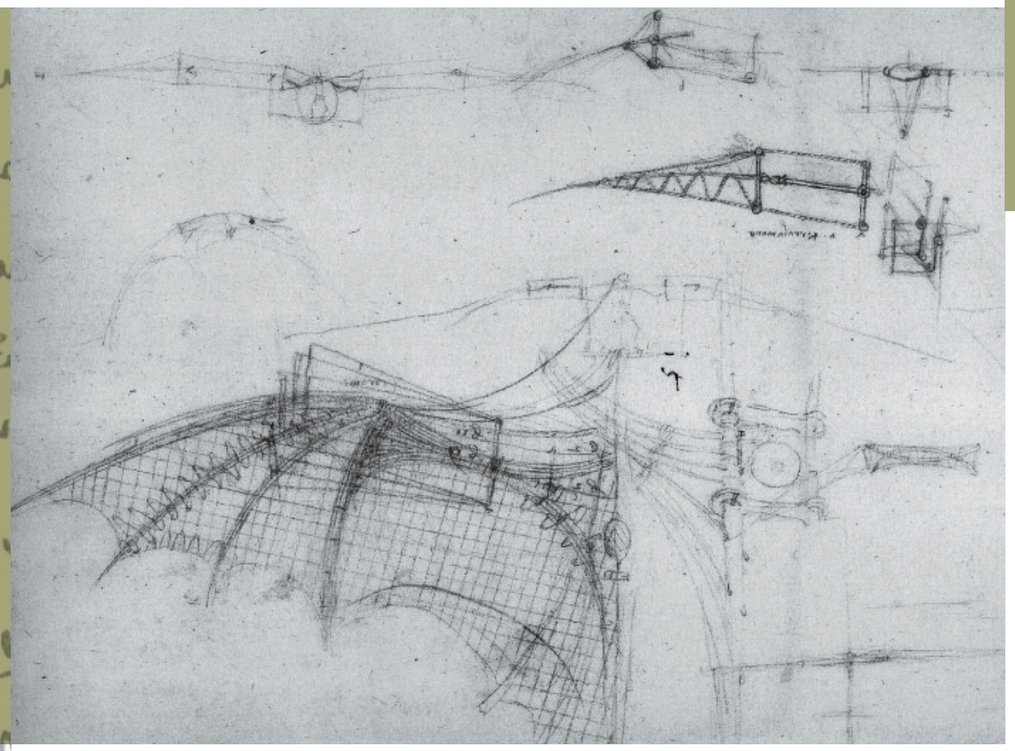
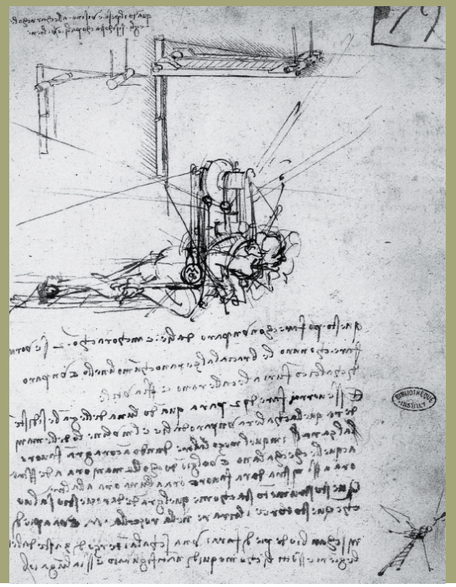
LEONARDO'S
Design Method Demystified

BY NGIOM





AMONG HIS INVENTIONS WERE DOORS THAT OPENED AND CLOSED AUTOMATICALLY BY MEANS OF COUNTERWEIGHTS TABLE LAMPS WITH DIMMERS, TEXTILE MACHINES FOR SPINNING, WEAVING, TWISTING HEMP, TRIMMING FELT AND MAKING NEEDLES.

Design as a distinct specialised discipline is a twentieth-century notion. During Leonardo da Vinci's time, there was no deliberate separation between the different fields of design: there was not even a distinction between art and science. If we were to remember his various engineering inventions, viewing him as a designer in that sense means applying a modern perspective that did not exist at that time.

