CURATOR'S STATEMENT

My father earned a PhD in astrophysics. His doctoral research? Too hard to understand. But he glossed it in almost metaphysical terms: basically, he measured the temperature of the universe. The sheer magnitude of the idea has always entranced me.

So of course I'm attracted to Leonardo da Vinci. He was a dreamer, a practical joker, a brilliant thinker with an all-consuming curiosity, unafraid to offer theories explaining the mysteries of the universe and life on Earth. He revealed the beauty in nature's complexity and understood seemingly prosaic aspects as manifestations of forces almost too profound to comprehend. He recognized the immensity of the world even in its smallest details.

I read somewhere that human creativity is the most precious resource of the 21st century. A supple mind, the ability to knit together seemingly unrelated parts to arrive at a larger truth, can change the world. This exhibition is an exploration of the creative mind at work: Leonardo's, first and foremost, but also the minds of our contemporaries and, ultimately, ours. We mustn't be in awe of Leonardo, genius though he was, for that would suggest his gifts are unattainable. Each of us has the capacity to create, to dream big, and to make a difference, and I hope this exhibition inspires you to recognize the creative potential that lives within.

Alex Bortolot

Good ideas emerge from creative interactions with others. For their many valuable contributions to this show, I wish to thank **Jennifer Komar Olivarez**, Curator of Decorative Arts and Design at the MIA, and **Barry Kudrowitz**, Program Director of Product Design at the University of Minnesota's College of Design.

THE CODEX LEICESTER AND THE CREATIVE MIND

Portrait of a Bearded Man, c. 1512, Italian school, possible self-portrait by Leonardo da Vinci, red chalk on paper, Biblioteca Reale, Turin

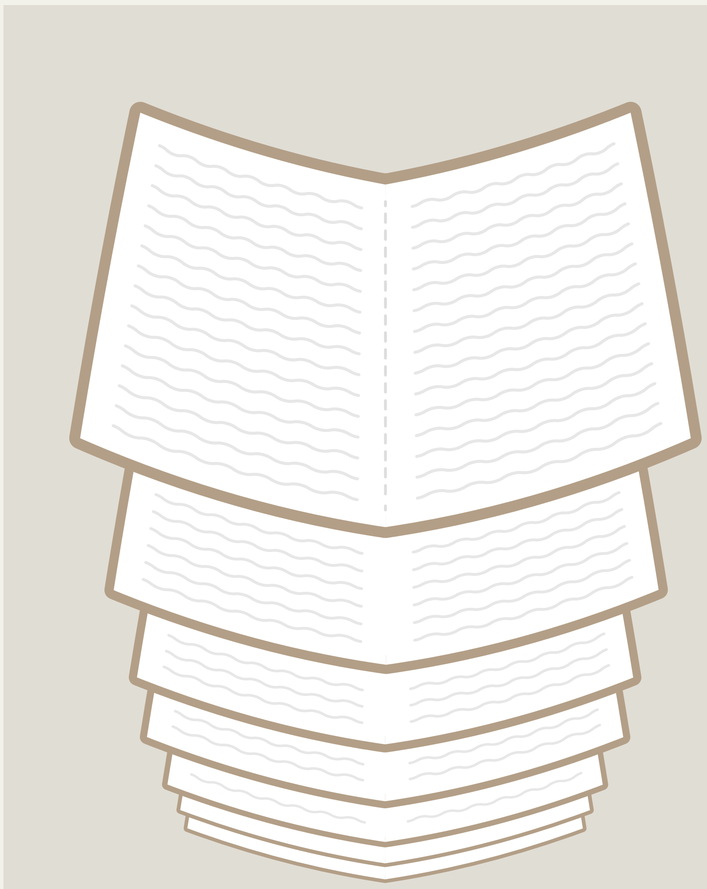
We most often think of Leonardo da Vinci (1452–1519) as a visual artist, the painter of the famous *Mona Lisa*. But throughout his life he regarded himself as an inventor, applying practical and theoretical knowledge to create things never before seen.

