



"MAGNIFICENT AND SPELLBINDING." —DAVID McCULLOUGH

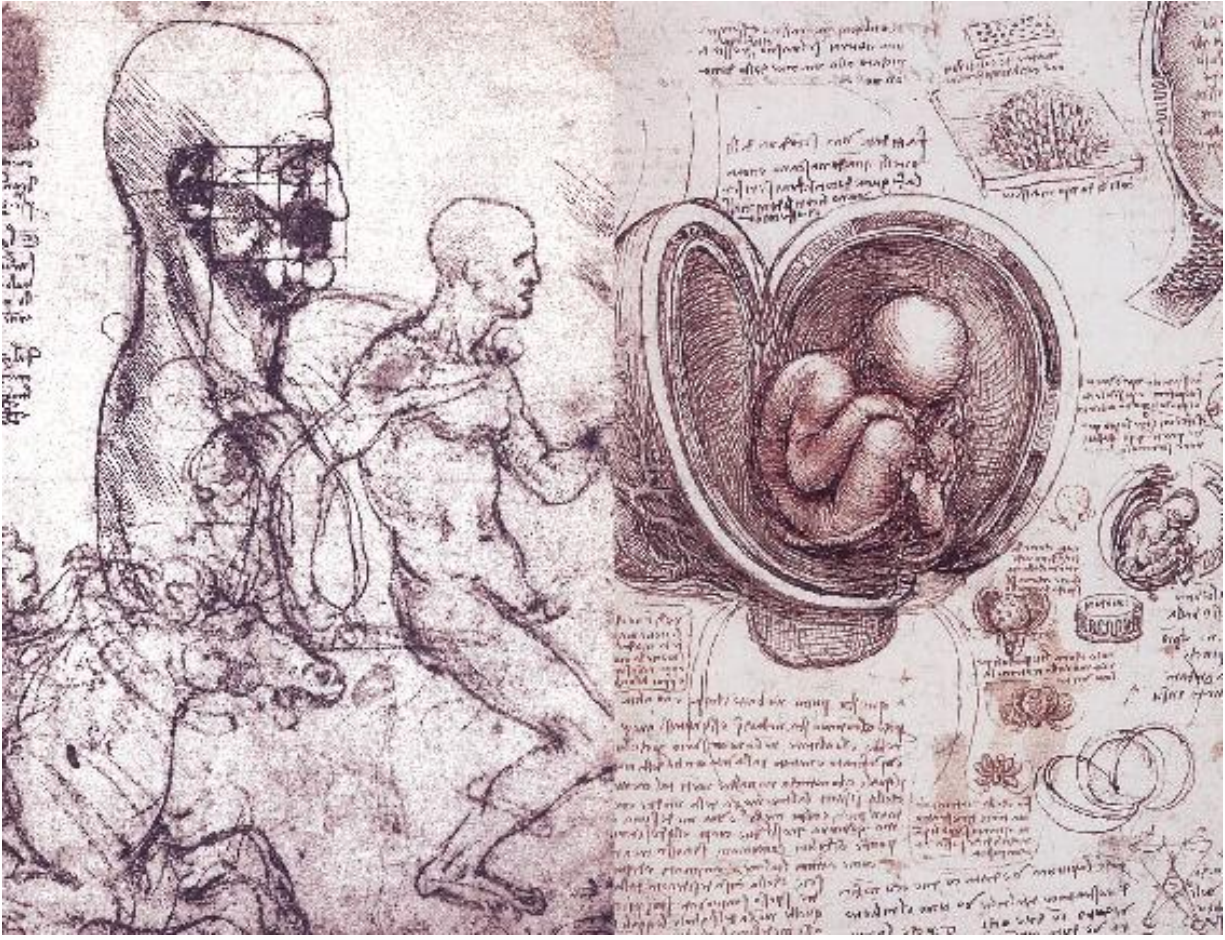


LEONARDO
DA VINCI

BY THE AUTHOR OF THE *NEW YORK TIMES* BESTSELLERS

STEVE JOBS AND *EINSTEIN*

WALTER
ISAACSON



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Juliana Barone of Birkbeck College, University of London, was also a professional reader of much of the manuscript. She wrote her doctoral dissertation on Leonardo at Oxford and is the author of *Leonardo: The Codex Arundel* (British Library, 2008), *Studies of Motion: Drawings by Leonardo from the Codex Atlanticus* (De Agostini, 2011), *The Treatise on Painting* (De Agostini, 2014), and the forthcoming books *Leonardo, Poussin and Rubens* and *Leonardo in Britain*.

