

# GENESIS REDUX



Essays in the History  
and Philosophy of Artificial Life

EDITED BY JESSICA RISKIN

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and Philosophy of Artificial Life

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13 Perpetual Devotion:  
A Sixteenth-Century Machine  
That Prays ELIZABETH KING

Lord, make me an instrument of your peace.

*From the prayer of Saint Francis*

In 1977 the Smithsonian Institution's National Museum of History and Technology purchased a small automaton believed to have been made in south Germany or Spain near the year 1560 (figures 13.1 and 13.2). The figure of a Franciscan monk, clad in the tunic, cowl, and sandals of the order, the automaton is sixteen inches high—about one-fourth life-size. The body is carved and turned linden wood, hollowed out to contain an animating mechanism whose many parts are made of hand-forged iron, all of which is hidden beneath the cloth of the habit. The visible hands, head, and feet are delicately carved, and polychromed. The paint, now cracked with age, was clearly once aglow with life: a faint flush still lingers on cheek and lip. An X-ray of the inside of the head reveals the machinery that controls the motions of the eyes and mouth (figure 13.3). The eyeballs themselves are made of iron, hammered round and painted. The monk grasps a small wooden crucifix and rosary in one hand, while the fingers and thumb of the other converge in the classic gesture of Latin emphasis (figure 13.4). Only the movement's mainspring and the monk's cloth garment are not original, and the cross and rosary have also been replaced in the intervening centuries. All else is remarkably well-preserved. The whole machine weighs just under five pounds.

In the history of European clock technology, the monk is an early and rare example of an automaton whose mechanism is self-contained and hidden within its body. Its performance takes place not on a mediating plinth or within an animated grotto (where there would be ample "backstage" room



FIGURE 13.1 | Automaton figure of a monk, south Germany or Spain, ca. 1560 (National Museum of American History, Smithsonian Institution, Washington, D.C.).

for concealing the drive hardware), but on a table or floor in the viewer's own world. Let us imagine it set in motion by a trusted steward, in a privileged setting. The mainspring has been wound ahead of time, out of sight of the assembled spectators, and the key withdrawn. The steward steps forward, holding the figure upright on the palm of one hand, and silently sets it down on a table, with a feint that discreetly releases the stop-work lever. Slowly the monk comes to life. He turns his head to single out one among the company. Left foot stepping forth from under the cassock hem, then right foot, the monk advances in the direction of his gaze, raising the crucifix and rosary before him as he walks. His eyes move: turning his head he looks to the



FIGURE 13.2 | Side view of automaton figure of a monk, south Germany or Spain, ca. 1560 (National Museum of American History, Smithsonian Institution, Washington, D.C.).

raised cross and then back to his subject. His mouth opens, then closes, affording a glimpse of teeth and interior. He bends his right arm, and with the gathered fingers of his hand, he strikes his breast. The small blow is audible. And now he is lowering and turning his head as he walks: with elbow and shoulder in synchronized motion he brings the cross higher, up to his lips, and kisses it. Thirty seconds into the act, he has taken eight steps, beaten his chest three times, kissed the cross, and traveled a distance of twenty inches. At what seems like the last moment—for doubtless the subject of his attention has backed away from the table's edge—he looks away, arms still aloft, executes a turn to his right, and makes a new appointment. He will make

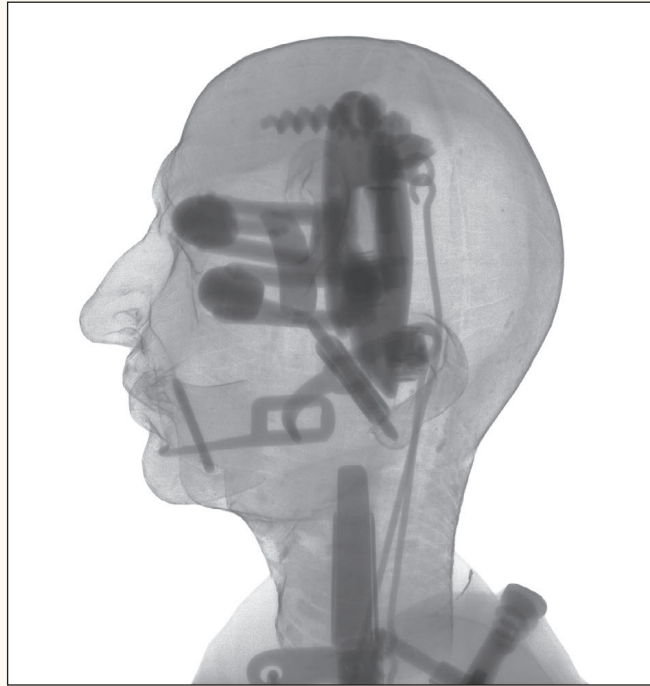


FIGURE 13.3 | X-ray of the interior of the monk's head, revealing the mechanism of the eyes, mouth, and neck (National Museum of American History, Smithsonian Institution, Washington, D.C.).

seven such turns and advances in his campaign if the mainspring has been fully wound. The uninterrupted repetition corresponds exactly to a trancelike performance of prayer, incantation.<sup>1</sup>

After more than four hundred years, the figure is still in good working order. Tradition connects its manufacture to Juanelo Turriano, engineer and mechanic to Emperor Charles V and then to his son King Philip II of Spain. How it came to be made is a tale a curious viewer today might hear if he or she presses anyone at the museum. King Philip, the legend goes, praying at the bedside of a dying son of his own, promised a miracle for a miracle, if his child be spared. And when the young prince did indeed recover, Philip kept his bargain by having Turriano construct a penitent clockwork homunculus.

Historian Otto Mayr, then curator at the Smithsonian's National Museum of History and Technology, wrote to his acquisition board before the



FIGURE 13.4 | The monk's hands. Photograph ©Rosamond Purcell, 2002.

purchase, "For the history of technology, this automaton is important as one of the earliest program-controlled self-acting machines that have survived to the present. It is a direct predecessor of the eighteenth-century automata of Vaucanson and Jaquet-Droz, of the Jacquard loom and Babbage's computer." Mayr equally understood its significance to philosophy and to the literature of artificial life, for few of the miraculous automata attributed to inventors and thinkers from Archimedes to Descartes have materialized beyond legend. Fate is reversed in the case of the monk: it arrives intact from the tumult of history with no letter of introduction. Yet among the documents in the accession archives, there are some credible recent records proposing a Spanish origin in connection with the court of Philip II.

## A MIRACLE AND A PROMISE

History records the illness of Don Carlos, Philip's son and Spain's crown prince, in 1562. We know Carlos today as the hero of Verdi's opera *Don Carlo*, the story of a defiant prince destroyed by his father in a tale of empire, doomed love, and Inquisition. The historical Spanish prince, king, and court are a different story, though remnant contention yet clings to the subject of Don Carlos's short and strange life. He was seventeen years old in 1562 when, perhaps on an illicit errand, he took a fall down a flight of little-used stairs in his royal lodgings in the university town of Alcalá de Henares and struck his head against a closed door in the passageway below.

William Prescott, in his 1874 *History of the Reign of Philip the Second*, describes what happened to Don Carlos after the fall:

He was taken up senseless, and removed to his chamber, where his physicians were instantly summoned. . . . At first it seemed only a simple contusion on the head. . . . But soon the symptoms became more alarming. Fever set in. He was attacked by erysipelas; his head swelled to an enormous size; he became totally blind; and this was followed by delirium. It now appeared that the skull was fractured. . . . Meanwhile, the greatest alarm spread through the country at the prospect of losing the heir-apparent. Processions were everywhere made to the churches, prayers were put up, pilgrimages were vowed, and the discipline was unsparingly administered by the fanatical multitude, who hoped by self-inflicted penance to avert the wrath of Heaven from the land.<sup>2</sup>

A recent study by historian L. J. Andrew Villalon, "Putting Don Carlos Together Again: Treatment of a Head Injury in Sixteenth-Century Spain," takes us through day by appalling day of the ordeal, quoting from the accounts of the prince's surgeon.<sup>3</sup> On the afternoon of May 9, in the aftermath of an unsuccessful attempt by physicians to trepan the patient's skull, the townspeople of Alcalá gathered at the Church of Saint Francis. "With Franciscan friars in the lead, they marched toward the palace, carrying with them the remains of a fifteenth-century member of the order, Diego de Alcalá, for whom they had long hoped to win sainthood."<sup>4</sup> Prescott transmits the story a little differently, having the king himself and his court fetching "the mouldering remains of the good father, still sweet to the nostrils, as we are told." Laying the corpse on the prince's bed, they removed the cloth that wrapped the dead man's head and placed it on Carlos's forehead.<sup>5</sup> But by evening so imminent was Carlos's death that the king took his closest advisors and departed before midnight, riding toward the Jeronymite monastery outside Madrid, to

await the final news. Yet that night Carlos slept peacefully for the first time in weeks. The next day commenced a sudden, extraordinary recovery. The patient regained his sight a week later, his fever disappeared soon thereafter, and within a month, he was completely healed.