Combining acute powers of observation, avid curiosity, and intellectual rigor, Leonardo's innovative mind pushed past 15th- and 16th-century boundaries into new realms of understanding. On the pages that became the Codex Leicester, Leonardo recorded observations, connected ideas, worked out problems, and formulated theories that he tested and revised. The Codex reveals his greatest legacy—his approach to the world. In mastering many branches of knowledge, he defined the Renaissance ideal of the "universal man."

Leonardo's mental discipline and far-reaching interests resonate strongly today. In addition to presenting the Codex Leicester, this exhibition includes recent manifestations of Leonardo's creative process.

WHAT IS THE CODEX LEICESTER?

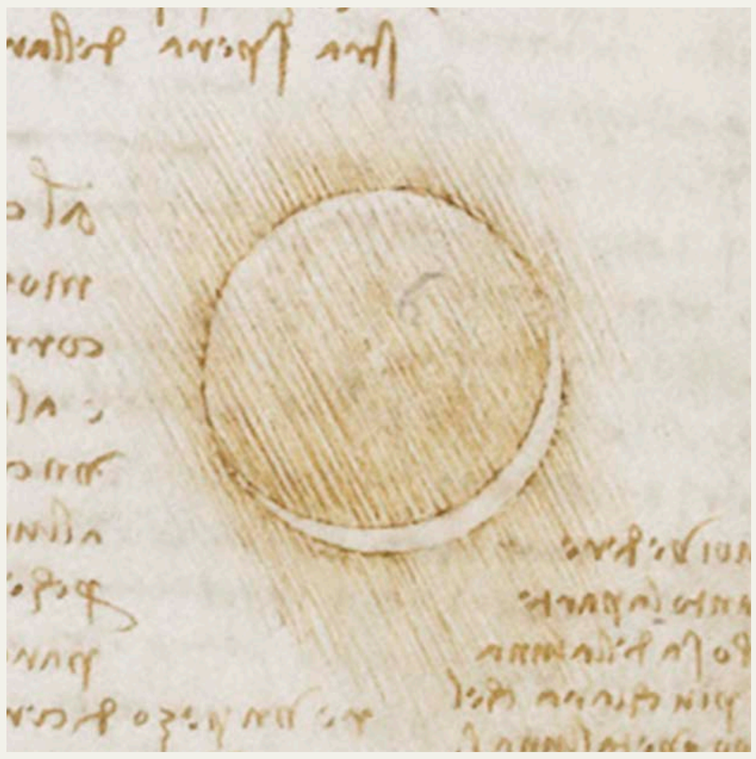
Leonardo recorded his thoughts and ideas on paper, filling more than ten thousand sheets with drawings and observations. He wrote from right to left, reversing the letters, because he was left-handed and writing backwards kept his sleeve out of the ink.



A codex is a manuscript made up of folded sheets of paper or parchment stacked together and bound along one edge. The eighteen sheets that make up the Codex Leicester (pronounced Lester) date from around 1508 to 1510. Each is folded in half to form two leaves (four pages), for a total of seventy-two pages. Leonardo worked on one sheet at a time, filling it in a backwards sequence, so that the last page he wrote became the first a reader would encounter.

At some point, the sheets were folded and bound together into a codex. After Thomas Coke, Earl of Leicester, purchased the codex in 1719, it became known as the Codex Leicester. Later, the sheets were restored to their unbound state, as Leonardo created them.

LEONARDO'S CURIOSITY



Crescent moon, Codex Leicester, sheet 2A, folio 2r, 1508–10
Courtesy Bill Gates / ©bgC3

Leonardo has been called "the most relentlessly curious man in history." His interests led him to investigate engineering, anatomy, optics, geometry, acoustics, astronomy, geology, and aerodynamics.

