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Leonardo da Vinci, Portrait of Lisa Gherardini (known as the Mona Lisa), c. 1503–19, oil on poplar panel, 77 x 53 cm (Musée du Louvre, Paris) We live in a culture that is so saturated with images, it may be difficult to imagine a time when only the wealthiest people had their likeness captured. The wealthy merchants of renaissance Florence could commission a portrait, but even they would likely only have a single portrait painted during their lifetime. A portrait was about more than likeness, it spoke to status and position. In addition, portraits generally took a long time to paint, and the subject would commonly have to sit for hours or days, while the artist captured their likeness. View of crowd surrounding Leonardo da Vinci, Portrait of Lisa Gherardini (known as the Mona Lisa), c. 1503–19, oil on poplar panel, 77 x 53 cm (Musée du Louvre, Paris; photo: -JvL-, CC BY 2.0) The most recognized painting in the world The Mona Lisa was originally this type of portrait, but over time its meaning has shifted and it has become an icon of the Renaissance—perhaps the most recognized painting in the world. The Mona Lisa is a likely a portrait of the wife of a Florentine merchant. For some reason however, the portrait was never delivered to its patron, and Leonardo kept it with him when he went to work for Francis I, the King of France. Leonardo da Vinci, Portrait of Lisa Gherardini (known as the Mona Lisa), c. 1503–19, oil on poplar panel, 77 x 53 cm (Musée du Louvre, Paris) The Mona Lisa's mysterious smile has inspired many writers, singers, and painters. Here's a passage about the Mona Lisa, written by the Victorian-era (19th-century) writer Walter Pater: We all know the face and hands of the figure, set in its marble chair, in that circle of fantastic rocks, as in some faint light under sea. Perhaps of all ancient pictures time has chilled it least. The presence that thus rose so strangely beside the waters, is expressive of what in the ways of a thousand years men had come to desire. Hers is the head upon which all "the ends of the world are come," and the eyelids are a little weary. It is a beauty wrought out from within upon the flesh, the deposit, little cell by cell, of strange thoughts and fantastic reveries and exquisite passions. Set it for a moment beside one of those white Greek goddesses or beautiful women of antiquity, and how would they be troubled by this beauty, into which the soul with all its maladies has passed! Left: Piero della Francesca, Portrait of Battista Sforza, c. 1465–66, tempera on panel (Galleria degli Uffizi, Florence); right: Leonardo da Vinci, Portrait of Lisa Gherardini (known as the Mona Lisa), c. 1503–19, oil on poplar panel, 77 x 53 cm (Musée du Louvre, Paris) Piero della Francesca's Portrait of Battista Sforza is typical of portraits during the Early Renaissance (before Leonardo); figures were often painted in strict profile, and cut off at the bust. Often the figure was posed in front of a birds-eye view of a landscape. A new formula Hans Memling, Portrait of a Young Man at Prayer, c. 1485–94, oil on oak panel (Museo Thyssen-Bornemisza, Madrid) With Leonardo's portrait, the face is nearly frontal, the shoulders are turned three-quarters toward the viewer, and the hands are included in the image. Leonardo uses his characteristic sfumato—a smokey haziness—to soften outlines and create an atmospheric effect around the figure. When a figure is in profile, we have no real sense of who she is, and there is no sense of engagement. With the face turned toward us, however, we get a sense of the personality of the sitter. Northern Renaissance artists such as Hans Memling (see the Portrait of a Young Man at Prayer) had already created portraits of figures in positions similar to the Mona Lisa. Memling had even located them in believable spaces. Leonardo combined these Northern innovations with Italian painting's understanding of the three dimensionality of the body and the perspectival treatment of the surrounding space. Left: Unknown, Mona Lisa, c. 1503–05, oil on panel (Museo Nacional del Prado, Madrid); right: Leonardo da Vinci, Portrait of Lisa Gherardini (known as the Mona Lisa), c. 1503–19, oil on poplar panel, 77 x 53 cm (Musée du Louvre, Paris) A recent discovery An important copy of the Mona Lisa was recently discovered in the collection of the Prado in Madrid. The background had been painted over, but when the painting was cleaned, scientific analysis revealed that the copy was likely painted by another artist who sat beside Leonardo and copied his work, brush-stroke by brush-stroke. The copy gives us an idea of what the Mona Lisa might look like if layers of yellowed varnish were removed. More Analysis of Mona Lisa The portrait shows the subject sitting upright and sideways in a chair, with her face and chest turned slightly towards the viewer: a posture derived from the 'pyramid' image used to depict a sitting Madonna. Her left arm sits comfortably on the armrest of the chair and is clasped by the hand of her right arm which crosses her front. The slightly protective position of her arms, as well as the armrest, creates a sense of distance between sitter and spectator. The background landscape behind the sitter was created using aerial perspective, with its smoky blues and no clearly defined vanishing point. It gives the composition significant depth, although its details reveal a clear imbalance between the (higher) rocky horizon to the right, compared to the (lower) flatlands stretching away on the left. This imbalance adds to the slightly surreal atmosphere of the picture. Another slightly surreal feature of the Mona Lisa is her lack of eyebrows and eyelashes. This was not a deliberate act of the artist, as scans indicate that originally she was given both. It is possible that the colour pigment used for these facial features has since faded or been inadvertently removed during cleaning. The Mona Lisa exemplifies Leonardo's contribution to the art of oil painting, namely his mastery of sfumato. This painterly technique involves the smooth, almost imperceptible, transition from one colour to another, by means of ultra-subtle tonal gradations. Evident throughout the painting, Leonardo's use of sfumato is particularly visible in the soft contouring of Lisa Gherardini's face, around the eyes and mouth. It was a technique of oil painting that he had already demonstrated with great success in The Virgin of the Rocks (1483-5). The general impression created by the Mona Lisa portrait is one of great serenity, enriched by a definite air of mystery. The serenity comes from the muted colour scheme, the soothing sfumato tonality, and the harmony created by the sitter's pyramid-shaped pose and understated drapery. The mystery stems from a number of factors: first, her enigmatic half-smile; second, her gaze, which is directed to the right of the viewer; her hands which have a slightly unreal, lifeless quality - almost as if they belonged to a different body. Created by one of the greatest Old Masters in the history of art, the Mona Lisa is a wonderful example of High Renaissance aesthetics of the early cinquecento, and has become an unmistakable icon of Western culture: a fact recognized by Marcel Duchamp (1887-1968), the father of modern art, in his parody entitled L.H.O.O.Q. The line width corresponds to 1 mm in the original painting (desktop) # The Louvre provides the unframed version of the painting against a black background. On the one hand, this shows that Leonardo did not paint the entire wooden panel. Secondly, it is clear that the painting has not been cropped at the edges. This means that Leonardo deliberately chose this particular section of the painting. The frame used for this analysis is indicated by a white border (mouseover/tap) I The painting has an aspect ratio of 2:3.This allows it to be divided into six squares of equal size.As in the previous portrait, La Belle Ferronière, the central vertical line runs through the sitter's left eye II The portrait shows the golden ratio.The distance between the front edges of the column feet and the height of the picture form a golden rectangle (blue transparent area).If the height of the picture is divided twice in succession in the golden ratio, this leads to the height of the Mona Lisa's eyes (orange horizontal line). Further divisions just miss prominent elements and therefore appear unintentional (mouseover/tap) III The painting shows the scene from several perspectives.The sitter, the wall and the landscape each have their own horizon lines.As a result, the landscape is depicted from three perspectives at the same time, which is impossible in reality.The left vanishing line (left column base to the center of the forehead) is inclined by exactly 60° (interior angle of an equilateral triangle). The right vanishing line by exactly 54° (angle bisector in an equilateral 5-sided corner) IV The unnaturally blue mountains on the right are reminiscent of masses of water (mouseover) V In the lower part of the painting, the geometric relationships correspond to the dimensions of Noah's ark mentioned in the Bible. Its entrance was at the side. The ark had three storeys (green line, mouseover). Its roof was raised by 1/30. The golden ratio of the picture height is 1/30 above the lower edge of the parapet (upper green and orange horizontal line). The dimensions are thus related to the water depicted in the right background of the picture VI Halfway up the wall, an isosceles triangle (30°,30°,120°) is formed, the apex of which meets the