Leonardo from LaRouche's Standpoint: The Principle of Least Action

For five hundred years, the writings and discoveries of Leonardo da Vinci have been dispersed and put through "the shredder," his paintings mutilated and lost, by an oligarchy determined to stamp out every vestige of his method of creative discovery. At least two-thirds, perhaps more than three-fourths, of his legacy has vanished. Yet, every so often, someone discovers a new truth about the great scientist-artist, which stuns the Aristotelians. In 1965, there was the fabulous rediscovery, in the Biblioteca Nacional in Spain, of what are now called the *Madrid Codices*—two notebooks filled with drawings and investigations of technology, hydrodynamics, military science, and many other domains of knowledge. The *Codex* had languished on the library shelf, lost to the world for 135 years, because of confusion in the library's filing system.

Now, a new discovery: Geologist Ann Pizzorusso, in a lecture at the American Museum of Natural History in November of last year, presented convincing proof concerning an ongoing suspicion amongst art historians that, of the two versions of Leonardo's "The Virgin of the Rocks," the London one was *not* painted by Leonardo (the two versions are at the Louvre in Paris, and the National Gallery in London). Or rather, at least not all of it was painted by Leonardo. Pizzorusso's presentation was part of a lecture series held in conjunction with the Museum's Oct. 26, 1996–Jan. 1, 1997 exhibition of Leonardo's *Codex Leicester*.

It seems that for five hundred years, when people looked at the paintings, they looked at the Virgins; now, somebody has looked at the rocks. Pizzorusso's findings are quite startling. Whereas the geological accuracy of the rock formations in the Louvre painting is, she says, "astounding . . . a geological *tour de force,*" the rocks in the London version are "synthetic, stilted, grotesque characterizations." Further, in the Louvre version, the vegetation is appropriate to the setting and is found among only those rocks where such plants could actually grow, whereas in the London painting, the plants are arranged arbitrarily and "resemble cultivated annuals needing considerably more light than would be available in the grotto."[1] [SEE Diagram, pp. 88-89]

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Leonardo da Vinci, "Virgin of the Rocks" (Louvre version), 1483-86.

Pizzorusso notes Leonardo's sensitivity to the portrayal of landscapes, and his objection to those artists, such as Botticelli, who painted "very bad landscapes," as mere backdrops for human figures. Wrote Leonardo, a "painter is not well-rounded who does not have an equally keen interest in all things within the compass of painting."

Why is Pizzorusso's finding so interesting? Why did Leonardo think the landscapes were worth so much bother? This gets to the core issue of da Vinci's importance as a scientist.

Five centuries of misinterpretation have attempted to brand Leonardo an "empiricist." Martin Kemp, in his essay in the catalogue of the *Codex Leicester* exhibition, concedes only that Leonardo's "empiricism" was "tempered by the role he assigned to deductive reasoning."[2] Ivor Hart, in his book on Leonardo, goes so far as to describe Nicolaus of Cusa, the founder of Renaissance science who profoundly influenced Leonardo, as a forerunner of Francis Bacon![3] According to such an idiotic view, Leonardo painted rocks accurately because of his "realism." In a word: "He painted them that way, because that's the way they looked." Or, as Aristotle had it: The purpose of art is to *imitate* nature.

In this brief article, I shall indicate why this is not the case, drawing upon the in-depth treatment of the epistemological issues provided in many works by Lyndon H. LaRouche, Jr.[4]

Leonardo's Conception of Physical Geometry

Contrary to the empiricists, Leonardo approached the natural world from the standpoint of the Platonic method of hypothesis: looking beyond the Many—the predicated phenomena of the natural world—to conceptualize the One—the higher-order idea that generates and encompasses that diversity. Studying the geometry of natural forms (whether rocks, water, air, or living bodies), in collaboration with mathematician Luca Pacioli, he sought to understand the way in which the physical geometry of space-time bounds the patterns of natural growth and development.

