; Dear, "Mechanical Microcosm," 64–65. See also Beaune, "Classical Age of Automata," 431; Agnew, *Worlds Apart,* 162–69; Stallybrass and White, *Poetics and Politics,* 106–11.

21. Chapuis and Droz, *Automata,* 96–97 (Hugenin), 273–77 (Vaucanson), 289–92 (Knaus). For Knaus, see also Heckmann, *Die andere Schöpfung,* 235–38, and for the aftermath of Vaucanson's automata, see 228–32. For Paris automata, see Isherwood, *Farce and Fantasy,* 48–49, and Benhamou, "From *Curiosité to Utilité.*" For the Lyons consortium, see Doyon and Liaigre, *Vaucanson,* 87–89.

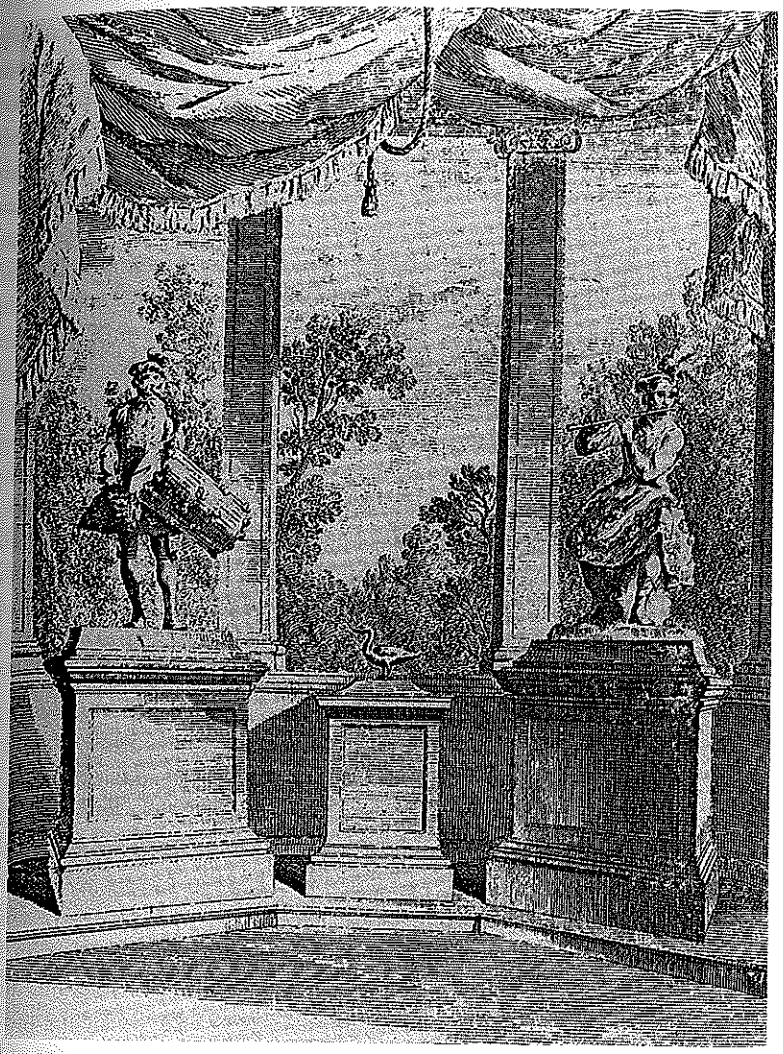

Fig. 5.2. Vaucanson's three automata: a drummer, a duck, and a flute player. From Jacques de Vaucanson, *An Account of the Mechanism of an Automaton,* translated by Jean Desaguliers (London, 1742).

London, metropolis of enlightened consumption, was peculiarly susceptible to the automata shows. The reputation there of John Merlin, who ran a mechanical museum in the West End, rivaled even that of Vaucanson. In his reminiscences of these London fairs, William Wordsworth punningly evoked the "Clock-work, all the marvellous craft / of modern Merlins. . . . All jumbled up together, to compose / a Parliament of Monsters." After winning prestigious finance from the backers of Boulton and Watt's new steam engines, Merlin kept

a stock of figures "in brass and clockwork, so as to perform almost every motion and inclination of the human body, viz. the head, the breasts, the neck, the arms, the fingers, the legs &c. even to the motion of the eyelids, and the lifting up of the hands and fingers to the face." The Cambridge mathematician Charles Babbage, who later saw one of Merlin's mechanical dancers, remembered that "she used an eye-glass occasionally and bowed frequently as if recognizing her acquaintances."[22] Such machines were fine resources for contemporary debates on the art of acting and the "physics" of emotions. The fashionable Horace Walpole learned from one Parisian hostess, the marquise du Deffand, that among "the numerous company at my place yesterday evening, men and women seemed to me to be spring-driven machines . . . each played their role by habit." David Garrick's contribution, written in 1744 and indebted both to contemporary automata and to his reading of French materialist physiology, criticized "automaton Players who are literally such mere Machines that they require winding up almost every time before they act, to put them in action and make them able to afford any pleasure to an audience." But neither Garrick nor his more enlightened admirers, notably Diderot, severed the link between actor's bodies and the machines. On the contrary, automata showed that artificial organization could in principle display phenomena that were more powerful, and more dramatically effective, than mere clockwork.[23]

There were suggestive links between discussions of Garrick's powers and those of one of the most famous automata of the eighteenth century, a "Musical Lady," originally brought to London in 1776 by the great Swiss horologist Jaquet-Droz. The accomplished lady's eyes really moved, her breast heaved. "She is apparently agitated," a contemporary remarked, "with an anxiety and diffidence not always felt in real life." Such shows often turned to titillating effect modish materialist philosophies that, like enlightened theories of sensibility and mesmeric strategies for restoring health, sought to mechanize the passions. Terry Castle has shown how such an apparently innocent commodity as the weatherglass could be taken as an embodiment of the automatic movements of sexual desire, the *femme-machine,* while Jan Golinski's account of the marketing of the barometer in chapter 3 of this book demonstrates how consumer goods could carry Enlightenment values of curiosity, discipline, and patrician wit.[24] The hydraulic pornography of John Cleland's fictions and the erotic devices of James Graham's celestial bed were both much indebted to the philosophical materialism found in such texts as Julien Offray de La Mettrie's

22. French, *John Joseph Merlin;* Altick, *Shows of London,* 72–76; Babbage, *Passages,* 17. For Wordsworth, see Stallybrass and White, *Poetics and Politics,* 120.

23. Deffand to Walpole, 1766, cited in Benhamou, "From *Curiosité* to *Utilité*," 93; Garrick, 1744, cited in Roach, *Player's Passion,* 91.

24. Altick, *Shows of London,* 66; Castle, *Female Thermometer,* 31.

Man a Machine (1747). As Roland Barthes has argued, the late eighteenth century's notions of "the total machine," in which entire human groups were "conceived and constructed as a machine," reached their fullest elaboration in the libertine fantasies of Sade.[25] This was at least one way, as Joan Landes and Dena Goodman point out, in which the public sphere of the Enlightenment acquired its pronounced ambivalence toward the feminine. Erotic watches (the best were Genevan) were marketed carrying cunningly concealed automata of debauched monks and nuns. More visible automata adverts put love on sale:

> If the Poet speaks truth that says Music has charms
> Who can view this Fair Object without Love's alarms
> Yet beware ye fond Youths vain the Transports ye feel
> Those Smiles but deceive you, her Heart's made of steel
> For tho' pure as a Vestal her price may be found
> And who will may have her for Five Thousand Pounds.[26]

Since the 1760s, Merlin and his erstwhile employer James Cox had built extraordinary automata for the East India Company's China trade, opened shops in Canton where mandarins could acquire mechanical clocks, mobile elephants, and automatic tigers, and thus oiled the wheels of the tea trade. When this lucrative eastern commerce languished, Cox's firm went broke, and his successor, Thomas Weeks, never quite managed to revive it.[27] According to Weeks's advertisements, "these magnificent specimens which constitute almost all the labor of a long life, and were all executed by one individual, were originally intended as presents for the east, they have, indeed, all the gorgeous splendour, so admired there, and we can fancy the absorbing admiration they would create in the harems of eastern monarchs, where their indolent hours must be agreeably relieved by these splendid baubles, which however are so constructed as to combine in almost every instance some object of utility."[28] Caricatures of languor mixed with images of commerce and helped define the roles of automata in the mechanisms of Enlightenment culture.

Technico-Politics

According to a French dictionary of 1727, the word "machine" referred "in general to automata, and to all those things which move by themselves whether by

25. For Cleland, see Braudy, "*Fanny Hill* and Materialism"; for Graham, see Porter, "Sexual Politics of James Graham"; for Sade, see Barthes, *Sade, Fourier, Loyola,* 156–7.

26. For the feminine and the public sphere, see Landes, *Women and the Public Sphere;* Baker, "Defining the Public Sphere"; Goodman, *Republic of Letters;* Sutton, *Science for a Polite Society,* 341–48. The verse is cited from Ord-Hume, *Clockwork Music,* 42; for erotic watches, see Landes, *Revolution in Time,* 269.

27. Altick, *Shows of London,* 350–51; Chapuis and Droz, *Automata,* 107–110. For the long history of clockwork, trade, and orientalism, see Landes, *Revolution in Time,* 37–52, 401n. 29.

