

The Scientific of Renaissance Artworks - Based on Dürer and Leonardo da Vinci's Work

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Abstract. From the second half of the 14th century to the end of the 16th century, Western and Central European countries witnessed a revolutionary movement in cultural thought, the Renaissance, which was guided by humanism and a human-centred world view. The works of art were transformed by this humanist ideology, and the achievements of science were combined with the use of scientific theories such as perspective, mathematics and anatomy to make their works more relevant to their time. The use of scientific theories underpinned the development of Renaissance painting as a whole. The relationship between Renaissance works and science is explored through an analysis of typical Renaissance works by Dürer and Leonardo da Vinci. This paper will discuss Dürer and Leonardo da Vinci's work and its connection to science. It will discuss how Dürer used the golden ratio in *Adam and Eve* and how Dürer linked the human body to geometry to demonstrate his profound study of mathematics in his book *The Four Books of Human Proportions*. At the same time, this paper will discuss how Leonardo da Vinci applied his study of human proportions and perspective to painting. The study finds that the study of the golden ratio in these works has implications for the creation of today's graphic design students.

Keywords: Renaissance, scientific, Dürer, Leonardo da Vinci.

1. Introduction

Renaissance artworks flourished under the influence of humanist ideas as well as the scientific method. The guiding ideology of the Renaissance was humanism, which advocated a human-centred approach. They demanded that literature and art express human thought and feeling, that science work for the welfare of life and that education develops the human personality, which entailed the liberation of human feelings, thoughts and wisdom from theology [1]. It was under this guiding ideology that Renaissance art gradually developed. Painters combined science and art, and their works reflected the scientific nature of their work, which had a distinctive character for the period. In particular, the principles of mathematical and geometric knowledge play an important role in Dürer's art. Throughout his life, Dürer produced a large number of figures with different human proportions. In his manuscript sketches and notes, Dürer would make copious notes of his own random thoughts and precise measurements as a means of studying the laws of proportion and the beauty of different human proportions in miniature [2]. In his artwork *Adam and Eve*, he depicted Adam and Eve as having the perfect proportions, based on scientific theories, so that the supple bodies of the figures appear to have some structural solidity, and the raised arms are striving to show the elegance and rhythm of classical posture [3]. In his book, he also provides an in-depth study of the golden ratio, which became the peak of the theory of human proportions and still influences artists and designers today. Leonardo was also a multi-tasker, creating art as well as conducting scientific research such as anatomical studies. In *The Vitruvian Man*, a nude male stands in an overlapping circle and square, somewhat stereotypically upright, with his arms held horizontally and upwards, and his legs held together in an upright and separate position. On closer inspection, the figure is not presented in just two standing positions, but sixteen different standing positions can be derived from the different combinations of arm and leg movements on either side of the body, so that the perfect proportions of the figure and the rationality of the number are harmoniously combined. Leonardo combines classical culture, draughtsmanship and complex knowledge of natural science, and the interplay of art and science

makes for a complex and profound conception of Renaissance humanism. Outstanding works of art must contain the laws of natural science [4].

All discussions of the role of science in Renaissance art today are broad, and while there is a great deal of abstract generalisation about science and art in general terms, there is a relative lack of specific exploratory studies of examples and no specific studies of science and art design in relation to each other. In order to study the science of Renaissance artworks, it should be important to add an understanding of the cultural details of the Renaissance, and how the scientific theoretical guidance underlying Renaissance works, such as the golden ratio and perspective, influenced the field of graphic design today. How does it affect the practice of today's graphic design students? An exploration of these questions is highly relevant to the study of the scientific nature of Renaissance works. In a theoretical sense, this study will depart from the current analysis of the articulation between the general direction of science and art, and provide a focused study of science and art design. It reflects the dialectical relationship between them and to a certain extent complements the relevant research on the importance of science to art. In a practical sense, the paper explores and summarises the existence of the golden ratio in art and design, and provides an opportunity for today's graphic design students to use this principle in practice to express the integration of reason and sensibility.