In the aftermath of this recovery, there was controversy as to how the cure was effected, but soon attention focused on Fray Diego de Alcalá, with a groundswell of feeling that here was the agent of a miracle. We can look back today and see two miracles, the second being the patient's survival of the physicians' purging and bleeding, and the daily probing of the wound with nonsterile instruments. ("They went on placing upon the exposed portion of the skull a powder made of iris and birthwort, and on the lips of the wound a mixture of turpentine and egg yolk. Following this, they cleaned the wound with honey of roses and applied a plaster of betony.")<sup>6</sup> The most dramatic evidence came from Don Carlos himself. When he regained his senses, he reported that on the night of May 9, a figure dressed in Franciscan habit and carrying a small wooden cross had entered his room and spoken to him. Certain that the apparition had been Brother Diego himself, Don Carlos vowed, together with his father, to bring this miracle before the Pope.<sup>7</sup> In Counter-Reformation Spain, even Andreas Vesalius, among the physicians laboring at the bedside, would risk heresy to contest such testimony to divine intervention.

In the end, it took Philip twenty-six years of respectful petitions to four consecutive popes to bring about the institutional confirmation of the miracle of Don Carlos's cure. The documents his scribes amassed are available today in the archives of the Escorial; they are the source of the close detail we have of the illness. Diego de Alcalá was canonized as a saint by the Roman Catholic Church in 1588. He was the first Counter-Reformation saint, commemorated in paintings by Zurbarán (figure 13.5), Murillo, and Carracci. A mission in his name was established in the new world in 1769, which later grew into San Diego, California.

The cure itself was not the first wonder performed by this thaumaturgical corpse. Through the hundred years before its appearance on the royal stage, Diego's body had drawn a steady procession of ailing pilgrims come to touch the holy flesh of an illiterate Franciscan lay-brother (figure 13.6).<sup>8</sup> He had lived a life of uninterrupted poverty, famous for the asceticism of his practice, but his death in 1463 was only the beginning of his holy career. The first miracle was the perfect absence of death's mark on the body: the monastery guardian apparently had second thoughts after the burial and had the body disinterred, and one visitor in the first month tried to take its



FIGURE 13.5 | Francisco de Zurbarán, Portrait of Diego de Alcalá (Museo de la Fundación Lázaro Galdiano, Madrid).

pulse.<sup>9</sup> His remains, 540 years later, are still in Alcalá de Henares; the body has been moved now to the Iglesia Magistral. Over the small tomb, an inscription appears on the wall:

DIEGO DE ALCALÁ  
CUERPO INCORRUPTO

The name of Juanelo Turriano, celebrated Italian-born clockmaker (1500?–1585), has been connected not just to the monk, but to several other automata that have survived to the present day. Court mechanic and engineer to Philip II, and before Philip to his father Charles V, Turriano worked in Madrid and Toledo for the better part of his life. “The prince of the masters



FIGURE 13.6 | Cornelius Galle, Diego de Alcalá (vita), engraving, first published in 1614 (Museo Franceseano, Istituto Storico dei Cappuccini, Rome).

of clockmaking,” the emperor called him. To this day, a street in the heart of Toledo bears his memory: Calle del Hombre de Palo—“street of the wooden man”—so named for a fabled automaton he built that walked daily to the archbishop’s palace and returned “laden with an allowance of bread and meat, after doing ceremonious obeisance to the donor.”<sup>10</sup> Turriano would certainly have known the young prince Don Carlos, for his friend Ambrosio de Morales, court annalist to Philip II, had been appointed to oversee the preparation of documents on the life of Diego de Alcalá, submitted in petition to the Vatican. The same Ambrosio de Morales, in his encyclopedic volume *Las antigüedades de las ciudades de España*—a descriptive inventory of Spain’s material history, commissioned by Philip and published in Madrid in 1575—provides us with an eyewitness account of the works of Turriano. Inventions large and small—but especially his clocks, how he made them and what he had to say about them—were chronicled by Morales in eloquent Old Spanish. Among all these marvels is a small automaton, “la dama que tañe y dança”:

Juanelo as a diversion also wanted to create anew the ancient statues which moved and, on that account, were called automata by the Greeks. He made a lady more than one *tercia* high who, placed on a table, dances all over it to the sound of a drum which she meanwhile beats herself, and goes round in circles, returning to where she started. Though it is a toy and fit for mirth, it is nevertheless a great proof of his high intelligence.<sup>11</sup>

A *tercia* is a Spanish linear measure of approximately eleven inches. In 1934, an automaton turned up in Vienna that so closely resembled this description that the horological historian Ernst von Bassermann-Jordan cited Morales to suggest an attribution to “Master Juanelo.”<sup>12</sup> The figure plays a lute rather than a drum, but her dancing steps and circular tour and her small size certainly fit the slipper. The material and design of her clockwork, like that of the monk, indicate a mid-sixteenth-century pedigree. She is now in the collection of Vienna’s Kunsthistorisches Museum. Turriano’s name, once connected to her, moves through her in turn to circle the monk; we see at least a schematic similarity between the two iron movements. But tantalizing as the Morales passage is, we have no further words from him in reference to any other automaton.<sup>13</sup>

Yet, in the archives of the Smithsonian, we learn that the monk, purchased through a private broker in Geneva in 1977, arrived in Washington with documents that included a letter written in 1975 by Servus Gieben, director of the Istituto Storico dei Cappuccini in Rome. Solicited by the broker for his opinion of the automaton, which by then had been dated materially

and stylistically to the sixteenth century, Gieben confirmed its Franciscan iconography and hypothesized that the monk was a portrait of Diego de Alcalá. He based his opinion on a constellation of factors: his strong impression that the figure was Spanish; the fact that Diego’s saintly attributes are precisely the small cross and rosary; the observation that the automaton is given the shaved head of a lay brother (as Diego was) and not the tonsure of an ordained priest; the opinion that the face even bore a likeness to other portraits of the saint (Gieben had enclosed photocopies of two engravings from the collections of the Istituto’s Museo Francescano, one of which I reproduce here as figure 13.6); and the reasoning that the illness and miraculous cure of prince Don Carlos provided the occasion for a votive portrait:

It is in this climate of religious exaltation—processions, public prayers, pilgrimages for obtaining the prince’s cure—that one must locate the fabrication of the automaton, as a kind of *ex-voto* and—why not?—as an exhortation to the young prince to a more serious life (he was very capricious). The date should be 1562 or a little later, and the author Juanelo Turriano (or de la Torre, dead in 1585), who was chief engineer to Philip II.<sup>14</sup>

In 1999, twenty-four long years after this letter was written, I was lucky to contact Servus Gieben in Rome, where today he is once again, at age eighty-two, head of the Istituto Storico dei Cappuccini and director of its Museo Francescano. A scholar of medieval theology and a specialist in the lives of the saints as depicted in the history of art, he responded to my letter in fluent English (one of his six languages), writing, “I certainly will be pleased to read your paper on the ‘Mechanical Monk,’ of which I preserve nice photographs and curious memories.” My first question for him: Had the Geneva broker mentioned either Turriano’s name or the precedent of the Vienna automaton? No, he replied, no link whatsoever had been made to another automaton, and in fact he learned of such a connection only from reading the draft of the essay I had just sent him.<sup>15</sup> At most, he recalled the suggestion of a sixteenth-century origin for the piece. His opinion that the monk represented a Spanish figure was based on the physiognomy of the carved face, a judgment confirmed by his search through the Museo Francescano print archives and the match, not just with the person of San Diego, but with the saint’s symbols, lay status, and gestures.