28. Ord-Hume, *Clockwork Music,* 45.

art or naturally." Enlightened natural philosophies were sometimes associated with versions of materialism, including the claim that all living beings, and even humans, could be seen as machines. The new industrial and political systems of the classical age have comparably been interpreted as apparatuses of mechanical discipline, in cameralist administration and military tactics. In his genealogy of the prison, for example, Michel Foucault claimed that in the eighteenth century "the great book of Man-the-Machine was written simultaneously on two registers," that of "anatomico-metaphysics," pursued in roughly Cartesian terms by physicians and philosophers, and that of "technico-politics," manifest in military, classroom, and hospital management. Foucault wanted to distinguish these two registers—"there was a useful body and an intelligible body." He also wanted to link them, especially by appeal to La Mettrie's *Man a Machine*, which he read as a text both of materialism and of bodily manipulation, and to the regime of Friedrich II, "the meticulous king of small machines," who provided La Mettrie with asylum at Potsdam after Calvinist attacks on his work in 1748.[29] No doubt the technico-politics of the Age of Reason was especially apparent in military training. Prussian military regulations, highly influential in the British army too, called for at least six years' basic training in what was called "material exercise." Where soldiers were officers' property and often seen as an unreliable mob, mechanical repetition was understood as crucial to subordinate individual willfulness. Standard paces, musical cadence, and the decomposition of actions such as loading and firing were all parts of this automatic system. French programs such as that of Jean-Charles de Follard in the 1730s treated line soldiers as automata. French critics of the Prussian system adopted there after the 1760s noted that in drill depots "the wretched soldiers have all been put into a variety of artificial and enforced postures." Parade ground automatism was a model, barely realized on the battlefield. Foucault thus judged that "the celebrated automata," Friedrich's playthings and La Mettrie's exemplars, "were not only a way of illustrating an organism, they were also political puppets, small-scale models of power."[30]

Foucault was not alone in linking the mechanization of the body with the disciplinary apparatus of the old regime. As Ken Alder points out above, comparisons of the military-political strategies of Louis XIV and Friedrich II were and remain rich sources for an understanding of this apparatus. In his analysis of the Grand Monarch's theatrics, Jean Apostolides has insisted that by 1700

29. Thomson, *Materialism and Society*, 41, for the definition of machine; Foucault, *Discipline and Punish*, 136; Mattelart, *l'invention de la communication*, 38, on Foucault, Vaucanson, and La Mettrie.

30. Foucault, *Discipline and Punish*, 136; Houlding, *Fit for Service*, 259, 267–68; Childs, *Armies*, 67, 105; Duffy, *Military Experience*, 54, 105 (citation from Guibert, 1772); Alder, *Engineering the Revolution*, 116.

the old regime had displaced the powers of territorial reach by those of permanent, machinelike, organization: "the glorious body" of the king, "which functioned like clockwork, brought with it an extremely mechanized court ceremonial. At a moment when the actions of the first labourers working on industrial machines were decomposed and analyzed to improve performance, the body of the king-machine found itself being laid out in a multitude of mechanical actions." But in this intriguing analysis, the suggestion of some linkage between absolutist automata and the new industrial formation of the early eighteenth century remains coincidental.[31] Analyses of political philosophy, such as that of Reinhart Koselleck, have connected Enlightenment clubland with Hobbesian mechanization, asserting that Leviathan, "the automaton, the great machine," forced the philosophical construction of a secluded space of alienated critique where a politically impotent intelligentsia could assert its judgmental superiority. Unconcerned with Hobbesian natural philosophy or with its progeny in Enlightenment materialism, Koselleck, however, also ignored the issue of military and political discipline. He understood Friedrich II's predicament in terms of the dualism of morality and politics rather than the monism of his subjects' bodies.[32] Histories of technology, such as that of Otto Mayr, have associated clockwork models of physiological order with images of the absolutist state, and later eighteenth-century homeostatic machinery with the liberal critique of tyranny. Though he indicated the intimate connection between Frederician absolutism and the mechanical philosophy and noted the Prussian king's patronage of La Mettrie, Mayr was in the end unwilling to suggest more than an interesting coincidence between fashions for clockwork and for absolutism, and between self-regulating machines and liberalism.[33]

La Mettrie's *oeuvre* helps show that there was more than a coincidental connection between the mechanization of the animal economy and the handbooks of discipline and training. Brought up as a Jansenist in Paris, he may well have absorbed mechanist theories common among several of the sect's physicians. After training at Leiden in 1733–34, and practicing and publishing the version of Boerhaave's medicine he learned there for almost a decade back in Brittany, La Mettrie's first preferment was in Paris and on the battlefield as medical officer in the French guards. It was in this period, in the milieu of supreme barrack discipline, that he penned his first materialist treatises. In his eulogy, Friedrich II noted that La Mettrie's *Natural History of the Soul* (1745) was composed after experiences of camp fever at the siege of Freiburg. *Man a*

31. Apostolides, *Le roi-machine*, 156.

32. Koselleck, *Critique and Crisis*, 117. For a critique of Koselleck, see Jacob, *Living the Enlightenment*, 14–15.

33. Mayr, *Authority, Liberty, and Automatic Machinery*, 107–9.

Machine was written during 1746–47 when La Mettrie was in charge of the French military hospitals in the theater of war in the Low Countries. Violent controversies both with churchmen and with the medical establishment drove the military physician to the Netherlands, and thence, after his most notorious work had been burned by the public hangman, to Berlin.[34] On the basis of a sketchy summary of the active matter whose organization formed the human body, *Man a Machine* argued that "the human body is a machine which winds up its own springs. It is the living image of perpetual motion." According to the exiled physician, it was this fact that dispossessed priests of their authority. Physicians, who "alone have laid bare to us those hidden springs beneath the coverings which conceal so many wonders from our eyes," had the sole "right to speak here."[35]

From these principles, especially in his remarkable *Discourse on Happiness* (1748), a commentary on Stoicism that appeared soon after his arrival in Berlin, La Mettrie insisted on the linkage between determinism and medical management, for the education of individuals dominated their character. Adam Smith, for one, was impressed by La Mettrie's use of medical principles to construct an entire social therapeutics. According to the Breton physician, moral sentiment flowed from social discipline: "ideas of generosity, greatness and humanity have been tied to important actions of human commerce; respect, honour and glory to those actions which serve the country; and by these goads a great many animals with a human shape have become heroes." Thus political power acted on the social body the way the medical-military manager directed patients. In particular, because of the fragility of this form of socialization, and the tendency of the body to revert to its primitive state, it was crucial that training be maintained. The exercise of political power represented a constant struggle to bend the subject to public action and, as he put it, to exterminate the "mad dogs" who disrupted good order. La Mettrie's man machine was not an iatromechanical reverie of clockwork and pulleys, but a natural body subject to exercise and training, imbued with innate vitality and therefore simultaneously capable of, and requiring, external discipline.[36]

In 1747, La Mettrie assumed his readers would take the point that the human body was composed of self-moving matter at the highest stage of organization by citing the example of "Vaucanson, who needed more skill for making his flute player than for making his duck, and would have needed still more to

34. Vartanian, *La Mettrie's L'Homme Machine*, 4–7.

35. La Mettrie, *Man a Machine*, 93, 89. For mechanism and Jansenism, see Brockliss, "The Case of Philippe Hecquet," 212–13.

36. Wellman, *La Mettrie*, 226–28; Sutter, *Göttliche Maschinen*, 121–50. For the displacement of the mechanical body by the disciplinary body, see Foucault, *Discipline and Punish*, 155. For Smith on La Mettrie, see "History of Astronomy," 47.

make a talking man, a mechanism no longer to be regarded as impossible." By summer 1740, Friedrich had already contacted his agent in Paris to recruit Vaucanson to the Berlin court. The engineer was offered a pension of twelve thousand pounds to take up the Prussian offer; in the event, he refused in favor of better chances with the French government.[37] That government cared about these automata because of its interest in medical and economic reform. Parisian designers were experts in making "moving anatomies" of the human body. In the 1730s, several surgeons argued that by building hydraulic machines they could demonstrate physiological facts that corporate physicians were too prejudiced to accept. The young surgeon François Quesnay proposed "a human automaton in which will be seen the performance of the principal functions of the animal economy, by means of which the mechanical effects of bloodletting can be determined and several interesting phenomena which do not seem susceptible will be submitted to the balance of experiment." La Mettrie, a medical student in Paris in 1727–31, was a notable protagonist of the surgeons' cause from 1737.[38] There was a connection between these medical debates and economic theory because the economy itself was figured as a perpetually moving automaton. Quesnay began composing powerful physiocratic treatises on the hydraulic model of active fluid flow as an image of the right form of government. Here Adam Smith found his most important topic for political economic argument, and Lavoisier incentives for his important studies of agronomy and physiology. Meanwhile, Vaucanson had proposed the construction under royal commission of a dramatic automaton, "to perform experiments on animal functions, and thence to gather inductions to know the different states of health of men so as to remedy their ills. This ingenious machine," Vaucanson boasted in 1741, "which will represent a human body, could in the end serve to perform demonstrations in an anatomy lecture." The context of state regulation and medical controversy was important for Vaucanson's projects. His celebrated automata posed the problem of the working of the human machine and of the means by which it could be understood and governed.[39]

Mimesis and ingenuity remained nice matters. Vaucanson explained that he had left the workings of his mechanical duck "exposed to view" because he wished "rather to demonstrate the manner of the actions than to shew a

37. Doyon and Liaigre, *Vaucanson*, 133–36; La Mettrie, *Man a Machine*, 140.

38. Wellman, *La Mettrie*, 20–33; Doyon and Liaigre, *Vaucanson*, 120–24; Benhamou, "From *Curiosité* to *Utilité*," 101–2; Gelfand, "Empiricism and Eighteenth Century French Surgery"; Sutter, *Göttliche Maschinen*, 114–20.

