

Leonardo's Programmable Automaton and Lion

These schemes [i.e. blue-prints] which have provided the basis for our reconstruction of Leonardo's car, along with the hypotheses that one may speculate about, confirm our conviction that this vehicle could never function the way it was designed by Leonardo.

Giovanni Canestrini, *Leonardo costruttore di macchine e di veicoli*, Roma-Milano, Tumminelli & C. Editori 1939, p. 128

My discovery that one of the leg diagrams in Giovanni Alfonso Borelli's *De Motu Animalium* was the same as in Madrid MS I had Carlo Pedretti diving into his library as the realization set in that perhaps the missing material had been discovered at last. There had been a controversy when Madrid MS I was discovered in the 1960s about when the missing material may have been removed. Interviews were made and the case closed.¹

And then if Leonardo's Book of Mechanics featured the similarity of man to machine, it is logical that he took it one step further—to automata that mimic the very motion and movement of life itself.

Leonardo developed a means of locomotion and control for automata which would later become common in the festivals and court masques of the sixteenth and seventeenth centuries. In 1478, while under the patronage of the Medici, he designed a programmable, mechanical computer-controlled automaton. This automaton was a precursor to mobile robots and was perhaps the earliest "computer" in western civilization. By reinterpreting material from Leonardo's notebooks, as well as the work of Japanese artisans of the eighteenth century, I was able to reconstruct Leonardo's intentions for the programmable automaton. This basic design may have been recycled by Leonardo in France some thirty-six years later for use as a platform for a self-propelled mechanical lion, again under a commission from the Medici. This has been ascertained only recently by Carlo Pedretti. Michelangelo Buonarroti the Younger, nephew of Leonardo's great rival, recorded the spectacle he witnessed at the wedding in 1600 of Maria de' Medici, Queen of France and Navarre, to Henry IV son of Antoine de Bourbon and Jeanne d' Albret. He was the first of the Bourbon Kings of France. In a booklet published in Florence in 1600, Michelangelo the Younger mentions an automaton that was presented at a banquet: a mechanical lion that walked a few steps and then rose on its hindquarters, opening its breast to show that it was full of fleurs-de-lis, a concept, concludes the younger Michelangelo, "similar to that which Leonardo da Vinci realized for the Florentine Nation on the occasion of Francis I's triumphal entry into Lyons" in 1515.²

¹ See the section on "News and Notes" in *Renaissance Quarterly*, New York, Renaissance Society of America, XXIV, no. 3, autumn 1971, pp. 430–431, for the "Notice" signed by the members of a committee—Theodore S. Beardsley, Jr. (Hispanic Society of America), Carlo Pedretti (UCLA), and Paul Oskar Kristeller (Columbia U), Chairman—charged by the Renaissance Society of America "to investigate the circumstances under which two Leonardo manuscripts entitled *Tratados de fortificación, mecanica y geometria* had been recently discovered in the Biblioteca Nacional in Madrid".

² Nothing is left of Leonardo's project for the mechanical lion and what used to be known of it was only through the mentions by Vasari and Lomazzo, who did not indicate the precise occasion of the event nor its symbolism. The missing information is supplied by the *Descrizione delle felicissime nozze della Cristianissima Maesta' di Madama Maria Medici Regina di Francia e di Navarra* by Michelangelo Buonarroti the Younger (Florence, Giorgio Marescotti, 1600), p. 10, as first discussed and reproduced by Pedretti, *Leonardo architetto*, cit., p. 322. See also, by the same author, "Leonardo at Lyon," in *Raccolta Vinciana*, XIX, 1962, pp. 267–272, and *Leonardo. A Study in Chronology and Style*, London, Thames & Hudson, and Berkeley and Los Angeles, University of California Press, 1973 (second edition, New York, Johnson Reprint Corporation, 1982), p. 172.

The occasion of the earlier spectacle was described in Lomazzo's 1584 retrospective account of the allegory of friendship between the Medici and Francis I, which occurred at the latter's accession to the throne of France. Lomazzo writes that "once in front of Francis I, King of France, [Leonardo] caused a lion, constructed with marvelous artifice, to walk from its place in a room and then stop, opening its breast which was full of lilies and different flowers."³ The Lion was an old symbol of Florence, and the lilies referred to the *fleur-de-lis* that Louis XI of France had given to Florence as a token of friendship. The two powerful families were combined symbolically in a dramatic presentation by one fantastic machine. Figure 2.1 shows my recreation utilizing the automaton presented in this chapter with a Lion shell over it.

Scholars offered no explanation for how Leonardo's lion walked. Carlo Pedretti felt that it would have been an anatomically correct approach. However, supplying the power required for actually walking, even in the twenty-first century, is a daunting task. In general, Renaissance Italian scholars have tended to under-rate the abilities of the court "special effects" people of the fifteenth to sixteenth centuries, perhaps, in part, because they tend to be non-technical, but also because it challenges the idea that Renaissance engineers were not as sophisticated as we.

There have been a number of books claiming to collect Leonardo's mechanical studies.⁴ All have missed the overriding patterns, to say nothing of the complex devices. They concentrate on the clearly illustrated mechanical elements which are often reproduced in museums. The pulleys, bearings and gears along with some locks, weight lifting devices and other components or simple machines that would have been considered unremarkable by Leonardo's contemporaries. What is being reconstructed here is a much broader richer tapestry with far more complex mechanisms than previously known.



Fig. 2.1. Leonardo's Lion

Pieces of the Puzzle

My reconstruction of Leonardo's programmable cart began in 1999 when I was invited to give the keynote speech at the 40th annual *Biblioteca Leonardiana* in Vinci, Italy, the town of Leonardo's birth. An honor usually bestowed on professors and scholars, the invitation came with a serious drawback: I would be asked to deliver the speech in Italian. Thus forewarned, I began a crash course in Italian at Hamline University. My first university class in perhaps 15 years started at 8:00 A.M. (very early for this night owl) and met three times a week. There I found myself sitting with teens and early twenty-somethings, a few of whom would show up for class in their pajamas.

Meanwhile, I had to think of a topic for the lecture, a problem that, compared to the prospect of carrying on in Italian for hours on end, seemed a bit more manageable. Codex Atlanticus,⁵ f. 296 v-a [812 r] (Fig. 2.2) shows the formation of a technological idea as early as c. 1478, when Leonardo was about twenty-six years old. Since 1929, when it was first recognized by Guido Semenza as a self-propelled vehicle, the machine represented there has convinced all interpreters that the arbalest springs

³ Carlo Pedretti, *Leonardo architetto*, cit., p. 209, and, by the same author, "Leonardo at Lyon," in *Raccolta Vinciana*, XIX, 1962, pp. 267–272.

⁴ Ivor B. Hart, *The Mechanical Investigations of Leonardo da Vinci*, London, Chapman & Hall, 1925. Arturo Uccelli, *Leonardo da Vinci's Libri di Meccanica*, Milan, Hoepli, 1940. *Zur Mechanik Leonardo da Vincis* (Hebelgesetz, Rolle, Tragfähigkeit von Ständern und Trägern). Inaugural Dissertation Fritz Schuster. Germany, K. B. Hof- und Univ.-Buchdruckerei von Junge & Sohn, 1915.

⁵ Henceforth cited as CA.