The study of science by Dürer and Leonardo da Vinci, among others, drove the development of Renaissance art, showing the scientific nature in their works, with far-reaching and lasting effects. In doing this, it will demonstrate the important connection between Renaissance artworks and science.

2. Dürer's Artwork and Its Scientificity

In the Germanic region, the spirit of the Italian Renaissance was also quietly changing the mindset of artists and the face of art [5]. Dürer was a pioneer and representative of this movement of artistic change. In the German region where Dürer lived, the painting was often naturalistic. On the other hand, Italian Renaissance art sought realism and objectivity in form, and their painting was based on the formal beauty of realistic and clear forms. During the Renaissance, there was no strict boundary between art and science, and artists began to think about using mathematical methods to show spatial relationships on a two-dimensional plane, using science to rationally reproduce the reality of what people saw, which was an essential feature of the art of this period. This emphasis on scientific rationality in art profoundly influenced Dürer [6].

2.1. Adam and Eve

In 1504 Dürer completed the etching of *Adam and Eve*. In this print, Dürer uses two metaphorically rich figures as examples of the ideal human form, no longer drawn traditionally, according to experience, but based on scientific theoretical guidance [7]. He depicts *Adam and Eve* before the Fall as possessing the perfect human proportions through the accumulation of human proportions, measurement doctrine and the study of a natural experience [8]. The figures of *Adam and Eve* are based on Dürer's study of the classical Italian human body: Adam from Apollo and Eve from Venus. The proportions of both figures are based on Vitruvius' rules of human proportion. For example, Adam's head is an eighth of his body length, his chin to hairline is a tenth of his body length, his chest is a sixth of his body length, and his forearms are a quarter of his body length.

2.2. Another Version of Adam and Eve

And after 1507, Dürer returned to Nuremberg, producing another version of *Adam and Eve* in oil. Unlike the previous prints, this one shows Adam and Eve in life-size form, with Dürer giving greater prominence to the most important figures of Adam and Eve themselves and then ignoring other backgrounds and accompaniments [9]. In the scene, Eve is youthful and spirited, walking briskly and cautiously forward; Adam is hapless, his mouth slightly open as if to say something. Compared with the previous *Adam and Eve* of 1504, *Adam and Eve* appear softer, slimmer and lighter in the oil version, their postures echo each other, and their bodies are contoured with elasticity. The proportions

of the figures have changed, with the head being 1/9th of the length of the body. Instead of being painstakingly constructed, the figures' bodies appear natural and authentic. This change responds to Dürer's Northern Gothic tradition and the application of a newly constructed classical form.

The differences between the two versions of *Adam and Eve* also reflect Dürer's understanding of the spirit of the Renaissance. Before his trip to Italy, Dürer had been exploring the timelessness of art under the empiricism of his Northern Gothic tradition, and his artistic perception began with concrete, intuitive phenomena. While grasping the beauty of the human body rationally through science, Dürer was also acutely aware of the irrational nature of artistic beauty and the rigid rules of mathematics and science that could lead it to rigidity. Unlike the Italian Renaissance concept of ideal beauty, Dürer was more interested in establishing the harmonious proportions of the human appearance and a sense of natural realism. In his paintings, the abstract nature of human beauty and the sensual nature of the form are closely linked.

2.3. Four Books on Human Proportion

As a craftsman and an artist, Dürer possessed not only an exquisite skill in painting but also a wealth of scientific knowledge and boundless creativity. The principles of science, especially mathematics and geometry, played an essential role in Dürer's art. Throughout his life, he produced many figures with varying proportions. In his manuscript sketches and notes, Dürer would make copious notes of his random thoughts and precise measurements as a means of studying the laws of proportion and the beauty of the different proportions of the human body in miniature [10]. In his book *Four Books on Human Proportion*, he uses the principles of proportion to depict the human body in a sophisticated manner. The book trained painters in geometric drawing and enhanced their understanding of natural science. It had a profound influence on the development of later art [11]. Through his work on this book, Dürer furthered his understanding of form and aesthetics. Dürer's life was a tireless pursuit of 'beauty' and 'nature', embodying his pursuit of authenticity and rationality in painting while also aspiring to the embodiment of sensuality and the painter's intuition and feeling in the process of painting.