39. Doyon and Liaigre, *Vaucanson*, 148; Puymèges, "Les anatomies mouvantes." Compare Fryer and Marshall, "Motives of Jacques de Vaucanson"; Stafford, *Artful Science*, 191–95. For Quesnay and perpetual motion, see Wise, "Mediations," 226.

machine. . . . I would not be thought to impose upon the Spectators by any conceal'd or juggling contrivance."[40] Transparency and cunning were connected. Nowhere was this more obvious than in Vaucanson's new initiatives of the 1740s. His project to build medical automata stalled, the government hired Vaucanson as inspector of the silk trade, sending him in 1741 to Lyons and to Piedmont to examine best practices in the silk mills. Back at his workshop in Paris, Vaucanson staged trials of reformed manufacture processes, and proposed a massive new state-regulated transformation of work practices, in particular, a system of surveillance centered in a royal factory based in Lyons. Vaucanson's regulations were fiercely resisted by the silk masters and artisans; he was forced to flee the turbulent city disguised as a monk, and the new state regulation collapsed. Instead, from 1744, Vaucanson began designing automatic silk-weaving machinery. Just as his mechanical flute player had relied on a carefully controlled rotating barrel, whose rate was fixed by calibration against an expert human player, so his silk machines used barrels timed to manage the weaving rates. He reckoned his automatic silk machine was a device "with which a horse, an ox or an ass can make cloth more beautiful and much more perfect than the most able silkworkers. . . . Each machine makes each day as much material as the best worker, when he is not wasting time." In 1751–54 Vaucanson tried installing these machines at a new-style silk mill in the Ardèche, but he soon found that lack of skilled workmen and local resistance again frustrated his plans.[41]

Diderot reprinted Vaucanson's accounts of his automata in the opening volume of the *Encyclopédie,* and in 1776 Vaucanson himself chose to publish in the proceedings of the Royal Academy of Sciences a series of plans of the idealized factories he had constructed: airy, light, disciplined, efficient, if ultimately bankrupt. The following year an authoritative dictionary echoed the view that adept artisans were those who lacked "any principle or any rule of movement," and this was what made them lowly. By 1804, Vaucanson's admirer, Jean Jacquard, had rebuilt the looms in Paris and was thus prompted to develop a new and decisive system of weaving automata, which in turn provided Babbage with one model of an intelligent calculating engine.[42] Real connections were forged between these endeavors to produce a disciplined workforce, an idealized workspace, and an automatic man. Vaucanson's London opposite number, Desaguliers, was as committed to these links between the

40. Vaucanson, *Automaton,* 23.

41. Gillispie, *Science and Polity,* 413–21; Doyon and Liaigre, *Vaucanson,* 197–203, 210.

42. Giedion, *Mechanization Takes Command,* 35–36. For Babbage and Jacquard, see *Passages,* 116–17. For the 1777 dictionary, see Doyon and Liaigre, *Vaucanson,* 39 n. For Vaucanson and Diderot, see *Encyclopédie,* 1:451 ("Androide"); 896 ("Automate").

mechanical modeling of human capacity and the labor discipline of the artisan trades.[43] Two decades before it hosted Vaucanson's automata, the Haymarket Theatre had staged shows of German strongmen. After collaborating with Alexander Stuart, a Leiden-trained expert on muscular anatomy, Desaguliers lectured on the means through which these theatrical feats could be replicated with an elementary knowledge of mechanics. Mechanical calculation overmastered brute strength.[44] He applied the same public calculus to the new silk industry. In 1718 a Derby entrepreneur, John Lombe, introduced Italian silk-throwing machines after industrial espionage in Tuscany. Lombe collaborated with the hydraulic engineer George Sorocold to build a profitable silk mill. As the historian Thomas Markus points out, in Lombe's system the spatial distribution of social order, flowing from owner through supervisors to workers, did not yet match the flow of mechanical power, since workers sharing the same space did not use machines sharing the same power source. New automatic systems were required to make the distribution of regulated workers and of mechanical power correspond to each other. Desaguliers devoted some pages to these works in his lectures on natural philosophy and mechanics, explaining to his audience that despite the demands of industrial secrecy he could reveal that the "power of a hand" might be multiplied by Lombe's machines.[45]

The multiplication and intensification of power was Desaguliers's key theme. He explained that genteel "men of theory" could be deluded by their cunning workforce and by utopian optimism. "There is a Combination among most Workmen to make a Mystery of their Arts and they look upon him as a False Brother who lets gentlemen into their Manner of Working and the Knowledge of the Price of all Materials." To gain power over mechanical schemes, it was therefore necessary to employ engineers to master the workforce and direct the market. Speculators attributed power to the machines themselves, breeding false hopes of endless profit and perpetual motion: "the Vulgar commonly speak of a Machine as they do of an Animal, and attribute that effect to the Machine which is the Effect of the Power by means of the Machine." Wrong models of the animal-machine relationship spawned commercial and political disaster. The powers of machinery were the property of enlightened mechanics, not of the workforce nor the machines. These errors bred loss through the resistance of the workforce, or of friction.[46] Enlightened

43. Stewart, *Rise of Public Science,* 119–30, 213–54; Morton, "Concepts of Power," 67–70.

44. Stewart, *Rise of Public Science,* 126; Poni, "The Craftsman and the Good Engineer," 224; Stafford, *Artful Science,* 178.

45. Desaguliers, *Course of Experimental Philosophy,* 1:69–70; Markus, *Buildings and Power,* 263–6.

46. Desaguliers, *Course of Experimental Philosophy,* 2:415, 1:127. For perpetual motion and loss, see Schaffer, "Show That Never Ends."

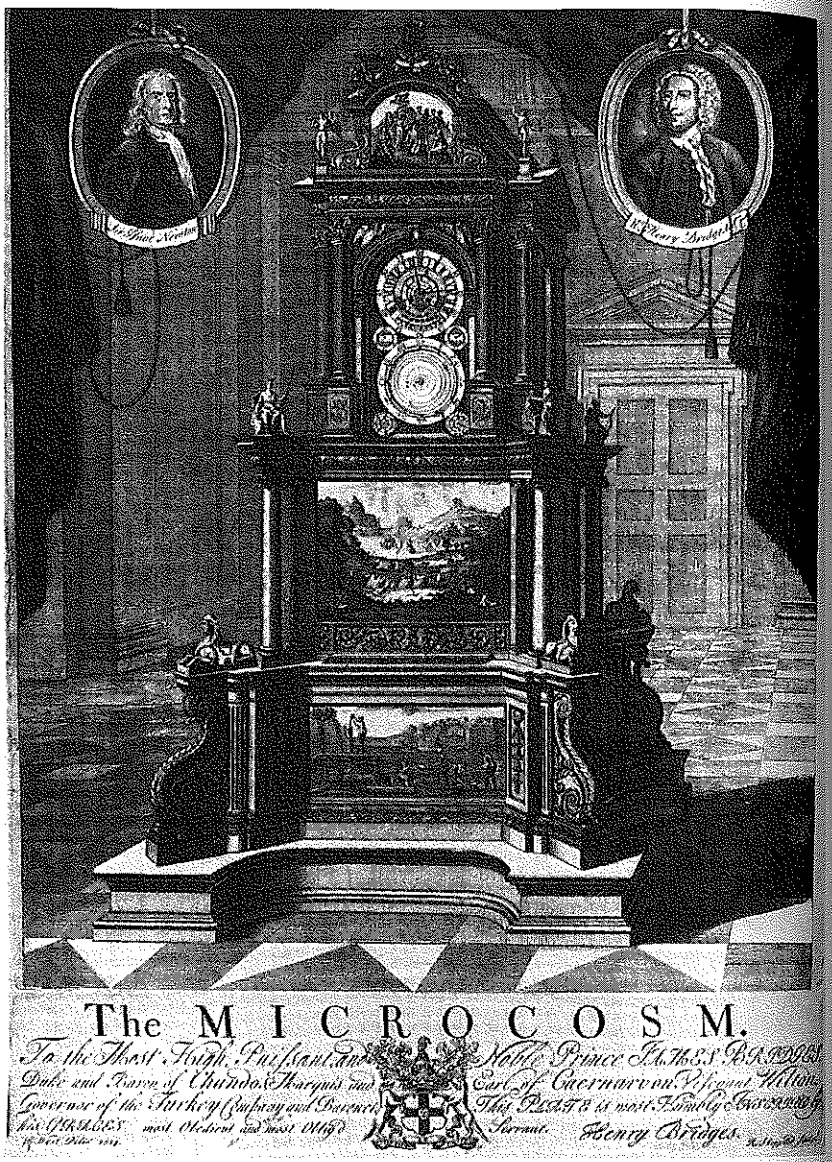

Fig. 5.3. Henry Bridges's "Microcosm," built for the duke of Chandos in the 1730s. The clocks show solar time, lunar phases, and the Copernican system; above, a moving landscape of Parnassus and Orpheus; below, the automatic shipyards and carpenters' shops.

lecturers and engineers, who claimed to represent nature's laws, aimed for a striking shift of power, away from artisans toward the masters of the powers on which machines and projects depended. Automata were good signs of this shift. At the palace of Desaguliers's principal patron, the vicious speculator, entrepreneur, and oligarch the duke of Chandos, the engineer Henry Bridges built and installed a vast automaton clock. The "Microcosm," driven by more than one thousand wheels and pinions, displayed all the phenomena of the heavens, picturesque scenery, and an efficient wood yard. In 1741, the Microcosm went on show at a Charing Cross coffeehouse. A print of the device carried portraits of its designer, and of Isaac Newton, plus a fulsome dedication to Chandos. These were the owners and makers of the world machine. The Microcosm was a typical piece of showmanship whose concealed works and pompous exterior emblematized the relation between cunning engineering and outward show.[47]

But automatic machinery was never merely emblematic in the world of enlightened engineering. Alongside orreries and planetary machines, as the historian Alan Morton points out, Desaguliers showed paying audiences a machine that could measure the maximum effect of a laborer's power to raise a load, a device comparable to the new machines being introduced into the London coal trade to mechanize unloading at the docksides. Endemic struggles between the coal heavers and the managers culminated in the 1758 Coal Act and the introduction of a system of "whipping" on board ship.[48] Desaguliers's estimates of the maximum work extractable from labor remained a standard reference for later eighteenth-century engineers and industrialists keen to scotch the shows of dubious engines by projectors "who put them in motion for some minutes, by vigorous people, who make a momentary effort." These estimates helped establish later eighteenth-century maxims on the utmost work to be extracted from laborers: they were then cited, for example, by the Paris Academy of Science's preeminent mathematical chronicler Jean Montucla in a 1778 edition of a work on recreational mathematics. From the same year, Coulomb began to argue that the slight difference between theoretical and observed maxima of available human work established in French military projects and in the laboratory was due to "the instinct natural to all men" that "with a given burden" prompted them to adopt "the speed which most economizes their force." These academicians' accounts of the productive human machine then let their fellow Lavoisier establish during the later 1780s universal laws of labor,

47. Desaguliers, *Course of Experimental Philosophy*, 2: viii. For the "Microcosm," see Britten, *Old Clocks*, 430–31, and Chapuis and Droz, *Automata*, 128–31. For Chandos and Desaguliers, see Stewart, *Rise of Public Science*, 214–15.