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People and the Painting (Oxford University Press, 2017), and in countless emails offered his opinions on a variety of issues.

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As usual, my greatest gratitude goes to my wife, Cathy, and our daughter, Betsy, who are wise, smart, supportive, and very loving. Thank you.

MAIN CHARACTERS

Cesare Borgia (c. 1475–1507). Italian warrior, illegitimate son of Pope Alexander VI, subject of Machiavelli's *The Prince*, Leonardo employer.

Donato Bramante (1444–1514). Architect, friend of Leonardo in Milan, worked on Milan Cathedral, Pavia Cathedral, and St. Peter's in the Vatican.

Caterina Lippi (c. 1436–1493). Orphaned peasant girl from near Vinci, mother of Leonardo; later married Antonio di Piero del Vaccha, known as Accattabriga.

Charles d'Amboise (1473–1511). French governor of Milan from 1503 to 1511, Leonardo patron.

Beatrice d'Este (1475–1497). From Italy's most venerable family, married Ludovico Sforza.

Isabella d'Este (1474–1539). Beatrice's sister, the Marchesa of Mantua, tried to get Leonardo to paint her portrait.

Francesco di Giorgio (1439–1501). Artist-engineer-architect who worked with Leonardo on Milan's cathedral tower, traveled with him to Pavia, translated Vitruvius, and drew a version of Vitruvian man.

Francis I (1494–1547). King of France from 1515, last patron of Leonardo.

Pope Leo X, Giovanni de' Medici (1475–1521). Son of Lorenzo de' Medici, elected pope in 1513.

Louis XII (1462–1515). King of France from 1498, conquered Milan in 1499.

Niccolò Machiavelli (1469–1527). Florentine diplomat and writer, became envoy to Cesare Borgia and friend of Leonardo in 1502.

Giuliano de' Medici (1479–1516). Son of Lorenzo, brother of Pope Leo X, Leonardo's patron in Rome.

Lorenzo “the Magnificent” de' Medici (1449–1492). Banker, art patron, and de facto ruler of Florence from 1469 until his death.

Francesco Melzi (c. 1493–c. 1568). From a noble Milan family, joined Leonardo's household in 1507 and became a surrogate son and heir.

Michelangelo Buonarroti (1475–1564). Florentine sculptor and rival of Leonardo.

Luca Pacioli (1447–1517). Italian mathematician, friar, and friend of Leonardo.

Piero da Vinci (1427–1504). Florentine notary, father of Leonardo, did not marry Leonardo's mother, subsequently had eleven other children with four wives.

Andrea Salai, born Gian Giacomo Caprotti da Oreno (1480–1524). Entered Leonardo's household at age ten and was dubbed Salai, meaning “Little Devil.”

Ludovico Sforza (1452–1508). De facto ruler of Milan from 1481, Duke of Milan from 1494 until his ouster by the French in 1499, patron of Leonardo.

Andrea del Verrocchio (c. 1435–1488). Florentine sculptor, goldsmith, and artist in whose workshop Leonardo trained and worked from 1466 to 1477.

CURRENCY IN ITALY IN 1500

The ducat was the gold coin of Venice. The florin was the gold coin of Florence. Both contained 3.5 grams (0.12 ounces) of gold, which would make them worth about \$138 in 2017. One ducat or florin was worth approximately 7 lire or 120 soldi, which were silver coins.

NOTE REGARDING THE COVER

The cover is a detail of an oil painting in Florence's Uffizi Gallery that was once thought to be a self-portrait painted by Leonardo. Based on recent X-ray analysis, it is now considered to be a portrait of Leonardo by an unknown artist done in the 1600s. It is based on, or is the basis for, a similar portrait rediscovered in Italy in 2008, called the Lucan portrait of Leonardo da Vinci. It has been copied many times. A watercolor-on-ivory version painted in the 1770s by Giuseppe Macpherson is in the British Royal Collection and in 2017 was in the show "Portrait of the Artist" in the Queen's Gallery of Buckingham Palace.