golden section of the picture height.An equilateral triangle stretches from the eye of the Mona Lisa to the base of the isosceles triangle.The distance from the eye to the apex of the isosceles triangle corresponds to the minor of the golden section of the picture height (orange horizontal line) VII The landscape on the left has a completely different character to the one on the right.In the Mona Lisa's hair, the picture puzzle of an old, bearded man can be seen looking at the base of the column on the left edge of the picture at a 60° angle (mouseover).The base of the column is located in the golden section of the picture's height and is the starting point for numerous geometric relationships in the painting VIII There are numerous geometric relationships between prominent points and lines in the painting.What all the resulting triangles have in common is that their upper angles are symbolic angles and increase in size towards the bottom (60°, 72°, 90° and 120°) to finally form an equilateral triangle whose apex emphasizes the left eye of the Mona Lisa (mouseover).The bases of the triangles are the rear edge of the wall and half the height of the front wall, as well as a 5° angle from the left base of the column to the shoulder of the Mona Lisa (blue parallel to the blue line of the bridge) IX 45° angles of the fingers form a geometric crab (red areas).The lower triangle (30°, 120° and 30°) can be moved to the upper edge of the picture.From its base, a 45° angle leads to the left and right lower edge of the picture (angle between the yellow slanted lines). 45° is the center angle of an equilateral 8-sided corner. The elegance of the geometric design becomes clear on mouseover. The uppermost angle from the edge of the picture to the perspective horizon line of the column bases is 135°, the interior angle of an equilateral 8-corner is Mona Lisa Leonardo da Vinci 1503-1519 Oil on wood (poplar) 53,4 x 79,4 cm Paris, Musée du Louvre The identity of the Mona Lisa has not yet been established beyond doubt. However, the majority of researchers assume that it is Lisa del Gicondo, born Lisa Gherardini. What makes the identification of the Mona Lisa so difficult is the fact that no commission documents, contracts, invoices or similar exist for the portrait. Leonardo da Vinci did not mention the painting in his notes, nor are there any clear descriptions from contemporary witnesses. The majority of Leonardo scholars consider the sitter to be Lisa del Giocondo. All the arguments that support this thesis are now listed. Lisa di Antonmaria Noldo Gherardini is a historically documented person and was a Florentine noblewoman. Despite extensive research on her, little is known about her life today. The Gherardini Family The Gherardini family was an established Florentine family. Much of their once extensive land holdings were lost due to political missteps. Their ancestral castle was destroyed around 1300, leaving only the foundations. Nevertheless, they were not impoverished. They moved to the Villa Gherardini, a castle-like vineyard, which they developed into the family seat over the following centuries. The Villa, located about 20 km southeast of Florence in the Chianti region, is now known as Villa Vignamaggio, a popular tourist attraction. It houses a restaurant ('Monna Lisa') and hosts wine tastings and weddings. Leonardo may have been inspired by a loggia of the Villa and used it as a reference for the background in the portrait of the Mona Lisa. A loggia is an open balcony, usually with small columns supporting a roof. Despite political setbacks, the Gherardini family remained influential, maintaining close ties with Florence's most important families. Lisa's father, Antonmaria Gherardini, was wealthy and owned a centrally located townhouse in Florence and an estate in San Donato in Poggio, near the Villa Gherardini. He had married Camilla, a daughter of the significant Ruccelai family, creating ties to the influential Medici family through marriage. Who was Lisa Gherardini? Lisa Gherardini was born in 1479. At the age of sixteen, in 1495, she married Francesco del Giocondo, a wealthy cloth merchant from Florence. Francesco, 30 years old at the time, had previously been married to Camilla, Lisa's stepmother's sister, who died young. Francesco and Lisa had six children, with one daughter dying shortly after birth in 1499. After the birth of their second child on December 12, 1502, they moved into a townhouse on Via della Stufa in Florence in March 1503. The house, located near the Medici Palace, showcased Francesco's economic success. Because such a move was a typical reason for commissioning a portrait at the time, most researchers believe that the portrait of the Mona Lisa began around 1503. Given that Leonardo's father knew Francesco del Giocondo since 1497, it is likely that he facilitated the commission to Leonardo. During that period, it was common for affluent city dwellers to retreat to the countryside in the hot summer months. The del Giocondos also owned the Villa Antinori, a magnificent property on the outskirts of Florence. A loggia from this building is also considered as a possible background for Leonardo's portrait of the Mona Lisa. After her husband's death in 1538, Lisa Gherardini entered the convent of Saint Ursula in Florence. She passed away there on July 15, 1542, at the age of 63. Giorgio Vasari (1511-1574) was a renowned architect and painter in Florence. Thanks to his artist biographies published in 1550, he is also considered the first art historian. The work includes a much-quoted account of the life of Leonardo da Vinci, who had passed away 30 years prior. Vasari mentions the Mona Lisa: "Leonardo also began to paint the portrait of Mona Lisa, the wife of Francesco del Giocondo. He spent four years on it, then left it unfinished, and it is now in the possession of King Francis of France at Fontainebleau. Anyone who wanted to see how far art could imitate nature recognized it in this beautiful head. Every small detail was depicted in the finest manner, the eyes had brightness and moisture, as we see in life, all around one noticed the reddish-blue circles and veins, which can only be executed with the greatest delicacy. At the brows, you could see where they were fullest, where they were sparse, how they emerged from the pores of the skin and arched, as naturally as one can think. On the nose, the delicate openings were rosy and faithfully reproduced. The mouth, where the lips close and the red blends with the color of the face, had a perfection that made it appear not painted, but truly like flesh and blood. Whoever looked closely at the hollow of the neck believed to see the pulsating of the veins. In short, one can say that this painting was executed in a way that made every excellent artist and everyone who saw it tremble. Mona Lisa was very beautiful, and Leonardo needed the precaution that, while he was painting, there always had to be someone present who sang, played, and made jokes so that she would remain cheerful and not acquire a sad look, as often happens when one sits to have their portrait painted. Above this face, however, hovers such a lovely smile that it seemed to be more from a heavenly than a human hand; and it was considered admirable because it was completely lifelike." Vasari refers to Lisa del Giocondo as "Mona Lisa." "Mona" is an Old Italian abbreviation for the address Madonna ('My Lady'). Vasari's praise for the painting of the Mona Lisa's eyebrows indicates that he did not see the painting himself, as the Mona Lisa does not have eyebrows. Historians Kemp and Zöllner have been able to demonstrate that Vasari was acquainted with two cousins of Francesco del Giocondo. Therefore, it is likely that Vasari could have personally met the older couple del Giocondo, as Lisa del Giocondo lived until 1542. Additionally, Vasari grew up under the care of the Medici family and was educated alongside their children. The Medicis were well-connected in Florence, familiar with Leonardo, and, moreover, distantly related to Mona Lisa's mother. It is likely that Vasari knew that Leonardo created a portrait of Lisa del Giocondo. However, Vasari tends to create legends, and his statements do not always align with the findings of art historians. It is also often unclear which of his statements are based on hearsay, meaning he lacked sufficient sources. Leonardo paints the Mona Lisa, Cesare Maccari, 1863 Maccari was inspired by Vasari's story. It is part of Vasari's legend that Leonardo had the Mona Lisa lavishly entertained while he painted her. In fact, the sitters of the time did not sit for hours on end. It was customary for professional painters to make a rough, yet faithful sketch of the sitter once and then use it as a template for the later painting. Characteristics of the final painting, such as a particular smile, hairstyle, pieces of jewelry, etc. were thought up by the artists or added separately based on models Although the portrait of the Mona Lisa is said to have been commissioned by her husband Francesco, the painting was never in the possession of the del Giocondos. It is possible that it was not Francesco but Giuliano de Medici who commissioned the painting, as reported by a contemporary source. During Leonardo's last three years, when he lived at the French royal court in Amboise, he was visited in 1517 by a delegation from Cardinal Luigi d'Aragona. The cardinal's scribe, Antonio de Beatis, wrote a report on the visit. This last eyewitness account is of great importance in Leonardo research as it mentions other paintings