48. Morton, "Concepts of Power," 75; Linebaugh, *London Hanged*, 311–12.

provided "the person submitted to experiments doesn't carry his efforts too near to the limit of his forces, since otherwise he would be in a state of suffering and leave the natural state." Lavoisier's respiration trials on these states demonstrated "that there exists for each person an unfailing law" governing body condition and work rate.[49]

Lavoisier's assays of the worth of philosophers and musicians alongside artisans and farmers moved well beyond the realm of metaphor. In summer 1791, he explained how his laboratory work on the animal economy would place the levers of power in the hands of the savant. Automatic systems of nature and society were susceptible to this careful management. "Like the physical order, the moral order has its regulators, and if it were otherwise human societies would long ago have ceased to exist, or rather they never would have existed." As Norton Wise points out in his study of the technologies of late-eighteenth-century French rationalism, strategies used to produce the sphere of enlightened action secured that culture to the extent that they disappeared from view, so that the nature of the late Enlightenment seemed an unmediated reality. Soldiers, engineers, prisoners, and workers were subjected to rather literal forms of enlightened discipline. The social order engineered their mechanization, and thus those who did this engineering could represent this condition as natural.[50] Vaucanson and Desaguliers, like Coulomb and Lavoisier, demonstrated machines well-matched to their accounts of the working human body and the principles that should govern disciplined labor. Peter Linebaugh, historian of the eighteenth-century London working class, connects the mechanization of coal heaving and silk weaving with measures against artisan resistance and customary labor processes. In his comparison of the Lyons initiatives of Vaucanson and comparable measures in the silk trade in Spitalfields, Linebaugh argues that strong legal codes were insufficient to impose new work systems. "Mechanical, organizational and geographical strategies were necessary accompaniments to strictly legal prohibitions." This is why the automata were vital for the materialization and evaluation of the laboring body.[51]

Machines under the Similitude of Men

It was not obvious to all eighteenth-century observers that social order could be secured by automatism. In the early-eighteenth-century exchanges involving Samuel Clarke, Leibniz, and the deists, as in responses to Joseph Priestley's materialism and determinism in the 1770s, it was a common theme that the identification of the human and the machine would spawn libertinism, atheism, and insurrection.[52] When issues of materialism and its morality were salient, connections with the automata shows and with bodily discipline were pervasive and threatening. In the immediate wake of Joseph Priestley's texts on philosophical materialism, for example, the Catholic priest Joseph Berington suggested that the notorious materialist should team up with James Cox, who would be able to stuff his Mechanical Museum with "two or three men machines of his own construction, that might really operate in a human manner, might gradually advance to the summit of knowledge in all the arts and sciences, and perhaps present the public with their several discoveries in religion, philosophy and politics." Among Priestley's contemporary supporters, the London journalist William Kenrick filled pages of his widely read *London Review* with ribald jokes and vicious attacks on materialism's enemies. He reckoned that a priest like Samuel Clarke "was confessedly so merely a reasoning machine that he would almost tempt one to think matter might think and that he himself was a living proof of it."[53]

These jokes depended on the familiarity of the metropolitan audience with the capacities of automata. Berington's squib set a precedent for connections between attacks on enlightened progressivism and on the capacities of such machines, prefiguring the satires of the *Anti-Jacobin* in the 1790s against Erasmus Darwin's similarly materialist doctrines.[54] Within the communities of enlightened philosophers themselves, furthermore, the discourse of self-moving machines was increasingly fashionable. Kenrick and his Grub Street friends, denizens of the lowlife of the Enlightenment, used automata to represent the behavior of the theater and the workshop. Debates on the mechanical passions prompted a duel between Kenrick and Garrick in the 1760s. Soon after, Kenrick published a series of essays on perpetual motion and automatism that defended materialism against the critique of pious divines, insisted on the indistinguishability of humans and automata, and concluded that it was feasible to produce self-moving machines. "A discovery of this nature," he announced, "would be of the utmost advantage to the commercial world."[55] In that world, of which Priestley and the rational dissenters were members, the automatism of humans was a crucial issue. Priestley's enlightened patron Josiah Wedgwood set out to "make machines of men as cannot err." His works were run according to a system of unprecedented time discipline, rendering

49. Lindqvist, "Labs in the Woods," 307–10. Desaguliers's estimate of maximum work is cited in Ozanam, *Recreations*, 2:100. Coulomb's results are in his "Mémoire sur la force des hommes," 292, discussed in Gillmor, *Coulomb*, 78, and Vatin, *Le travail*, 41–51. Lavoisier's law is stated in Lavoisier and Seguin, "Mémoire sur la respiration," in Lavoisier, *Oeuvres*, 2:696.

50. Lavoisier and Seguin, "Premier mémoire sur la transpiration des animaux," *Oeuvres*, 2:704–14, 713 (read June 1791); Wise, "Mediations," 244–47; Bensaude-Vincent, *Lavoisier*, 221, 228.

51. Linebaugh, *London Hanged*, 270. See Stewart and Weindling, "Philosophical Threads."

52. Vartanian, *Diderot and Descartes*; Yolton, *Thinking Matter*; Porter, "Barely Touching."

53. Yolton, *Thinking Matter*, 117–19.

54. Edmonds, *Poetry of the Anti-Jacobin*, 147 (April 1798).

55. Kenrick, *Lecture on the Perpetual Motion*, 9, 41, and *Account of the Automaton*, 24.

employees clockwork machines in an all-but-literal sense. Simultaneously, the educational programs touted by reformers like Wedgwood and his Midlands allies supposed that the human mind could be programmed if suitably planned and mechanically ordered.[56]

Thus the relation between the automaton, the rational human, and the social geography of industry, training, and display was fundamental for these late Enlightenment projects. In 1782, Wedgwood counseled his colleague James Watt on the right way of self-management: Watt's own body should be handled like "any other machine under your direction." "Production utopias," Thomas Markus's term for the visionary workshops of the late Enlightenment, often included provision for the mechanical training of their inmates. The ambitious lawyer Jeremy Bentham notoriously presented himself as this kind of self-regulated machine, seeking to contest plebeian cultures of the body with an exemplary public postmortem and the proposal that the corpses of the enlightened be used in "dialogues of the dead." With such inanimate bodies, "a commemorative festival might be exhibited after the manner of a comedy at one or more of the theatres," starring Bentham himself in conversation with Aristotle or Bacon.[57] This visionary self-image was developed alongside the palpable schemes of Benthamite panopticism, first designed by Samuel Bentham, Jeremy's brother, to accelerate production in tsarist wood yards in the 1780s. This was a scheme its protagonists reckoned would allow "the construction of a set of machines under the similitude of men." After 1795, Samuel Bentham and his collaborators, the engineers Marc Brunel and Henry Maudsley, used the resources of the Royal Navy to overhaul shipyards under a regime that connected public shows with automatic labor. The self-acting tools of the new precision workshops began to intrude on, and subvert, customary labor relations. Maudsley's lathes and blocks for the dockyard production line depended on, and in turn helped secure, reliable artisans. As in Vaucanson's silk mills, visibility was an invaluable aspect of this industrial reformation. Accountancy mechanized scrutiny while automation disciplined labor. "On entering the block mills, the spectator is struck with the multiplicity of its movements and the rapidity of its operations."[58] So the mills became impersonal, their inmates engines the parts of which were men. The automatism of the machines and of the workforce sustained—and was regulated by—the enlightened supervision of military and industrial production.

56. Thompson, *Customs in Common*, 385–86, 403; McKendrick, "Josiah Wedgwood," 34.

57. For Wedgwood, see Ignatieff, *Just Measure of Pain*, 68; for Bentham, see Richardson and Hurwitz, "Bentham's Self Image"; Schaffer, "States of Mind," 287–89. For Bentham and "production utopias," see Markus, *Buildings and Power*, 123–27, 286.

58. For "machines under the similitude of men," see Bentham, *Panopticon*, 127–28. For Portsmouth, see Cooper, "Portsmouth System," 213–14; Linebaugh, *London Hanged*, 399–401; Ashworth, "System of Terror."

In the work in which he described the panopticon as the culmination of enlightened political anatomy, Foucault argued that the knowledge of and power over "those who are stuck at a machine and supervised for the rest of their lives" accompanied the production of the modern soul as "the prison of the body."[59] To argue that the mechanics of social order produce the individual, who could scarcely possess a subjectivity without becoming a cog in this machine, is one version of the theme of the human automaton traced here. Foucault's final interrogation of the philosophy of the classical age involved a series of commentaries on Kant's essay "Answer to the Question, What is Enlightenment?" This paper, sent to the *Berliner Monatsschrift* at the end of September 1784, has been treated as a key to the Enlightenment's meanings. It has provided the occasion for a major exchange between Foucault's genealogy of the present and Habermas's theory of the public sphere. Scholars have rightly insisted on the immediate political context in which the question was posed in the reading clubs of Frederician Berlin, debates about the limits of civil marriage and of the rights of the state to deceive its subjects. They have also noted the transformations of that context implied by Kant's lapidary answer: "Enlightenment is humanity's emergence from its self-incurred immaturity." The theme soon became banal or, worse, risible. By 1790, under a more conservative Prussian regime, one pamphlet asked, "[I]f this is Enlightenment, what is nonsense?" while two years later appeared a similarly minded proposal "to abolish the fashionable term Enlightenment."[60]

Kant's text was linked with the discourse of automata that Foucault himself saw as a distinctive characteristic of the milieu that produced it. "Dogmas and formulae, those mechanical instruments for rational use (or rather misuse) of his natural endowments, are the ball and chain of his permanent immaturity. If anyone did throw them off, he would still be uncertain about jumping over even the narrowest ditch, because he would be unaccustomed to free movement of this kind." Priests, doctors, and tutors were all figured as parts of an oppressive apparatus, their immature victims turned into automata. Kant conceded the necessary restriction on private reason, since "we require a certain mechanism whereby some members of the commonwealth must behave purely passively so that they may. . . . be employed by the government." Subjects so employed, especially in its military, fiscal, and ecclesiastical functions, were seen as acting "as part of the machine." In his positive argument for the free use of public reason, Kant lauded Friedrich II's regime, argued that the