PRIMARY PERIODS OF LEONARDO'S LIFE

Vinci

1452 – 1464

Florence

1464 – 1482

Milan

1482 – 1499

Florence

1500 – 1506

Milan

1506 – 1513

Rome

1513 – 1516

France

1516 – 1519



Becomes a member of the painters' guild; first known drawing is a landscape

c.1473

Collaborated with Verrocchio on the *Baptism of Christ*



c.1475



c.1478

Portrait of Ginevra de' Benci, daughter of a wealthy Florentine banker

1452

Born on April 15

End 100 Years' War; fall of Constantinople

Michelangelo is born

Ludovico Sforza becomes ruler of Milan; Magellan is born

Gutenberg prints the Bible

Machiavelli is born; Lorenzo de' Medici takes power

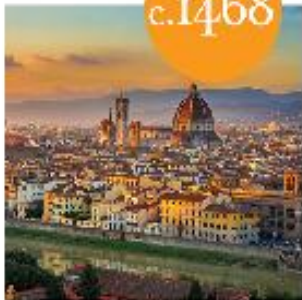
Copernicus is born

Johannes de Spira starts publishing house in Venice

Raphael is born

Becomes an apprentice in Verrocchio's studio in Florence

c.1468



The *Adoration of the Magi* commissioned



1482

Moves to Milan and begins keeping notebooks

1481

The *Annunciation*: youthful experiment with perspective is flawed, but heralds brilliance

c.1472



science

life

world

art



Lady with an Ermine; clay model for the horse monument is put on display in Milan



Does the drawings for Pacioli's *De divina proportione*

1496

1493



1498



First attempt at a flying machine

Studies anatomy & architecture

1489

Dias of Portugal rounds the southern tip of Africa

Christopher Columbus sails to the New World; Lorenzo de' Medici dies; Rodrigo Borgia becomes Pope Alexander VI

Vasco da Gama finds a sea route to India; Louis XII becomes King of France; Savonarola's Bonfire of the Vanities; France conquers Milan

Süleyman I, of the Ottoman Empire, is born; Ludovico officially becomes Duke; Savonarola deposes the Medici in Florence; King Charles VIII of France invades Italy

c.1490



Vitruvian Man; Feast of Paradise is presented for the wedding feast of the duke's nephew; Salai comes to live with Leonardo

1483



Commissioned, along with the de Predis brothers, to paint *Virgin of the Rocks*

Begins *The Last Supper* in the refectory in the convent of Santa Maria delle Grazie

1495



1499

Leaves Milan

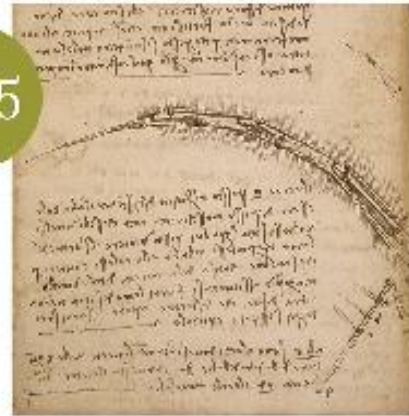


Studies the flight of birds; second unsuccessful attempt to fly; struggles to paint the *Battle of Anghiari*, a major commission in Florence that is eventually abandoned, unfinished.

1503

Returns to Florence, begins painting the *Mona Lisa* and works on it for the rest of his life

1505



Michelangelo's statue of David; young Raphael comes to Florence to study with Leonardo and Michelangelo

Leonardo's friend, Amerigo Vespucci, publishes his account of sailing to the New World

The architect Donato Bramante is hired by the pope to rebuild St. Peter's church in Rome

