Reviews

Leonardo's 'leaps': metaphor and the process of creative discovery

by Susan Welsh

Leonardo da Vinci, Codex Leicester: A Masterpiece of Science
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> "*Iron rusts from disuse; stagnant water loses its purity and in cold weather becomes frozen; even so does inaction sap the vigor of the mind.*"—Leonardo da Vinci

This quotation from Leonardo, chosen by American Museum of Natural History President Ellen V. Futter to introduce the catalogue of this wonderful exhibition on the Codex Leicester, aptly situates this remarkable scientific notebook and its author, one of the most vigorous minds the world has ever known. The Codex is on display at the museum in New York City until Jan. 1. Written between 1506 and 1510, it contains some of Leonardo's most important work on astronomy and the science of water. It was purchased by the first earl of Leicester in 1717, and stayed in his family until 1980, when it was bought by Armand Hammer. William H. Gates III purchased it from Hammer's estate in 1994, for $30.8 million.

As with most of Leonardo's notebooks, the Codex Leicester is not an orderly presentation ready for publication, but rather the scientist's private jottings, sketches, and thought experiments. Indeed, none of Leonardo's written work was published during his lifetime. As if anticipating the complaints of later scholars, he himself comments in the Codex, on his intention to eventually write something more systematic:

"I will not consider the demonstrations here, because I will reserve them for the ordered work; my concern now is to find cases and inventions, gathering them as they occur to me; then I shall have them in order, placing those of the same kind together; *therefore you will not wonder nor will you laugh at me, reader, if here I make such great leaps from one subject to the other*" (emphasis added).

For five centuries, historians have made fools of themselves, complaining about Leonardo's "leaps."

To take just one example, Pio Emanuelli, in an essay on "Da Vinci's Astronomy,"[1] asserts: "Leonardo cannot in any way or for any reason be considered an astronomer. It was impossible for him to be one because of the very nature of his mind, which was essentially encyclopedic and tended to sudden leaps and fragmentary treatments."

But the truth is, that it is precisely such "leaps" which are the basis of human creativity. It is through *metaphor,* leaping from one domain to another, that the mind comes up with new ideas that can transform history.[2] Nowhere is this more clear than in the work of Leonardo—the bane of those Aristotelian "experts" who want to place everything in neat categories, and who lose sleep at night wondering whether Leonardo should properly be classified as an "artist" or a "scientist."