59. Foucault, *Discipline and Punish*, 29–30.

60. Kant, "What is Enlightenment?" The Habermas-Foucault exchange is documented in Kelly, *Critique and Power*; the background to Kant's text is described in Bahr, "Kant, Mendelssohn, and the Problem of Enlightenment from Above"; Birtsch, "Die Berliner Mittwochsgesellschaft"; Schmidt, "Question of Enlightenment," 269–91. The anti-enlightenment satires are described in Schneiders, *Die wahre Aufklärung*, 224, 233.

development of free thought would gradually increase subjects' capacity to act freely, and finally predicted that the state would find it could "profit by treating man, who is *more than a machine,* in a manner appropriate to his dignity." Kant's essay thus ended with an explicit rejection of La Mettrie, the burden of his essay insisting that the sphere of free reason lay outside the machine.[61]

As an academic philosopher and Prussian subject, Kant's argument that such mechanization was a limit on freedom could be contrasted with that of his most eminent predecessor, Christian Wolff. Appointed mathematics professor at Halle in 1706, Wolff thereafter attained a central role in the Republic of Letters. As principal writer for the Leipzig *Acta eruditorum,* Wolff was in a good position to judge and explicate the variety of machines touted round the European courts, and to link these new devices with Leibnizian doctrines of living force. As William Clark shows in detail in his contribution to this book, Wolff's expulsion from Brandenburg and his chair by Friedrich Wilhelm I followed a controversial lecture in which, by lauding the morals of Confucianism, he enraged modish Pietists by arguing for the redundancy of Christian revelation in the cultivation of good social order. Some saw Wolff's disgrace as a result of his exaggeratedly stiff sense of self and, as Clark points out, the expulsion was entangled with issues of fatalism and automatism. The young natural philosopher Leonhard Euler met Wolff at Marburg University soon after these events in 1723. According to Euler, a member of the Berlin court had told the king "that, according to [Wolff's] doctrine, all soldiers were nothing but machines, and that, should one desert, it would be a necessary consequence of its structure, so that it would be unjust to punish them, as if one might punish a machine for producing such and such a motion." Marburg was already notable for its links with engineering and state planning: the Hesse-Kassel regime encouraged links between new machinery, military discipline, and economic reform. Meanwhile Wolff's admirers, led by Ernst von Manteuffel, founded a Berlin club in his honor, struck a medal bearing Wolff's image, adding the telling phrase "sapere aude" in 1736. This was just the phrase Kant picked up in his 1784 essay.[62]

On the accession of Friedrich II, the Marburg exile was attracted back to his chair at Halle. The themes of determinism and political order then dominated the often violent debates that raged at Berlin and elsewhere on the implications of Wolffian philosophy and its alternatives in the newly powerful

61. Kant, "What is Enlightenment?" 54–55, 56, 59–60: emphasis in the original. Compare Foucault, "What is Enlightenment?" 36.

62. Euler, *Lettres,* vol. 2, letter 84 (December 1760). For Wolff's predicament in the 1720s, see Wundt, *Der deutsche Schulphilosophie,* 199–230; Saine, "Who's Afraid of Christian Wolff?" 102–33. For Hesse-Kassel and technology, see Philippi, *Landgraf Karl von Hessen-Kassel,* 609–15. For "sapere aude," see Venturi, *Utopia and Reform,* 6–9.

Prussian military state. It was for this reason that Euler, a staunchly Calvinist protagonist of these academic fights, chose in the early 1760s in a set of published letters to the king's young cousin Charlotte to revive memories of Wolff's troubles and, in particular, of the ambiguities of automatism. Chief among these ambiguities was, again, the puzzle of discipline: "[I]f the bodies of men are machines," Euler alleged, "like a watch, all their actions are a necessary consequence." As Mary Terrall and William Clark both point out elsewhere, Euler was a preeminent expositor of the reality of final causes in well-founded sciences. Materialism reeked of antiteleological dogma.[63] The king himself rejected the view that his subjects might be "a sort of machine, only marionettes moved by the hand of a blind power," for then all political discipline would be supererogatory. In 1784, Kant asserted a strong distinction between loyal subjects, who must behave like automata, and rational citizens, who must be allowed public freedom of conscience. Conservatives under the new Prussian regime insisted that there could be no such distinction. "A tolerant governor," wrote the arch-reactionary Johann Wöllner in 1785, "looks upon all his subjects from a single point of view, namely that they should be citizens of the state." Thus, if Wolff had once been accused of limiting state power by exaggerating subjects' internal (and mechanical) determination, Kant proposed to limit state power by redefining that form of determination.[64]

So Kant's account of true enlightenment and its relation with governmentality hinged on a careful specification of the mechanization of the subject. His final remark against La Mettrie was itself rather pointed, since his monarch had penned the eulogy of the refugee physician. La Mettrie's book, the king wrote, "was bound to displease men who by their position are declared enemies of the progress of human reason." "All those who are not imposed upon by the pious insults of the theologians mourn in La Mettrie a good man and a wise physician." Kant's insistence on the falsehood of La Mettrie's central thesis thus appeared reflexively as an example of his claim to free use of public reason, in despite of piety and politics, for which his 1784 essay argued.[65] The appeal to automata, so often a theme in biographical reminiscences of Kant's daily habits—William Clark links Kant's obsessive timetables with his attack on metaphysics—was also a fundamental theme in his political critique in this decade. In his second *Critique* (1788), he asserted transcendental freedom, the

63. Euler, *Lettres,* vol. 2, letter 84. For Wolff's polemics, see Polonoff, *Force, Cosmos, Monads,* 68–92, and Calinger, "Newtonian-Wolffian Controversy," 329. For anti-Wolffianism in Berlin see, especially, Terrall, "Culture of Science," 354, 359.

64. Friedrich II against Holbach in Cassirer, *Philosophy of the Enlightenment,* 71; Wöllner in Henri Brunschwig, *Enlightenment and Romanticism,* 167; compare Epstein, *Genesis of German Conservatism,* 140–54.

65. Friedrich II, "Julien Offray de la Mettrie," 8–9.

precondition of moral law, in contrast to determinists' notions of automatism. Humans subject to mere physical or psychological causality would enjoy "nothing better than the freedom of a turnspit." He attacked notions of time and space as "attributes belonging to the existence of things in themselves" because then "man would be a marionette or an automaton, prepared and wound up by the Supreme Artist. Self-consciousness would indeed make him a thinking automaton, but the consciousness of his own spontaneity would be mere delusion if this were mistaken for freedom." When his critique turned to the polity, in the *Groundwork of the Metaphysics of Morals* (1785), Kant insisted that a monarchy "corresponds to a living body when ruled by the inherent laws of the people, and to a mere machine when ruled by a single absolute will." Tyranny made its subjects machines and was itself one.[66]

A Naked Automaton Ends the Enlightenment

The very moment at which Kant's essay appeared coincided with a remarkable show of the power and meaning of an automaton, the Turkish chess player. In that month of September 1784, this astonishing machine appeared first at the great Michaelmas Fair in Leipzig, then elsewhere in the German lands. Spectators were shown into a darkened chamber in which stood a large cabinet running on castors, behind it an impressive full-scale model of a seated Turk smoking a pipe. On top of the cabinet was screwed a chessboard, the object of the Turk's fixed attention. The showman would open the front and back of the cabinet, revealing a complex array of gearwheels, barrels, and pulleys. The custom was to shine a candle into the cabinet to show that nothing could possibly be hidden, and the Turk's torso and legs would also be stripped bare. "You see at one and the same time, the naked Automaton, with his garments tucked up, the drawer and all the doors of the cupboard open." After the automaton had been wound up, giving it enough power to run for about a dozen moves, the games would begin, the Turk gracefully moving pieces with his left hand, nodding his head when giving check, tapping the table and replacing any piece if a false move was made by his opponent, and bowing to the spectators when the game ended, almost always with the Turk's triumphant victory. One intriguing and suggestive accomplishment of the automatic chess player well illustrated how it helped link public show and enlightened reason. The academies' mathematicians had devoted some attention to the puzzle of the Knight's Move, the path of a knight touching every square on a chessboard just once. Baptized

66. Kant's use of the automaton in these texts is described in Mayr, *Authority, Liberty, and Automatic Machinery,* 133, 136. For a contemporary Berlin account of Vaucanson's automata, see Martius, "Vaucansons Beschreibung eines mechanischen Flötenspielers" (1779), in Völker, *Künstliche Menschen,* 103–12. For the political background, see Hinske, *Kant als Herausforderung an die Gegenwart,* 67–78; Beiser, *Enlightenment, Revolution, and Romanticism,* 32–6.

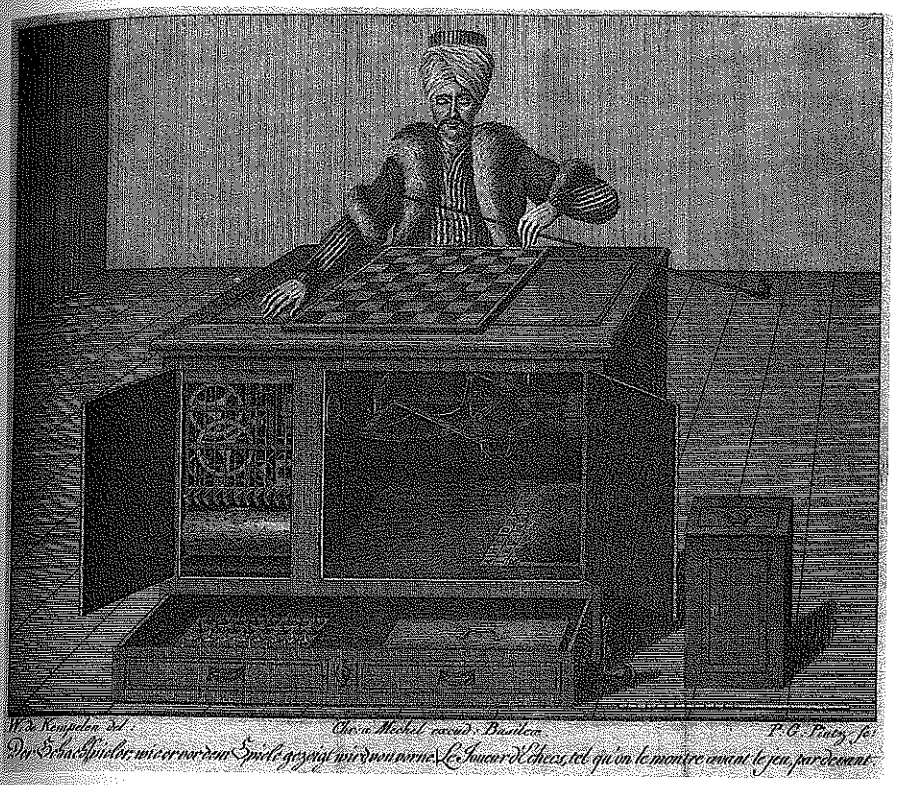

Fig. 5.4. Wolfgang von Kempelen's Turkish chess player, showing its internal gearing and chessboard. From Karl Gottlieb von Windisch, *Inanimate Reason* (London, 1784).