LaRouche has described the epistemological current in history of which Leonardo was a part: "[T]he literature of modern physical science is divided into two camps. The first camp, which founded modern physical science in terms of reference to Plato and Archimedes (287-212 B.C.), is the school of Nicolaus of Cusa, Leonardo da Vinci, Johannes Kepler, G.W.F. Leibniz, Gaspard Monge (1746-1818), Carl Gauss, and Bernhard Riemann, based upon the 'hereditary principle' of *synthetic physical geometry.* The second camp, which invaded the province of physical science from the outside, during the Seventeenth century, about two hundred years later, is based upon the 'hereditary principle' of the deductive theorem-lattice. Although the literature of the two camps often appears to coincide, on closer scrutiny of both, there is an unbridgeable gulf between the two."[5]

It is that "hereditary principle of synthetic physical geometry" that holds the key to Leonardo's so-called landscapes, and the depiction of the geological formations in the Virgin's grotto.

The breakthrough in the science of perspective made during the Renaissance by Leonardo and other artists, for the first time located geometry firmly in the study of real physical processes. From their investigations of optics and of how human beings perceive the world around them, they developed an understanding of the laws of perspective that went far beyond the linear, Euclidean geometry of their predecessors.[6]

Compare the Earth-centered geometrical universe of hoaxster Claudius Ptolemy, for example, who described the universe as a complex interaction of circles upon circles, to account *mathematically* for the observed paths of the celestial bodies. While Ptolemy's geometrical construct succeeded, up to a point, in describing the motions of the sun, moon, and planets, it was never even intended to be a description of reality. The concatenated sets of epicycles, equants, and deferents imposed by Ptolemy were never assumed to have any physical reality, and no explanation was ever offered, as to how this description might relate to the actual physical processes at work. (Of course, it couldn't!)

But, for Leonardo, mathematics—i.e., geometry—must describe real processes in space-time. It is therefore, necessarily, a description of change, of continuing transformation. Starting with the division of a spherical shell by means of the Golden Section (or what Leonardo and Pacioli called "the Divine Proportion"), to generate the five Platonic solids, Leonardo would proceed to investigate the specific geometries expressed by both living and non-living processes. He studied what happens to a shape, such as a triangle, when it is deformed by wind, water, or other physical process. He probed the geometry of wave formation, founding the science of hydrodynamics. His astronomical and optical drawings, such as those in the *Codex Leicester,* were an attempt to understand how light actually behaves. This quest led him to two revolutionary conceptions: (1) that light is propagated at a finite rate, not instantaneously (two hundred years before Ole Rømer proved this); and (2) that light is propagated by transverse wave motion, not by "rays" of tiny particles (two hundred years before Christiaan Huyghens and Johann Bernouilli elaborated this).[7] The two ideas are related, since if light travels in

Diagram of the Louvre *Virgin of the Rocks*

"From top to bottom: Rounded (spherically weathered) mounds of horizontally layered (bedded) sandstone form the top of the grotto. The column of rock above the Virgin's head is diabase, an igneous rock deposited on the sandstone as a molten liquid. As it cooled, the diabase formed a layer of rock (a sill) and shrank in volume. The contraction caused the rock to crack perpendicular to the sandstone, forming columnar joints (fractures). The columnar joints in the painting are not perfectly vertical, but inclined slightly. This implies that the sandstone dips a few degrees away from the observer, which is borne out by close study of the layers. Directly above the Virgin's head is a horizontal line (basal contact) that separates the diabase sill from the weathered sandstone below. The texture and rounded weathering pattern of the sandstone below the basal contact are the same as they are at the top of the grotto. In the foreground, the sandstone is layered, or bedded, with the utmost accuracy. In the background, rocky towers, or pinnacles, rise from a blue-gray mist. These towers are remnants of erosional processes that strip away the overlying softer rock and leave the more weather resistant, harder rock intact."