What emerges from the remains of Leonardo's sketches is his ability to think systematically – not under the perennial scattered cloud that seems to hover over artistic heads, which we inexplicably see as an admirable trait in artists. Leonardo exemplifies instead the good designer's ability to visualise and translate what he sees into accurate drawings. Over and above the usual emotive attributes associated with an artist, Leonardo had an uncanny ability to visualise and solve mechanical problems, a key element in good engineering.

In other words, Leonardo would have made a very good car designer.

Leonardo's designs were not wholly original, but were in fact adaptations of earlier models. He often improved on past inventions to a point where their origins became unidentifiable. Thus, they became inventions in their own right. In the end, Leonardo's inventions brought this well-respected artist additional fame as an engineer.

Leonardo was thought to have invented some three hundred devices. He produced invention after invention, the way a magician comes up with one trick after another. Many of his inventions were 'futuristic' considering that they were done in the late fifteenth and early sixteenth century. Among his inventions were doors that opened and closed automatically by means of counterweights, table lamps with dimmers, textile machines for spinning, weaving, twisting hemp, trimming felt and making needles. He also tried his hand at making flying machines and various types of weaponry.

Again, all these accomplishments came on top of his rigorous studies of human anatomy and his famous works of art, including 'The Last Supper' and the 'Mona Lisa.' This last is arguably the world's most famous painting and continues to draw crowds at the Louvre Museum in Paris.

During the Renaissance, the masters were what today we would call multi-disciplined. Leonardo's teacher, Verrocchio was a renowned goldsmith, sculptor, and painter as well as an engineer. The great architect, Brunelleschi who was responsible for the great dome in Florence was first trained as a goldsmith and became a well-known sculptor before becoming an architect. He was also later acclaimed as an innovative engineer for both civil and military works. Leonardo was known to have admired Brunelleschi and redrew his lifting devices and architectural plans.

Leonardo was incredibly prolific and he recorded many of his inventions in his notebooks. Unfortunately, more than half the materials have been lost and no one knows what they contained.

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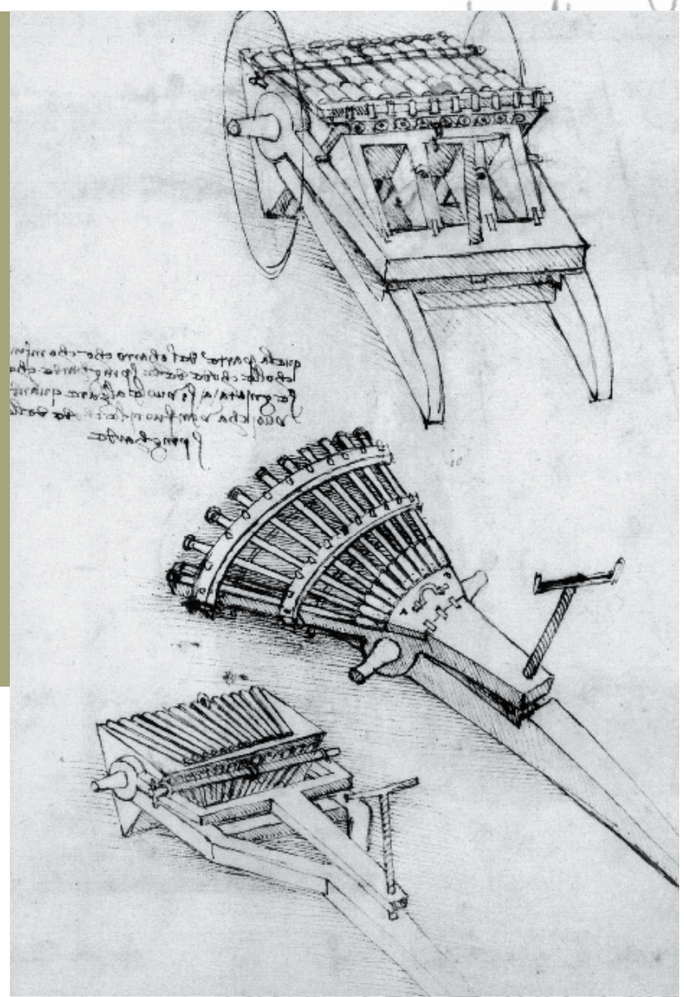

Leonardo was also extraordinary in that much of what he designed was not realised until several centuries later. Furthermore, Leonardo was unique in the easy way he transitioned between the arts, engineering and pure science. Leonardo was tirelessly curious not only about how things worked (engineering); but also why things worked (science).