For his study of the general properties of water in the Codex Leicester, Leonardo recorded, in words and drawings, his observations concerning the movement of water. He looked at how water can be controlled through systems of canals, locks, and dams and how its action relentlessly erodes the land. He also explored such diverse topics as the brightness of the moon, the origins and locations of marine fossils, the subtle movement of grasses, and the dynamics of gunshots.

Leonardo's wide-ranging curiosity, vast knowledge, and mental agility led him to skip from topic to topic, joining seemingly disparate bits of information. The more he knew, the more adept and creative he became at analyzing problems and working out solutions.

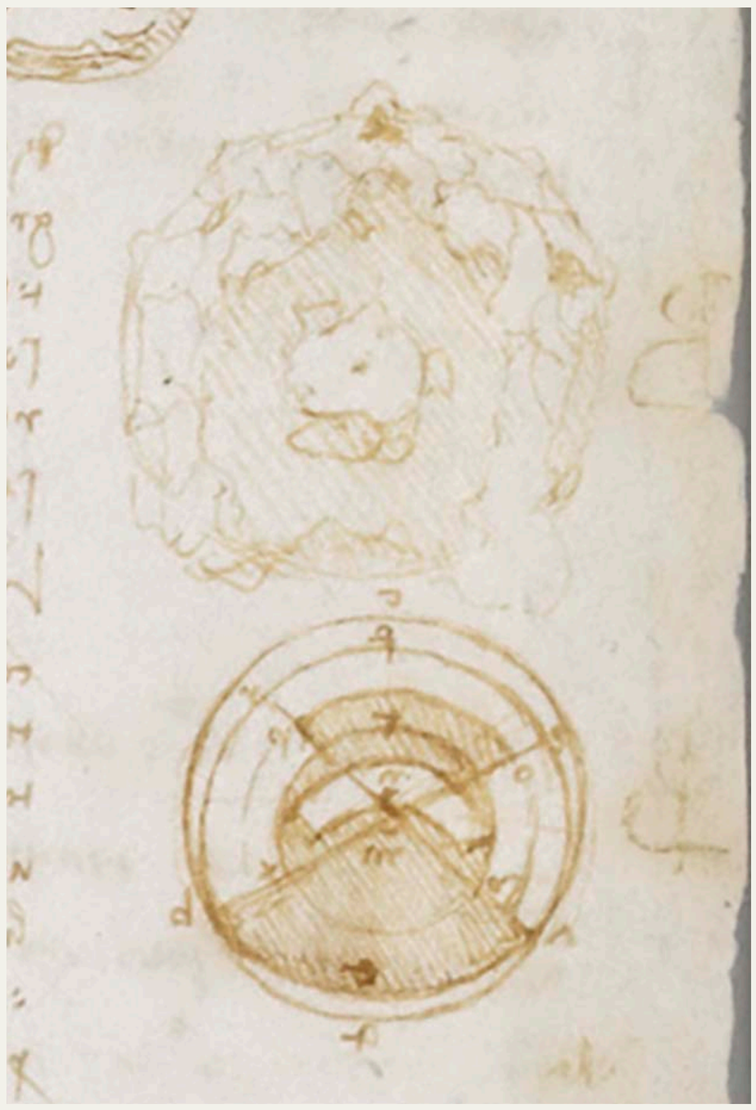
LEONARDO'S POWERS OF OBSERVATION

Concentric waves in a pond, Codex Leicester, sheet 14B, folio 14v, 1508–10
Courtesy Bill Gates / ©bgC3

Leonardo was an illegitimate child without access to a university education and academic training. Rather than hindering him, however, this situation liberated him. He approached all areas of inquiry free of the intellectual constraints that a formal education might have imposed. His unfiltered observation of nature sometimes led to controversial conclusions that challenged the conventional wisdom of his time. Reflecting on his position, he wrote, "If they despise me who am an inventor, how much more should they be blamed who are not inventors, but trumpeters and reciters of the works of others?"