that de Beatis saw in Leonardo's workshop. "In one of the districts, my lord and the rest of us went to see the Florentine Leonardo da Vinci, more than 70 years old [Here the scribe is mistaken; Leonardo was only 65 at the time], an outstanding painter of our time, who showed his illustrious lordship three paintings: one of a certain Florentine lady, a very beautiful painting made at the request of the Magnificent Giuliano de Medici; the second of a young John the Baptist, and one of the Madonna and her son, who are placed in the lap of Saint Anne, all very perfect, ..." The "certain Florentine lady" most likely refers to the Mona Lisa. Lisa Gherardini's family was indirectly connected to the Medicis through marriage. The Florentine youths Giuliano de Medici and Lisa Gherardini were of the same age and grew up in close proximity. Due to the familial connection, it is highly likely that they knew each other, and there is speculation that Giuliano fell in love with Lisa. However, the Medicis were expelled from Florence in 1494 and could only return in 1512. The 15-year-old Giuliano had to leave the city and spent many years in exile at the court of the Duke of Urbino. One year after the Medicis' expulsion from Florence, Lisa Gherardini married the wealthy merchant Francesco del Giocondo. Leonardo had been living in Milan since around 1482 and returned to Florence only in 1503 for a few years. According to the theory, the exiled Giuliano de' Medici asked Leonardo to create a portrait of the now-married Lisa del Giocondo for sentimental reasons. This would explain why the painting was never in the possession of the del Giocondos. Giuliano de Medici was the brother of Pope Leo X (1513-1521) and an admirer of Leonardo. At Giuliano's request, Leonardo stayed at the papal court in Rome from 1513 to 1516. When Giuliano unexpectedly died in 1516, Leonardo left Rome and went to France. De Beatis's report indicates that he had the portrait of a certain Florentine lady with him, made at the request of Giuliano de Medici. Therefore, Leonardo may not have been able to hand over the Mona Lisa to Giuliano because the painting was still unfinished, or he took back the completed work after Giuliano's death. This theory is speculative, and the only evidence is Beatis's mention of the certain Florentine lady commissioned by Giuliano de Medici. Portrait of Giuliano de' Medici, Raphael, around 1513-16 In the background the Castel Sant'Angelo, a refuge in the Vatican, Rome Portrait of Giovanni de' Medici as Pope Leo X, Raphael, c. 1518-19 Giovanni was the older brother of Giuliano A source published in 2005 proves that Leonardo worked on the portrait of Lisa del Giocondo. A book about the ancient politician and writer Cicero, which was printed in 1477, was found in the Heidelberg University Archive (shelfmark D 7620 qt. INC). It has been proven that the book belonged to one Agostino Vespucci. Vespucci was a scribe and close collaborator of the famous Florentine politician Niccolo Macchiavelli. At the time, Macchiavelli supported Leonardo with commissions from the Florentine city government. It was probably at his instigation that Leonardo was commissioned to paint the huge mural "Battle of Anghiari". For this purpose, Vespucci translated a description of the battle from Latin, which is still preserved today, and gave it to Leonardo. Vespucci and Leonardo therefore knew each other well, which increases the credibility of the source. Agostino Vespucci left a short handwritten note in the book in which he praised Leonardo's painting and mentioned that he was currently working on a portrait of Lisa del Giocondo. The note also confirms Leonardo's work on the paintings "Anna Selbdritt" and "Battle of Anghiari" for the Council Chamber of Palazzo Vecchio. This note is considered an important document in the history of the Mona Lisa's creation, even if the authenticity of the note can hardly be proven. The Heidelberg note, where the ancient painter Appeles is mentioned by Cicero. The handwritten note on the right refers to this.It reads: "The painter Apelles.This is what Leonardo da Vinci does in all his paintings, such as the Face of Lisa del Giocondo and Anna, Mother of the Virgin.We will see what he will do about the Great Council Chamber, on which he has just reached an agreement with the Gonfaloniere.October 1503." In the Renaissance, wordplay was very popular, and Leonardo da Vinci had a particular fondness for it. His famous portrait of the lady with an ermine features Cecilia Gallerani. The ermine belongs to the weasel family, and the Ancient Greek word for weasel is "galê" or "galéê." Another portrait depicts the lady Ginevra de' Benci. She is seated in front of a juniper tree. "Juniper" translates to "Ginepro" in Italian. Leonardo's preference for wordplay also supports the identification of the lady as Lisa del Giocondo. The most noticeable feature of the painting is her cheerful expression. "Gioconda" is the Italian word for "the Cheerful," and it is assumed that her joyous smile alludes to her surname "del Giocondo." Salai's Estate Salai was one of Leonardo's longest-serving collaborators and was named as one of Leonardo's heirs in his will. A few years after Leonardo's death in 1519, Salai died unexpectedly in a duel in 1524. Following his death, his wife and sisters disputed his estate. A document has been preserved, revealing that Salai owned a painting referred to as "La Joconda," described briefly as "a woman turned backward." Even today, the Mona Lisa is referred to as "La Joconda" or "La Joconde" in France. "La Joconde" was originally not a French term but is derived from the Italian "Gioconda." This designation from Salai's estate links that particular portrait with the surname of the Florentine lady Lisa del Giocondo. The value of Salai's "La Joconda" was set by the notary at 100 Scudi (= 175 Florins = 612.5 Gold). For the time, this was a considerable sum, strongly suggesting that Salai's "La Joconda" was an original painting by Leonardo. If so, it could only be Leonardo's portrait of Lisa del Giocondo. In addition to the identification of the Mona Lisa as Lisa del Giocondo, a few researchers propose the idea that it could be a portrait of Pacifica Brandani. Since the hypothesis is internally consistent, it should not go unmentioned. The starting point for this theory is the well-known travel report from de Beatis in 1517, which stated "[...] one of a certain Florentine lady, a very beautiful painting made at the request of the Magnificent Giuliano de Medici." Giuliano's biography includes the tragic fate of his only son, Ippolito. When Giuliano was in exile, he had an affair with the court lady Pacifica Brandani at the court of Urbino. She became pregnant but died in 1511 during the birth of their son, Ippolito. Since Ippolito could not know his mother, Giuliano is said to have commissioned from Leonardo a painting of an idealized, cheerful mother figure. The painting was intended to console young Ippolito over the loss of his mother. Therefore, the portrait is said to have been named La Gioconda (Italian for "the Cheerful"). However, according to the theory, Ippolito did not receive the painting. When his father Giuliano died in 1516, Leonardo is believed to have retained the still unfinished painting when he left for the French court in 1516. While this narrative seems plausible, it relies solely on the remark "at the request of the Magnificent Giuliano de Medici" in de Beatis's travel report. The most significant discovery related to the identity of the Mona Lisa was made by the French physicist Pascal Cotte. He developed an innovative physical method to reconstruct the chronological order of paint layers in paintings. The Louvre granted him the rare permission to examine the original painting between 2004 and 2015. Surprisingly, he found that beneath the portrait of the Mona Lisa, there is an earlier portrait depicting a significantly younger lady. The current Mona Lisa is, therefore, the result of overpainting. The earlier portrait is largely identical in position and overall composition but differs significantly in hairstyle, face, and shoulder area. Mona Lisa, result of the radiological examination by the French physicist Pascal Cotte. Based on the chronological order of paint layers, an earlier paint layer was identified, depicting a substantially altered portrait that, however, appears self-contained. Presumably, the painter Raphael saw this original version of the Mona Lisa in Leonardo's workshop and, following his example, created three portraits of his own. @Pascal Cotte / Lumiere Technology Lady with the Unicorn, Raphael, 1505–1507 The painting exhibits many parallels to the original version of the Mona Lisa: posture, shoulder area, sleeve folds, backward-directed hairstyle, the wall with protruding columns, the landscape in the background, and the overlapping hands. The unicorn likely references Leonardo's legendary court festivities, where he elaborately costumed animals and let them roam freely Portrait of Maddalena Doni, Raphael, 1506 The posture of the hands lying on the chair back is clearly related to Leonardo's Mona Lisa. The dynamically twisted sitting posture of Leonardo's Mona Lisa was so innovative that it cannot be a mere coincidence. Another indication of imitation is the transparent veil over her shoulders La Muta ('The Mute'), Raphael, 1507-08 This painting is also very similar to Leonardo's Mona Lisa. It portrays the same pose and likewise features a transparent veil over her shoulders The result of Pascal Cotte's examination clarifies