In architecture, Leonardo saw buildings as metaphors of living organisms, and he saw them as forms of sculptors rather than visual semantics as was common with classical architects. Common among Renaissance architects, a good architect was like a good doctor, and Leonardo observed that a building must have good flow as a body must have good circulation. He wrote about the 'metabolism' of a building, studying how stairs and doors facilitate movement through a building. Using the metaphor of the human body, he described the dome of a church as akin to the human cranium and the arches in its vaulting as the rib cage.

It all sounded like medieval fuddle until Leonardo applied his ideas to urban design. Plagues were regular tragic features of his time and Leonardo realised that it might have something to do with poor sanitation. Responding to this, he proposed that Milan, the city of his residence at the time, be rebuilt to allow the streets to be cleaned regularly by flushing them with water. For his ideal city, which was radical at the time, he claimed that the city be divided into ten townships along the river, each with approximately thirty thousand inhabitants. In this way, he suggested, "you will disperse each agglomeration of people, packed like a herd of goats, on each other's backs, who fill every corner with their stench and sow seeds of pestilence and death."

Just like buildings, he saw the city as a kind of living organism in which people, material goods, food and waste needed to move and flow easily to remain healthy. He proposed a three-tiered city, where the upper tier would comprise of 'beautiful' houses, arcaded walkways and terraced gardens; the lower tier for storage of goods, roads and canals for the delivery of goods and, underground canals for the discharge of sewage and fetid substances. Leonardo was so ahead of his time in urban planning that something like this would not be willingly implemented until centuries later, specifically when the World Health Organisation implemented its Healthy Cities project in the 1980s.

However, the King of France did ask Leonardo to draw up plans for a new capital and royal residence two years before he died, where Leonardo was to apply his theories on urban design. Ironically the project was abandoned soon after as the workforce was decimated by plague.

In areas of construction, Leonardo's inventions are many, even for the small in scale: for example, not many are aware that in the performing arts, Leonardo invented the first revolving stage. The stage design for countless performances would not be the same if not for this invention. He was also the first to raise the curtain rather than to have it fall at the start of the performance, as had been the custom. When he staged the play Orfeo, he invented a series of gearwheels and counterweights to create a mountain that would suddenly split open: dramatically revealing Pluto rising on his throne, accompanied by terrifying sounds and 'infernal lights'. This spectacle established Leonardo as a kind of magician in stagecraft.

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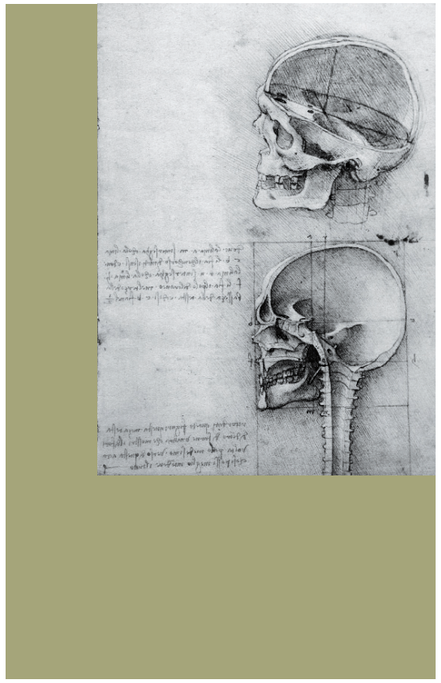
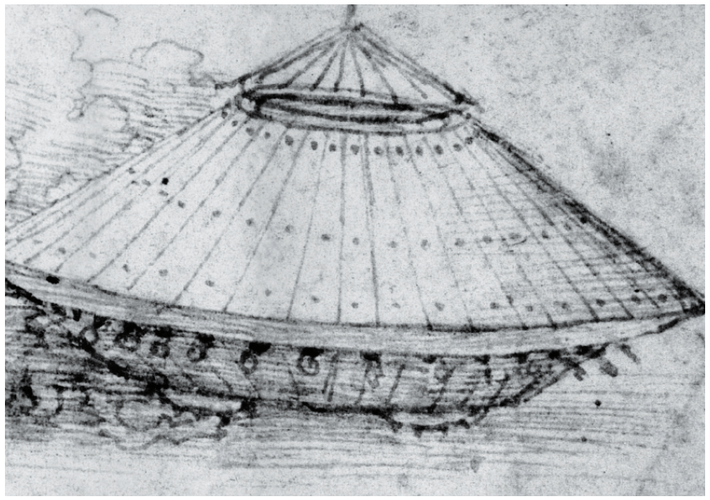
All of the above skims only the surface of the enormous amount of innovations that Leonardo came up with across the disciplines, not including those that have been lost. However, what was apparent in Leonardo's remaining notebooks was his reliance on direct observation, no different from the way scientists work today. It is worth noting that Leonardo's scientific attitude contrast sharply with the attitude of the time – which was to uncritically repeat the pronouncements of past classical texts – indeed the typical classical Renaissance humanist went out of his way to rediscover and follow classical rules, and this was then deemed as the correct thing to do.





