

# The Relationship between Art and Mathematics in the Renaissance: Please Center Take the Work of Leonardo Da Vinci for Example

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**Abstract.** During the Renaissance, both mathematics and art underwent significant development. This article focuses on an artist, who comes from that period, Leonardo da Vinci, who not only excels in painting, but also excels in multiple fields such as mathematics, science, architecture, anatomy, and more. This article mainly studies how mathematics and art are connected in Leonardo da Vinci's eyes. The article draws conclusions by searching for different references and observing da Vinci's works. In Leonardo da Vinci's eyes, he loved art, but mathematics was equally important to him. He studied mathematics and excelled in incorporating mathematical elements into his paintings. He invented many painting techniques related to mathematics, such as Aerial perspective, color perspective, invisible perspective, etc. These techniques make his works more natural and scientific. Through research, it was found that Leonardo da Vinci's proficient mastery of painting skills is related to his attitude toward mathematics. He attaches great importance to mathematics and has also conducted in-depth research. He is skilled in using mathematical principles to compose and create paintings, using mathematical relationships to enrich the visuals.

**Keywords:** Renaissance, Da Vinci, Mathematics, art.

## 1. Introduction

During the Renaissance, in order to better understand the relationship between art and mathematics, this article chooses to explore the relationship between mathematics and art in the eyes of the great Renaissance artist Leonardo da Vinci. By reading various literature materials, understand the mathematical principles he invented and how he applied mathematical elements to his own works. Through several classic works Leonardo da Vinci, attempts to understand art and mathematics Leonardo da Vinci's eyes, The relationship between these two subjects from Leonardo da Vinci's perspective. By watching his works, understanding the combination of mathematics and art, which are two different disciplines.

At present, there are some prospective studies on Leonardo da Vinci and his artistic studies on academic websites, and a small portion of them have studied mathematics and art in Leonardo da Vinci's eyes. However, the overview is relatively general and does not bring his classic works into his perspective for analysis. This article studies how Leonardo da Vinci's specific mathematical theory was specifically applied to some of his famous paintings.

## 2. The Development of Mathematics during the Renaissance

During the Renaissance, with the development of the economy, people's interest in physics and causal phenomena increased, and they developed a stronger desire to explore mathematics. Even during the Renaissance, the important concept of calculus emerged, indicating the stable development of mathematical theories during this period. People believe that the essence of science is mathematics. People try to view all things in the world with a more rational attitude, and in their eyes, some natural phenomena are no longer caused by God. They try to explain everything around them in a more scientific way. As long as they can solve problems with science and mathematics, they will no longer use God to explain them.

Europeans have discovered that nature is designed mathematically, and this design is a very harmonious and beautiful internal truth [1]. The development of mathematics also naturally influenced art and other disciplines, and artists were also influenced by some of the concepts of mathematics. They studied the ideas of mathematicians and attempted to not only pay attention to the appearance of things when drawing but more importantly, they also attempted to understand the essence of things through phenomena [1]. They will pay more attention to whether the painting conforms to reality, rather than just focusing on whether the work is beautiful.

### **3. The Fusion of Mathematics and Art in Da Vinci's Eyes**

#### **3.1. Biography**

Although Da Vinci did not have deep exposure to mathematics since childhood, he began to explore various fields such as anatomy, optics, dynamics, geology, mathematics, and so on after arriving in Milan in 1481 [2]. Da Vinci returned to Milan in 1513 and continued to study mathematics and other fields. He constantly learns mathematics, and he has a strong interest in it. Mathematics has a great attraction for him, and he wants to continue to delve deeper into it. He was learning computational methods, and he always kept asking questions to the teacher and often stumped them, indicating that he was very diligent and inquisitive, had a great interest in mathematics, and always kept delving into it.

Leonardo da Vinci believed that mathematics is a subject with certainty, with well-defined concepts and clear content classification [2]. It can be seen that he not only enjoys mathematics, but also devotes himself to research and has developed his own insights and experiences, and even invents some new techniques to fully integrate mathematics into his works. Not only did Leonardo da Vinci acknowledge his interest in mathematics, but others also recognized his achievements. Da Vinci was praised by Engels as "not only a great painter, but also a great mathematician, mechanist, and engineer." [3]. Da Vinci's interest in mathematics also led to many achievements in mathematics.