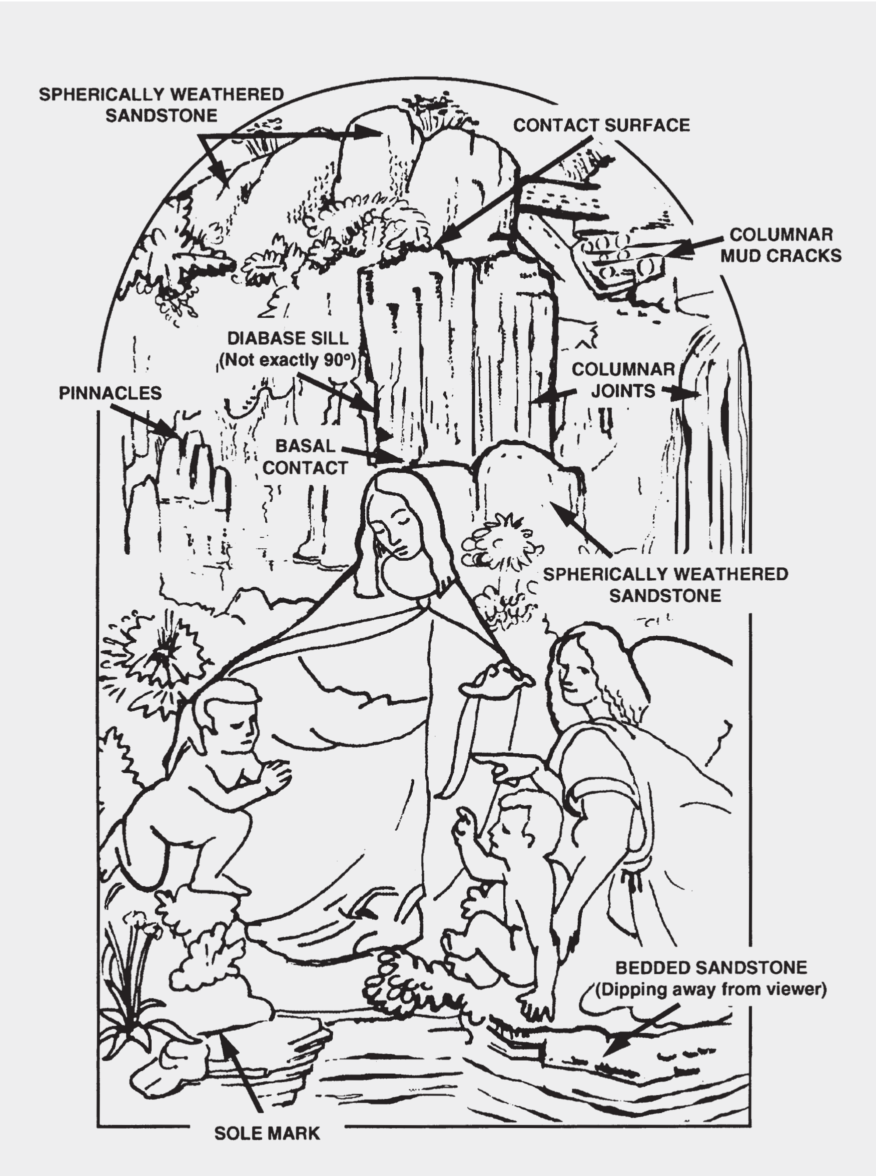
waves, it cannot propagate instantaneously. Without the idea of the finite rate of propagation of light, there can be no scientific comprehension of optics—only Newtonian magic.

An Example: The Least-Action Principle

The contribution of an outstanding individual such as Leonardo is best understood by looking at the current of human thought from which it derives, "hereditarily," and where it leads. Starting with Nicolaus of Cusa's discovery of the Maximum-Minimum Principle, we work our way through the founding of applied physics by Leonardo and Pacioli, through Kepler's establishment of a comprehensive mathematical physics, and on to the work of Leibniz, Gauss, Riemann, and LaRouche.

To understand Leonardo's conception of *physical geometry,* it is useful to look at what LaRouche has called "the Cusa-Leonardo-Kepler-Leibniz-Riemann definition of the Principle of Least Action." (Actually, we need another hyphen: "-LaRouche." It is only with LaRouche's contribution that the continuity of the work of the earlier figures comes into clear focus.)

As Martin Kemp notes in the *Codex Leicester* catalogue, Leonardo believed that every phenomenon was *constrained to act in accordance with the laws of nature,* and that *every form was designed to perform its function by the "shortest way."* But, these are none other than Leibniz's principles of *necessary and sufficient reason* and *least action,* two of the most important ideas in the history of science (although Kemp mentions them only in passing, and does not identify them by name). Indeed, two hundred years before Leibniz, Leonardo wrote: "Every action in nature takes place in the shortest way possible."[8]



What is the least-action principle? Many lies have been told about this in the past five hundred years. If you are an "Information Age" modern, and search for it on the Internet, you will find that it was "stated for the first time by Pierre-Louis Moreau de Maupertuis (1698-1759) as '*Nature is thrifty in all its actions.*'"[9]

Thrifty? —"Thrift, thrift, Horatio!" said Hamlet, with reference to his mother's marriage to her husband's murderer: "The funeral baked meats did coldly furnish forth the marriage tables."