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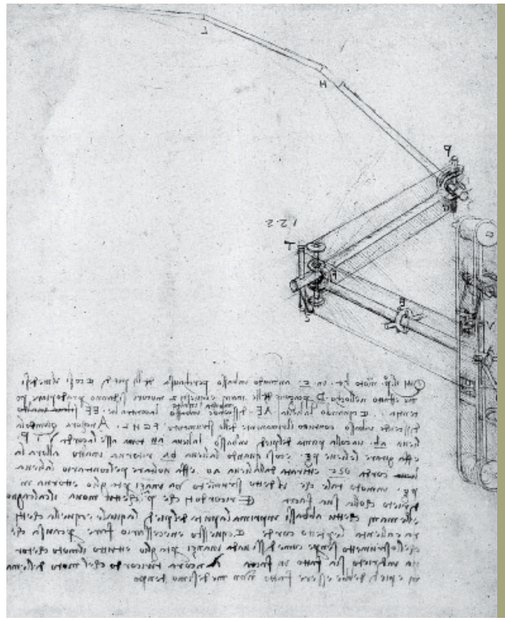
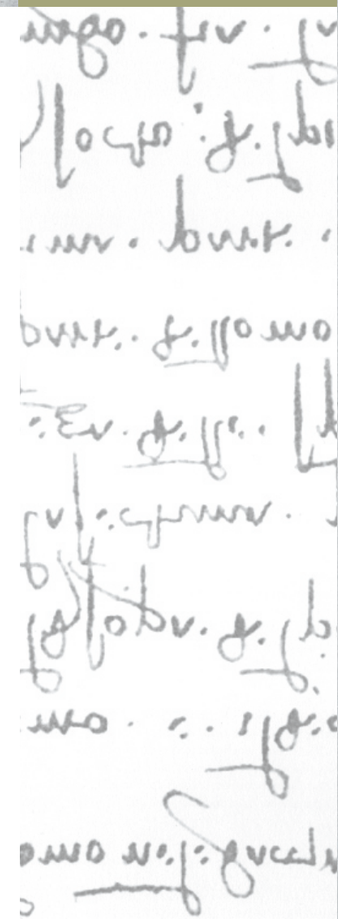
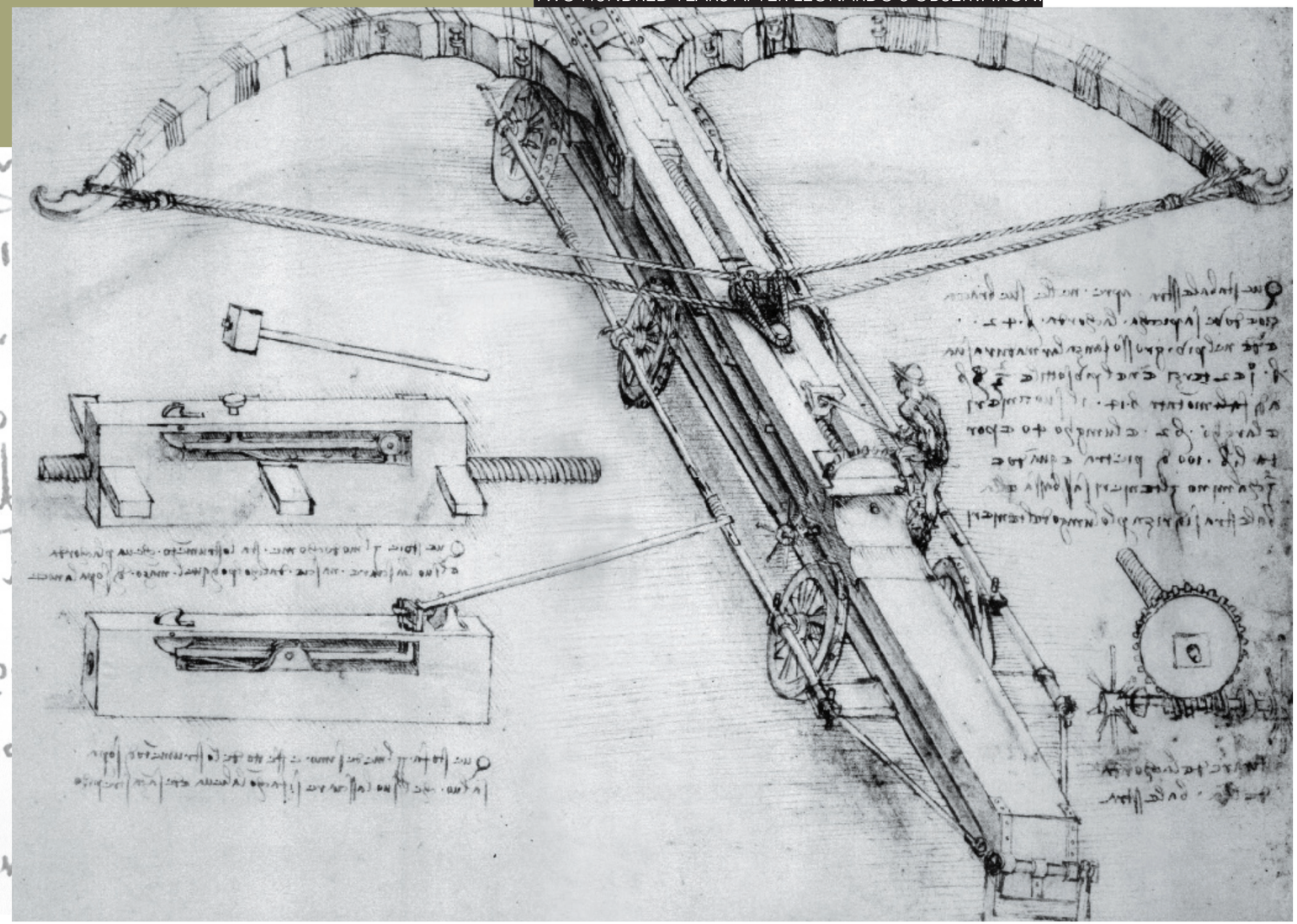