#### **3.2. Achievements**

Leonardo da Vinci's manuscripts contain a lot of mathematical content, among which the Codex Atlanticus, Madrid Manuscript, Hammer Manuscript, Foster Manuscript 1, Manuscript L, and other manuscripts have mathematical-related content with different emphases [4]. The mechanical, architectural, anatomical, physical, and other related content in the manuscript all reflect his unique insights into mathematics. He provided detailed definitions of concepts such as points, lines, faces, angles, squares, rectangles, diamonds, parallel lines, circles and their diameters and radii, triangles and their types in straight lines, arches, crescents, sickles, and leaf shapes in quadrilateral and polygonal curves [2]. He also rediscovered liquid pressure, put forward the principle of Communicating vessels, mastered the knowledge of human anatomy, studied physiology and medical mapping, and designed the first robot in human history. In addition, he also designed a variety of mechanical devices such as aircraft, parachutes, and machine guns, and supervised the Milan Fortress to apply springs to clock design [5]. He also incorporated mathematics into his works of art and invented a special perspective method for painting. Therefore, mathematics is extremely important in his eyes. He not only enjoys mathematics but also has achieved many achievements.

#### **3.3. Aesthetic Thought**

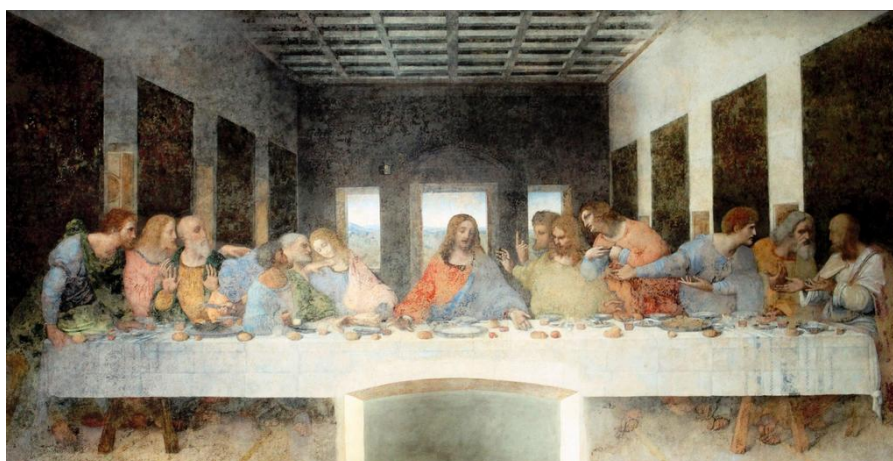
Da Vinci was a famous painter, whose aesthetic ideas originated from the artistic creation practice and scientific experiments of the Renaissance period. It was a theoretical improvement after thorough philosophical thinking, and the issues discussed were both specific and full of universal theoretical significance [5]. There is no doubt that Leonardo da Vinci loves art. He has created many world-famous works, such as The Mona Lisa, The Last Supper, The Virgin of the Rocks, and others works. At the same time, he continuously studies art and attempts to create his own aesthetic views. Leonardo da Vinci attaches great importance to the application of the principle of contrast in the same painting

[6]. He believes that this is a means of generating a strong visual beauty: among the same beautiful colors, direct contrast between colors is the most pleasing to the eye, such as the combination of black and white, which produces a distinct visual effect. Black clothes make the human skin appear whiter than before, while white clothes make the skin appear black. Da Vinci believed that painting was based on practice and science, and he believed that experience and practice were important. From his attitude towards mathematics and art can see that Leonardo da Vinci has many interests. He is not only good at art but also excels in many other fields, such as anatomy, science, architecture, mathematics, and so on. It can be seen that he believes that there must be a figure of mathematics in painting to ensure the accuracy and rigor of painting. He believes that works need to be authentic and must involve mathematical elements. A painter who relies solely on practice and visual judgment when painting without using reason is like a mirror, only copying what is presented in front of him, yet unaware of them [7]. That's why in his eyes, art should be combined with mathematics, which can make the picture more rational and realistic. Leonardo da Vinci has made many artistic achievements with mathematical elements, including his condensed line perspective, Aerial perspective, invisible perspective, and some unique light and shadow painting methods. In his paintings, he will analyze in detail how he uses these perspective techniques to make the picture more harmonious.

## 4. The Relationship between Mathematics and Art

### 4.1. Aerial Perspective and Focus Perspective

The first painting is The Last Supper, as shown in figure 1. It is 420 centimeters wide and 910 centimeters long. This painting depicts the scene of Jesus and his 12 disciples having dinner together [8]. This painting is not only admired in art but also contains many mathematical elements. For example, this painting uses the Aerial perspective method, which was created by Leonardo da Vinci. He studies the influence of the distance between different objects on their color. Da Vinci believed that although the color itself did not change, it would become different in people's eyes due to distance. This method only involves the distance of an object, which will be affected by the atmosphere. Close objects should be painted in warm colors, while distant objects should be painted in cool colors. In this painting, nearby objects such as Jesus and the Twelve Apostles use warm colors such as yellow, red, and brown. But distant objects such as rooms and distant landscapes are painted in cool tones, such as blue, black, gray, etc. The scenery in the outside window is blue, which is also one of the manifestations of Leonardo da Vinci's Aerial perspective method. Objects in the distance, especially the scenery, tend to be blue. In addition to color, in the composition of the picture, Jesus' hands are spread out to form a pyramid shape. The spire of the pyramid is placed in the middle window, and all eyes are focused on Jesus using a focal perspective. The walls on both sides further strengthen and highlight the focus of perspective [9].