1502

Begins to work for Cesare Borgia as military engineer



Returns to Milan, where he remains, on and off, for seven years

1506

1507

Painter and engineer to Louis XII



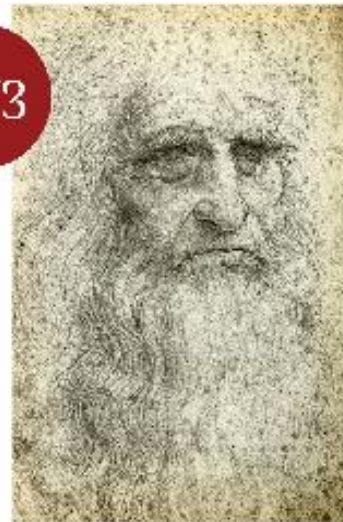


c.1508



Divides his time between Milan and Florence; studies of waterworks; designs the Trivulzio monument; second *Virgin of the Rocks*

1513



Moves to Rome; the iconic Turin drawing, a possible self-portrait done in the preceding years, often defines our image of Leonardo

Michelangelo finishes painting the Sistine Chapel; Gerardus Mercator, who produces the first map of the world, is born; Medici return to power in Florence

Andreas Vesalius, who publishes the first accurate book on human anatomy, is born in Brussels

Martin Luther launches Protestant Reformation

King Henry VIII becomes king of England

Vasari is born

Giovanni de' Medici becomes Pope Leo X

Francis I becomes king of France



1509



Pursues his studies of anatomy and continues with hydraulics

1514

1516

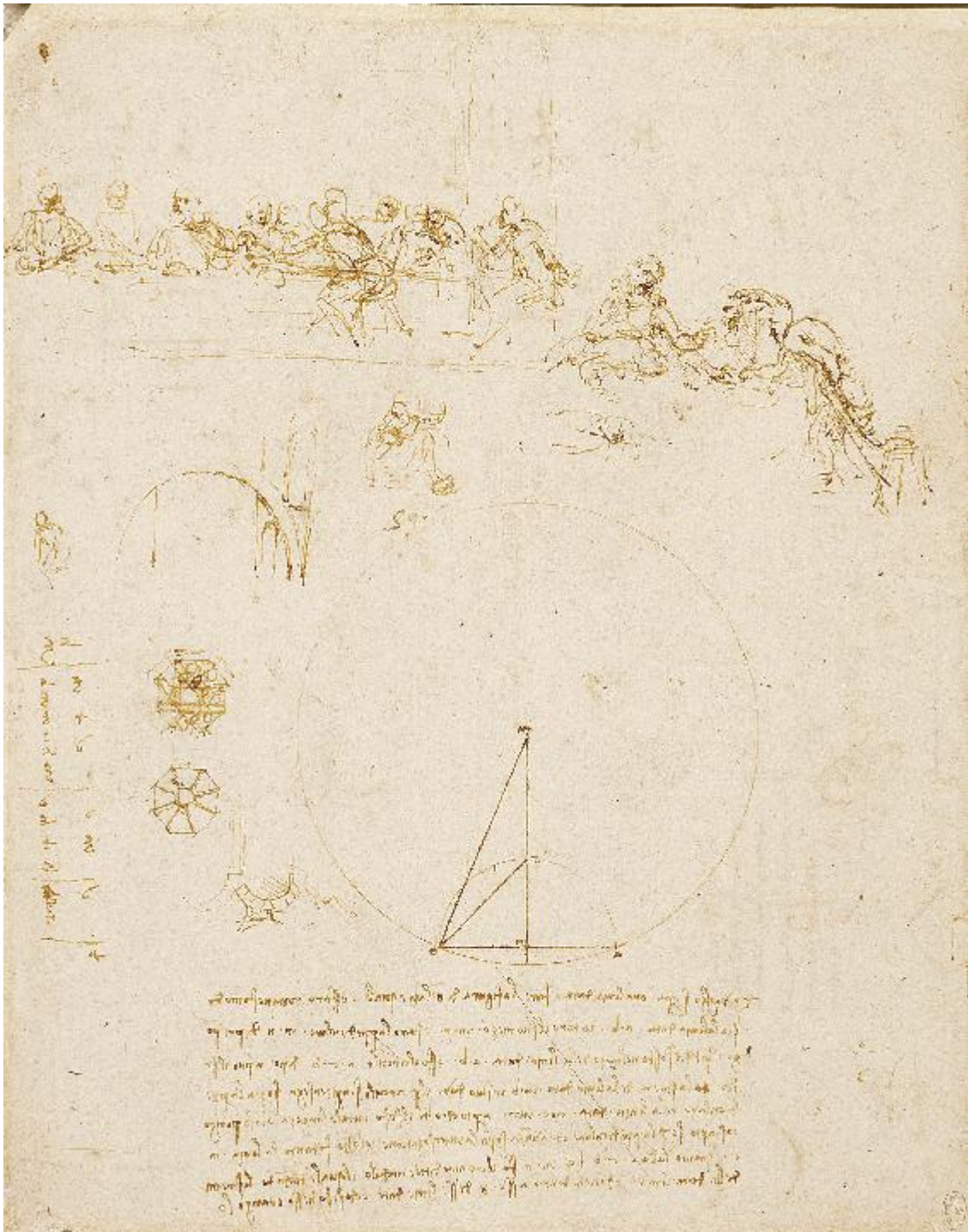
Moves to Amboise as a guest of Francis I