"Euler's problem" after the great mathematician's analysis published by the Berlin Academy in 1759, it became a cynosure of rational skill. Chess puzzles mirrored the evolutions of Potsdam parade-ground drill. The Turk's manager would challenge the audience to choose an initial square; the Turk would then show the right route round the board. Matching Euler's analysis demonstrated the machine's intelligence and played on the materialist possibilities of mid-century mathematics. "Never before did any mere mechanical figure unite the power of moving itself in different directions as circumstances unforeseen and depending on the will of any person present might require." Nowhere else in Europe did the relation between intelligence, mechanism, and concealment become such a matter of public interest.[67]

67. [Windisch], *Inanimate Reason,* 25–26, vi. For the show at Leipzig, see Carroll, *Chess Automaton,* 22–23. For the history of the Knight's Move, see Frolow, *Le problème d'Euler.* For the enormous contemporary literature on the Turkish chess player, see Dotzler, Gendolla, and Schäfer, *Maschinen-Menschen,* 14–22.

This automatic Turk was built for display at the Habsburg court in 1769–70, in the wake of Knaus's earlier writing automata, which merely represented the mechanical rote of bureaucracy—the Turk instead mechanized higher faculties. Its designer was a Slovak engineer and courtier, Wolfgang von Kempelen, a prominent civil administrator and devotee of a range of schemes ranging from mining technology and steam pumps to the mechanization of the human voice. His chess player was first put on show in competition with magnetic tricks at Schönbrunn and then at Kempelen's house in Bratislava in the early 1770s. The automaton went on its travels round Europe in early 1783, partly as a result of the commands of the Emperor Joseph II, then rather involved in a major anti-Turkish diplomatic campaign, partly through the commercial ambitions of its promoters.[68] A game was staged at the Paris Academy of Sciences in May 1783 against the preeminent chess player Philidor (the Turk, for once, lost). By the following winter, the Turk had reached London and its notoriety had been assured by the appearance of a catchpenny booklet penned by Kempelen's aide, Karl von Windisch. This work, whose English translation bore the significant title *Inanimate Reason,* cheerfully acknowledged that some "deception" must be involved in the automaton's design, reported that there were those who suspected Kempelen of dealing with the devil, and chorused that "mathematicians of all countries have examined it with the most scrupulous attention without being able to discover the least trace of its mode of operation." Some Londoners straightforwardly guessed that within the Turk's cunning cabinet lay hidden a diminutive and human player. In Paris in September 1783, Friedrich Melchior von Grimm's *Correspondance littéraire,* chief organ of a decisive if restricted public of enlightened taste, agreed that the Turk "could not perform such a large number of different moves, whose determination could not be known in advance, without being subjected to the continual influence of an intelligent agent." Despite, if not because of, this view of the Turk's true nature, the Parisian journalists drew the moral that "physics, chemistry and mechanics have produced in our times more miracles than those believed by fanaticism and superstition in the ages of ignorance and barbarism."[69] As the Turk moved between absolutist courts, public fairs, and salon journalism, Kempelen's design and Windisch's publicity for it thus linked the fate of the Enlightenment with that of their intelligent machine.

News of the automaton spread through the German lands during 1784.

68. Faber, *Der Schachautomat,* and Hankins and Silverman, *Instruments and the Imagination,* 190–97, for Kempelen's career.

69. Windisch, *Inanimate Reason,* 12–13, 35; [Grimm], *Mémoires Historiques,* 3:70 (September 1783). For the role of Grimm's *Correspondance,* see Bryson, *Word and Image,* 154; Habermas, *Public Sphere,* 41; Chartier, *Cultural Origins,* 36.

One report, sent by Karl Friedrich Hindenburg to the eminent head of the Berlin observatory, Johann Bernoulli, reckoned that since the Turk must need both a directing and motive force to play, it depended on a combination of mechanical gearing and some array of magnets. An even more enthusiastic analysis, under the name of Johann Jakob Ebert, mathematics professor at Wittenberg, was published in Berlin in early 1785. Both texts seemed convinced rather that the automaton was devoid of human agency than worried by just how the human intelligence on which it relied was concealed. Another observer, Johann Lorenz Böckmann, who saw the automaton during its visit to Karslruhe, accepted Hindenburg's idea that some form of magnetism was involved, but urged instead that magnetic counters might be used to communicate to the hidden chess player inside. He published this "hypothetical clarification of the famous chess player" in his local *Magazin für Auklärung* in early 1785. It was even credulously reported that Friedrich II himself had been beaten by, then had tried to buy, the Turkish machine.[70]

The persistent link between the Turk and magnetism, ranging from Kempelen's original attempt to quash magnetic tricks at Vienna in 1769 to the theme that some hidden magnets must drive the Turk in the 1780s, suggested an obvious comparison with the contrivances of another Viennese wizard, Franz Anton Mesmer, whose animal magnetic fluids were supposed to govern the human economy. Like Kempelen, Mesmer wowed French and German audiences between the later 1770s and 1784, and, as with the contemporary Turk, mesmerized subjects were seen as puppets under the guidance of a hidden and cunning master. In summer 1784 Benjamin Franklin, rather a fan of his acquaintance Kempelen's chess player, joined Lavoisier and other government commissioners in damning Mesmer's victims: "They are entirely under the government of the person who distributes the magnetic virtue." These commissioners concluded that Mesmer's victims were subject to the power of their own imagination, not to the effects of any genuine fluid. The methods Lavoisier used to calibrate mental and mechanical labor were here used to scotch irrational vaporings. One of Mesmer's fiercer critics was the reformist Paris physician Jean-Jacques Paulet, who published his attack at the same moment as the commissioners. According to Paulet, the tendency of mesmerism and a host of similar projects, whether masonic or physiocratic, was to teach "that destiny itself is determined by particular genies who guide us without our knowing and without our seeing the strings which hold us; at last that in this lower world we are all like real puppets, ignorant and utterly blind slaves."

70. Carroll, *Chess Automaton,* 23–25, 36; for the doubtless spurious purchase by Friedrich II, see [Walker], "Chess Automaton," 725.

Paulet carefully noted the mesmerists' insistence that each victim should "enlighten himself, that man must enjoy his rights, or at least make out the hand which guides him."[71]

In short, their critics alleged, mesmerists convinced their victims that they were slaves by turning them into real automata under the power of imagination, then proclaimed a spurious path to liberty in which boulevard showmanship was substituted for enlightened freedom. The year 1784 was marked in Paris by the establishment of the secret societies that Paulet attacked, through which, as Dena Goodman tells us, women were excluded and marginalized as subversive of truly rational philosophy—their alleged vulnerability to Mesmer's blandishments only reinforcing this offensive. Mary Terrall explains elsewhere in this book just how academic analysis worked to exclude putatively unsound female mentality from the security of rational judgment, and specifies how the commissioners investigating mesmerism deployed their own status as state-sponsored judges of illusion. Robert Darnton has seen mesmerism and cognate marvels as a mark of the French Enlightenment's final descent into an occultist culture of the spectacle, most appealing to disaffected radicals and hacks. Henri Brunschwig similarly analyzes the collapse of the Prussian Enlightenment from the 1780s in terms of young (and unemployed) intellectuals' belief in the miraculous quality of everyday life. He found mesmerism, and other enterprises that seemed to turn bodies into marionettes under hidden power, among this new grouping. Indeed, Brunschwig connects the conservative reaction against the Enlightenment, of which Kant was an eminent victim, and the experiences of the new king with a notorious somnambulist and clairvoyante at the decade's end.[72] In these eschatological settings, therefore, the distinction between the self-proclaimed community of enlightened philosophers and those of their critics and enemies was decisive. In 1784 Lavoisier and his allies asserted a strong boundary between plebs, women, the aged, and the weak, who were the unconscious subjects of spurious imagination, and rational savants, who alone could make out the realities of nature and morality. One mesmerist then complained that if one believed these commissioners then imagination "would almost be our normal state. If that is so, they should have told us how they protected themselves when they judged magnetism." They did so with the logic of the automata: subjects were to be seen as governed machines, and this was uniquely obvious to the citizens of the late Enlightenment.[73]

71. Franklin, *Report,* 27; Paulet, *L'Antimagnétisme,* 3–4. For mesmerism's fate in Paris in 1784, see Gillispie, *Science and Polity,* 279–83. For Franklin's contact with Kempelen, see Hankins and Silverman, *Instruments and the Imagination,* 197.

72. Goodman, *Republic of Letters,* 240–41; Brunschwig, *Enlightenment and Romanticism,* 165–66, 181–222; Darnton, *Mesmerism,* 162–65.