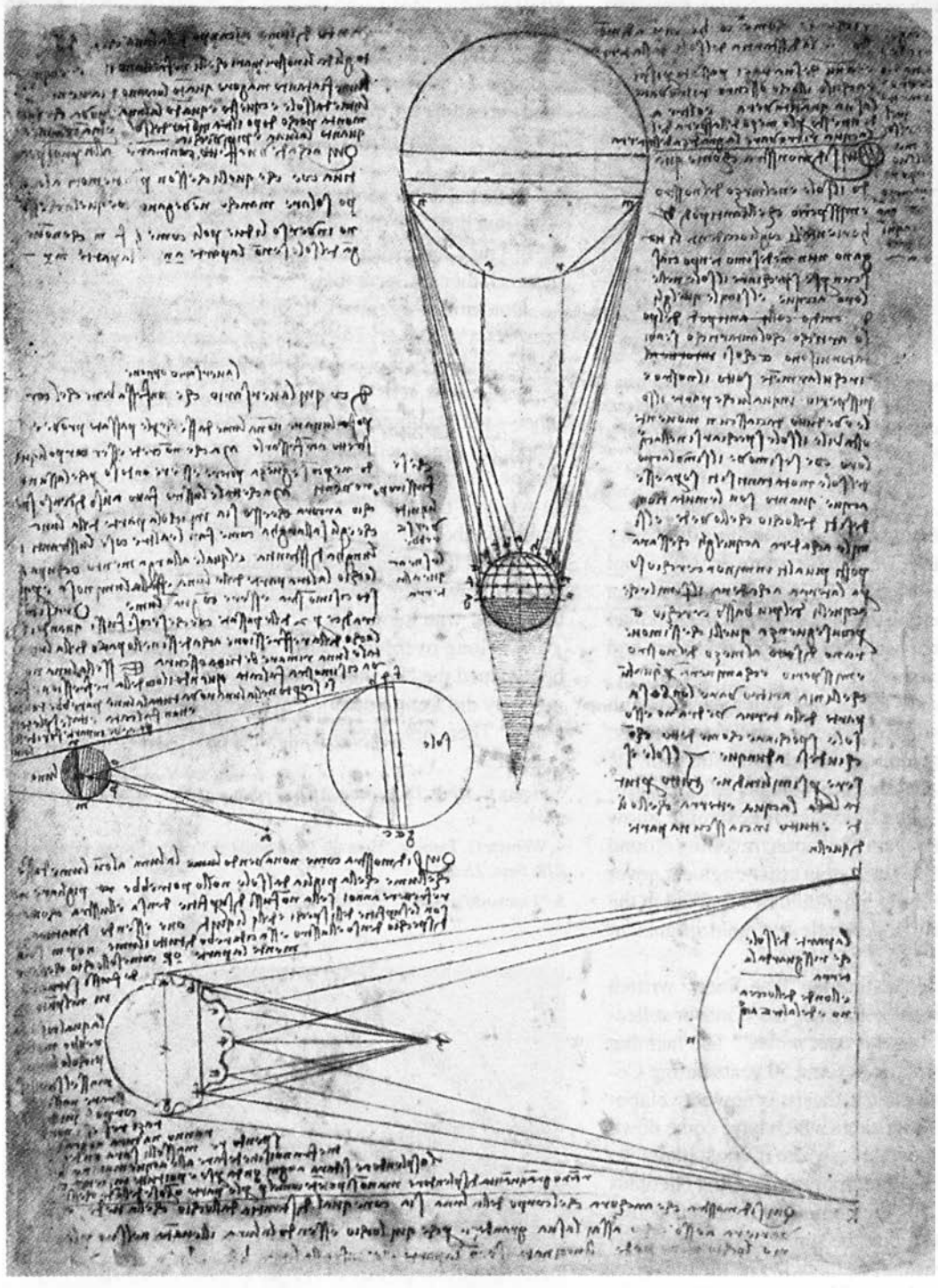
A cautionary note: Take anything you read about Leonardo in secondary sources with a grain of salt. Bear in mind, that the 5,000 or so manuscript pages that have come down to us, are only a fraction of what Leonardo left behind; at least two-thirds of his total legacy has been lost or destroyed. For every historian who says that Leonardo had "essentially no impact on the scientific progress of the Renaissance" (as Harvard's Owen Gingerich says in an essay in this catalogue), you will find a dozen who document his impact in one field or another. Virtually every detail of his biography has been subject to dispute, in scholarly and not-so-scholarly dissertations, for the past five centuries.

Leonardo's astronomy

What is the significance of Leonardo's work in astronomy? Historian Emanuelli, quoted above, ends his essay: "We conclude by saying that although Leonardo cannot be consid-