Servus Gieben’s hypothesis comes not from the history of technology, but from the history of theology, for he arrived at his conclusion without an awareness of the attribution to Juanelo Turriano of any similar automaton figure. It is remarkable that two separate tracks converge on so close

an explanation of the monk's origin. Nonetheless, the attribution can of course remain only an educated guess.<sup>16</sup> The clockmaker himself evades us, for none of the machines Juanelo Turriano made with his own hands have survived in a form we can surely identify. His greatest astronomical clock, the work of a lifetime, he signed with an engraved inscription in Latin: "QVI. SIM. SCIES. SI. PAR. OPVS. FACERE. CONABERIS," which can be very roughly translated as "You will know who I am if you try and make this."<sup>17</sup>

## TWO QUESTIONS

Years ago, when I first saw the automaton monk perform on a table in the museum conservation lab in Washington, I wondered how this object was seen in the age in which it was made. Could this lifelike thing have been perceived as alive? Could it even momentarily have been perceived as alive, just for the space of a shudder? In pursuing the source of the legend, a second question took hold. *What was perceived to be transferred from the corpse to the prince? With death so close, it could almost be said that one dead body was resurrected by another. Could my two questions in any way be useful, one to the other, in the attempt to glimpse something of the emotional and imaginative undertow beneath declared understandings of the substance of living matter—judging the quick from the dead—in mid-sixteenth-century Europe? After all, the automaton, in good running order after four and a half centuries, comes to life in animated defiance of time and decay. Like the saint's body, it still "delivers" after all these years. Whether or not the automaton commemorates the cure, just the proximity of the machine and the corpse on the historical stage is worth considering (figure 13.7).*

The automaton monk may be small and portable, but to consider it a toy—*juquete* is the word Morales uses for the dancing lady—presents an awkward dilemma for the interpretation of its performance.<sup>18</sup> So drilled are we against "presentism" in interpreting historical events, we hardly know what to do with our own emotional response to the objects we have inherited. Everyone who sees the monk in action agrees that it is intimidating—when the redesign of the museum's Hall of Timekeeping began in 1997 and the monk was taken off display, some of the staff were actually relieved.<sup>19</sup> I can offer my own testimony that when this machine heads in my direction on a table, my animal flight urge stirs. The bare mechanics of the gear motion are straightforward compared to other automata of the age. But look at the delicacy of the carved face in the X-ray (figure 13.3)! Seeing past the skin of cracked and discolored paint, we can make out the sculpture itself. The

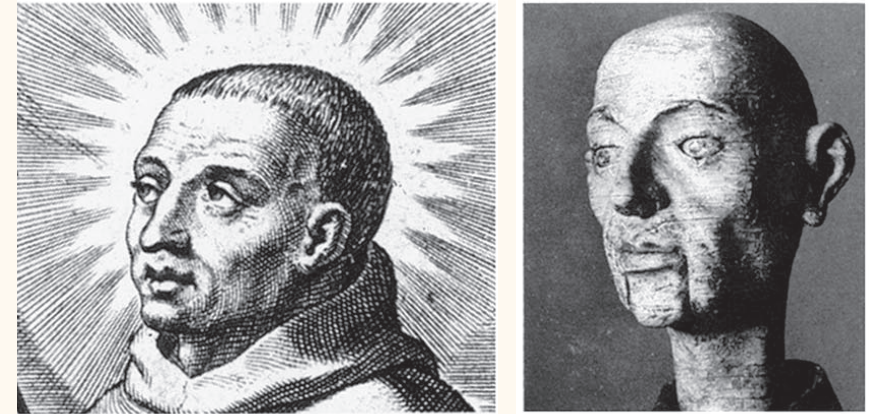


FIGURE 13.7 | Comparison of the automaton's head with an engraved portrait of San Diego de Alcalá. From the auction catalog *Très importante collection de tableaux Espagnols du XIII<sup>e</sup> au XVIII<sup>e</sup> siècle [...]* (Paris: Pierre Cornette de Saint-Cyr, 1976), 84.

character of the image, together with its head-on motion, makes an object that is impossible to regard with objective remove. And is this not precisely how works of art connect us most intimately to the past? As David Freedberg asks in *The Power of Images: Studies in the History and Theory of Response*, how can we hope to understand how representational objects were seen in history if we repress our own responses to these works?<sup>20</sup>

Freedberg's book tracks the history of human response to many classes of objects. The votive image, the effigies of sorcery, the wax museum, the religious relic and object of pilgrimage, acheiropoietic images (those believed not made by human hands), images that bled, or wept real tears, or whose eyes moved—all these as well as works from the high canon of Western painting and sculpture come under his scrutiny. The book itself is a master's response to Roland Barthes's call for a "History of Looking."<sup>21</sup> Although he does not focus on automata per se, his broad theme of figural verisimilitude and his discussion of objects associated with miracles provide correlative insights.

A strong devotional image may invoke what Freedberg calls an answering act of *reconstitution* performed by the beholder. Using the terminology of semiotics, he proposes that the gap between sign and signified may remain unacknowledged in the devout response. The statue is not just a metaphor or stand-in for the saint. It is a metonym: a piece of the real cloth, God Himself in the image. The power of an image, together with the empathy

and desire of the beholder, collapses the distinction between representation and presence:

The sign has become the living embodiment of what it signifies. Perhaps it will be suggested that a strong or ingrown belief in the powers of the Virgin easily inclines the believer to see her present, disencumbered of everything that makes her dead representation. Perhaps the suggestion will run that one cannot believe that the Virgin is in the picture—or is the picture—unless one believes, to begin with, in the Virgin. Then, wanting her to be there, to exist (because of the love we bear her), we willingly concentrate on the image, and what is represented on it becomes present again. She is, quite literally, re-presented. The slip from representation to presentation is crucial, from seeing a token of the Virgin to seeing her there. What happens? How do we proceed without engaging in the analysis of the propositional status of statements about belief, or the relations between the nature of beliefs and reports about them?<sup>22</sup>

This slip from representation to presentation, Freedberg argues, is something we experience every time we respond emotionally to an image, and such a slip accounts for the unacknowledged traces of animism in our own time: “not necessarily ‘animism’ in the nineteenth-century ethnographic sense of the transference of spirits to inanimate objects, but rather in the sense of the degree of life or liveliness believed to inhere in an image.”<sup>23</sup> Just as the body of Christ inheres in the host, the divine spirit (the Holy Ghost) inheres in the corpse, and the saint inheres in the image, in a fusion effected by will and belief.

Artists have long understood the dangers of an overdetermined verisimilitude, for too much realism (or too visible an effort to achieve it) can halt the imaginative motion of the viewer. Michael Baxandall speaks of the asymmetry of relations between the image and the beholder in the devotional setting, offering a glimpse of the burden of expectation and desire we address to images.<sup>24</sup> The fusion Freedberg proposes between an image and what it represents may paradoxically be induced precisely by what the image *does not* do. That it is finally only a picture, for example, lets the viewer meet the Virgin more than halfway. But what if the *image* is doing the moving? If the motion is slight, uncertainty can ignite perception. In the case of the monk, whose activities are anything but slight, there are two conditions that check a potential excess of “signal.” One is the possibility that it may only have been seen for the four minutes of its performance—that is, it was removed from the table and the room at the end of the play. The other is its small size.

Size is always a matter of weight and material: the nature of a thing is often a consequence of pure conditional imperative. The iron, spring-driven table clock had to be small enough so its motive force could accommodate its weight. An automaton was a virtual concert of clocks in one piece, with compound gear trains and multiple axes of rotation to accomplish both sequenced and simultaneous motions levered into space. To conceal the full iron mechanism within the body of a wooden figure, and an ambulatory figure at that, the maker had to precisely calculate its net mass. In fact, at sixteen inches and five pounds, the monk does so much *because* he is so small. Could the monk’s size, in relation to his lifelike figure and performance, be urgent to his effect? The combination of “small” and “moving” holds something of an animal, even primal anxiety for us: the monk can play to only so large an audience, but his relation to a spectator is *personal*.