On Kempelen's death in 1804, the Turk was soon acquired by a clever Viennese musical engineer, Johann Maelzel, court mechanician for the Habsburgs and a close ally of one of their favored composers, Beethoven. Maelzel swiftly saw the patronage he could win by trading on Kempelen's automaton, and the Turk became a temporary habitué of the new Napoleonic courts in Germany. Automata like this one seemed to symbolize what enlightenment might achieve. This may help explain the appearance of automata and androids in immediate post-Enlightenment fictions such as those of Jean Paul (in *Titan*), Georg Büchner *(Leonce and Lena)* and E. T. A. Hoffmann.[74] Hoffmann, a fellow musician, found the figure of a mechanical Turk a suitably exotic subject for his pen and in 1814 sent a Leipzig musical magazine a story entitled *The Automata,* in which he "took the opportunity to express [himself] on everything that is called an automaton," teasingly hinting that the Turk might work by setting up a musical harmony with the mind of its audience. Hoffmann used his story to debate the most up-to-date views of occultist German philosophies of nature, much devoted to the inner rhythms of human mental life. The following year, he completed *The Sandman,* his most remarkable exploration of the "fraudulent imposition of an automaton upon human society" by a brilliant and demonic impresario-philosopher. Like Kleist's *Marionette Theatre,* which appeared in the Berlin newspapers in 1810, one salient theme of Hoffmann's story was that from the viewpoint of post-Enlightenment critique, automata might become all too perfect. To be truly human in an age when mechanics had engrossed so much was to be either inexact and faltering or a visionary genius akin to God.[75]

Maelzel threw himself into a lucrative mechanical project for regulating genius with a machine he named the "metronome." The metronome was, of course, a rather more potent means of mechanizing errant human capacities than any mere chess player. After furious patent suits with rival inventors, and complex negotiations with Beethoven, Maelzel established himself as the monopoly distributor of these newfangled musical timekeepers and repurchased

73. Deslon in *Supplément aux deux Rapports de MM. les Commissaires,* 9. For savants' insistence on imagination at the expense of mesmerists, see Azouvi, "Sens et fonction épistémologiques."

74. Sauer, *Marionetten,* 65–119; Gendolla, *Lebenden Maschinen,* 76–103.

75. Carroll, *Chess Automaton,* 43–46; Hoffmann to Rochlitz, 16 January 1814, in Hoffmann, *Selected Letters,* 217. The citation of the *The Sandman* is from Hoffmann, *Tales,* 212. Compare Hankins and Silverman, *Instruments and the Imagination,* 225–26; Völker, *Künstliche Menschen,* 476–79.

the Turk from the Bavarian court, where the occultist philosopher Franz von Baader and his colleagues were intrigued by automatism and mesmerism. Then, in 1818, Maelzel set off on a marketing and publicity tour of Paris and London. He helped realize his metronomic dream of an automatic orchestra, the Panharmonicon, for which Beethoven had composed his ghastly *Battle Symphony*. One London paper praised such an orchestra, which "displayed none of the *airs* of inflated genius, but readily submitted to being wound up."[76] Maelzel faithfully followed Kempelen's recipe and his metropolitan audience reproduced their earlier enthusiasm for the show. Ever considerate to this public, Maelzel even announced that the automaton would purposely make bad moves so as deliberately to lose if the company seemed bored with overlengthy games, while the Turk's opponents were ordered to move as fast as possible to alleviate the tedium. A pamphlet authored by a pseudonymous Oxford graduate alleged the whole trick relied on a hidden piece of wire or catgut: "[I]t seems to be a thing absolutely impossible," the Oxonian alleged, "that any piece of mechanism should be invented which possessing perfect mechanical motion should appear to exert the intelligence of a reasoning agent."[77]

By the end of 1820, the Turk's nemesis had appeared in the person of Robert Willis, an ingenious young Londoner, heir to a distinguished medical family—his father famously attended George III during the monarch's madness. In later life Willis himself became a distinguished Cambridge mathematician and professor of applied mechanics, introducing an innovative teaching strategy using entire museums of model machines.[78] The young mechanic bought copies of the games the Turk had played and made sure to visit Maelzel's show while it occupied a cramped space, "more favourable to examination as I was enabled at different times to press close up to the figure while it was playing." He smuggled an umbrella into the room so as to measure "with great accuracy" all the dimensions of the Turk's celebrated cabinet. Willis's accurate umbrella and his command of wheelwork made all the difference. The chest, he demonstrated, was much larger than it seemed, giving enough room for a fully grown (and skillful) human chess player to fit inside. "Instead of referring to little dwarfs, semi-transparent chess boards, magnetism, or supposing the possibility of the exhibitor's guiding the automaton by means of a wire or piece of catgut so small as not to be perceived by the spectators," Willis's *Attempt to Analyze the Automaton Chess Player*, finished in December 1820, proffered the simplest possible scheme of the Turk's hidden intelligence. The noisy gearwheels were there so that their sound would conceal any noise made by the

76. Harding, *The Metronome*, 22–28; Altick, *Shows of London*, 357–59.
77. Carroll, *Chess Automaton*, 47–51; *Observations on the Automaton*, 7.
78. Hilken, *Engineering at Cambridge*, 52–54.

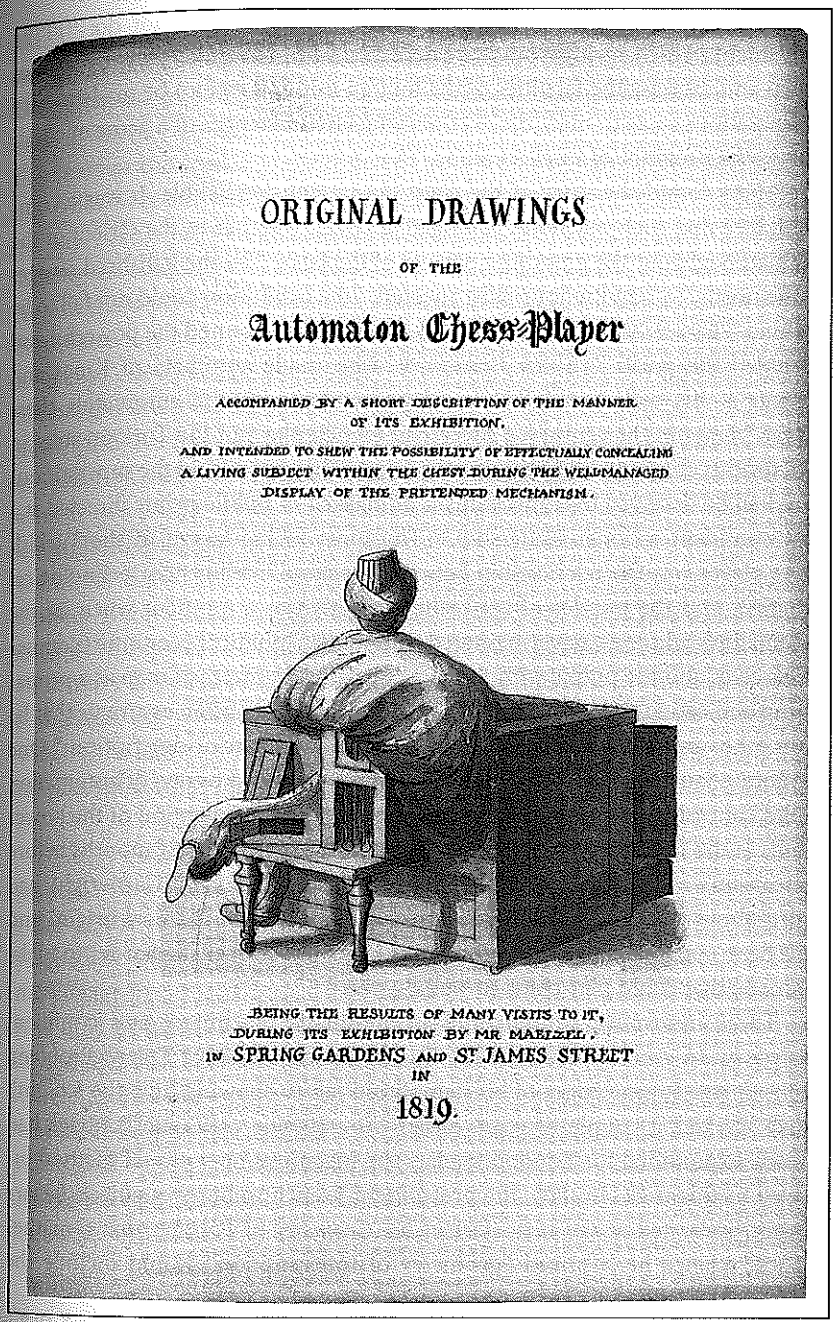

Fig. 5.5. Robert Willis's initial attack on the problem of the Turkish automaton. From Robert Willis, *Original Drawings of the Automaton Chess Player* (London, 1819).

concealed player. Willis explained what mechanism could not do: "[T]he movements which spring from it are necessarily limited and uniform, it cannot usurp and exercise the faculties of the human mind, it cannot be made to vary its operations so as to meet the ever-varying circumstances of a game of chess. This is the province of intellect alone."[79]

Many found the story of the chess automaton irresistible. It was a commonplace that such machines belonged at court, whether in the Orient of the Arabian Nights or the grandiose palaces of the tsars. "To the half-bred savages of the north," a London journalist sneered, "the exhibition could not fail to be striking." Novels and reviews told how the Turk had conned the powerful and humbled the great: "[E]ven Bonaparte, who made automata of Kings and Princes at his will, was foiled in an encounter with the automaton chess player." Later in the century, a successful French play put the Turk on stage in a victorious contest with Catherine the Great. The genteel and the superstitious could all be deceived by a mechanism unmasked in public prints directed at a new confident rational readership.[80] The most telling lesson of the Turkish chess player was the relationship between machine intelligence, technological progress, and the puzzles of concealment. This was a moment when, as the automaton's admirers never hesitated to remark, "political economists amuse themselves and the public with the nicely-balanced powers of man as a propagating and eating *animal* and philosophers and divines often assure us that he is, in other and higher respects, but a *machine* of a superior description." One economic journalist, describing the rapid growth and progress of automation in the Lancashire cotton industry, told the story of the invention of the power loom, in the famous year of 1784, by Edmund Cartwright. Just months before Vaucanson's swivel looms reached the Lancashire factories, Cartwright had heard about the mechanical Turk, trusted its purely mechanical origin, and thus been convinced that a weaving machine could scarcely be harder to make than one that could play chess so well.[81]

These innovative conjunctions of automatic machinery and confident analysis were even apparent in the Turk's capacity to solve Euler's Problem. Willis devoted some pages of his demolition job to showing how the Knight's Move worked; a couple of years earlier his erstwhile colleague Babbage had already expounded for London readers the ingenious operational method involved in this trick. In 1803, the preeminent French military engineer, Lazare Carnot, indicated at the very start of his *Geometry of Position* that a mathematical science he baptized "geometry of transposition" would include the

79. Willis diary, 78 (6 June 1820), 88 (16 October 1820), 106 (21 December 1820); Willis, "Original Drawings"; Willis, "An Essay," 2; Willis, *An attempt*, 11.