Leonardo's dedication to observation as the root of understanding was revolutionary. His native landscape—rivers, mountains, canals, and bridges—became his laboratory. He devised equipment that enabled him to generate and observe effects over and over again, in a controlled environment. He essentially invented the scientific method, the basis of modern scientific knowledge and discovery: systematic observation of nature, experimentation to test ideas, repeatable results, logical conclusions supported by evidence.

THINKING ON PAPER



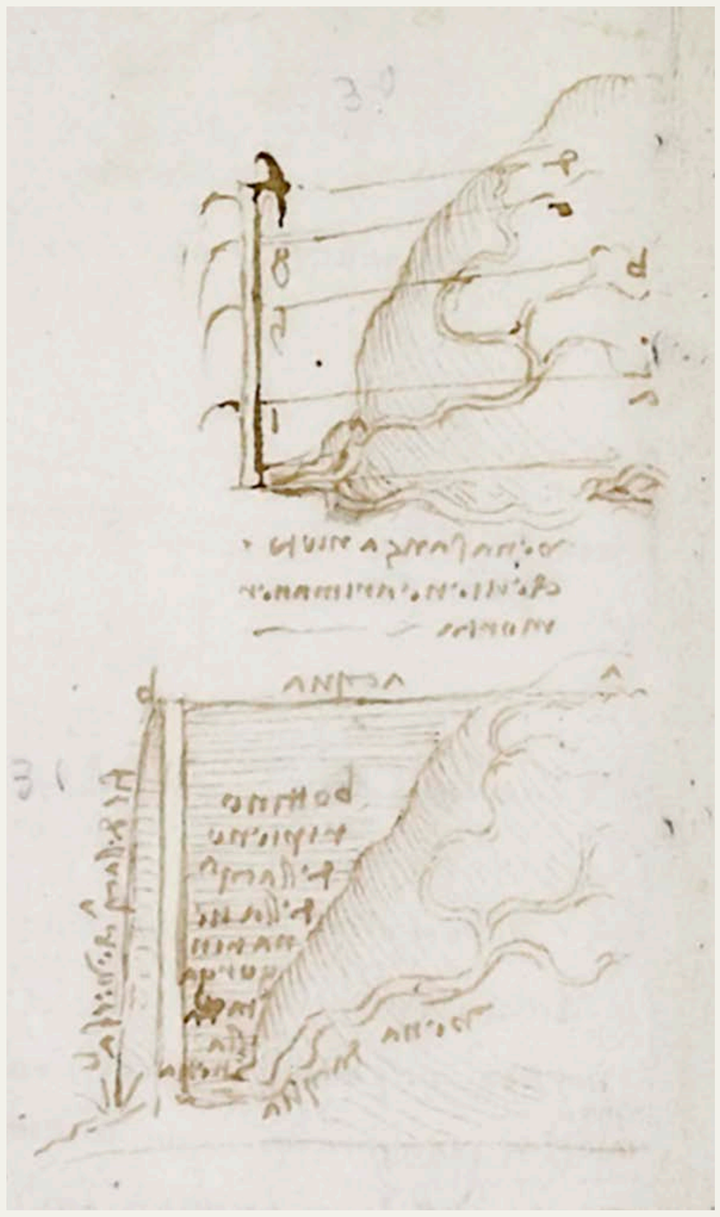
Cross section of the earth showing interior caverns, Codex Leicester, sheet 1B, folio 36r, 1508–10
Courtesy Bill Gates / ©bgC3

The Codex Leicester reveals how Leonardo's artistic gifts perfectly supported his intellectual powers. In fact, he saw these abilities as inseparable. His writings on art emphasize the connection between representing natural forms and understanding their intrinsic nature and the principles underlying them.

Leonardo had a messy sketching style, obsessively adding slight variations so that his compositions look blurry. He spent years on his paintings. Using oil paints, which dry slowly and can be overpainted repeatedly, he could literally think with his brush, revising and reworking as his ideas progressed.