No, the least-action principle is not a question of thrift, although Adam Smith and the bankers of the City of London might think so! It is a principle of creation. Leibniz described it as "God's decree always to produce his effect by the simplest and most determinate ways."[10]

In fact, Maupertuis stole the least-action principle from Leibniz, stripping it of its true scientific-epistemological content, and turning it into a calculus for the later economics of Adam Smith and utilitarian philosophy of Jeremy Bentham.[11] When his swindle was exposed, he was defended by the Swiss mathematician Leonhard Euler, who otherwise devoted his career to crushing the influence of Leibniz.

From Cusa to LaRouche

To find the true origins of the least-action principle, we must begin with Nicolaus of Cusa. By his proof of the impossibility of "squaring" the circle, he made possible the entire future development of mathematical physics. As LaRouche writes,[12] the crucial feature

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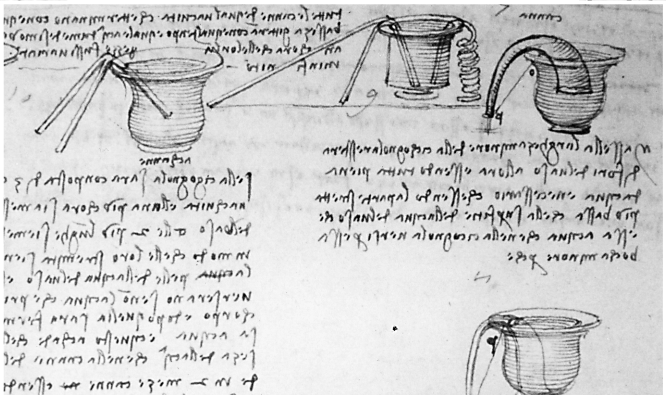

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Notes and observations from the "Codex Leicester." **Left:** *Obstacles affecting currents, and their use to prevent damage to riverbanks (detail, fol. 13B).* **Right:** *Movement of water through narrow passages and under bridges (detail, fol. 9r).* **Below:** *Siphons and centers in the sphere of water (detail, fol. 34v).*

was the "Maximum-Minimum" principle, from which the isoperimetric principle of topology is derived, and also Leibniz's principle of least action. The circle is the minimum form that encloses the maximum area.

Among the implications of Cusa's isoperimetric principle, writes LaRouche,[13] are that (1) circular action is a distinct geometrical species of action in space-time; and (2) it is defined as the *least action* of closed perimetric displacement required to subtend the relatively largest area. "Thus, the Fermat-Huyghens-Leibniz-Bernouilli principle of least action is already implicit, 'hereditarily,' in Cusa's discovery."

Cusa's work set the stage for the crucial discoveries of Pacioli and Leonardo respecting the importance of the Golden Section. They showed that all living processes are ordered harmonically, bounded by the Golden Section relationship, whereas non-living processes are not. For living processes, the Golden Section represents a *least-action pathway* of growth and development.

In the same way, Leonardo investigated least-action pathways in wave and vortex formations in water. In optics, he explored the pathways of the propagation of light, the formation of caustics, and which geometrical configurations of lenses could eliminate the caustic and allow a light beam to focus.

"Then, with stunning force, comes Kepler," writes LaRouche.[14]

Reflecting on the work of Cusa, Pacioli, and Leonardo, Kepler comments that "there were three things in particular about which I persistently sought the reasons why they were such and not otherwise: the number, the size, and the motion of the circles [planetary orbits]."[15] He discovers that the orbits of the planets are far from arbitrary; they are determined by the curvature of physical space-time itself, as reflected in the Platonic solids, harmonic musical proportions, and conic functions. (That is, he supplies a particular sort of "why" missing in Ptolemy's descriptive construct.)