3. Leonardo da Vinci's Artwork and Its Scientificity

Born in April 1452 in the small town of Vinci near Tuscany, Leonardo da Vinci apprenticed under the famous artist Verrocchio from the age of 14. At the same time, he quickly rose to prominence in the field of art. In the light of the humanist and rational spirit of the Renaissance, artists were keen to break away from the god-centred artistic formulae of the medieval tradition and to establish a new and unique concept of artistic naturalism [12]. The all-round talent of Leonardo, who created art as well as scientific research such as anatomical studies, also allowed him to combine classical culture, draughtsmanship and complex knowledge of natural science, and the intersection of art and science made Da Vinci's identity as an artist and his conception of humanism complex and profound.

3.1. The Vitruvian Man

The Vitruvian Man is a sketchy portrait of a human body by Leonardo da Vinci, executed around 1490. It shows a nude male standing in a section where a circle and a square overlap, with the man's body somewhat stereotypically upright, his arms held in a horizontal and uplifted position, and his legs showing a movement of standing upright and apart together. On closer inspection, the figure is not presented in just two standing positions, but sixteen different standing positions can be derived from the different combinations of arm and leg movements on either side of the body, so that the perfect proportions of the figure and the rationality of the number are harmoniously combined [13].

The Vitruvian Man was based on the rules of human proportions of the ancient Roman architect Vitruvius. In his magnum opus, Vitruvius recorded his research into the proportions of the human body, culminating in the writing of the 'perfect human' proportions of the classical era. Vitruvius used the human body as a measurement tool, using the length of body parts as the unit of measurement to

establish proportional relationships [14]. He estimated that the length of the head, measured from the chin to the top of the head, was equal to one-eighth of the length of the body, while the length of the face, measured from the chin to the top of the forehead, and the length of the hand, measured from the wrist to the tip of the middle finger, were each estimated to be one-tenth of the total length of the body. One-quarter of the animal's length is from the centre of the chest to the top of the head. Human feet measure one-quarter of an arm's length and one-sixth of the body's height. Vitruvius also thought that the navel served as the body's central point. The fingers and toes of a lying person can be moved to match the perimeter of a circle with their limbs spread out and the navel at its centre. In addition, a square can be found on this circle's equator. This is due to the fact that the distance between an upright person's feet and the top of their head is equal to the length of their spread arms.

Vitruvius's descriptions of the human body's proportions were not precisely adhered to, but Leonardo da Vinci proceeded to develop and build on them. Leonardo da Vinci left tangent marks with a ruler and ruler on important human body parts including the knee joints, chest, and shoulders in this incredibly symmetrical depiction of the human body. These joints serve as the separating lines for the human body's proportionate relationship. In the image, the circle is encircled by the bottom edge of the square, the figure is in the middle of the area where the two objects overlap, his highest point is perpendicular to the square's upper line, and the tangent point is also the upper line's halfway, and the two close together. Step on the bottom of the square and exactly coincide with the midpoint of the circle tangent to the bottom line of the square. When looking at the separated legs and arms in the picture, the soles of the characters' feet meet the circle, and the arms are raised at the same height as the top of the head, and meet the intersection of the square and the circle [15]. The man depicted in this sketch is recognised worldwide as having the perfect golden ratio of the human body. To da Vinci, painting is a noble visual art, which is filled with mathematical rigorous logic inside, such as perspective, proportion, etc. But he also thinks that painting is above mathematics, because painting can show the natural aesthetic law outside the fixed mathematical logic.

3.2. Annunciation

Another of his works, *Annunciation*, also reflects the scientific nature of the Renaissance. Leonardo's horizontal composition was intended to open up the view to show the beautiful aristocratic courtyard life. He chose a symmetrical form, showing Mary reading calmly in the courtyard and the angel kneeling on the grass to convey the holy message. Although Mary appears calm in this situation, her retracted left hand indicates that she is internally shocked by the angel's unexpected pronouncement. She appears uncertain of herself and wonders if she misheard what the angel said [16].