#### PETITION AND REPETITION

When his performance is over and I pull myself together, I look at the object itself, now at rest (the luxury of this!) and marvel at the almost seamless elegance by which the sculpture and the machine are combined. Here is a remarkably characterized figure carved in wood, and inside it is a functional clockwork of forged iron that has well withstood the test of time. How was it made? Inside out, first the mechanism, then the wooden parts carved and pieced together around it? Or outside in? The X-ray of the wooden head reveals a crisp, vertical, transverse seam just behind the ears: the head could have been carved and then sliced in half and hollowed out. Or perhaps a wooden blank was sliced first, roughly hollowed, and then temporarily clamped back together to be carved. Already the sculptor is operating on both sides of the divide. I am convinced that the chassis assembly supporting the eyes and jaw, together with the linkages for the movement of these parts, were made before the final carving of the face. The interface between wood and mechanism is precise—it must be, to permit the rotational and reciprocating motions of eyes and mouth to take place without loss of registration. Either or both the wood and the iron had to be cut and teased and adjusted for the fit. The automaton was made from the inside *and* the outside. Back and forth, we can look at the motions of the arms and feet, and read the same story: the artful negotiations between the very separate requirements of image and movement.

The question of how the monk was made is as challenging as that of how it was seen. How did the maker regard his task? In tracing the rise

and perfection of the gear-based clock in the period between 1550 and 1650, Otto Mayr has illustrated the parallel rise of the machine metaphor that would come to be paradigmatic in describing not only the animate human body but the animating principles of state, world, and cosmos.<sup>25</sup> In a clockwork universe, concepts of harmony, hierarchy, regulation, period, authority, balance, system, division of labor, and predictable cause and effect were rendered visible in the mechanism of the timepiece: coiled spring as originating force, fusee as gatekeeper, verge and foliot as balance and regulator, gear train as transfer and distribution, cam and lever as memory, and the multitude of linkages as fibers to locate the motion in space, be it the limbs of an automaton, the hands of a clock, or the heavenly bodies of the astrarium.<sup>26</sup> The clockmaker who fashioned these parts and assembled them to make the internal mechanism of the monk was producing a coherent model of the motive force and coordinate will of the human anatomy.

We will see the reach of the mechanical/rational paradigm in Enlightenment philosophy and engineering. But among the early clockwork automata of the late fifteenth and the sixteenth centuries, the monk to my mind is the example par excellence of the birth of the machine in the Age of Faith. Here is nothing less than a machine that prays. As Carlos Fuentes once wrote, “‘El movimiento se demuestra andando,’ you demonstrate movement by moving.”<sup>27</sup> Among the ecclesiastical automata we know, I am not aware of another independently moving clockwork figure that so explicitly performs the authorized and orthodox gestures of Catholic prayer.<sup>28</sup> Moreover, considering that the rosary is an instrument guiding the cumulative repetition of a spoken prayer—and repetition is the key to efficacy—why not build a machine to make the petition perpetual?

#### THE AUTOMATON AND THE HOMUNCULUS

The sixteenth century, ignited by Reformation iconoclasm and Counter-Reformation Inquisition, also saw the rise of Paracelsian alchemy. The monk's diminutive realism and functional autonomy warrants comparison with another small, willful, artificial being: namely, the alchemist's homunculus. For here is a competing paradigm for understanding and manufacturing the live body from the inside out. If the automaton's internal mechanism was forged in the smith's fire, the fabled homunculus—the alchemist's little test-tube man—was made in the heat of the flask. To us these are two very different models for the creation of artificial life: we might say that one is technological, the other mystical. But William Newman has argued that the

alchemists of the late medieval period, in their profound attention to the world of matter and change, made one of the earliest and most articulate defenses of technology in the history of Latin Christendom.<sup>29</sup>

There are two points of contact between the mechanical and the chymical arts for the context of this study; one pertains to practice, the other to product.<sup>30</sup> The metallurgy of iron in this period—especially the literature on the transformation of iron to steel and steel to temper—shares common territory and history with the occult literature of alchemical transmutation, and both in turn are ancestors to experimental chemistry. With the rise of printing and literacy, by the sixteenth century such a book as Giambattista Della Porta's *Magia naturalis*, to take one example, became a best seller among schooled and lay readers alike. First published in 1558, it was re-edited and expanded by Della Porta over the next twenty-five years, in spite of the censure, publishing bans, and arrests of the author by the Inquisition. Ultimately comprised of twenty *libri* gathered into one volume, its pages offered prescriptions and experiments in everything from the medical arts to alchemy, optics, pneumatics, magnetism, the technology of fire, the secrets of generating new kinds of animals and plants, the marvels of putrefaction, the distillation of elixirs, perfuming, invisible ink, and the arts of disguise—all presented, as William Eamon says, in *sprezzatura* style.<sup>31</sup> The forbidden, the practical, the technically innovative, the scientifically advanced, and the apocryphal flourish side by side. Of the twenty *libri*, the fifth, “Which treateth of Alchymy; shewing how Metals may be altered and transformed, one into another,” together with the thirteenth, “Of tempering Steel,” give us a glimpse in turn of the alchemist in his laboratory and the smith in his shop, each at work at his coal-fired forge with its bellows, surrounded alike by mortars, anvils, crucibles, cupels, ladles, hammers, alembics, and by plasters, liquors, fluxes, and quenches. If we squint through the smoke, they are brothers.

But how can we compare their handiwork? While the making of a homunculus is not exactly standard practice in the alchemical program at large, neither is the making of an automaton within the broader sphere of the metalcrafts, which included blacksmiths, lock and gunsmiths, smiths for the precious metals, many kinds of toolmakers, instrument makers, nail makers, and so on, along with the makers of large tower clocks and small table clocks. And, as we may have suspected by now, it is all but certain that the monk was made by more than one master. A clockmaker, but also a smith, a sculptor or wood carver, perhaps a painter, and certainly a tailor are all likely to have contributed their skills to the task. So I embark on a rarefied

comparison, and between incommensurates: a recipe and a machine. But, contemporary to the second half of the sixteenth century, both required a master's (or adept's) proprietary skill with nature's materials. Both entailed the creation of an artificial being with the power to perform tasks to aid or excel human agency. Both were associated with magic and sorcery. And both were small.

While Della Porta and many other writers extolled the fundamentals of "putrefaction" and its role in the production of living creatures both imperfect and perfect,<sup>32</sup> the now classic text on the homunculus is found in *De natura rerum*, supposedly written in 1537 and published as the work of Paracelsus in 1572 by the iatrochemist and physician Adam von Bodenstein. Some scholars, including William Newman, have questioned the authorship of this text, although Newman suggests that it may be reworked material from a genuine Paracelsian script. Referring to its author provisionally as "pseudo-Paracelsus," Newman has made a close study of the work in the context of alchemy's pursuit of artificial life.<sup>33</sup> The famous recipe for the making of the homunculus appears in *De natura rerum* after a lengthy discussion of the transmutational virtues of putrefaction and the powers of human art. Here is Newman's translation from the original Latin:

We must now by no means forget the generation of homunculi. For there is something to it, although it has been kept in great secrecy and kept hidden up to now, and there was not a little doubt and question among the old philosophers whether it even be possible to nature and art that a man can be born outside the female body and [without] a natural mother. I give this answer—that it is by no means opposed to the spagyric art and to nature, but that it is indeed possible. But how this should happen and proceed—its process is thus—that the sperm of a man be putrefied by itself in a cucurbit for forty days with the highest degree of putrefaction in a horse's womb, or at least so long that it comes to life and moves itself, and stirs, which is easily observed. After this time, it will look somewhat like a man, but transparent, without a body. If, after this, it be fed wisely with the arcanum of human blood and be nourished for up to forty weeks, and be kept in the even heat of the horse's womb, a living human child grows therefrom, with all its members like another child, which is born of a woman, but much smaller.<sup>34</sup>