1. In Istituto Geografico De Agostini, *Leonardo da Vinci* (New York: Reynal and Co., n.d.), pp. 205-208.

2. Lyndon H. LaRouche, Jr., "On the Subject of Metaphor," *Fidelio,* Fall 1992.

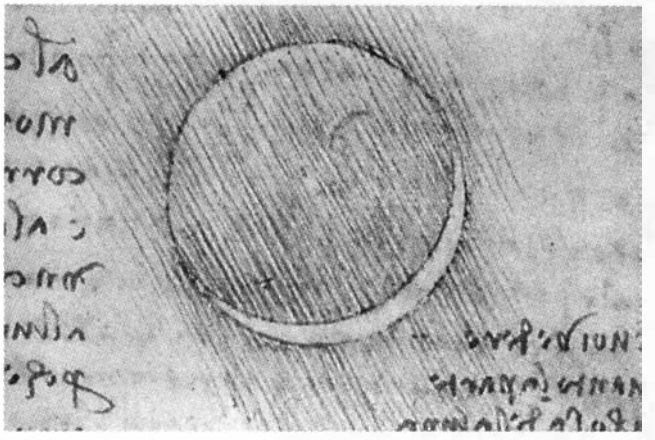


These drawings from Leonardo's Codex Leicester explore the geometrical relationships of the sun, earth, and moon, and the pathways of light from one to another. The bottom figure, the scallop-edged sphere, shows waves on the surface of the moon, which Leonardo believed to be covered with water.

ered as being an astronomer, still his speculations on some celestial phenomena deserve to be recalled, without giving them any excessive importance."

Let us submit this outrageous statement to closer scrutiny.

Looking at the Codex Leicester, we find that Leonardo was the first to correctly identify the phenomenon known as "earthshine": how, as he puts it, "in some aspect of the sky the shaded side of the moon has some luminosity, and how in some other part of the sky it is deprived of such luminosity." In other words, a ghostly image of the entire moon can be seen when only a crescent is illuminated by the sun's rays. Leonardo surmised that the luminosity is due to the reflection of sunlight by the waters of the earth. Galileo (1564-1642), who—as we read in the present catalogue—was familiar with



Detail from the Codex Leicester, showing the phenomenon known as "the old moon in the new moon's arms." Leonardo was the first to identify the reason for the luminous glow of the darker part of the moon, which we now call "earthshine."

Leonardo's unpublished manuscripts, claimed this discovery as his own a century later (we'll have more to say about Galileo, below). Johannes Kepler (1571-1630) published a similar explanation, attributing the idea to his teacher Michael Maestlin (neither Kepler nor Maestlin, so far as is known, had access to Leonardo's manuscripts).

But, the devil's advocate might say, this idea, although original, is of minor importance in the history of astronomy. After all, Leonardo's astronomical work was stuck in the ancient Ptolemaic, earth-centered cosmology. All the astronomical drawings in the Codex Leicester, for example, show the earth at the center, and the sun and moon travelling around the earth. Writes Gingerich, "The Italian artist-engineer never thought of the earth as anything other than firmly fixed in the middle of the cosmos, just as Aristotle had held in ancient Greece."

What, then, of Leonardo's stunning "one-liner," written in unusually large letters, in a document in the Windsor collection of manuscripts: "*The sun does not move*"? The fact that this revolutionary statement, made some 50 years before Copernicus published his heliocentric thesis, is nowhere elaborated in those of Leonardo's writings which have come down to us, does not negate the fact that he wrote it. Most likely, he was influenced by his great contemporary Cardinal Nicolaus of Cusa (1401-64), who, for theological/philosophical reasons, reached the conclusion that the sun, not the earth, must be at the center of what was then believed to be the universe.

Another surprise to students of Leonardo, is his cryptic notation, "Construct glasses to see the moon magnified." Telescopes were, supposedly, not made until about 1600, and Galileo, supposedly, was the first to use them to look at the moon and the planets. What, then, was Leonardo doing?

Galileo did not (usually) claim that he had actually invented the telescope; the instrument developed by the Dutchman Hans Lipperhey was provided to Galileo by Venetian intelligence agent Paolo Sarpi. But with his typical arrogance, Galileo dismissed Lipperhey as "a simple spectacle-maker who, handling by chance different forms of glasses, looked, also by chance, through two of them, one convex and the other concave . . . and thus found the instrument. On the other hand, I, on the simple information of the effect obtained, discovered the same instrument, not by chance, but by the way of pure reasoning."[3]

In fact, there is good reason to believe that it was Leonardo who invented the telescope, and that Galileo, steered by Sarpi,[4] may have plagiarized Leonardo's observations of the moon (rather badly, at that).