**Fig 1.** The last supper [10]

#### 4.2. Aerial Perspective and Invisible Perspective

The second painting is the Mona Lisa, which is 53 cm long and 77 cm wide. This is a famous painting by Leonardo da Vinci. It is a portrait as shown in figure 2. Although on the surface this painting is only a portrait of a peaceful woman, there is actually a lot of mathematical involvement in this painting. The painting uses Aerial perspective and invisible perspective. In this painting, the woman in close proximity has a clear face and can see the folds on her clothes as well as the strands of her hair passing through the veil. But in the background can only vaguely see some mountains and rivers, unable to see their patterns clearly, and the objects behind become less clear. This is an application of the invisible perspective, whose principle is that the closer the object is, the clearer it is to see, and the farther it is, the less clear it is to see. Concealed perspective cleverly utilizes mathematical principles. Considering the issue of human perspective and object proximity.

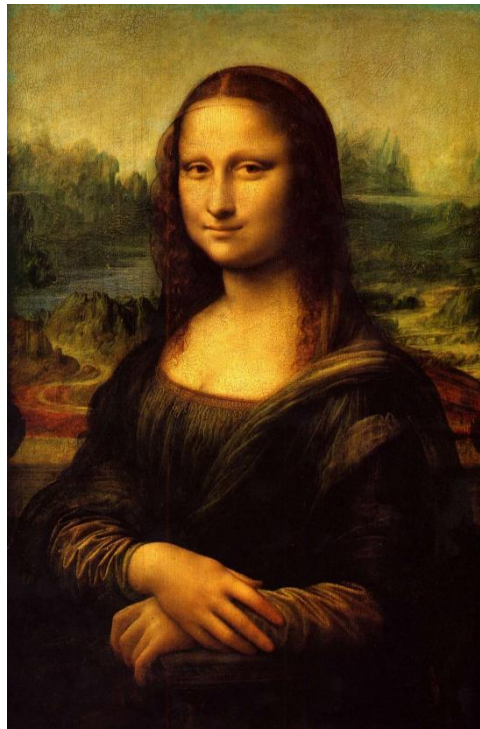


Fig 2. Mona Lisa [11]

#### 4.3. Concealed Perspective

The third painting is 'The Virgin Mary of the Rock', which is 198 centimeters long and 123 centimeters wide. It is an altar painting as shown in figure 3. In the picture, four people form a circle, with rocks and other backgrounds behind them. This painting uses more mathematical elements, such as Aerial perspective, color perspective, and concealed perspective. Leonardo da Vinci's basic understanding of Aerial perspective is that since any object has universal reflection not can see the original color of the object with eyes [12]. Near objects have more warm hues, while far objects have more cool hues. In Da Vinci's paintings, the four characters are brighter, while the mountains and waters behind them are more blue. At the same time, Leonardo da Vinci applied the triangle stability rule in mathematics to form a triangular composition of four people, making the picture look more stable. The background is a deep rock cave, dotted with flowers and plants. The light source in the upper left is balanced with the sense of weight in the lower right, which is widely adopted by later artists. At the same time, it organically combines the characters with the scenery, giving the entire painting a unique poetic flavor [9]. In this painting cannot see the clear outline of the characters because it uses Leonardo da Vinci's "halo method". Leonardo da Vinci believed that a clear outline of a person would make the picture appear unreal, so the principle of perspective should be used correctly.



## 5. Conclusion

During the Renaissance, both art and mathematics underwent greater development, and mathematics to some extent influenced the development of art. Art became more rational than before, and artists attempted to pay more attention to reality. During this period, the famous artist Leonardo da Vinci was not only good at art but also incorporated mathematical elements into his artworks. He invented new perspective methods: Aerial perspective, concealed perspective, and concealed perspective. By analyzing Leonardo da Vinci's paintings can understand how he specifically applied mathematics to his own paintings. This study found that the relationship between mathematics and art is closely connected, clarifying how mathematics is integrated into artistic works. In future research, it is not only necessary to explore the relationship between mathematics and art during the Renaissance but also to pay attention to the connection between art and other disciplines, explore how they are integrated together, and explore whether other artists have integrated mathematics into their own paintings, exploring the relationship between art and science during the Renaissance from multiple perspectives.

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