Newman examines the recipe in relation to other passages on the homunculus from Paracelsus's oeuvre, to earlier sources from the Hermetic tradition, and—as in his essay "The Homunculus and the Mandrake" in this volume—in relation to the narratives of artificial generation in popular

folk legend. This last comparison Paracelsus himself makes, and Newman translates the following passage from the *De vita longa libri quinque*: "The homunculus, which the necromancers falsely call *alreona* and the natural philosophers *mandragora*, has become a topic of common error, on account of the chaos in which they have obscured its true use. Its origin is sperm, for through the great digestion that occurs in a *venter equinus*, the homunculus is generated, like [a man] in all things, body and blood, with principal and lesser members."<sup>35</sup>

The legends of the *alraun*, or mandrake, indeed provide a remarkably analogous narrative to that of the homunculus. The *alraun*, according to German folk legend, was the root—in the shape of a tiny man—of a plant that sprouted in the earth beneath the gallows from the sperm of a hanged criminal. Such a man-root had powerful magic properties if one could get hold of it, but legend warned that anyone who tried to pull the *alraun* out of the ground would perish from its lethal scream. It had to be harvested by secret means. A lively trade in roots carved into human shape and sold as *alraun* naturally flourished in the sixteenth and seventeenth centuries, and Newman details some memorable cases of peddlers arrested for fraud. "You little extract of a man!" cries a thief, in another folk legend originating in the sixteenth century, the story of Tom Thumb.<sup>36</sup>

In surveying the myths and burlesques of the mandrake in search of the homunculus's own roots (Paracelsus's "homuncular ruminations," as he calls them), Newman emphasizes the alchemist's claim to improve on nature, not imitate her, and this distinction between the perfective and the merely mimetic is central to the difference not only between the homunculus and the *alraun*, but broadly between alchemy itself and the pictorial or plastic arts.<sup>37</sup> The alchemist distills and extracts the pure essences of matter, accomplishing by natural means what nature in her imperfection cannot. The homunculus was the promise of an incorrupt man, whose powers would be concentrated and increased. One may assume that an automaton would have been considered a thin imitation by the alchemist's standard since, as in painting or sculpture, it is made of "found" and not "like" materials.<sup>38</sup> In the homunculus as a made thing, Freedberg's concept of *reconstitution* in the context of works of art becomes literal and technical, a generative phenomenon occurring not in the beholder's ardent response to a hypnotic signal, but instead entirely in the laboratory of the maker—with elemental matter, from scratch. The resulting creature becomes agent to its own powers in a way that short-circuits the orthodox channel through which Freedberg's icon comes to life.

“MORE ALIVE THAN LIFE ITSELF”

Renaissance high realism in the visual arts was underwritten by a rhetoric built on biological metaphor. Fredrika Jacobs has made a study of the language that was used in the Italian sphere to define likeness, lifelikeness, and liveness in works of art, both painting and sculpture.<sup>39</sup> In regard to portraiture in particular, one finds a wealth of commentary rendering images as alive in their own right. Consider Giorgio Vasari’s words of praise for Raphael’s great 1518 painting of Pope Leo X: “più vivo . . . che la vivacità,” by which he meant “more alive than life” or perhaps even, given his own inimitable *sprezzatura*, “more alive than life itself.”<sup>40</sup> The word *risuscitare* (to resuscitate, to bring back to life) was widely used to describe the power of a commemorative portrait; and a sculpture might be declared “a speaking likeness,” for example. Further, the classicizing impulse to correct nature—to make perfect—in reproducing the human physiognomy meant that the artist, like the alchemist, was in the business of perfecting nature. The creative process itself was exalted as a form of begetting, one that mixed the artist’s own *ingenium*—his genius, his *spiritus*—with what he saw in order to bring the work of art to life.<sup>41</sup> The biological metaphor in art for both process and product extends back into linguistic time; the word *engineer* also takes its meaning from the Latin *ingenium*. Implicit in the metaphor is precisely the feat of infusing inanimate materials with life, through the breath and issue of the artist’s own soul.

Across all of these models—from the devotional image and icon to the automaton, the homunculus, the magic *alraun*, and the cult of the artist—we can notice an implicit shift in the way images were seen. The concept of an inherent or originating divinity is replaced in varying degrees by a chronicle of human agency. Artist, engineer, and alchemist are introduced as masters *sine qua non* of bringing ingredient matter to life. While the charisma of the icon is a form of grace vouchsafed by God alone—for to “animate” means, literally, to “give a soul to”—the difference between an icon and a homunculus is nothing less than a gnostic shift from Faith to Art in a bid to claim the means of implanting a soul in senseless stuff. No wonder the homunculus was kept such a secret. Is it possible the monk survives in such good condition because he, too, was carefully hidden? The Reformation made even the holy icon itself dangerous, for if an image is so powerful that God himself is seen as present in it, then the image will be worshipped and it becomes an idol. And an idol laid a seductive and deceiving path away from the true God.

In the next century, the whole glittering array of artificial beings is swept aside in a passage that William Newman takes from the Calvinist divine John Edwards. Edwards, in his *Demonstration of the Existence and Providence of God* published in 1696, extols the irreducible vitalism of the living human body:

This is no Workmanship of Humane Skill, here is no Automaton made by Art, no Daedalus’s walking Venus, no Archytas’s Dove, no Regiomontanus’s Eagle and Fly. Here is none of Albertus magnus or Frier Bacon’s speaking head, or Paracelsus’s Artificial Homuncle. Here is nothing but what proceeds from a divine Principle and Art, and therefore cannot be reckoned among those mechanical Inventions which have an external Shew of Sensation and Life for a time, but are destitute of a vital Spring.<sup>42</sup>

As Newman declares, Edwards turns on its head the alchemist’s claim of superiority over nature and adds it to the list as just one more feeble human art.

THE MACHINE IN THE AGE OF FAITH

Vitalism, in its various guises since the time of Aristotle, insists on the presence of a life-granting force within the body that is not reducible to material explanation. But what about the wounded body, “the thousand natural shocks that flesh is heir to?” Perhaps the deeper human motivation in the effort to control nature has less to do with power and procreation and more to do with sheer repair. The practice of medicine in the sixteenth century was itself a manifold art, woven from responses to the mysteries of nature and divinity. For example, what are we to make of the miraculous absence of putrefaction in Fray Diego’s disinterred body, and the life-inducing marvels of the same putrefaction in the alchemist’s glass? It would seem that decomposition was as promising in the laboratory as its absence was marvelous in the monastery. Don Carlos’s suppurating head wound, the physicians’ pharmacopoeia for the treatment of infection, the ascetic Franciscan and his uncanny corpse (still sweet to the nostrils), the apparition of the midnight visit, the immaculate cure—all this forms the subject of another kind of study of sixteenth-century substance. What is living stuff made of? All the players here are busy with ideas about the hidden matter within the *corpus*.

If, as legend has suggested, the automaton monk is a portrait of San Diego, its status as a votive object invokes the broad and age-old tradition of promising a form of thanks that would commemorate the providential gift for all time, a form of thanks that would outlast the supplicant, the broker—that would continue after his death. To return to the two questions I asked at the beginning of this study—might the automaton monk

have been taken as live? and what resuscitating essence was divined to be transferred from the corpse to the prince?—it would seem that the very impulse to reach beyond death affords a clue. The automaton may be a votive object for the giving of thanks, a prophylactic talisman, a promise, a petition, or a phantom, but like the homunculus it is also a maiden work of biotechnology. As for the corpse: in 1589, the year following Fray Diego's secure entrance into the pantheon of saints, his tomb was formally opened and the bones of his lower legs removed (still bearing flesh) to provide relics for the king.<sup>43</sup> Veneration—but health insurance too.