LEONARDO SAID: "TO ME IT SEEMS THAT THOSE SCIENCES ARE VAIN AND FULL OF ERRORS AND ARE NOT BORN OF EXPERIENCE, MOTHER OF ALL CERTAINTY - THAT IS TO SAY, WHICH DO NOT AT THEIR BEGINNING, MIDDLE OR END PASS THROUGH ANY OF THE FIVE SENSES.

"REMARKABLY, LEONARDO DETERMINED THAT "AS MUCH FORCE IS EXERTED BY THE OBJECT AGAINST THE AIR AS THE AIR AGAINST THE OBJECT". THIS IS EQUIVALENT TO NEWTON'S THIRD LAW OF MOTION, WHICH STATES THAT: "FOR EVERY ACTION, THERE IS AN EQUAL AND OPPOSITE REACTION". NEWTON'S THIRD LAW WAS PUBLISHED SOME TWO HUNDRED YEARS AFTER LEONARDO'S OBSERVATION.





In contrast, Leonardo said: "To me it seems that those sciences are vain and full of errors and are not born of experience, mother of all certainty - that is to say, which do not at their beginning, middle or end pass through any of the five senses." These same principles are applied to science today, which the scientific revolution of the seventeenth century also relied upon. It seems that Leonardo pre-empted them all (Galileo was born 112 years after Leonardo). It was just unfortunate that Leonardo's notebooks were discovered in bits and pieces in the eighteenth, nineteenth and even in the twentieth century, and none of the materials were published during his lifetime.

In contemporary scholarship, for example, as recommended by Leon van Schaik in 'Mastering Architecture' (2005), it is recommended that novices spend a considerable period of apprenticeship under a master, which Leonardo was fortunate to have done under Verrocchio; however, in today's digital world, not many of us would have that opportunity. In the absence of that, Leonardo recommended the cultivation of an empirical attitude – in other words, direct doing and testing, following nature and not having to rely on the past: He suggested that: 'The surer way is go to the objects of nature, rather than those that are imitated with great deterioration, and so acquire sad habits; for he who can go to the well does not go to the water jar."