significant open questions related to the Mona Lisa. Vasari describes the finely painted eyebrows of the Mona Lisa, even though she obviously has none. He must have relied on accounts he heard about the first version of the Mona Lisa. He likely never saw the original painting himself, as it was at the French court in Fontainebleau during his lifetime, as he himself reports. Pascal Cotte's findings also explain the striking similarity of three portraits by Raphael to that of the Mona Lisa. They undoubtedly originated around the same time. Raphael was in Florence between 1504 and 1505, the period when the Mona Lisa was started. The younger Raphael knew Leonardo personally and imitated his style in many of his works. It is very likely that Raphael saw the portrait of Lisa del Giocondo in Leonardo's workshop. It must have been the version revealed in Pascal Cotte's examination because that's the only way to explain why Raphael's portraits closely resemble Leonardo's Mona Lisa but differ significantly from the present version. Raphael must have seen an earlier version of the Mona Lisa, precisely the one Pascal Cotte identified. The extensive copies by Raphael and the analysis by Pascal Cotte now lead to a straightforward conclusion, consistent with all previous findings. In 1503, Leonardo received the commission in Florence to paint Lisa del Giocondo. The commission either came from her husband, Francesco del Giocondo, through the mediation of Leonardo's father, or from the infatuated Giuliano de' Medici in exile in Urbino. Leonardo began the portrait but left it unfinished. At that time, the painting looked as Pascal Cotte discovered. Raphael must have seen the unfinished work between 1504 and 1505 in Leonardo's workshop and imitated this Mona Lisa in at least three portraits. When Leonardo left Florence for the second time in 1508 and returned to Milan, four years of unfinished work on the portrait, mentioned by Vasari, had passed. After 1508, Leonardo must have extensively revised the work until it took its present form. This supports the theory that in this second version, Leonardo no longer had Lisa del Giocondo in mind but probably created an idealized female figure. Whether this happened after 1511 and again on the commission of Giuliano de' Medici, following the Pacifica Brandani theory, to give his grieving son a comforting image of a mother, or whether Leonardo revised the work on his own initiative, remains unclear. Overall, this is currently the simplest explanation for the history of the creation of the Mona Lisa. This does not rule out the possibility that contemporaneously with Leonardo's work on the painting, there were copies by students in his workshop. However, when objectively considering their painterly quality, these copies do not match Leonardo's Mona Lisa and are evidently imitations. They demonstrate how challenging it is for painters to imitate Leonardo's style. Mona Lisa del Prado, 1508-1519 The painting most likely originated in parallel with the Mona Lisa, as some overpaintings are exactly the same. Judging by the color palette, it is presumably a work of Leonardo's student Francesco Melzi Isleworth Mona Lisa, unknown artist The painting is done on canvas. However, Leonardo always painted on wooden panels. The style is also atypical for Leonardo When Leonardo began the portrait of the Mona Lisa in 1503, he was approximately 50 years old. Born and raised in Florence, he had been living in Milan since the age of 30. After completing "The Last Supper" in 1498, he was considered the greatest living artist. However, when the Duke of Milan was expelled by the French the following year, turbulent times began for Leonardo. He fled the war, sought new patrons in northern Italy, but eventually returned to Florence in the summer of 1500. Around 1501, he started the large-scale painting "The Virgin and Child with Saint Anne" and the "Madonna of the Yarnwinder" for a French court official. Influenced by his collaboration with the mathematician Luca Pacioli, he delved into mathematical studies during this time. The Virgin and Child with Saint Anne (Burlington House Cartoon), Leonardo da Vinci, about 1501 A study for the painting likely created around 1508, The Virgin and Child with Saint Anne Madonna with the Spindle, about 1501, Workshop of Leonardo da Vinci The work of a student of Leonardo was created for Florimond I. Robertet, one of the most influential financial officials of the French king The Virgin and Child with Saint Anne, Leonardo da Vinci, about 1502-1519 Leonardo likely worked on this painting simultaneously with the Mona Lisa. Both paintings remained in his possession until his last years Geometric Studies, Leonardo da Vinci, Codex Atlanticus (folio 258) The sheet examines the equality of areas in a circle divided according to integer proportions Leonardo's Bridge, Leonardo da Vinci, Codex Atlanticus (folio 258) The bridge is self-supporting and consists of individual loose tree trunks that need to be simply laid on top of each other, requiring no ropes or nails. Leonardo employed it when accompanying Cesare Borgia on a military campaign, and the troops needed to cross a river In the summer of 1502 until spring 1503, Leonardo accompanied Cesare Borgia, the son of the Pope, as a military engineer. Upon his return to Florence, he started the portrait of the Mona Lisa. In 1504, his father died, and Leonardo's illegitimate son was excluded from the inheritance. In the same year, he received the commission for his second major fresco, the "Battle of Anghiari," for the city parliament of Florence. The younger painter Michelangelo was to create an equally large painting on the opposite wall simultaneously, initiating a competition between the two artists. However, due to wet walls, the work progressed slowly and was eventually abandoned. In 1504, Raphael also came to Florence and painted portraits in the style of the Mona Lisa, inspired by Leonardo's painting. Study for the Battle of Anghiari (Tavola Doria), Leonardo da Vinci, around 1504 The painting was intended to be over 4 meters in height, larger than Leonardo's Last Supper. However, the battle painting was never completed Battle of Cascina (Copy by a student), Michelangelo, around 1504 The battle painting was on the opposite wall and also remained unfinished Leonardo undertook flight experiments on the Schwanenberg near Florence around 1505. They coincide with the time when the Mona Lisa was painted. Model of a Sail Glider, Codex Atlanticus (folio 860) Leonardo's analogy-based thinking is evident in the shape of the hull, reminiscent of a boat. He likely considered applying the principles of aviation to his underwater vessels, or vice versa From 1506, he commuted between Florence and Milan, and by 1508, he was living in Milan again. The portrait of Mona Lisa likely had less significance until then, as Leonardo focused on more prestigious commissions. Vasari claims it was still unfinished in 1508, and it probably received its final form after that year. According to de Beatis, the painting accompanied Leonardo to France in 1516 and remained there until his death in 1519 at Château du Clos Lucé. It is unclear what happened to the paintings that de Beatis saw with Leonardo. Leonardo's will does not mention any paintings, but it does include bequests to two of his pupils. Francesco Melzi received Leonardo's significant notebooks, other books, equipment, clothes, and gold. On the other hand, Salai received a property in Milan, which he had already leased from Leonardo. Salai's will indicates that he likely owned some of Leonardo's paintings. Salai's Will Salai died in 1524 at the age of about 44 in a duel, just a few years after Leonardo's death. His sisters and his widow subsequently contested the inheritance, which mainly consisted of valuable paintings. The notarial records list a painting titled "La Joconda," and since it is relatively highly valued in the document at 100 Scudo (175 Florin = 612.5 Gold), it is likely the Mona Lisa. Shortly thereafter, the French King Francis I must have acquired the painting. Salai's Sale of Paintings In 1999, French art historian Bertrand Jestaz published an essay about a rediscovered sales contract. He explains that the painting currently housed in the Louvre ended up in the royal collections in 1518 as part of a sale of some of Salai's paintings to King Francis I. The king paid Salai about 2604 Livres (approximately 651 Florin = 2.3 kg Gold), "for certain panel paintings that he gave to the king." Therefore, it is widely believed today that Leonardo gave the still unfinished paintings, including the Mona Lisa, to Salai about a year before he died. The paintings listed in Salai's will are presumed to be copies made by Salai. In the Possession of French Kings The exact circumstances of how the painting came into the possession of the French king remain uncertain to this day. However, Vasari reported in 1550 that the Mona Lisa was now at Fontainebleau Castle, an important hunting lodge of Francis I. The painting remained there until Louis XIV had it moved to Versailles around 1682. The French Revolution and Napoleon's Bedroom During the French Revolution in 1789, all paintings from the royal collection were transferred to the Louvre, and in 1793, the Mona Lisa was publicly exhibited for the first time. The painting may have remained there for only a few years because there is a legend that Napoleon had the painting brought to his bedroom in the Tuileries Palace around 1799. According to the legend, the portrait hung there until his exile in 1815. The