Domenico Argentieri, in an essay on Leonardo's optics,[5] presents a strong argument for Leonardo's invention of the telescope: a very low power instrument (1.41 magnification), with a convex lens at one end and a concave lens at the other—the configuration known today as a Galilean telescope. As Argentieri says, the fact that Leonardo's telescope was not very good, is not the issue. "The history of science," he writes, "has the duty of finding out who was the first to make a tube having a convergent lens at one end and a concave at the other and making the objects observed appear large; today, after my researches, we are able to say that this 'first' was Leonardo."

It is long overdue for the "Galilean" telescope design to be renamed the "Leonardian."

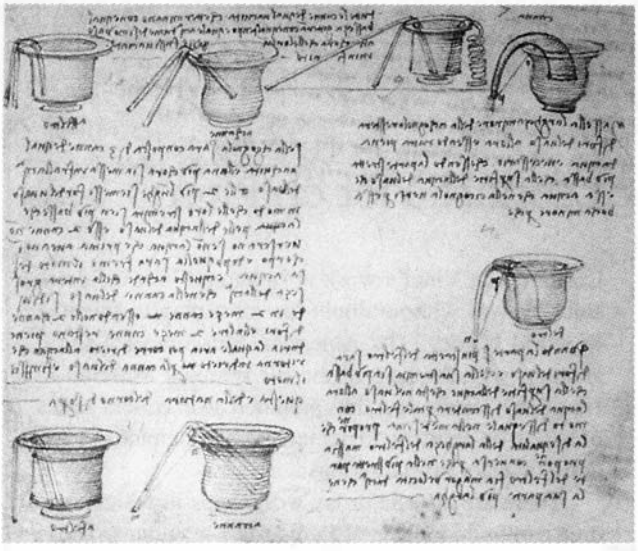
Why did Leonardo not make his discovery known to the world? There are several possible reasons, of a personal and

3. Henry C. King, *The History of the Telescope* (New York: Dover, 1979), p. 34.

4. Webster G. Tarpley, "How the Dead Souls of Venice Corrupted Science," *EIR,* Sept. 23, 1994.

5. "Leonardo's Optics," in Istituto Geografico, *op. cit.,* pp. 405-436.

One of Galileo's drawings of the moon, allegedly seen through a telescope. None of the features sketched corresponds to reality.