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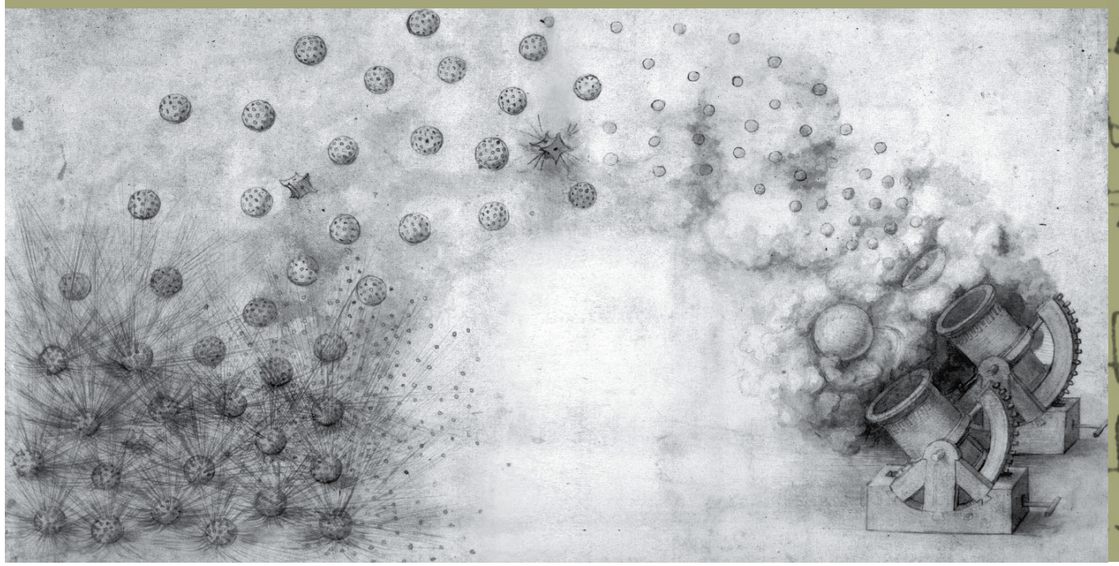
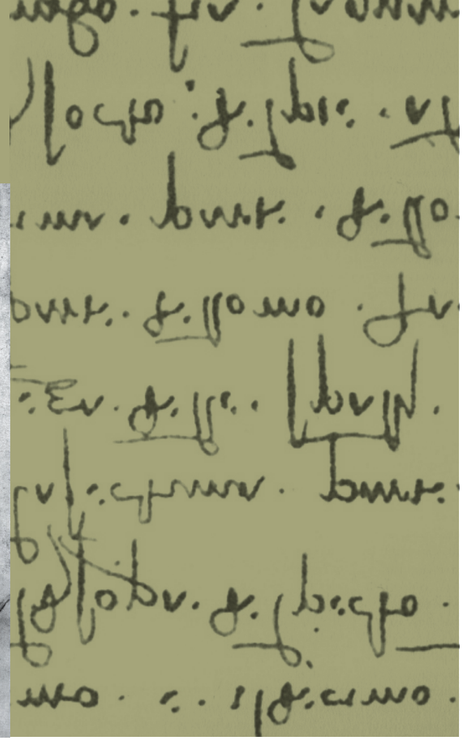




IF LEONARDO HAD THOUGHT OF MAKING THE BLADES ROTATE, IT WOULD HAVE BEEN THE FIRST ATTEMPT AT DESIGNING A HELICOPTER.

Leonardo's almost superhuman sense of observation is evident in his sketches of human anatomy. He was also organised and methodical – like a scientist and, quite unlike the characteristics normally associated with the artist. In other words, Leonardo was more than just pure instinct – he was systematic and deliberate.

He had an insatiable thirst for knowledge and he continually tested and refined his work. Under scrutiny, his paintings are known to have layers upon layers of previous overlays until a perfect picture comes to the fore. His paintings are not accidental compositions but are often geometrical constructs, which in any event was the norm for Renaissance painters.