Mona Lisa has been publicly displayed in the Louvre since at least 1815. Napoleon in his Study, Jacques-Louis David, 1812 According to legend, the Mona Lisa is said to have been in Napoleon's bedroom Portrait of Karl Marx, 1875 In this famous photograph, Karl Marx imitates both the posture of the Mona Lisa and the hand gesture particularly associated with Napoleon. Karl Marx founded the philosophical school of communism The Mona Lisa was stolen on August 21, 1911, by the Italian Vincenzo Peruggia in a sensational act from the Louvre. The Louvre Museum, fearing vandalism, had decided to secure all paintings behind a glass barrier by 1911. Peruggia was one of the glaziers involved in this project. Due to his work at the museum, he was well-known to the staff and familiar with the premises. On the day of the theft, a Monday when the Louvre was closed to the public, Peruggia entered the building in his work clothes, blending in with the staff. He went to the Mona Lisa and took advantage of an unobserved moment to remove the painting, initially placing it in a staircase where he took it out of the frame. The Mona Lisa, painted on a wooden panel, is relatively small (53 × 77cm), making it easy for Peruggia to conceal. He might have hidden it under his smock or wrapped it up, carrying it like a sheet of glass. Then he left the Louvre. The theft was only noticed the following day when a painter, who had been copying the Mona Lisa for some time, inquired about the painting. Peruggia viewed the theft as a patriotic act, intending to bring the painting to Italy, Leonardo da Vinci's homeland. The theft remained unsolved for two years. It was only when Peruggia attempted to sell the painting to the Uffizi Gallery in Florence that he was arrested during the planned handover. The painting was exhibited in several Italian cities for a few months before returning to the Louvre on December 31, 1913. Picasso and the Theft of the Mona Lisa For a while, the Spanish painter Pablo Picasso and his circle were suspected of being involved in the theft. Picasso lived in Paris at the time and was acquainted with Géry Pieret through his friend, the poet Apollinaire. Apollinaire and Pieret were friends, sometimes living together. Pieret was an occasional thief who stole valuable sculptures from the then barely secured Louvre and sold at least two of them to Apollinaire in 1907, who then passed them on to Picasso. Shortly after the theft of the Mona Lisa, Picasso returned the two sculptures and was questioned by the police, while Apollinaire was even arrested for two days. They were accused of being part of an international theft ring. Picasso was not charged further after the interrogation, and Apollinaire was acquitted in a subsequent trial due to a lack of evidence. World War II During World War II, France was occupied by Germany. Before the Germans took Paris, the Louvre, fearing theft or damage, conducted an elaborate operation to transport almost the entire art collection anonymously and sealed to Château de Chambord. The Mona Lisa was in an inconspicuous crate. During the war, the valuable painting was moved several times to different locations in France without falling into the possession of the German occupiers. Château de Chambord, around 1519-1547, Loire Valley, France The entire art collection of the Louvre was transferred to Chambord at the start of the war. Chambord is the most significant Renaissance castle in Europe. The design of the castle is attributed to Leonardo. At the center of the main building is a unique double-helix staircase With the end of the war, the Mona Lisa was able to return to the Louvre, where it was publicly displayed again from October 1947. Vandalism In 1956, an unknown individual poured acid on the painting, causing severe damage to the lower part of the image. In the same year, a visitor threw a stone at the painting, damaging the left elbow of the figure. Since then, the Mona Lisa has been behind bulletproof glass. The Mona Lisa in the USA In 1961, Jacqueline Kennedy, the wife of U.S. President John F. Kennedy, persuaded the then French President Charles de Gaulle to exhibit the painting in the United States. In an elaborate operation, the painting was transported across the Atlantic in January 1963 under tight security and exhibited at the National Gallery of Art in Washington, D.C., and shortly afterward at the Metropolitan Museum of Art in New York. The then-director of the museum, Thomas Hoving, wrote in his memoirs that the Mona Lisa was exposed to flowing water from an accidentally triggered sprinkler system overnight during the exhibition. However, since the painting was behind water-resistant bulletproof glass, the Mona Lisa remained undamaged. The Mona Lisa in Japan and Russia In 1974, there was a second international exhibition in Tokyo and Moscow. Vandalism In 2022, a visitor attempted to shatter the bulletproof glass of the Mona Lisa. As expected, he failed, but he smeared the glass with a cream pie. To approach the painting, he had disguised himself as a woman and sat in a wheelchair. He claimed that his motive was to draw attention to the environment. Public exhibition at the Louvre in Paris The painting is currently displayed in the largest hall of the Louvre in Paris, the Salle des États. The leading art historian and Leonardo expert Martin Kemp (Oxford, Harvard, Princeton) associates the Mona Lisa, specifically the right background of the painting, with the depiction of a deluge. This image analysis follows and elaborates on this view, recognizing the motif of water as the connecting element in the background. This perspective is justified by the interplay of trompe-l'oeil effects and complex yet clear geometric relationships of high symbolic value existing among prominent elements of the painting. After a general presentation of formal peculiarities of the painting, it becomes clear that Leonardo conceived the Mona Lisa closely tied to the motif of water and the hidden power within it. Correspondingly, symbolic connections are made to the two most famous floods. Firstly, Leonardo suggests a rearing water wave in the right background reminiscent of Noah's flood. He confirms the initially barely perceptible by using the proportions of Noah's Ark mentioned in the Bible for the lower third of the painting. Secondly, the painting reveals a simple but complex system of geometric relationships that ultimately refer to the Platonic solids. They are first described in Plato's book Timaeus. This book talks about the legendary city of Atlantis and its downfall. For this second aspect, it will be shown how much Leonardo's persona was equated with that of Plato by contemporary artists. Additionally, how Leonardo uses geometric relationships between prominent elements in the painting to guide the viewer's gaze to her hands, only to ultimately focus on the Mona Lisa's left eye. To clearly depict the geometric relationships that underpin these connections, the unframed version available on the Louvre's website was used for this analysis #. A lady in a three-quarter portrait is seated on a chair. The chair's back forms a semicircle, connected to the seat through small balusters, with five balusters visible. The chair is oriented to the left, and the lady, through a slight rotation of hip, shoulder, and head, faces left towards the viewer. While doing so, she looks slightly past the viewer to something behind them, smiling. Her hands are clasped one over the other on the left chairback. The left hand holds a brown blanket, draped over her legs. The index and middle fingers of the right hand are slightly spread. She wears a dark green dress with orange sleeves, finely gathered into folds. The dark green part of the dress is turned up at the sleeves and fastened at the shoulder. The seam at the neckline is intricately embroidered with orange stitches. The dress falls in fine waves due to the gathered seam. Her neck and neckline are uncovered, and she wears no jewelry. Her brown open hair cascades in fine curls from a center part down to her shoulders on both sides. Her hair is covered by a very long, nearly transparent veil. The veil is rolled down tow