In 1974 (three years before he purchased the monk for the Smithsonian), Otto Mayr published an essay in German entitled “Automaton Legends in the Late Renaissance.”<sup>44</sup> It focuses on the interpretation of precisely the Antique and Medieval legends of artificial life that Edwards lists, together with the efforts of philosophers from Cardano to Descartes to separate myth from legend from fact. As Mayr himself negotiates the uneven border between rational mechanism and legendary magic, he speaks of a double world: “Medieval literature certainly displays no lack of interest in the fantastic and the supernatural. But at the same time the official philosophy—scholasticism—was, in its way, strictly rational. Such contradictory schools of thought exist side by side without being reconciled.”<sup>45</sup>

This double world is with us still. Surveying the historical record, I feel a distinct companionship with the uninitiated devout who were tricked by statues made to speak and move by hidden means.<sup>46</sup> Chapter 62 of *Don Quixote*, entitled “Which Deals with the Adventure of the Enchanted Head, Together with Other Trifling Things That Cannot Be Left Untold” (from part 2 of the novel, 1615), presents an Iberian version of Albertus Magnus's brazen head complete with a company of the fooled whose hair stands on end when the head speaks. Its owner must smash it “lest word of this should reach the alert ears of those reverend gentlemen, the sentinels of our faith.”<sup>47</sup> Here was a machine meant to deceive the viewer, and Cervantes gives us an antic satire of the response. One must tread carefully in the business of simulating miracles. A different and final class of objects to which the monk might be compared can be found within the Spanish tradition of penitential processions during Holy Week. On these occasions, elaborately dressed wooden figures of patron saints—some with hidden mechanisms for animating the arms and heads—were carried through the streets in a commingling of theater and devotional passion. These articulated sculptures, *imágenes de vestir* as they are called (images with clothes), were seen throughout the year in

static repose in the churches. But at Easter out they came, live from the altar as it were, and suddenly at large.<sup>48</sup> The full community participated in the ritual enactment of a wooden figure coming to life. There is no deception, but the peoples' hair still stands on end.

Such processional objects reenact the moment when the hand of providence touches and repairs the broken world. The Christian mysteries of resurrection and transubstantiation—not to mention the persuasions of the Inquisition's faith police—would surely have vivified an iconic, ecclesiastical automaton—or ghosted it. David Freedberg's less feverish term *reconstitution* carries the sense of this for the rest of us. The story of San Diego, even if no more than contemporary to the monk, helps us see how invested this machine is with the burden of faith.



FIGURE 13.8 | Photograph © Rosamond Purcell 2002.

## NOTES

This essay is a study for the final chapter of a forthcoming monograph on the monk, *A Machine, a Ghost, and a Prayer: The Story of a Sixteenth-Century Mechanical Monk*, written with W. David Todd and with a foreword by Silvio Bedini and photographs by Rosamond Purcell.

I want to thank Jessica Riskin, William Newman, Fredrika Jacobs, Leslee Asch, and Joan Baixas, who together represented the worlds of science, art, and theater on a panel entitled “The Automaton, the Homunculus, and Other Artificial Beings: Toward an Interdisciplinary History” that David Todd and I organized for the College Art Association Conference in Philadelphia in 2002. The published works of these individuals have been essential to my study.

To Father Servus Gieben, president of the Istituto Storico dei Cappuccini in Rome, and director of its Museo Francescano, whose 1975 research on the automaton monk was pivotal in suggesting a connection to the Spanish court, and whose wisdom has guided my own search, I owe the deepest respect and gratitude.

1. This description of the monk’s performance is based on the detailed conservation work of W. David Todd, clockmaker, associate curator emeritus, and former conservator of timekeeping at the Smithsonian Institution.

2. William H. Prescott, *History of the Reign of Philip the Second, King of Spain*, ed. John Foster Kirk, 3 vols. (Philadelphia: J. B. Lippincott, 1874), 2:467–68. (Compare this publishing date with the 1867 premiere performance of Verdi’s opera in Paris.) Erysipelas, also called St. Anthony’s fire, was a spreading inflammation of the skin and subcutaneous tissues, now understood as caused by a streptococcus.

3. L. J. Andrew Villalon, “Putting Don Carlos Together Again: Treatment of a Head Injury in Sixteenth-Century Spain,” *Sixteenth Century Journal* 26, no. 2 (1995): 347–65. Chief among the primary texts Villalon consults is the document written by Dionisio Daza Chacon, the prince’s surgeon: “Relación Verdadera de la herida de cabeza del Serenísimo Príncipe D. Carlos nuestro Señor, de gloriosa memoria, la cual se acabo en fin de julio del año de 1562,” printed in *Colección de Documentos Inéditos para la Historia de España*, 112 vols. (Madrid: Academia de la Historia, 1842–95), 18:537–63.

4. Villalon, “Putting Don Carlos Together,” 356.

5. Prescott, *Philip the Second*, 469.

6. Villalon, “Putting Don Carlos Together,” 354 (betony or lousewort: a plant native to Eurasia).

7. For eyewitness accounts of Don Carlos’s report, see Fr. Lucio M. Núñez, “Documentos sobre la curación del príncipe D. Carlos y la canonización de San Diego de Alcalá,” *Archivo Ibero-Americano*, año 1, núm. 4 (Julio–Agosto 1914): 424–46. This four-part article series continues to año 2, núm. 9 (Julio–Agosto 1915): 374–87; año 3, núm. 13 (Enero–Febrero 1916): 107–26; año 4, núm. 19 (Enero–Febrero 1917): 421–31.

8. L. J. Andrew Villalon, “The Miracle Book of San Diego de Alcalá; or, The Fifteenth-Century Failure to Canonize the First Counter-Reformation Saint,” *Mediterranean Studies* 10 (2001): 9–35.

9. *Ibid.*, 26.

10. Sir William Stirling-Maxwell, *The Cloister Life of the Emperor Charles V*, 4th ed. (London: John C. Nimmo, 1891), 444. Comparison here with the Jewish Golem is irresistible.

11. “Tambien ha querido Ianelo por regozijo renouar las eftatuas antiguas, que fe mouian, y por effo las llamauan los Griegos Automatas. Hizo vna dama de mas de vna tercia en alto, que puefta fobre vna mefa dança por toda ella al fon de vn atambor, que ella mifma va tocando, y da fus bueltas, tornando a donde partio. Y aunque es juguete y cofa de rifa, todauia tiene mucho de aquel alto ingenio.” Ambrosio de Morales, *Las antigüedades de las ciudades de España* (Madrid: 1575), 93v. The English translation here is from José A. García-Diego, *Juanelo Turriano, Charles V’s Clockmaker: The Man and His Legend*, trans. Charles David Ley (Sussex: Antiquarian Horological Society; Madrid: Editorial Castalia, 1986), 101.

12. Ernst von Bassermann-Jordan, *Alte Uhren und Ihre Meister* (Leipzig: Wilhelm Diebener, 1926), 58, 66–69. Bassermann-Jordan had seen the figure in a private collection sometime before 1922.

13. I have elsewhere traced out the larger web of primary and secondary sources that may shed light on the automaton monk, both in relation to the story of Don Carlos, and to the workshop of Juanelo Turriano. See Elizabeth King, “Clockwork Prayer: A Sixteenth-Century Mechanical Monk,” published in *Blackbird: An Online Journal of Literature and the Arts* 1, no. 1 (Spring 2002), at [http://www.blackbird.vcu.edu/v1n1/nonfiction/king\\_e/king\\_e.htm](http://www.blackbird.vcu.edu/v1n1/nonfiction/king_e/king_e.htm), and in *Breaking the Disciplines: Reconceptions in Knowledge, Art and Culture*, ed. Martin L. Davies and Marsha Meskimmon (London: I. B. Tauris, 2003), 84–128. This essay includes a close comparison of the monk with the several kindred tabletop figures that survive from the same period, together with a discussion of the likely court scenarios in which they were viewed. The online version includes a streaming media video of the monk in action.

14. Excerpt, letter written in French, dated 16 November 1975, to Georges Sedlmajer in Geneva from Servus Gieben in Rome. Photocopy in the Registrar’s Office of the Smithsonian’s National Museum of American History. The English translation is my own.