LaRouche emphasizes the aspect of *curvature* in Kepler's work: "The additional crucial feature of circular action, is that it defines our universe in terms of both negative and positive curvatures, with the demonstration that negative curvature predominates. This point is summed up rather neatly in Johannes Kepler's 1611 booklet, *On the Six-Cornered Snowflake.* The snowflake is a non-living process determined by the function of positive curvature in determining the close packing of spherical bubbles. The negative curvature of the interior of each and all bubbles determines structures 'hereditarily' cohering with the five Platonic solids, and, thus, with the harmonic orderings cohering with the Golden section of the circumscribing sphere's great circle.

"The universe can be considered as everywhere superdensely packed with spherical bubbles of all imaginable radii, as the unique, bounding characteristic of generalized 'non-algebraic' function shows this to be necessarily the case. By the close of the seventeenth century, it was implicitly demonstrated that this bubbly universality of the least-action principle is otherwise characterized by the combined notions of electromagnetic least action and hydrodynamic forms of such action. Thus, frequency of radiation is associated with a corresponding resonant set of bubbles—e.g., of corresponding radii."[16]

Leibniz's concepts of *necessary and sufficient reason* and *least action* derive, hereditarily, from Kepler's work.

The first, Leibniz defines simply as "that nothing happens without it being possible for someone who knows enough things to give a reason sufficient to determine why it is so and not otherwise."[17] This is the principle underlying Kepler's question, quoted above, as to the number, size, and orbits of the planets.[18]

The least-action principle is a special

case of the principle of necessary and sufficient reason. As Leibniz explains: "It follows from the supreme perfection of God that he chose the best possible plan in producing the universe, a plan in which there is the greatest variety together with the greatest order. The most carefully used plot of ground, place, and time; *the greatest effect produced by the simplest means;* the most power, knowledge, happiness, and goodness in created things that the universe could allow. For, since all the possibles have a claim to existence in God's understanding in proportion to their perfections, the result of all these claims must be the most perfect actual world possible. And *without this, it would not be possible to give a reason for why things have turned out in this way rather than otherwise.*"[19] [Emphasis added]

Now, returning to the *Virgin of the Rocks* after this quick tour through the history of ideas, we are better situated to look at the "landscape" through Leonardo's eyes. He wonders about the processes that long ago formed the diverse varieties of rocks in the grotto. At the top of the cave, in the Louvre painting, reports Pizzorusso, are mounds of sandstone, a sedimentary rock. It has crumbled sufficiently to allow the roots of plants to grow. Above the Virgin's head is diabase, an igneous rock. No plants grow here—it is too hard and resistant to erosion. Directly above the Virgin's head is a horizontal crack in the rocks, called a basal or bottom contact—the seam between the diabase above and another layer of sandstone below.

In the *Codex Leicester,* Leonardo puzzles over how fossils of seashells and other creatures can be found at the tops of mountains. He rejects the theory that they were swept there by the turbulent biblical Flood: If they had been, they would all be a jumble, and yet, we find them in orderly groups and colonies, just as they grow today. The mountains must, he writes, have been covered by standing water at one time.

So, too, in the Louvre *Virgin of the Rocks,* Leonardo asks: How did this come to be? He records his exploration of the processes, in physical geometry, which produced these geological forms. The processes must result in the most perfect actual world possible, a world whose perfection lies in the greatest possible variety coupled with the greatest order. The scientific exploration of this plan of perfection is the reason why, for Leonardo, the painted landscapes are no less important than the human dramas man plays out upon them.