Among the most mesmerising of his mechanical constructs are his attempts at flight. He followed the experimental method and his acute observation of nature. Watching birds, he observed that air under their wings is compressed at the downstroke: "See how the wings, striking against the air, sustain the heavy eagle in the thin air on high." Remarkably, Leonardo determined that "As much force is exerted by the object against the air as the air against the object". This is equivalent to Newton's third law of motion, which states that: "For every action, there is an equal and opposite reaction." Newton's third law was published some two hundred years after Leonardo's observation.

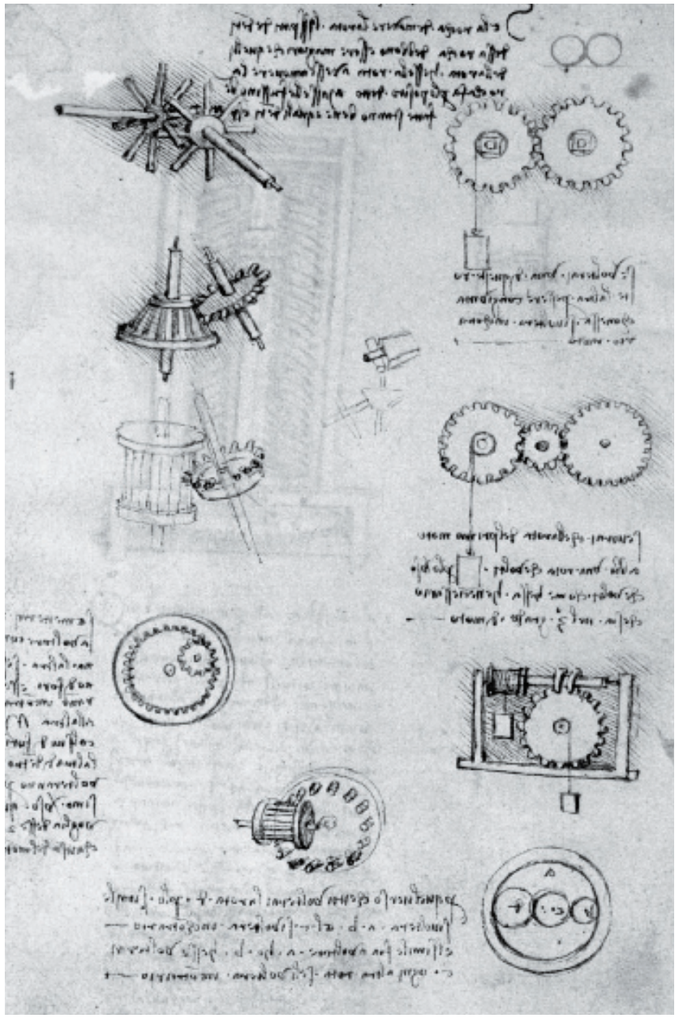
Leonardo tested one design after another in drawings to persuade himself of the most viable option, with the later designs being an improvement over the previous ones. An earlier design shows a man crouched down at the centre of the craft, with the pilot peddling with his feet and winding with his hands to generate enough force to flap the blades above him. If Leonardo had thought of making the blades rotate, it would have been the first attempt at designing a helicopter. The weight of the man and the heavy constructions are obviously far too heavy to be lifted off the ground by the thin blades. The power to weight ratio is implausible.

The closest conception that Leonardo had to a helicopter was to design a screw-like contraption over a frame that could house a man. He envisaged that the contraption would whirl and spiral through the air in flight. Quite obviously much work had yet to be done to make the machine more viable.

Some ten years after his early experiments in Milan, Leonardo entered into another intense period of designing flying machines. At first he concluded that human flight with mechanical wings would not be possible as it would be difficult to emulate the structure of a bird's anatomy, which had powerful pectoral muscles yet are light, needing only slight effort to be airborne.

However, Leonardo thought that "soaring flight," or gliding was possible and began to experiment with machines that had fixed wings, not unlike the modern hang glider. Based on Leonardo's designs British engineers built a glider and tested it successfully at Sussex Downs in Southeast England. Without engines of propulsion during medieval times, Leonardo could not have conceived of propelling the machines mechanically. Nevertheless, after Leonardo's glider, the first other known glider only appeared with the Wright brothers in 1900, nearly four hundred years later.

All pictures and references are from "Leonardo's Notebooks" Leonardo da Vinci, edited by H. Anna Suh, published by Black Dog & Leventhal Publishers, Inc.



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