80. Walker, "Anatomy of the Chess Automaton," 723; Chapuis and Droz, *Automata*, 365–67.

81. "Scientific Amusements," 441; Baines, *Cotton Manufacture in Great Britain*, 229.

Knight's Move within its scope. Carnot explained that such puzzles would form one aspect of a general technique that would allow "the passage from geometry to mechanics" and thus help forge a science of machines, such as knitting frames, where "the aim is to establish such-and-such relations between the directions or the speeds of the different points of a system." Carnot, Babbage, and Willis were among those scientific protagonists who now showed just how military, industrial, and mathematical concerns converged in puzzles like this. In using the Knight's Move to display its rational power, the impresarios of the Turkish chess player selected a key element in new physicalist sciences of machine behavior, important accompaniments of Enlightenment analysis, as Alder shows elsewhere in this book.[82] These new sciences were lauded by the Edinburgh natural philosopher David Brewster in his best-selling work *Natural Magic* (1832), which was devoted to teaching his fellow citizens the inner secrets on which all apparently miraculous and surprising mechanical devices depended. Part of the point was characteristic of a certain kind of enlightened demystification: gaudy tricks dangerously conned the ignorant into idolatry. Part of the argument, however, was economic. In his chapter on automata, Brewster summarized the unmasking of Kempelen's chess player and juxtaposed it with James Watt's engineering. "Those mechanical wonders which in one century enriched only the conjurer who used them, contributed in another to augment the wealth of the nation. Those automatic toys," he concluded, "which once amused the vulgar, are now employed in extending the power and promoting the civilization of our species."[83]

Aftermath: We Have Never Been Enlightened

Automata thus provided an apt topic for the Enlightenment's concerns with power and civilization and its attitudes to the vulgar and the worker. The Encyclopedists portrayed talented artisans as visible automata. "Most of those who engage in the mechanical arts have embraced them only by necessity and work only by instinct . . . [I]n a workshop it is the moment that speaks, and not the artisan."[84] Smith and Ferguson also defined for themselves a place whence they could analyze the efforts of labor, thus discriminating between philosophers' freedom and the mechanics of manufacture. La Mettrie, Desaguliers, and Vaucanson set out the mechanisms governing the animal economy and the social economy, specifying as they did so the crucial role they should discharge. Coulomb and Lavoisier then designed techniques for the precise

82. Babbage, "Euler's Method," 72–77 and Carnot, *Géométrie de Position*, xxxvi. For machines and physicalism, see Gillispie, *Lazare Carnot*, 132; Daston, "Physicalist Tradition," 282–83; Séris, *Machine et communication*, 343–76; and, especially, Guillerme, "Network," 154.

83. Brewster, *Natural Magic*, 336.

84. D'Alembert, *Preliminary Discourse*, 125–26.

evaluation of labor on the presumption that the animal economy—and thence the moral economy— could be understood as a self-regulating system. These British and French views provide examples of ways in which philosophers specified their own predicament. During the 1780s, when the very character of the Enlightenment was in question, further cases of this self-analysis were provided by Bentham's simultaneous production of new personae for the wardens and the inmates of productive institutions, by Kant's discrimination between the free citizen-philosopher and the automated soldier-subject, and by French savants' distinction between the victims of imagination and the rationality of the enlightened. The automatic chess player provided a dramatic case of these relations between the automaton, the enlightened, and the self because for some it was a machine that displayed remarkably human attributes, while for others, including its designer, it was a human who performed in a strikingly machinelike manner. The intelligent automaton has remained a salient theme in analyses of the Enlightenment's aftermath.

Inspired by Willis and Brewster's stories, Poe set out the mechanical principles of poetic composition, and Babbage used games-playing automata to theorize the mechanization of intelligence, thence establishing the principles of a political economy of intellectual labor. For Marx the culmination of manufacture was just a system "set in motion by an automaton, a moving power that moves itself; this automaton consisting of numerous mechanical and intellectual organs, so that the workers themselves are cast merely as its conscious linkages." Thus science "compels the inanimate limbs of the machinery to act as an automaton" and ultimately "the machine is itself the virtuoso."[85] The automaton stays in place as a symbol of modernity because it helps us see the effects of this expropriation of virtuosity, science, and reason. Enlightened science imposed a division between subjects that could be automated and those reserved for reason. Such a contrast between instinctual mechanical labor and its rational analysis accompanied processes of subordination and rule. It seemed as if most subjects had never been, could perhaps never be, enlightened. The concern here has been to see how an enlightened public produced this grim view of society's mechanics.

Primary Sources

Babbage, Charles. "An Account of Euler's Method of solving a problem relative to the Move of the Knight at a Game of Chess." *Journal of Science and the Arts* 3 (1817): 72–77.

Baines, Edward. *History of the Cotton Manufacture in Great Britain.* London: Fisher, 1835.

Bentham, Jeremy. *Panopticon; or, the Inspection House.* London: Payne, 1791.

Brewster, David. *Letters on Natural Magic.* 1832. Reprint, London: Chatto and Windus, 1883.

Carnot, Lazare. *Géométrie de position.* Paris: Crapelet, 1803.

85. Wimsatt, "Poe and the Chess Automaton"; Babbage, *Passages,* 465–71; Marx, *Grundrisse,* 692–93 (February 1858).

Coulomb, Charles. "Mémoire sur la force des hommes." In *Théorie des machines simples.* Paris: Bachelier, 1821.

D'Alembert, Jean. *Preliminary Discourse to the Encyclopaedia of Diderot.* Edited and translated by Richard Schwab. Indianapolis: Bobbs Merrill, 1963. First French edition published 1751.

Desaguliers, John Theophilus. *A Course of Experimental Philosophy.* 2 vols. London, 1734–44.

Deslon, Charles. *Supplément aux deux Rapports de MM. les Commissaires.* Amsterdam, 1784.

Diderot, Denis, and Jean le Rond d'Alembert, eds. *Encyclopédie, ou Dictionnaire raisonné des Sciences, des Arts et des Métiers.* Paris, 1751–72.

Edmonds, Charles, ed. *Poetry of the Anti-Jacobin.* London: Sampson Low, Marston, Searle and Rivington, 1890.

Euler, Leonhard. *Lettres à une Princesse d'Allemagne.* 3 vols. Paris, 1787–89. First edition published 1768–74.

Ferguson, Adam. *An Essay on the History of Civil Society.* Edited by Duncan Forbes. Edinburgh: Edinburgh University Press, 1966. First edition published 1767.

Franklin, Benjamin, et al. *Report of Dr. Benjamin Franklin and other Commissioners charged by the King of France with the Examination of the Animal Magnetism.* London, 1785.

[Grimm, F. M. von]. *Mémoires historiques littéraires et anecdotiques.* London, 1813.

Hoffmann, E. T. A. *Tales of Hoffmann.* Edited by E. F. Bleiler. New York: Dover, 1967.

———. *Selected Letters.* Edited by Joanna C. Sahlin. Chicago: University of Chicago Press, 1977.

Kant, Immanuel. "An Answer to the Question: What is Enlightenment?" (1784). In *Kant: Political Writings,* 2d ed., edited by Hans Reiss, 54–60. Cambridge: Cambridge University Press, 1991.

Kenrick, William. *Account of the Automaton constructed by Orffyreus.* London, 1770.

———. *Lecture on the Perpetual Motion.* London, 1771.

La Mettrie, Julien Offray de. *Man a Machine.* Edited and translated by Gertrude Carman Bussey. La Salle: Open Court, 1912. First French edition published 1747.

Lavoisier, Antoine. *Oeuvres.* 6 vols. Edited by J. B. Dumas and E. Grimaux. Paris: Imprimerie nationale, 1864–96.

———. *De la Richesse Territoriale du Royaume de France.* Edited by Jean-Claude Perrot. Paris: C.T.H.S., 1988. First edition published 1791.

Observations on the Automaton Chess Player. London, 1819.

Ozanam, Jacques. *Recreations in mathematics and natural philosophy.* 4 vols. Edited by Jean Montucla, translated by Charles Hutton. 1778. Reprint, London: Kearsley, 1803.

Paulet, Jean-Jacques. *L'Antimagnétisme.* London, 1784.

"Scientific Amusements—of Automata." *New Monthly Magazine* 1 (1821): 441–48, 524–32.

Smith, Adam. *An Inquiry into the Nature and Causes of the Wealth of Nations.* 2 vols. Edited by R. H. Campbell, A. S. Skinner, and W. B. Todd. Oxford: Clarendon Press, 1976. First edition published 1776.

———. *Lectures on Jurisprudence.* Edited by R. L. Meek, D. D. Raphael, and P. G. Stein. Oxford: Clarendon Press, 1978.

———. *Essays on Philosophical Subjects.* Edited by W. P. D. Wightman and J. C. Bryce. Oxford: Clarendon Press, 1980. First edition published 1795.

Vaucanson, Jacques. *An Account of the Mechanism of an Automaton.* London, 1742.

[Walker, George]. "Anatomy of the Chess Automaton." *Fraser's Magazine* 19 (1839): 717-31.

Willis, Robert. Diary, 1819-1821. Cambridge University Library MSS ADD 7574.

———. "Original drawings of the Automaton Chess Player." 1821. Cambridge University Library Adv.c.98.13.3.

———. "An essay on the Automaton Chess Player." London, 1821. Cambridge University Library Adv.c.98.13.4.

———. *An attempt to analyse the Automaton Chess Player.* London, 1821.

[Windisch, Karl Gottlieb von]. *Inanimate Reason, or a Circumstantial Account of that Astonishing Piece of Mechanism, M. de Kempelen's Chess-Player.* London, 1784.