Twentieth-century cognitive scientists discovered that "thinking on paper" helps people comprehend complex and highly abstract ideas. It structures and focuses our thinking and makes ideas visible and easier to explain to others. To present the knowledge he developed through his studies, Leonardo pioneered new types of drawings, such as cross sections and "exploded" views familiar to anyone who has assembled a bookshelf from IKEA.

ANALOGICAL THINKING



Cross section of a mountain showing interior water channels, Codex Leicester, sheet 7B, folio 7v, 1508–10
Courtesy Bill Gates / ©bgC3

Those who study creativity point to analogical thinking as an important way to come up with innovative ideas. Observations and conclusions about one area of experience can shed light on a different, seemingly unrelated, area. This approach reframes problems, shaking loose the conventional notions we traditionally rely on. It's the very definition of "thinking outside the box."

Leonardo was a master of analogical thinking. As he observed and analyzed the world, he recognized patterns that seemed common to disparate forms and processes, both big and small. Like others of his day, he understood the world in terms of *macrocosm* and *microcosm*: the structure of the whole is reflected in the parts; patterns in human beings correspond to those in the larger world. This sort of thinking allowed him, for example, to use his knowledge of the human circulatory system to theorize about the movement of water through the earth. His engineering investigations of levers, gears, and machines helped him understand the interplay of muscles and bones.

CREATIVE ENVIRONMENTS

Jacopo de' Barbari, *Portrait of Luca Pacioli*, 1495, oil on panel, Museo e Gallerie Nazionale di Capodimonte, Naples

New ideas seldom arise in a vacuum. Leonardo gravitated to Renaissance Italy's centers of creativity, including the artistic and architectural hothouse of Florence, the intellectual circles of Milan, and the great university library in Pavia. His creative network was a virtual Who's Who of Renaissance Italy: the mathematicians Luca Pacioli and Fazio Cardano, the architects Donato Bramante and Francesco di Giorgio, and the politician and writer Niccolò Machiavelli, among many others. His extensive personal library of Greek, Roman, and medieval texts numbered about two hundred manuscripts he either owned or borrowed.

Leonardo's working environment favored creative and technological cross-pollination. Anyone familiar with today's maker spaces or Fab Labs would recognize the workshop where Leonardo was an apprentice: a large, open space filled with painters' easels, sculptors' turntables, workbenches, firing kilns, and grindstones. Later, Leonardo replicated this atmosphere in Milan, where his patron Ludovico Sforza provided a cavernous space for projects and experiments. A crossroads for intellectuals and practitioners, it fostered a unique synthesis of art, technology, and science.

LEONARDO'S "IDEA FILE"

Whirlwind, Codex Leicester, sheet 7A, folio 30v, 1508–10
Courtesy Bill Gates / ©bgC3

Some of the greatest innovators in history, including Isaac Newton and Thomas Edison, kept notebooks in which they recorded ideas and organized their thoughts. Leonardo, too, understood the importance of collecting and cataloguing ideas, creating a file for constant consultation. Even as an apprentice, he would have kept a workbook for sketches, diagrams, and technical procedures. The Codex Leicester has the feel of an "idea file." It contains Leonardo's recollections of wind patterns, designs for experimental equipment, and theories (his own and others') that might explain what he observed in the world.

Leonardo also recognized that random bits of information or seemingly unrelated ideas, when combined, can have a serendipitous effect on the creative process.

Don't underestimate this idea of mine . . . that it would not be too much of an effort to pause sometimes to look into these stains on walls, the ashes from the fire, the clouds, the mud, or other similar places. . . . These will do you well because they will awaken genius with this jumble of things.

LEONARDO AND TODAY'S INNOVATORS

Leonardo was famous for his inventions, such as automatic doors and folding furniture. But how do ideas take shape and become reality? Figuring out creative solutions is almost never straightforward; the process tends to be tangled rather than linear. Ideas may come from other innovators, or be tossed aside, only to be recycled for another project later on.