15. This was an early draft of “Clockwork Prayer” (see n. 13 above).

16. There is a competing argument for a south German guild scenario for the production of both monk and lady—particularly of the internal iron clockwork. A forthcoming monograph on the monk, *A Machine, a Ghost, and a Prayer: The Story of a Sixteenth-Century Mechanical Monk*, which I coauthored with W. David Todd, explores this alternative.

17. Morales, *Antigüedades de las ciudades de España*, 93v.

18. The possibility that the monk is a species of toy begs consideration of what is and was meant by *toy* and what kinds of work toys do in the world. In his important essay “Automata and the Origins of Mechanism and Mechanistic Philosophy,” *Technology and Culture* 5, no. 1 (1964): 9–23, Derek J. de Solla Price describes the interdependent rise of biological and astronomical simulacra in antiquity: “Perhaps it is not altogether fanciful to see the astronomical zodiac as the first primitive coming together of a cosmic model and a set of animal models” (12). In ancient Greece, “these two great varieties of automata go hand-in-hand and are indissolubly wedded in all their subsequent developments” (15). More tellingly: “Amongst historians of technology there seems always to have been private,

somewhat peevish discontent because the most ingenious mechanical devices of antiquity were not useful machines but trivial toys. Only slowly do the machines of everyday life take up the scientific advances and basic principles used long before in the despicable playthings and overly ingenious, impracticable scientific models and instruments" (15). Daniel Tiffany, in his recent book *Toy Medium: Materialism and Modern Lyric* (Berkeley: University of California Press, 2000), weaves a philosophically rich narrative around Price's thesis in developing his own "discourse of automata"; see the chapter entitled "The Natural Philosophy of Toys." We continually remap the border between useful things and frivolous ones, regardless of the complexity of the objects themselves. Among classes of automata unique to the sixteenth century—figure clocks, musical tableaux, dancing animals, animated figures of pagan myth (and often the figures of play: Diana, Cupid, or Bacchus)—one finds a considerably less ludic subgroup of pieces representing biblical figures and Christian themes. Klaus Maurice, in an essay entitled "Propagatio fidei per scientias: Jesuit Gifts to the Chinese Court," published in the catalogue for the exhibition he curated with Otto Mayr, *The Clockwork Universe: German Clocks and Automata, 1550–1650*, ed. Klaus Maurice and Otto Mayr (Washington, DC: Smithsonian Institution; New York: Neale Watson Academic Publications, 1980), touches on the role such objects played in the Jesuit mission.

19. In 1980, three years after the monk entered the Smithsonian collections, the name of the Museum of History and Technology was changed to the National Museum of American History. In December, 1997, the monk and other rare instruments and clocks that once graced the museum's great Hall of Timekeeping were removed from display, and the galleries were redesigned for the new exhibition "On Time," which examined timekeeping from an exclusively American perspective. As I write, in the summer of 2006, that exhibition in turn is being dismantled as the museum itself closes down for a two-year renovation.

20. David Freedberg, *The Power of Images: Studies in the History and Theory of Response* (Chicago: University of Chicago Press, 1989): "[When our study] is too strictly based on reclamation of context [it] resolutely refuses to allow the integration of ourselves into the past, or—to put it less sentimentally—to allow the lessons we learn from our own responses to inform our judgments about the past" (431).

21. Roland Barthes, *Camera Lucida*, trans. Richard Howard (New York: Hill and Wang, 1981), 12.

22. Freedberg, *Power of Images*, 28.

23. *Ibid.*, 32.

24. Michael Baxandall, *The Limewood Sculptors of Renaissance Germany* (New Haven, CT: Yale University Press, 1980): "The disposition to infer character and feeling from a representation of a human figure is both strong and deep, and certainly one of the few constants in the older European art criticism. Indeed it seems a natural enough transference from our normal social interest, for character and feeling are things we want and need to know about in persons we address, and we are all very skilled in interpreting visual appearance to this end: posture, gesture, glance, the fixed lineaments of the body and the face. In particular we are sensitive to what all these imply of an attitude towards ourselves. The devotional image is often a special case because acts of devotion involve urgent and complicated kinds

of expectation and desire; to pray to an image—even, as the theory of images would have it, through an image—with a view to a spiritual or material return, or to meditate on an image as exemplification of spiritual quality or as simulacrum of the divine, is to enter an encounter of a testing kind, interpersonal in its general form but abnormally asymmetrical. For the image this means both that quite small cues of either appearance or context are open to more than usual attention, and that the beholder may project into a figure intimations of character and feeling not so much initiated as admitted by it" (153).

25. Otto Mayr, "A Mechanical Symbol for an Authoritarian World," in Maurice and Mayr, *Clockwork Universe*, 1–8. See also Otto Mayr, *Authority, Liberty, and Automatic Machinery in Early Modern Europe* (Baltimore, MD: Johns Hopkins University Press, 1986).

26. Thanks to W. David Todd for help with this morphology. See also n. 18 above.

27. Carlos Fuentes, "Velázquez, Plato's Cave and Bette Davis: When Narration Is a Visual Art," *New York Times*, 15 March 1987, Arts and Leisure sec.: "Where does true reality reside? On canvas, on film or in the imagination?" (38).

28. For my argument on this, see King, "Clockwork Prayer," under the heading "Part 3: A Sixteenth-Century Mechanical Masterpiece" in the online version (see n. 13 above), or in Davies, *Breaking the Disciplines*, 104–6.

29. See Pamela O. Long, *Openness, Secrecy, Authorship: Technical Arts and the Culture of Knowledge from Antiquity to the Renaissance* (Baltimore, MD: Johns Hopkins University Press, 2001), 146. Long quotes William Newman, "Technology and Alchemical Debate in the Late Middle Ages," *Isis* 80, no. 303 (September 1989): "The alchemists and their supporters gave a conscious and articulate defense of technology, indeed, one of the earliest and most thorough to be found in Latin Christendom" (427).

30. A detailed comparison of the works of the mechanic and the alchemist in the creation of artificial life in the sixteenth century would make a welcome and fascinating study. Newman's essay cited above and his more recent essay "Alchemy, Assaying, and Experiment," in *Instruments and Experimentation in the History of Chemistry*, ed. Frederic L. Holmes and Trevor H. Levere (Cambridge, MA: MIT Press, 2000), 35–54, make it clear how intertwined were the practices of alchemist and metalsmith in the pursuit of an operational knowledge of materials. Earlier works addressing the links between the alchemy and technology (as well as the folklore) of artificial beings include Robert Plank's short but pioneering essay "The Golem and the Robot," *Literature and Psychology* 15, no. 1 (Winter 1965): 12–28; John Cohen's indispensable *Human Robots in Myth and Science* (London: Allen & Unwin, 1966); and Jean-Claude Beaune's "The Classical Age of Automata: An Impressionistic Survey from the Sixteenth to the Nineteenth Century," in *Fragments for a History of the Human Body, Part One*, ed. Michel Feher (Cambridge, MA: MIT Press/Zone, 1989). Plank, Cohen, and Beaune offer a comparison of the products of mechanical and alchemical enterprises but not the practices themselves.

31. William Eamon, *Science and the Secrets of Nature: Books of Secrets in Medieval and Early Modern Culture* (Princeton, NJ: Princeton University Press, 1994). Eamon has illuminated the medieval origins of the *libri secretorum*, the rich genre of manuscripts and texts passed hand to hand that formed the nascent beginnings of experimental science and recorded craft tech-

nology. Chapter 6, “Natural Magic and the Secrets of Nature” (194–233), presents a fine, detailed portrait of Della Porta, his work, and his fortunes; see especially 217–21, “The Magician as Artisan.” The English translation of *Magia naturalis* that Eamon cites is John Baptista Porta, *Natural Magick*, ed. Derek J. de Solla Price (New York: Basic Books, 1957), originally published in London by Thomas Young and Samuel Speed, 1658.

32. Della Porta, *Natural Magick*; see “The Second Book of Natural Magick: Shewing how living Creatures of divers kinds, may be mingled and coupled together, that from them, new, and yet profitable kinds of living Creatures may be generated,” chapter 1: “the first Chapter treateth of Putrefaction, and of a strange manner of producing living Creatures” (26–27).