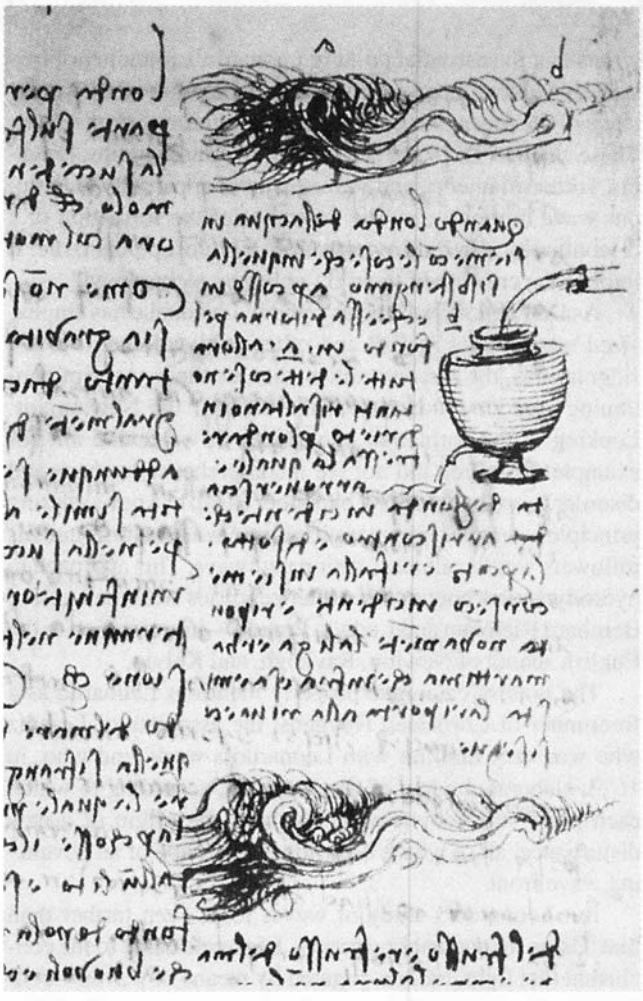


Leonardo's observations of self-priming siphons. He notes that water can climb out of a vessel, "doing something contrary to the nature of its gravity," if a piece of cloth is submerged in the water. (Enzo Macagno, "Leonardo Fluid Mechanics: What Remains to Be Investigated in the Codex Hammer, A Critical Study and a Challenge," Iowa Institute of Hydraulic Research, March 1988.)

strategic nature. The period during which Leonardo was doing his most intensive optical research was in Rome, toward the end of his life (1513-16). Although living at the Vatican, he was in a very precarious situation politically. Some accused him of being a magician or an alchemist; his dissection of human corpses had been banned by the pope; he was not receiving any commissions. The two German mechanics who assisted him were, he writes in his notebooks, always gossiping against him and selling his secrets in the marketplace. Leonardo worked in great secrecy; among his projects was the construction of an enormous parabolic mirror, which could have been used for astronomical observations, and may have had military applications as well. In 1516, he left for exile in France, where he died three years later, taking many of his secrets with him to the grave.

Compare Leonardo's meticulous drawings of the moon, as seen with the naked eye, with Galileo's sketches of the moon, allegedly as seen through a telescope (20-power), a century later. In Galileo's drawings, no features of the actual moon are recognizable! As one modern introductory astronomy textbook says, by way of encouraging students to sketch their observations, "It is not difficult to draw better moon maps than Galileo did in 1610."[6] Did Galileo look at the moon through his telescope at all? Or was he perhaps perpetrating a careless plagiarization of what he had seen among Leonardo's papers—papers which have since vanished?

6. Mary Kay Hemenway and R. Robert Robbins, *Modern Astronomy: An Activities Approach* (Austin: University of Texas Press, 1991), p. 22.



A subject of endless fascination of Leonardo: waves, with breakers hitting the shore and bounding back to sea.

The study of water: more 'leaps'

Much of the Codex Leicester is devoted to the study of water, both in its physical properties, and in engineering applications for the construction of canals and bridges. As the Leonardo scholar Carlo Pedretti writes in his essay in the catalogue, about one-third of all the illustrations in the Codex are fascinating representations of water currents, leaps, and vortices. "All forms of organic life and every aspect of growth and transformation in nature, from plants to animals and from combustion to decay, come to be associated by analogical process to the dynamics of water." A famous example, from the Windsor drawings, is the comparison of water to human hair. Many reflections of this metaphor can also be seen in the Codex Leicester.

Researcher Dino de Paoli has contributed a very provocative account of Leonardo's work on the science of water.[7] He

7. "Leonardo da Vinci and the True Method of Magnetohydrodynamics," *Fusion*, January-February 1986, pp. 14-38. *Fusion* magazine is now defunct, having been shut down by government decree in 1987, as part of the political railroad against LaRouche and his associates. For a copy of De Paoli's article,

writes that the essential point in Leonardo's founding of true fluid dynamics, "is his unambiguous indication of the importance of the formation of singular discontinuous phenomena. These can take the form of vortices, hydraulic jumps, breakers, vortex-filaments, and so forth, out of apparently continuous wave motions. . . . The relevance of the formation of a discontinuity in a fluid is not purely a philosophical issue. It implies the creation of the right or wrong technology."

As De Paoli shows, and as Lyndon LaRouche has emphasized many times in *EIR* and other publications,[8] it is the singularities, the discontinuities, that are the essence of continuing creation—contrary to the view of the Newtonians. Looking at the formation of vortices in water and air, for example, Leonardo did not see incomprehensible chaos and disorder, as many do today, but rather a leap to a new ordering principle, as matter organizes itself into what Leibniz and his followers would call least-action pathways. This approach to hydrodynamics continued in later centuries with the work of Bernhard Riemann and Ludwig Prandtl—in opposition to the English school of Newton, Rayleigh, and Kelvin.