Sketching is at the core of innovation. It serves different purposes at key moments in the creative process. "Thinking," or exploratory, sketching defines problems and reveals possible solutions. "Talking," or explanative, sketching communicates ideas about an invention's visual appearance or mechanical aspects and is often geared toward engineers or a client, who may add further refinements.

Prototypes and working models test ideas in reality. Some innovators, like Scott Olson, emphasize prototyping over sketching, essentially sketching in 3-D. They use inexpensive materials and sometimes modify existing designs to try out ideas. With little time and money invested in materials or manufacturing, they face fewer barriers to developing their concepts.

CROCHET CORAL REEF
BY MARGARET AND CHRISTINE WERTHEIM AND THE INSTITUTE FOR FIGURING

Stretching along the coast of Queensland, Australia, the Great Barrier Reef is the first living thing that can be seen from outer space. Inspired by the wonder of living reefs, in 2005 the sisters Margaret and Christine Wertheim, of the Institute For Figuring, began to crochet a reef out of yarn and plastic thread. Their *Crochet Coral Reef* project is a dynamic global experiment marrying mathematics, marine biology, community art practice, and ecological consciousness.

The sculptures on display here are from the latest iteration of the project. Their frilly forms mimic actual reef organisms, such as corals, kelps, and nudibranchs, that are biological manifestations of hyperbolic geometry (an alternative to the Euclidean geometry commonly taught in school). The *Crochet Coral Reef* is also a response to an environmental tragedy. Reefs everywhere are stressed. Global warming and ocean acidification, resulting from excessive carbon dioxide being pumped into the atmosphere, threaten these fragile ecosystems. The giant coral forest structures here were assembled by the Wertheims and represent thousands of hours of crocheting by the Wertheims and a core group of collaborators worldwide.

fig.
INSTITUTE FOR FIGURING

THE CROCHET REEF PROJECT AND LEONARDO

Leonardo believed that mathematical laws govern the natural world and that the phenomena he observed were expressions of geometrical truths. His ideas emerged from his study of the work of the ancient Greek mathematician Euclid.

Early in the 19th century, mathematicians discovered a new geometry, describing what came to be called hyperbolic space. At the time, it seemed pathological, with lines cavorting in aberrant formations and breaking from Euclidean rules. Yet it has been present in nature for millions of years.

In 1997, Daina Taimina, a mathematician at Cornell University, began to crochet models of hyperbolic surfaces. Expanding on Taimina's technique, the Wertheim sisters and their collaborators have developed methods for simulating a diversity of living organisms. Their host of reef-like forms not only look like coral but also embody the same geometric principles. Just as the vast range of living species has risen from variations in a genetic code, so a multiplicity of yarn-based "species" may be brought into being through modifications of a crochet code, creating an ever-evolving crochet "tree of life."

BILL VIOLA'S *THE RAFT*

10 MINUTES 33 SECONDS, RUNS CONTINUOUSLY

Leonardo da Vinci, *A Deluge*, c. 1517–18, black chalk on paper, Royal Collection Trust

Théodore Géricault, *The Raft of the Medusa*, 1819, oil on canvas, Louvre, Paris

Leonardo was fascinated by the dynamic forces shaping the world around him. He was a tireless observer of water's movement and power, of its effects on obstacles in its path. Bill Viola's *The Raft* offers an opportunity to place ourselves in Leonardo's shoes, to witness and analyze the effect of turbulent water on solid matter. No doubt Leonardo would have found *The Raft* fascinating.

Later in his life, Leonardo's interest in water took a darker turn. He imagined catastrophic deluges, drew them, and described the destruction. Viola's planning notebook—displayed below—reveals that he, too, took a special interest in the awful power of disasters. His title derives from Théodore Géricault's painting *The Raft of the Medusa*, a depiction of an actual shipwreck in which 147 men were left to drift on a hastily made raft. Many died of dehydration; the rest ate the dead to survive. Viola's *Raft* has a happier ending, reflecting his belief that catastrophe can draw people together even as it shatters their lives.