—*Susan Welsh*

1. Ann C. Pizzorusso, "Leonardo's Geology: The Authenticity of the *Virgin of the Rocks,*" *Leonardo,* Vol. 29, No. 3, 1996, pp. 197-200. See also Pizzorusso, "The Naturalist Genius of Leonardo da Vinci," *The Explorers Journal,* Spring 1996, pp. 24-29.
2. Martin Kemp, "The Body of the Earth," in *Leonardo da Vinci, Codex Leicester: A Masterpiece of Science,* ed. by Claire Farago (New York: American Museum of Natural History, 1996). In his book *Leonardo da Vinci: The Marvelous Works of Man and Nature* (Cambridge, Mass.: Harvard University Press, 1981), p. 139, he classifies Leonardo as an Aristotelian.
3. *The World of Leonardo da Vinci: Man of Science, Engineer, and Dreamer of Flight* (New York: Viking Press, 1961), p. 142.
4. See, for example, Lyndon H. LaRouche, Jr., "Leibniz From Riemann's Standpoint," *Fidelio,* Fall 1996 (Vol. V, No. 3); "On the Subject of Metaphor," *Fidelio,* Fall 1992 (Vol. I, No. 3); *In Defense of Common Sense,* in *The Science of Christian Economy and Other Prison Writings* (Washington, D.C.: Schiller Institute, 1991); *Cold Fusion: Challenge to U.S. Science Policy* (Washington, D.C.: Schiller Institute, August 1992); "We Must Attack the Mathematicians to Solve the Economic Crisis," *Fidelio,* Fall 1995 (Vol. IV, No. 3); See also Dino de Paoli, "Leonardo da Vinci and the True Method of Magnetohydrodynamics," *Fusion,* January-February 1986; and Susan Welsh, "Leonardo's 'Leaps': Metaphor and the Process of Creative Discovery," *Executive Intelligence Review,* Nov. 29, 1996 (Vol. 23, No. 48).
5. LaRouche, *Common Sense, op. cit.,* p. 36.
6. See Karel Vereycken, "The Invention of Perspective," *Fidelio,* Winter 1996 (Vol. V, No. 4), pp. 46-67.
7. "Just as a stone thrown into water becomes the center and cause of various circles, sound spreads in circles in the air. Thus every body placed in the luminous air spreads out in circles and fills the surrounding space with infinite likenesses of itself and appears all in all and all in every part."—*Codex Atlanticus, folio 9v*

   "It is impossible that the eye should project the visual power from itself, by visual rays, since, as soon as it opens, that front portion [of the eye], which would give rise to this emanation, would have to go forth to the object, and this it could not do without time. And this being so, it could not travel as high as the sun in a month's time when the eye wanted to see it."—*Codex Ashburnham, 2038, folio 1r*

   Quoted by Domenico Argentieri, "Leonardo's Optics," in Istituto Geografico De Agostini, *Leonardo da Vinci* (New York: Reynal and Co., n.d.), p. 405, 407.
8. *Quaderni d'Anatomia,* IV, folio 16r, quoted by Argentieri, p. 410.
9. Gérard A. Langlet, "The Least Action Principle (LAP) in APL," www.demon.co.uk/apl385/apl96/gerard.htm
10. *Discourse on Metaphysics,* in *G.W. Leibniz: Philosophical Essays,* trans. by Roger Ariew and Daniel Garber (Indianapolis and Cambridge: Hackett Publishing Co., 1989), p. 54.
11. In the *Dictionary of Scientific Biography,* biographer Bentley Glass quotes A.O. Lovejoy, that Maupertuis represents "the headwaters of the important stream of utilitarian influence through the work of the Benthamites." Glass describes Maupertuis' calculus of pleasure and pain, a product of intensity and duration, as "strictly analogous to his principle of least action in the physical world, and shows how he extended his philosophy of nature into a philosophy of life." Maupertuis belonged to the network of Enlightenment ideologues organized by the Abbé Conti; see Webster G. Tarpley, "Venice's War Against Western Civilization," *Fidelio,* Summer 1995 (Vol. IV, No. 2), p. 12.
12. LaRouche, *Common Sense, op. cit.,* p. 29.
13. LaRouche, "Metaphor," *op. cit.,* p. 20.
14. LaRouche, *Cold Fusion, op. cit.,* p. 29.
15. Johannes Kepler, *Mysterium Cosmographicum (The Secret of the Universe),* trans. by A.M. Duncan (New York: Abaris Books, 1981), p. 63.
16. LaRouche, "Metaphor," *op. cit.* pp. 21-22.
17. "Principles of Nature and Grace, Based on Reason," in Ariew and Garber, *op cit.,* p. 210.
18. Compare this to the prevalent modern view, reflected in the statement of Franklyn M. Branley, the former director of New York's Hayden Planetarium, in a book on astronomy for young people: "Why are there nine planets? . . . There appears to be no particular reason why our system is made up of nine planets." (*Mysteries of the Planets* [New York: E.P. Dutton, 1988], p. 8.)
19. Leibniz, "Nature and Grace," in Ariew and Garber, *op. cit.,* p. 210.