structure On the right side as well, the Louvre's digital scan shows the same horizontal structure at the same height. It is better visible in Melzi's copy Mona Lisa Prado, Francesco Melzi, 1508-1519 In the contemporary copy by Melzi, the division at the halfway point of the visible part of the wall is also evident (gray and orange) At half the height of the wall, an isosceles triangle with interior angles of 30°, 30°, and 120° can be constructed (white-transparent area). Such a triangle is formed by the angle bisectors in an equilateral triangle. The apex of the triangle touches the golden ratio of the image height (orange horizontal line)From the left eye of the Mona Lisa, which is already emphasized by the perpendicular bisector, two lines can be drawn to the base of the isosceles triangle. This creates an equilateral triangle, meaning the interior angles are 60° (white diagonals)The distance from the eye to the apex of the isosceles triangle corresponds to the distance from the column bases to the lower edge of the image, i.e., the golden ratio of the image height (white central vertical line)These relationships may not be exact in terms of the fundamental aspect ratio of 2:3, but the points are so close together visually that chance is conceivable, yet a geometric-constructive intention is more likely. It is unlikely that the image composition was randomly chosen so that the marking of the triangle base appears exactly at the midpoint of the height of a wall in the background. Leonardo must have consciously divided the wall at that point. Collaboration with Luca Pacioli Leonardo and the significant mathematician Luca Pacioli were in close contact since at least 1498 when Pacioli began working for the Milanese court. In this period, Pacioli completed his book "Divina proportione" (around 1498), which deals with the golden ratio in nature and its application in art and architecture. Leonardo created numerous illustrations for this work, including drawings of the Platonic solids, such as the tetrahedron. These geometric shapes were depicted in a novel skeletal structure that highlighted the spatial relationships of the bodies. The intensive exploration of geometric studies continued with Leonardo from 1501, as evident from his notebooks and contemporary letters. Leonardo then commenced work on the portrait of the Mona Lisa in 1503. Due to financial constraints, Pacioli's book was only published in 1509. Animation VI: The equilateral triangle emerges when the image edge at half the height of the wall is connected to the left eye of the Mona Lisa. The center of the triangle lies on the golden ratio of the image height. The geometric arrangement strongly resembles the two-dimensional representation of a tetrahedron, one of the five Platonic solids Tetrahedron, Leonardo da Vinci, circa 1500 A page from the manuscript of Pacioli's book "Divina Proportione" ('Divine Proportion'). The 60 illustrations depict geometric solids in this entirely novel skeletal structure, greatly enhancing their clarity Luca Pacioli with an unknown student, Jacopo de Barbari, circa 1495 At the time of the painting, Leonardo was around 43 years old. Pacioli, depicted here in monastic robes, was a Franciscan. The Franciscans were a medieval monastic order founded by St. Francis of Assisi (1181-1226). Pacioli has drawn an equilateral triangle on a panel while gazing at a glass cuboctahedron. The mathematician Pacioli surely approached the Bible with a focus on numerical aspects as well Up to this point, only the right background landscape has been examined. It has been demonstrated that this landscape is threatened by a tidal wave, referencing the biblical flood narrative. The geometric construction in the lower third of the painting corresponds to this visual representation and incorporates the dimensions specified for Noah's Ark in the Bible. Building upon this, the left eye of the Mona Lisa, emphasized by an equilateral triangle, points to the center of the painting. With the observation that the painting exhibits some geometric peculiarities, let's now take a closer look at the left side of the image. Leonardo's paintings always reveal, in addition to the obvious representation, further hidden images that may be more or less challenging to discover. The techniques used for these depictions are collectively referred to as anamorphic images. Throughout his entire body of work, Leonardo demonstrates a playful engagement with the resemblance of images, not limited to his paintings alone. Study of the mouth, Leonardo da Vinci, Windsor, Royal Library (9)19055 verso A forward-facing mouth has been positioned in a way that forms the eyes of a face The Virgin and Child with Saint Anne, Leonardo da Vinci, about 1501 The legs of the rear Anna could also be the legs of a standing Mary The right leg of the child continues into the foot of Mary. The course of the lamb appears as the leg bone of the child. An expression of Leonardo's anatomical studies The Last Supper, Leonardo da Vinci, 1494-1498 The head of Doubting Thomas (on the left, called the Twin) appears to be emerging from the body of the other. John the Baptist (Detail, rotated precisely 30 degrees to the right, right half of the face covered), Leonardo da Vinci, about 1513-1519 The left half of the face looks directly at viewers On the other hand, if the left half of the face is covered, it becomes clear that the right half of the face is looking to the right. Both halves of the face appear to belong to two different individuals, independent of each other The Mona Lisa is often described with maternal qualities: gentle, warm-hearted, and caring. Few people are aware that Leonardo emphasizes this indistinct feeling through hidden images, among other things. The Paternal On the right side of the painting, the outline of an unnaturally falling, almost transparent veil can be discerned VII. In conjunction with her reddish-brown, wavy falling locks, the facial shape of a bearded, older man can be recognized, gazing reverently towards the lower left in the direction of the left pillar base (Mouseover). The head is smaller than that of the Mona Lisa, so it must be positioned behind her. The Child The hair of the Mona Lisa appears to fall down to her elbow over her right shoulder. Upon closer inspection, it becomes clear that the hair-like structure on her right shoulder is the heavily compressed transparent veil covering her head and shoulders. Nevertheless, the area of the right shoulder appears like a part of her hairstyle. There is an impression that the Mona Lisa is embraced by a younger child coming from the left edge of the painting, burying its face into her right side. Particularly impressive is the depiction of the right arm of the Mona Lisa, which now becomes the right arm of the child. Leonardo's painting started two years earlier but still unfinished in 1503, The Virgin and Child with Saint Anne, also plays with a distorted variation of the theme of father, mother, and child. Leonardo probably continued working on it around the same time as the Mona Lisa from 1508 onwards when he returned to Milan after eight tumultuous years. An older, bearded man gazes downward to the left at the base of the column A child buries its face in the side of a mother while embracing her Leonardo's The Virgin and Child with Saint Anne also has the proportion of 2:3. It likely took its current form around 1508 as well. The rear Anna appears androgynous, almost paternal Leonardo was revered by contemporary artists as an equivalent of Plato. Plato was a significant ancient Greek philosopher, a student of Socrates, and a teacher of Aristotle. He founded a school for higher education in Athens called the "Akademeia," located near the sanctuary of Akademos, from which the modern term "academy" is derived. Legend has it that there was an inscription above the entrance to the Academy: "No one should enter without knowledge of geometry". Plato sought to create a holistic synthesis of natural sciences, metaphysical ideas, ethical principles, and political theories. The book "Timaeus" (Italian "Timeo") One of Plato's most famous works is the book "Timaeus." It contains two themes whose connection is not immediately apparent. Firstly, it introduces the legendary city of Atlantis and vividly describes how it sank into the sea after a tremendous flood. Secondly, it explains the so-called Platonic solids, named after Plato. The connection between flood and geometry in "Timaeus" establishes a link with Leonardo's Mona Lisa. Raphael portrays Leonardo as Plato with Timaeus After giving the Mona Lisa its current appearance around 1508, Leonardo was depicted by the younger Raphael as Plato in "The School of Athens" (1510-1511). In the painting, Plato is holding the book "Timaeus." Raphael had seen the original version of the Mona Lisa in Leonardo's workshop in Florence a few years earlier and imitated it in three paintings. The School of Athens, Raphael, 1510-1511 The painting depicts the idealized construction site of St. Peter's Basilica. Additionally, four contemporary artists are portrayed as ancient figures who were involved in or will be involved in the construction of St. Peter's Basilica: Leonardo (the visionary), Bramante (the initial architect), Raphael (the second architect), and Michelangelo (the fourth architect) Leonardo is centrally depicted as Plato with an upward-pointing index finger (on the left). To the right of him is his student Aristotle, who cannot be attributed to any contemporary person Leonardo, portrayed as Plato, is holding the book "Timaeus" (Timaios). This significant work contains the first mention of the legendary city of Atlantis and describes its downfall. It also includes the explanation of the platonic solids The younger Raphael may have depicted Leonardo as Plato out of a general sense of respect, or it could also express a teacher-student relationship, where Leonardo's workshop was understood as an academy in the Platonic sense. Around 1500, during a brief stay in Venice, Leonardo himself created several drawings with geometric interlace patterns. In their center, Leonardo wrote "Leonardo Academia," surrounded by the word "Vici" (Latin for 'I have won'), drawing inspiration from Plato's Academy. Drawing of an interlace pattern, Leonardo da Vinci, around 1500 In the center, "LEONARDO ACADEMIA" surrounds the word "VICI" (Latin for 'won') in the red seal. Interestingly, "Vici" and Leonardo's surname Vinci share the same word root. The Latin "Vinci" is the passive form of "vincere," meaning 'to be conquered.' Mona Lisa (Detail of the hem) Geometric interlace is the connecting element in the three undoubtedly genuine female portraits by Leonardo. It is a play on the word "Vinci," the imperative form of the Latin/Italian "vincire" (not to be confused with "vincere"), which means 'to connect something.' However, it can also mean to captivate, in the sense of captivating the gaze. So, "Vinci" can be interpreted as "Captivate!" or "Connect!" As shown earlier (IV and V), the proportions in the lower third of the painting correspond to the side view of Noah's Ark. With this knowledge, the question arises whether the crossbeam above the entrance of the structure provides space for an inscription. According to legend, the entrance of Plato's Academy bore the inscription: "No one should enter without knowledge of geometry" The old man in the Mona Lisa's hair is looking at a compressed cube with the left column base, on which there is a compressed sphere VII. The column bases are more sharply defined on the left side than on the right side, which appears almost transparent, which additionally emphasizes it. The column bases are also in the golden ratio of the picture height. Together with the central parting of the Mona Lisa, the corners of the column bases form the perspective vanishing lines of Painting III. The old man is therefore not looking at precisely this point for no reason. He is inviting us to discover further geometric features of the painting. The child on the left now appears almost jocular, fleeing into his mother's arms in the face of this task. The Platonic solids are the tetrahedron, octahedron, cube, dodecahedron and icosahedron. Sphere, Leonardo da Vinci, around 1500, illustrations for Luca Pacioli's "Divina proportione" Tetrahedron Octahedron Cube Dodecahedron Icosahedron All five Platonic solids consist of just three basic shapes: equilateral triangle, square and regular pentagon. Each of these shapes has specific angles. Sorted according to their size, these are30°, 45°, 54°, 60°, 72°, 90°, 108° and 120°. Equilateral triangle The angles are 60°, 120° and 30° Square The angles are 90° and 45° Regular pentagon The angles are 108°, 72° and 54° Leonardo's pictorial constructions are strongly geometrical. Geometry was the predominant form of mathematics until Leonardo's time. Arithmetic, i.e. calculating with numbers, only gained importance in the course of the Renaissance (see Adam Ries). Leonardo's pictorial designs are based on proportions, angles and shapes. For the angles, he mainly used those resulting from the two-dimensional basic forms of the Platonic solids. In terms of proportions, he mainly used halves, thirds, quarters, eighths and the golden ratio. Since Leonardo as a painter recognized vision as the most important sense, eyes have an important function in the system of geometric relationships in his paintings. Some examples: Virgin of the Rocks, 1483-1486 The right eyes of the four figures (or the left eye of the boy Jesus, below right) can be connected by a circle.They also form triangles with symbolic angles: 45°, 90° and 45° (yellow triangle), as well as 30°, 60° and 90° (blue triangle).The apex of the upper triangle lies exactly to the right of the Madonna's eye. The depiction illustrates Thales' theorem according to which all triangles circumscribed by a semicircle are right-angled Lady with the Ermine, c. 1491 The golden section of the picture's height and width (orange lines) and the central perpendicular (red line) form an isosceles triangle of 30°, 120° and 30°.Its corners are at the stoat's right ear and both eyes La Belle Ferronière, around 1497 Two squares resting on the wall are half as high as the lady. Ribbons with fine knots are attached to the dress on the left shoulder. They form an isosceles triangle of 30°, 120° and 30°. The base of the triangle is at the golden ratio of the height of the lower right square The Last Supper, 1494-1498 The hands and head of Jesus form an equilateral triangle The painting is composed of a semicircle and a rectangle. The index finger of the right angel is halfway up the rectangle. In contrast to the circle around the right eyes shown above, here the left eyes are emphasized by quarters and eighths of the picture width (except for the Madonna's). Leonardo's pictorial designs are also extraordinarily artistic on a geometric level The Virgin and Child with Saint Anne The painting was cropped at the top and bottom at a later date.The missing parts have been added here (gray stripes at the top and bottom).The eyes are also located here at half, quarter and eighth of the picture height, and the boy's eye at the right quarter of the picture width. Mary's left eye is centered on a straight line between Anna's right eye and the boy's left eye. The position of the tree is also based on quarters and eighths (green shading) The bridge in the right background of the Mona Lisa consists of 3, 4 or 5 arches, which can no longer be determined beyond doubt due to a light line through four arches that may have been added later. It is interesting to note that the bridge is tilted almost exactly 5° to the top right (blue line). This is the same angle as that from the left column base to the tip on the left sleeve of Mona Lisa VIII. Both lines therefore run parallel. Detail of the bridge Three arches are clearly recognizable. A light line on the left could mean a 4th arch (or be a later overpainting).On the right, a 5th arch could span the sandy part of the bank.The irritating nature of the depiction is possibly intentional, as 3, 4 and 5 are symbolic numbers in classical geometry. They are known there as the "Pythagorean triple" (Pythagorean theorem). Geometry and architecture are closely linked As in his other paintings, Leonardo used the angles of the three basic forms of the Platonic solids for the construction of the Mona Lisa. The angles are formed by the geometric relationships of prominent elements in the painting. Of great importance is, besides the left eye of the Mona Lisa, especially the front right corner of the left pillar's base, which is the focal point of important geometric relationships. This also explains that the old bearded man in Mona Lisa's hair is looking at the pillar's base VII. Reference lines (from top to bottom)The half height of the wall was marked by Leonardo with a slight color change (lower gray and red line)Above it is the golden ratio of the image height, marking the base of both pillar bases (lower orange line)From the front right corner of the left pillar base, a 5° angle leads to a folded peak on the left sleeve of the Mona Lisa. This line runs parallel to the orientation of the bridge, which also shows a 5° upward tilt (blue diagonals)From the front right corner of the left pillar base, a 60° angle leads to the central parting of the Mona Lisa (left white diagonal) and forms, at the intersection with the vanishing line coming from the right pillar base, the horizon of the central perspective (upper white horizontal)A square can be placed on the rear edge of the wall between the midline and the right edge of the image. Its upper edge meets the midline where it is also intersected by the extension of the right horizon line (red square, blue diagonal top right)The golden ratio, divided again in the golden ratio of the image height, leads over both eyes of the Mona Lisa (upper orange line)60° angle (central angle equilateral hexagon)Front right corner of the left pillar base, central parting of the Mona Lisa, and folded peak on her left sleeve (mouseover, upper green angle)72° angle (central angle equilateral pentagon)Front right corner of the left pillar base, left eye of the Mona Lisa, and folded peak on her left sleeve (mouseover, blue angle)90° angle (central angle square)Left edge of the image at the upper wall edge, left upper corner of a square on the wall edge, right edge of the image at the upper wall edge (mouseover, red angle). The 90° angle intersects the beginning of the bridge on the right.120° angle (central angle equilateral triangle)Left edge of the image at half wall height, intersection of the golden ratio of the image height and the midline, right edge of the image at half wall height (mouseover, lower green angle)Equilateral triangleBased on half wall height with triangle tip in the left eye of the Mona Lisa (mouseover, white-transparent area)A special feature of the composition is the waterfall-like arrangement of the angles. Leonardo chose the central angles of regular hexagons, regular pentagons, squares, and equilateral triangles. The angles, increasing downward, finally lead to the base of an equilateral triangle, the tip of which intersects the golden ratio of the image height at the left eye. The relationships make it clear how important symbolic angles were for Leonardo's composition. Overall, it gives the impression that Leonardo designed the geometric relationships as an end in itself, as they do not make the composition itself more balanced. They are only recognizable with prior knowledge of the symbolism of ancient geometry, specifically the geometry of the basic forms of the Platonic solids. Regular 3, 4, 5 and 6-angles drawn in a circle in such a way that their bases are parallel. From the center of the circumcircle to the respective base, the center angles are created The center angles from outside to inside: 120° (yellow), 90° (red), 72° (green) and 60° (blue) Certain elements of the picture are connected by symbolic angles VIII. With values of 60°, 72°, 90° and 120°, they refer to the central angles of the basic forms of the Platonic solids, as well as that of the regular hexagon. They are arranged in such a way that they increase in size towards the bottom, almost falling downwards like a waterfall. They can be understood as a geometric expression of the motif of water, which determines the background of the picture. While the background on the right-hand side of the painting suggests a gigantic tidal wave, the background landscape on the left shows a much calmer