dies on May 2

Visits Parma and Florence; Plans to drain the Pontine Marshes

1519



From Leonardo's notebooks c. 1495: a sketch for *The Last Supper*, geometric studies for squaring a circle, octagonal church designs, and a passage in his mirror-script writing.

INTRODUCTION

I Can Also Paint

Around the time that he reached the unnerving milestone of turning thirty, Leonardo da Vinci wrote a letter to the ruler of Milan listing the reasons he should be given a job. He had been moderately successful as a painter in Florence, but he had trouble finishing his commissions and was searching for new horizons. In the first ten paragraphs, he touted his engineering skills, including his ability to design bridges, waterways, cannons, armored vehicles, and public buildings. Only in the eleventh paragraph, at the end, did he add that he was also an artist. “Likewise in painting, I can do everything possible,” he wrote.¹

Yes, he could. He would go on to create the two most famous paintings in history, *The Last Supper* and the *Mona Lisa*. But in his own mind, he was just as much a man of science and engineering. With a passion that was both playful and obsessive, he pursued innovative studies of anatomy, fossils, birds, the heart, flying machines, optics, botany, geology, water flows, and weaponry. Thus he became the archetype of the Renaissance Man, an inspiration to all who believe that the “infinite works of nature,” as he put it, are woven together in a unity filled with marvelous patterns.² His ability to combine art and science, made iconic by his drawing of a perfectly

proportioned man spread-eagle inside a circle and square, known as *Vitruvian Man*, made him history's most creative genius.

His scientific explorations informed his art. He peeled flesh off the faces of cadavers, delineated the muscles that move the lips, and then painted the world's most memorable smile. He studied human skulls, made layered drawings of the bones and teeth, and conveyed the skeletal agony of *Saint Jerome in the Wilderness*. He explored the mathematics of optics, showed how light rays strike the cornea, and produced magical illusions of changing visual perspectives in *The Last Supper*.

By connecting his studies of light and optics to his art, he mastered the use of shading and perspective to model objects on a two-dimensional surface so they look three-dimensional. This ability to “make a flat surface display a body as if modeled and separated from this plane,” Leonardo said, was “the first intention of the painter.”³ Largely due to his work, dimensionality became the supreme innovation of Renaissance art.

As he aged, he pursued his scientific inquiries not just to serve his art but out of a joyful instinct to fathom the profound beauties of creation. When he groped for a theory of why the sky appears blue, it was not simply to inform his paintings. His curiosity was pure, personal, and delightfully obsessive.

But even when he was engaged in blue-sky thinking, his science was not a separate endeavor from his art. Together they served his driving passion, which was nothing less than knowing everything there was to know about the world, including how we fit into it. He had a reverence for the wholeness of nature and a feel for the harmony of its patterns, which he saw

replicated in phenomena large and small. In his notebooks he would record curls of hair, eddies of water, and whirls of air, along with some stabs at the math that might underlie such spirals. While at Windsor Castle looking at the swirling power of the “Deluge drawings” that he made near the end of his life, I asked the curator, Martin Clayton, whether he thought Leonardo had done them as works of art or of science. Even as I spoke, I realized it was a dumb question. “I do not think that Leonardo would have made that distinction,” he replied.