The impressive architecture of the mansion and the intricately carved table in front of Mary are meticulously examined in perspective while the spacious, orderly, and lovely courtyard is viewed from a scientific angle. Following extensive practise, Leonardo painted the folds of clothing on the two figures. All of this was carried out in an effort to accurately reflect objects on the painting plane, but it also displays the artist's early painting prejudices. Although this is an early work by Leonardo da Vinci, it has a strong poetic atmosphere, albeit with a slightly more nuanced and cumbersome expression. The basic painting style and techniques have begun to develop [17]. For example, the composition, the use of accurate perspective, the use of rendering, light and dark, and the use of real and imaginary techniques are all very natural and appropriate. The pine and cypress, the vibrant grass and trees, the light blue sky and the beautiful scenery of rocks and flowing water and the boats starting to work in the lake in the distance form the background of the painting, which shows that the painter has paid attention to the expression of the airy atmosphere in his depiction of the landscape, showing that Leonardo da Vinci was committed to solving the dialectical relationship between the realistic domain and the typical processing from the very beginning. The background, however, gives the impression of presence but not clarity, thus highlighting the two main characters in the picture well, indicating a technique of near-reality and far-reality in the painting. The scientific technique of focused perspective is used to depict the spacious, orderly, and lovely courtyard. The mansion's

beautiful architecture and the carved table in front of Mary's heels have both undergone rigorous perspective analysis [18]. This, together with the technique of close solidity and distant imagery, gives a sense of space and extension to the painting. Da Vinci's use of contrasting light and dark in his painting is also first-rate [19]. The background in the scene is somewhat dark, and the ground of the grass in the garden in the near distance is somewhat dark. Still, the angel and the Virgin are illuminated by the light all over their bodies. The dynamics of their expressions are apparent, so the main character is differentiated from and harmonised with the tones of his surroundings throughout the scene in just the right way. The figures and the outlines of the objects are very clearly depicted. The folds of the clothing on the two figures have been affirmed after a great deal of practice and are appropriately and generously dressed, highlighting the figures' image and status [20]. The painting is still a space of colour and depth. This is done in the quest for accuracy in reflecting things on a pictorial plane, but it also reveals the artist's early pictorial stereotypes.

4. Conclusion

Given the dialectical relationship between science and art, coupled with the lack of research related to the scientific nature of Renaissance works, this paper provides a targeted study of science and the Renaissance works of Dürer and Leonardo da Vinci, complementing and promoting it to a certain extent, while also attempting to explore the scientific principles present in their works. It offers viable suggestions for modern graphic design student practice to express the integration of reason and sensibility by virtue of mathematical geometric thinking.

In the course of the practical study, the author has adopted a range of appropriate and scientific research methods. Firstly, a more accurate control of the current state and context of the study is provided through a literature analysis method. Then, the author analyses the golden ratio and geometry in Dürer's *Adam and Eve* and *Four Books on Human Proportion* and the works of Leonardo da Vinci. By virtue of analyzing and comparing them one by one, a preliminary conclusion is drawn that Renaissance works are scientific in nature. Finally, by adopting an inductive approach and combining theories related to human proportion, perspective and geometry, after analyzing specific works, a longitudinal and in-depth analysis and comparison is made, concluding that the golden ratio, geometry and perspective studied during the Renaissance period are relevant to today's graphic design student practice has relevance.

There are also many categories in graphic design that cleverly use the golden ratio and have achieved good results, in graphic design such as logo design, poster design and web design by virtue of the influence of the golden ratio. In the composition process, the efficiency and impact of the work are improved by virtue of a rigorous layout, such as placing important content in the golden ratio of the image. A further test of the designer's own aesthetic refinement is the need to use techniques such as spirals and proportional division to aid design. Proportional relationships and geometric shapes are inseparable from the outset in the design of picture composition. This is why graphic design students are now beginning to focus on its practical application in order to achieve good visual effects and improve the competitiveness of their work.

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