33. William R. Newman, “The Homunculus and His Forebears: Wonders of Art and Nature,” in *Natural Particulars: Nature and the Disciplines in Renaissance Europe*, ed. Anthony Grafton and Nancy Siraisi (Cambridge, MA: MIT Press, 1999), 321–45; “Alchemy, Domination, and Gender,” in *A House Built on Sand: Exposing Postmodernist Myths about Science*, ed. Noretta Koertge (New York: Oxford University Press, 1998), 216–26; and most recently, “Artificial Life and the Homunculus” in Newman’s book *Promethean Ambitions: Alchemy and the Quest to Perfect Nature* (Chicago: University of Chicago Press, 2004), 164–237.

34. Newman, *Promethean Ambitions*, 203–4, translated from “[Pseudo?] Paracelsus,” *De natura rerum*, in *Theophrastus von Hohenheim, genannt Paracelsus, Sämtliche Werke, I. Abteilung*, ed. Karl Sudhoff, 14 vols. (Munich: Oldenbourg, 1922–33), 11:316–17. A “horse’s womb”—*venter equinus* in Latin—refers to decaying equine dung used as a source of heat. For the perceived homology between womb and dung, and for the context of this recipe in the broader history of beliefs on the procreative roles of male versus female, see Newman, “Artificial Life and the Homunculus,” 164–237.

35. See Newman, “The Homunculus and the Mandrake,” in this volume. See also Newman, *Promethean Ambitions*, 210–15: translated from Paracelsus, *De vita longa libri quinque*, in Sudhoff, *Theophrastus von Hohenheim*, 3:274.

36. “Hop-O’-My-Thumb,” in *Grimm’s Goblins* (London: George Vickers, ca. 1865–69), 155. But see W. Carew Hazlitt’s reprint, *Tom Thumbe, his Life and Death: Wherein is declared many Maruailous Acts of Manhood, full of wonder, and strange merriments: Which little Knight liued in King Arthurs time, and [was] famous in the Court of Great Brittain* (London: John Wright, 1630), in *Remains of the Early Popular Poetry of England; Collected and Edited, with Introductions and Notes*, ed. W. Carew Hazlitt (London: John Russell Smith, 1866), 167–250. In the Grimms’ version, the infant Thumb comes into the world by natural birth, “well formed in all its limbs, but no bigger nor higher than [a] thumb.” In lyric form, the passage seems to come directly from the homunculus, “with all its members like another child, which is born of a woman, but much smaller.” But in the original tale, as Hazlitt gives it, none other than Merlin himself produces the little man.

37. See Newman, “The Homunculus and the Mandrake,” in this volume. Newman pursues the distinction in detail in *Promethean Ambitions*, chap. 3, “The Visual Arts and Alchemy,” 115–63.

38. It is worth noting here that “image magic,” or *envoûtement*, as Freedberg presents it in his chapter on effigies and witchcraft in *Power of Images* (“Infamy, Justice, and Witchcraft: Explanation, Sympathy, and Magic,” 246–82), is widely based on the material principle of

like producing like. Freedberg offers a passage from James George Frazer’s 1913 work on the history of magic, *The Golden Bough*, to identify this principle, and in that passage we find a second precept that resonates with the themes of the present essay:

If we analyze the principles of thought on which magic is based, they will probably be found to resolve themselves into two: first, that like produces like, or that an effect resembles its cause; and second, that things which have once been in contact with each other continue to act on each other at a distance after the physical contact has been severed. The former principle may be called the Law of Similarity, the latter the Law of Contact or Contagion. From the first of these principles, namely the Law of Similarity, the magician infers that he can produce any effect he desires merely by imitating it. (J. G. Frazer, *The Golden Bough* [London: n.p., 1913], 1:52; quoted in Freedberg, *Power of Images*, 272)

The question of what was perceived to be transferred from the holy corpse to the ailing prince in the story of Don Carlos’s cure has an echo here in the Law of Contact, from the world of sympathetic magic. (As for the ancient concept of “action at a distance,” let us remember that this is now a leading field in contemporary quantum physics.)

39. Fredrika Jacobs, *The Living Image in Renaissance Art* (New York: Cambridge University Press, 2005). My grateful thanks to Professor Jacobs for permitting me to read final drafts of this book.

40. Giorgio Vasari, *Le opere di Giorgio Vasari*, ed. Gaetano Milanesi, 9 vols. (Florence: G. C. Sansoni, 1906), 4:352. Again, my thanks to Fredrika Jacobs for providing this quotation. Raphael’s painting is *Pope Leo X with Cardinals Giulio de’ Medici and Luigi de’ Rossi*, panel, 60½ × 47 inches, Uffizi Gallery, Florence.

41. I closely paraphrase both Jacobs, *Living Image*, 7, and, in turn, her reference, David Summers, “Aria II: The Union of Image and Artist as an Aesthetic Ideal in Renaissance Art,” *Artibus et Historiae* 20 (1989). Summers writes, “Petrarch closely follows Seneca, who wrote that, in effect, painting was fully capable of imitation. That is, it did not simply and literally duplicate; rather, the painter mixed his own *ingenium*, his own talent and vision, his own *spiritus*, with what he saw in order to make it seem alive, and to make it true” (26).

42. Newman, *Promethean Ambitions*, 226, quoting John Edwards, *A Demonstration of the Existence and Providence of God, from the Contemplation of the Visible Structure of the Greater and the Lesser World*, part 2 (London: Jonathan Robinson, 1696), 124.

43. Núñez, “Documentos,” año 3, núm. 13 (Enero–Febrero 1916): 119–22.

44. Otto Mayr, “Automatenlegenden in der Spätrenaissance,” *Technikgeschichte: Beiträge zur Geschichte der Technik und Industrie* 41, no. 1 (1974): 20–32. My thanks go to Henning Bauer for a fine translation.

45. *Ibid.*, 30.

46. See Freedberg, *Power of Images*, chap. 11, “Live Images: The Worth of Visions and Tales,” 283–316.

47. Miguel de Cervantes, *Don Quixote de la Mancha*, trans. Samuel Putnam (New York: Viking, 1949), 1090–91. Cervantes was a native of Alcalá, born just two years after Don Carlos. Part 1 of *Don Quixote* was published in 1605; part 2 in 1615.

48. Susan Verdi Webster, *Art and Ritual in Golden-Age Spain* (Princeton, NJ: Princeton University Press, 1998):

The spatial and temporal status of the sculptures in procession significantly enhance their mimetic effects, and their unique kinesthetic character allows them dramatic entrance into the realm of human experience. They are able to move both physically (through articulated limbs) and spatially (through the streets of the city). Furthermore, the incorporation of sculpture within a processional context acts to change a most fundamental aspect: the sense of time. No longer the static, eternal images of altars and *retablos*, their temporal state is extended so that they merge with the spectators' own experience of space and time. (167)

“Each of the essays in this volume ranges widely across technical and philosophical domains. They examine both familiar automatons from throughout history and delight us with yet more that will likely be unfamiliar to most readers. But the real treat of the essays is how they will make Artificial Life researchers squirm as they recognize their own intellectual sleights of hand exposed for all to see. Those researchers and the *Genesis Redux* contributors are all ultimately interested in what it is that truly distinguishes us beings from other lumps of matter.” | **RODNEY BROOKS**, director of the Massachusetts Institute of Technology Computer Science and Artificial Intelligence Laboratory and the Panasonic Professor of Robotics

Since antiquity, philosophers and engineers have tried to take life’s measure by reproducing it. Aiming to reenact Creation, at least in part, these experimenters have hoped to understand the links between body and spirit, matter and mind, mechanism and consciousness. *Genesis Redux* examines moments from this centuries-long experimental tradition: efforts to simulate life in machinery, to synthesize life out of material parts, and to understand living beings by comparison with inanimate mechanisms.

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Taking a historical approach to a modern quandary, *Genesis Redux* is essential reading for historians and philosophers of science and technology, scientists and engineers working in artificial life and intelligence, and anyone engaged in evaluating these world-changing projects.

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Cover image: Michelangelo Buonarroti (1475–1564), *The Creation of Adam*, detail  
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