I embarked on this book because Leonardo da Vinci is the ultimate example of the main theme of my previous biographies: how the ability to make connections across disciplines—arts and sciences, humanities and technology—is a key to innovation, imagination, and genius. Benjamin Franklin, a previous subject of mine, was a Leonardo of his era: with no formal education, he taught himself to become an imaginative polymath who was Enlightenment America’s best scientist, inventor, diplomat, writer, and business strategist. He proved by flying a kite that lightning is electricity, and he invented a rod to tame it. He devised bifocal glasses, enchanting musical instruments, clean-burning stoves, charts of the Gulf Stream, and America’s unique style of homespun humor. Albert Einstein, when he was stymied in his pursuit of his theory of relativity, would pull out his violin and play Mozart, which helped him reconnect with the harmonies of the cosmos. Ada Lovelace, whom I profiled in a book on innovators, combined the poetic sensibility of her father, Lord Byron, with her mother’s love of the beauty of math to envision a general-purpose computer. And

Steve Jobs climaxed his product launches with an image of street signs showing the intersection of the liberal arts and technology. Leonardo was his hero. “He saw beauty in both art and engineering,” Jobs said, “and his ability to combine them was what made him a genius.”⁴

Yes, he was a genius: wildly imaginative, passionately curious, and creative across multiple disciplines. But we should be wary of that word. Slapping the “genius” label on Leonardo oddly minimizes him by making it seem as if he were touched by lightning. His early biographer, Giorgio Vasari, a sixteenth-century artist, made this mistake: “Sometimes, in supernatural fashion, a single person is marvelously endowed by heaven with beauty, grace, and talent in such abundance that his every act is divine and everything he does clearly comes from God rather than from human art.”⁵ In fact, Leonardo’s genius was a human one, wrought by his own will and ambition. It did not come from being the divine recipient, like Newton or Einstein, of a mind with so much processing power that we mere mortals cannot fathom it. Leonardo had almost no schooling and could barely read Latin or do long division. His genius was of the type we can understand, even take lessons from. It was based on skills we can aspire to improve in ourselves, such as curiosity and intense observation. He had an imagination so excitable that it flirted with the edges of fantasy, which is also something we can try to preserve in ourselves and indulge in our children.

Leonardo’s fantasies pervaded everything he touched: his theatrical productions, plans to divert rivers, designs for ideal cities, schemes for flying machines, and almost every aspect of his art as well as engineering. His letter to the ruler of Milan is an example, since his military engineering

skills then existed mainly in his mind. His initial role at the court was not building weapons but conjuring up festivals and pageants. Even at the height of his career, most of his fighting and flying contraptions were more visionary than practical.

At first I thought that his susceptibility to fantasia was a failing, revealing a lack of discipline and diligence that was related to his propensity to abandon artworks and treatises unfinished. To some extent, that is true. Vision without execution is hallucination. But I also came to believe that his ability to blur the line between reality and fantasy, just like his sfumato techniques for blurring the lines of a painting, was a key to his creativity. Skill without imagination is barren. Leonardo knew how to marry observation and imagination, which made him history's consummate innovator.

My starting point for this book was not Leonardo's art masterpieces but his notebooks. His mind, I think, is best revealed in the more than 7,200 pages of his notes and scribbles that, miraculously, survive to this day. Paper turns out to be a superb information-storage technology, still readable after five hundred years, which our own tweets likely won't be.

Fortunately, Leonardo could not afford to waste paper, so he crammed every inch of his pages with miscellaneous drawings and looking-glass jottings that seem random but provide intimations of his mental leaps. Scribbled alongside each other, with rhyme if not reason, are math calculations, sketches of his devilish young boyfriend, birds, flying machines, theater props, eddies of water, blood valves, grotesque heads,

angels, siphons, plant stems, sawed-apart skulls, tips for painters, notes on the eye and optics, weapons of war, fables, riddles, and studies for paintings. The cross-disciplinary brilliance whirls across every page, providing a delightful display of a mind dancing with nature. His notebooks are the greatest record of curiosity ever created, a wondrous guide to the person whom the eminent art historian Kenneth Clark called “the most relentlessly curious man in history.”⁶

My favorite gems in his notebooks are his to-do lists, which sparkle with his curiosity. One of them, dating from the 1490s in Milan, is that day’s list of things he wants to learn. “The measurement of Milan and its suburbs,” is the first entry. This has a practical purpose, as revealed by an item later in the list: “Draw Milan.” Others show him relentlessly seeking out people whose brains he could pick: “Get the master of arithmetic to show you how to square a triangle. . . . Ask Giannino the Bombardier about how the tower of Ferrara is walled. . . . Ask Benedetto Protinari by what means they walk on ice in Flanders. . . . Get a master of hydraulics to tell you how to repair a lock, canal and mill in the Lombard manner. . . . Get the measurement of the sun promised me by Maestro Giovanni Francese, the Frenchman.”⁷ He is insatiable.