body of water. It is much deeper than the one on the right and, in direct comparison, once again emphasizes the different nature of the left half of the painting. With the knowledge of the tidal wave symbolism on the right-hand side of the painting, a second level of representation can also be recognized here. In particular, the sharp separation of the blue of the water from the reddish area below invites closer observation. This creates the impression of a point of view that allows the viewer to look partly above and partly below the water. Similar to looking through diving goggles at the surface of the water. Schematic of a photograph showing half a water surface and the other half an underwater world. The image impression is known, for example, from the view through diving goggles or from glass boats The background of the right-hand side of the picture is reminiscent of the motif of a tidal wave Depiction of reddish corals in an underwater landscape, with the blue of the sky above.The water surface breaks in waves on a glass wall, which is held under water and behind which the camera is located Hercules, lifting the skin of the sea, asks Venus to wait a moment longer before awakening love, Salvador Dali, 1963 The famous surrealist painter Salvador Dalí took up the motif of the water ceiling in this painting. In his late work in particular, he imitated Renaissance paintings, especially those by Leonardo, Raphael and Michelangelo Salvador Dalí, Fundació Gala-Salvador Dalí, Figueres, 2021 In connection with Leonardo's inventions, people today mostly talk about his fascination with flying. Less well known is Leonardo's holistic endeavor to explore his environment. Leonardo designed a functional submarine and a leather diving suit with glass eye openings and a snorkeling system. He thus anticipated developments that were not developed again until 250 years later (first submarine: "Turtle", 1776, first functional diving suit with helmet diving device: around 1800, e.g. Augustus Siebe). The studies shown here are taken from a notebook written by Leonardo around 1480, around 25 years before the work on the Mona Lisa. Studies on an unsinkable boat, Paris Manuscripts (Manuscript B, folio 11) Leonardo is widely regarded as the inventor of the submarine The hull is already streamlined.Cavities were drawn to the right and left of the side walls.If these are filled with water, the boat sinks.If the water is squeezed out again, the boat rises again. The bow and stern compartments are shown above this Snorkeling system to supply a diver with fresh air, Codex Arundel (f. 21r)Above, the cork buoy floating on the surface of the water with two tubes leading to the diver's face. On the left, the spiral-reinforced connections of the breathing tubes Study sheet for naval warfare, (Codex Atlanticus, folio 909 verso)The breathing system of the diving suit is indicated by narrow lines at the top of the head.The weights hanging over the shoulders are intended to make it possible to walk across the seabed. The fact that the suit is waterproof is made clear by the trouser legs tied together at the bottom. The suit had glass sewn in at eye level to allow visibility underwater On the same sheet, Leonardo depicts a diver with an airbag strapped to his stomach. He is held in shape by steel straps.The airbag provides buoyancy and breathing air.It is reminiscent of rescue systems for submarine crews in the early 20th century Analogous to the downward-leading symbolic angles, the perplexing image of a vertically cut body of water enhances the association of an underwater world for the lower third of the painting. In the context of Leonardo's submarine inventions and the associated imaginative world, this even seems plausible. The hands of the Mona Lisa The central motif of the lower third of the painting is the hands of the Mona Lisa. They are overlaid in a very special way. A first indication of something special is marked by the golden ratio of the image width, which is located where the lower lines of the hands intersect (mouseover, orange vertical). Given what has been shown so far, it is not surprising that the fingers of the Mona Lisa are aligned with specific angles: 30°, 45°, and 60°. When these are connected, they appear against the background of an underwater landscape and, in conjunction with the fingers that are symmetric to each other in a very special way, they resemble a crab. The angles of the handsFrom the center of the horizontal golden ratio (orange horizontal), a 60° angle can be drawn to the ring finger of the left hand (white line). From its end, a 75° angle leads over the knuckles to the upper left, to the middle of the height between the lower edge of the screen and the lower wall edge. This creates a symbolical triangle with inner angles of 45°, 60°, and 75° (72° + 3), which is not further explained herethe blue lines of the crab have an angle of 45°. They form an M-shaped network of lines. Exactly through the center of the "M," the golden ratio of the image width passes (mouseover, orange vertical)The middle finger and index finger of the right hand are slightly spread apart, and the angle of the index finger is 30° (orange line). Now it takes only a little imagination to recognize the crab (red areas). Study of crabs, Leonardo da Vinci The crabs have four legs on each side and a strong grasping arm Between the fingers of the Mona Lisa runs the perpendicular bisector of the painting, which intersects, among other things, her left eye (mouseover, red line). Above the crab lies the triangle with the 120° angle, which now acts like a net hanging in the water. It seems to be suspended on the perpendicular bisector. It is in the nature of a crab to use its pincers as such. If the crab intersects the perpendicular bisector, the 120° triangle has a reason to rise upward. Without changing its shape, this triangle fits precisely at the upper edge of the painting, so that the 60° angle that initiated the construction of the crab in the lower triangle now exactly tangents its right half of the head.From the center of the base of the triangle, now located at the upper edge of the screen (white area), a triangle leads to the two lower corners of the painting (yellow lines). The upper angle of this triangle is above the left eye of the Mona Lisa and is 45°. It also lies exactly on the right side of the triangle recognized in VIII (mouseover, white lines). The geometric construction is extremely skillful here as well. The relationship between the 120° and 45° angles (upper and lower triangles) is computationally traceable: In a rectangle with dimensions of 2:3 (proportion of the painting), the base of a triangle aligned with the upper edge of 30°, 120°, and 30° marks a 45° angle to the left and right corners of the rectangle. However, the agreement is only exact in terms of drawing. Computationally, there is a very slight deviation of 0.3%: Height of the white triangle (30°, 120°, 30°): 0.577 Height of the yellow triangle (67.5°, 45°, 67.5°): 2.414 Total height of both triangles: 2.991 (instead of 3, due to the proportion of 2:3. This corresponds to a deviation of 2.991/3 = 99.7% 100% - 99.7% = 0.3% The painting is 79.4 cm high. A deviation of 0.3% would be 2.382 mm. The deviation is very small in relation. It corresponds to about two stroke widths and is therefore negligible. Especially since the painting does not exactly have a proportion of 2:3, but deviates very slightly (~0.672 instead of ~0.666 (2/3), a deviation of ~0.784%). It has become clear that Leonardo's Mona Lisa was clearly composed according to geometric proportions and angles. The left eye of the Mona Lisa seems to be of particular importance here, as it represents a center of the composition in several respects. Painting as an art form is the art of seeing, the sense associated with the eye. This is why the eye of the Mona Lisa is so emphasized in the painting. The complexity with which Leonardo links the geometric relationships based on it is extremely impressive. Overall, it seems to be a play with geometry, especially that of the Platonic solids. A division of the picture into left and right halves, along the central vertical, through the left eye of the Mona Lisa, represents a starting point for angles and proportions that form the basic shapes of the Platonic solids: regular 3-corner, 4-corner and 5-corner. Leonardo constructed these shapes in such a way that they each contain an angle or a proportion from another shape and thus refer to it. From this concatenation, a sequence can be derived which, after an initial division on the median perpendicular, leads from a 5-corner (along the median perpendicular), via a 3-corner (with the proportion of the golden section) to a 4-corner (after construction of a triangle). Division The first observation is that the left eye of the Mona Lisa is on the central vertical 5-corner The left eye is also emphasized by the golden ratio of the picture height. In addition, a 72° angle leads from the eye to the left column base and to her left shoulder. The 72° angle (central angle) and the golden ratio are related to the regular 5-corner 3-corner Half the height of the wall is the base of an equilateral triangle.The center of the circumcircle (center of gravity of the triangle) lies on the golden ratio of the picture height.Its radius corresponds to the minor of the golden ratio of the picture height 4-corner From the base of a triangle of 30°, 120° and 30° at the top of the picture, a 45° angle leads to the bottom of the picture.45° is the angle of the diagonal in a square