The present catalogue properly identifies Leonardo as a forerunner of Christiaan Huygens, the associate of Leibniz who was very familiar with Leonardo's work, and who, in 1673, elaborated a law of wave motion, according to which each point struck by a wave becomes the origin of a new disturbance, all of which determines the shape of an advancing wave front.

But Leonardo's study of waves leapt even farther than that. Using the metaphor of water, Leonardo came to the conclusion that light, too, propagated by means of waves—contrary to the view at the time, that it was composed of tiny particles. "Just as a stone thrown into water becomes the center and cause of various circles," he wrote, "so every body placed within the luminous air spreads itself out in circles and fills the surrounding parts with an infinite number of images of itself, and appears all in all and all in each part."[9]

Leonardo's wave theory of light, one of the most important ideas in the history of science, was buried until the end of the 17th century, when Huygens, Leibniz, and the Bernoullis developed it further; but the growing hegemony of Isaac Newton in the 18th century generally suppressed this line of investigation, until the existence of light waves was established, to the satisfaction of even the empiricists, by Thomas Young in 1800, nearly 300 years after Leonardo asserted it.

The Codex Leicester is a milestone in the history of science. Most important, it gives the modern student a glimpse at the method which produced such wonderful discoveries.

write to *EIR*. See also Lyndon H. LaRouche, Jr., "Beethoven as a Physical Scientist," *EIR*, May 26, 1989.

8. Lyndon H. LaRouche, Jr., "The Essential Role of 'Time-Reversal' in Mathematical Economics," *EIR*, Oct. 11, 1996.

9. Codex Atlanticus, fol. 9v, cited by Argentieri, in Istituto Geografico, *op. cit.*, p. 405.

Leonardo for children

Leonardo da Vinci's work is "a natural" for children, since he was without doubt the most playful scientist in world history. The American Museum of Natural History, with the help of the Eli Whitney Museum in Hamden, Connecticut, has prepared an excellent series of hands-on exhibits, to demonstrate principles of Leonardo's water investigations.

There are also Saturday workshops in which children can build models of Leonardo's machines. Those still to come, on Dec. 15, include "Leonardo's Fountain," "Leonardo's Violin," "Leonardo's Catapult," and "Bathtub Leonardo."

Children's books on Leonardo are a mixed lot. My favorite for young children is the ingenious pop-up book *Leonardo da Vinci,* by Alice and Martin Provensen (New York: Viking, 1984), now, unfortunately, out of print.

A new release, *Leonardo da Vinci,* by Diane Stanley (New York: Morrow Junior Books, 1996, hardbound, $16.00), is a disappointment. Although the author researched her subject carefully, she has no real understanding of Leonardo. Her illustrations are dreadful: The most alive-looking picture is that of the cadaver on Leonardo's dissecting table. In her painting of Leonardo's underwater frogman with snorkel, not a ripple moves—not the water, not the frogman, not even the fish that happens to be in the neighborhood. It is as if all the participants had suddenly been trapped in ice. How totally un-Leonardian!

Her text describes Leonardo as though he were a child of the 18th-century Enlightenment, with its division between "religion" and "science," "natural science" and "the arts." Characterizing the Middle Ages as a time when people were guided by a deep religious faith, she writes that when Leonardo was born, "faith and tradition gave way to learning and curiosity." One has only to look at Renaissance paintings, including Leonardo's, to see how absurd a view that is of the Renaissance.

For children 10 and up, I recommend Richard McLanathan's beautiful book *Leonardo da Vinci,* in the "First Impressions" series (New York: Harry N. Abrams, 1990, hardcover, $19.95). It uses only Leonardo's own paintings and drawings by way of illustration (who could improve on these?), does not try to be cute, and the text is informative.—*Susan Welsh*