Over and over again, year after year, Leonardo lists things he must do and learn. Some involve the type of close observation most of us rarely pause to do. “Observe the goose’s foot: if it were always open or always closed the creature would not be able to make any kind of movement.” Others involve why-is-the-sky-blue questions about phenomena so commonplace that we rarely pause to wonder about them. “Why is the fish

in the water swifter than the bird in the air when it ought to be the contrary since the water is heavier and thicker than the air?”⁸

Best of all are the questions that seem completely random. “Describe the tongue of the woodpecker,” he instructs himself.⁹ Who on earth would decide one day, for no apparent reason, that he wanted to know what the tongue of a woodpecker looks like? How would you even find out? It’s not information Leonardo needed to paint a picture or even to understand the flight of birds. But there it is, and, as we shall see, there are fascinating things to learn about the tongue of the woodpecker. The reason he wanted to know was because he was Leonardo: curious, passionate, and always filled with wonder.

Oddest of all, there is this entry: “Go every Saturday to the hot bath where you will see naked men.”¹⁰ We can imagine Leonardo wanting to do that, for reasons both anatomical and aesthetic. But did he really need to remind himself to do it? The next item on the list is “Inflate the lungs of a pig and observe whether they increase in width and in length, or only in width.” As the *New Yorker* art critic Adam Gopnik once wrote, “Leonardo remains weird, matchlessly weird, and nothing to be done about it.”¹¹

To wrestle with these issues, I decided to write a book that used these notebooks as its foundation. I started by making pilgrimages to see the originals in Milan, Florence, Paris, Seattle, Madrid, London, and Windsor Castle. That followed Leonardo’s injunction to begin any investigation by going to the source: “He who can go to the fountain does not go to the water-jar.”¹² I also immersed myself in the little-tapped trove of academic

articles and doctoral dissertations on Leonardo, each of which represents years of diligent work on very specific topics. In the past few decades, especially since the rediscovery of his Codices Madrid in 1965, there have been great advances in the analysis and interpretation of his writings. Likewise, modern technology has revealed new information about his painting and techniques.

After immersing myself in Leonardo, I did the best I could to be more observant of phenomena that I used to ignore, making a special effort to notice things the way he did. When I saw sunlight hitting drapes, I pushed myself to pause and look at the way the shadows caressed the folds. I tried to see how light that was reflected from one object subtly colored the shadows of another object. I noticed how the glint of a lustrous spot on a shiny surface moved when I tilted my head. When I looked at a distant tree and a near one, I tried to visualize the lines of perspective. When I saw an eddy of water, I compared it to a ringlet of hair. When I couldn't understand a math concept, I did the best I was able to visualize it. When I saw people at a supper, I studied the relationship of their motions to their emotions. When I saw the hint of a smile come across someone's lips, I tried to fathom her inner mysteries.

No, I did not come anywhere close to being Leonardo, mastering his insights, or mustering a modicum of his talents. I did not get a millimeter closer to being able to design a glider, invent a new way to draw maps, or paint the *Mona Lisa*. I had to push myself to be truly curious about the tongue of the woodpecker. But I did learn from Leonardo how a desire to

marvel about the world that we encounter each day can make each moment of our lives richer.

There are three major early accounts of Leonardo by writers who were almost contemporaries. The painter Giorgio Vasari, born in 1511 (eight years before Leonardo died), wrote the first real art history book, *Lives of the Most Eminent Painters, Sculptors, and Architects*, in 1550 and came out with a revised version in 1568 that included corrections based on further interviews with people who knew Leonardo, including his pupil Francesco Melzi.¹³ A Florentine chauvinist, Vasari gave Leonardo and especially Michelangelo the most fulsome treatments for creating what he dubbed, for the first time in print, a “renaissance” in art.¹⁴ As Huckleberry Finn said of Mark Twain, there were things that Vasari stretched, but he told the truth, mainly. The remainder is a mix of gossip, embellishments, inventions, and unintentional errors. The problem is knowing which picturesque anecdotes—such as Leonardo’s teacher throwing down his own brush in awe of his pupil—fall into which category.

An anonymous manuscript written in the 1540s, known as the “Anonimo Gaddiano” after the family that once owned it, contains colorful details about Leonardo and other Florentines. Once again, some of the assertions, such as that Leonardo lived and worked with Lorenzo de’ Medici, may be embellished, but it provides colorful details that ring true, such as that Leonardo liked to wear rose-colored tunics that reached only to his knee even though others wore long garments.¹⁵

A third early source is by Gian Paolo Lomazzo, a painter who became a writer when he went blind. He wrote an unpublished manuscript called *Dreams and Arguments* in about 1560 and then published a voluminous treatise on art in 1584. He was the student of a painter who had known Leonardo, and he interviewed Leonardo's pupil Melzi, so he had access to some firsthand stories. Lomazzo is especially revealing about Leonardo's sexual proclivities. In addition, there are shorter accounts contained in writings by two Leonardo contemporaries, Antonio Billi, a Florentine merchant, and Paolo Giovio, an Italian physician and historian.

Many of these early accounts mention Leonardo's looks and personality. He is described as a man of eye-catching beauty and grace. He had flowing golden curls, a muscular build, remarkable physical strength, and an elegance of bearing when he was walking through town in his colorful garb or riding on a horse. "Beautiful in person and aspect, Leonardo was well-proportioned and graceful," according to the Anonimo. In addition, he was a charming conversationalist and a lover of nature, renowned for being sweet and gentle to both people and animals.

There is less agreement about certain specifics. In the course of my research I discovered that many facts about Leonardo's life, from the site of his birth to the scene at his death, have been the subject of debate, mythology, and mystery. I try to give my best assessment and then describe the controversies and counterarguments in the notes.

I also discovered, at first to my consternation and then to my pleasure, that Leonardo was not always a giant. He made mistakes. He went off on tangents, literally, pursuing math problems that became time-sucking

diversions. Notoriously, he left many of his paintings unfinished, most notably the *Adoration of the Magi*, *Saint Jerome in the Wilderness*, and the *Battle of Anghiari*. As a result, there exist now at most fifteen paintings fully or mainly attributable to him.¹⁶

Although generally considered by his contemporaries to be friendly and gentle, Leonardo was at times dark and troubled. His notebooks and drawings are a window into his fevered, imaginative, manic, and sometimes elated mind. Had he been a student at the outset of the twenty-first century, he may have been put on a pharmaceutical regimen to alleviate his mood swings and attention-deficit disorder. One need not subscribe to the artist-as-troubled-genius trope to believe we are fortunate that Leonardo was left to his own devices to slay his demons while conjuring up his dragons.

In one of the quirky riddles in his notebooks is this clue: “Huge figures will appear in human shape, and the nearer you get to them, the more their immense size will diminish.” The answer: “The shadow cast by a man at night with a light.”¹⁷ Although the same may be said of Leonardo, I believe he is, in fact, not diminished by being discovered to be human. Both his shadow and his reality deserve to loom large. His lapses and oddities allow us to relate to him, to feel that we might emulate him, and to appreciate his moments of triumph even more.

The fifteenth century of Leonardo and Columbus and Gutenberg was a time of invention, exploration, and the spread of knowledge by new technologies. In short, it was a time like our own. That is why we have much to learn from Leonardo. His ability to combine art, science, technology, the humanities, and imagination remains an enduring recipe for

creativity. So, too, was his ease at being a bit of a misfit: illegitimate, gay, vegetarian, left-handed, easily distracted, and at times heretical. Florence flourished in the fifteenth century because it was comfortable with such people. Above all, Leonardo's relentless curiosity and experimentation should remind us of the importance of instilling, in both ourselves and our children, not just received knowledge but a willingness to question it—to be imaginative and, like talented misfits and rebels in any era, to think different.



The town of Vinci and the church where Leonardo was baptized.