

Science of Movement in Painting Masterpieces

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Abstract: Introduction. Sciences and arts are often considered as different domains that could not be connected in teaching activities. For instance, painting masterpieces are highly regarded from pictorial and art movement point of view, but not for their significance in physics and particularly in science of movement. The aim of this study was then to analyse four different painting masterpieces through both science of movement and the art movements.

Methods. Two paintings were examined for their relevance in kinetics, "A man lifting a sake barrel" (circa 1804-1818) by Katsushika Hokusai and "The athlete" (1930) by Camille Bombois that shows a lifter with dumbbells raised above the head. The weights of the sake barrel in Hokusai's painting and of iron dumbbell in Bombois's painting were estimated from their dimensions and the density of respectively sake and iron. These weights were then compared to the possible lifting capabilities of adult man. Two other paintings were examined for their relevance in kinematics and balance capabilities, "The circus" by Georges Seurat that shows an acrobat standing on a horse running in a circle track of a circus and "The birth of Venus" by Sandro Botticelli that shows "Venus" standing on a shell that is floating on the sea.

Results. According to their sizes and density, the weights of the sake barrel in Hokusai's painting and of the iron dumbbells in Bombois's painting were estimated to respectively 105 kg and 714 kg. In Seurat's painting the body of the acrobat makes an angle of 30° with the vertical direction. Assuming that the radius of a standard circus track was about 13 m, the velocity of the horse should be 19 km/h in order to maintain the balance of the acrobat. In Botticelli's painting, the centre of mass of the body of Venus is clearly not vertically aligned with the support foot and Venus is not well balanced and just falling.

Discussion. In Hokusai's painting the 105 kg of the sake barrel is compatible with the maximal lifting capability of maximum 120 – 150 kg usually reported for adult man, and support the accuracy of the descriptions of daily life claimed by Hokusai in the Edo period. On the contrary the 714 kg of the dumbbells of Bombois's painting are clearly not realistic but in agreement with the naïve vision (or Primitivism art) of this painter. In Seurat's painting the acrobat balance is compatible with the possible running velocity of horses in circus, and could be related to the "Pointillism art" developed by Seurat in order to represent the reality from physics laws of light. The Venus is of Botticelli is a typical example of the theoretical beauty painted by this "Renaissance" artist, and it does not have to be real and compatible with anatomy and physics laws.

Keywords: *Paintings Masterpieces; Biomechanics; Movement*

I. INTRODUCTION

Sciences and arts are often considered as different domains that could not be connected in teaching activities. For instance, painting masterpieces are highly regarded from pictorial and art movement point of view, but not for their significance in physics and particularly in science of movement.

The aim of this study was then to analyse four different painting masterpieces through both science of movement and the art movements points of view.

II. METHODS

Two paintings were examined for their relevance in kinetics, "A man lifting a sake barrel" (circa 1804-1818) by Katsushika Hokusai and "The athlete" (1930) by Camille Bombois that shows a lifter with dumbbells raised above the head. The weights of the sake barrel in Hokusai's painting and of iron dumbbell in Bombois's painting were estimated from their dimensions and the density of respectively sake and cast iron. These weights were then compared to the possible lifting capabilities of adult man. Two other paintings were examined for their relevance in kinematics and balance capabilities, "The circus" by Georges

Seurat that shows an acrobat standing on a horse running in a circle track of a circus and "The birth of Venus" by Sandro Botticelli that shows "Venus" standing on a shell that is floating on the sea.

III. RESULTS

1) Camille Bombois was a stocky and muscular man. Thanks to its physical potential, he held successively labourer navy, wrestler professions. He was also showing "Hercules" activities in a circus. Along with these physical trades, he practiced drawing and painting. From 1922, he dedicated himself entirely to painting. His paintings describe naïvely his experience with the people he meets and with activities a practiced in his daily life.

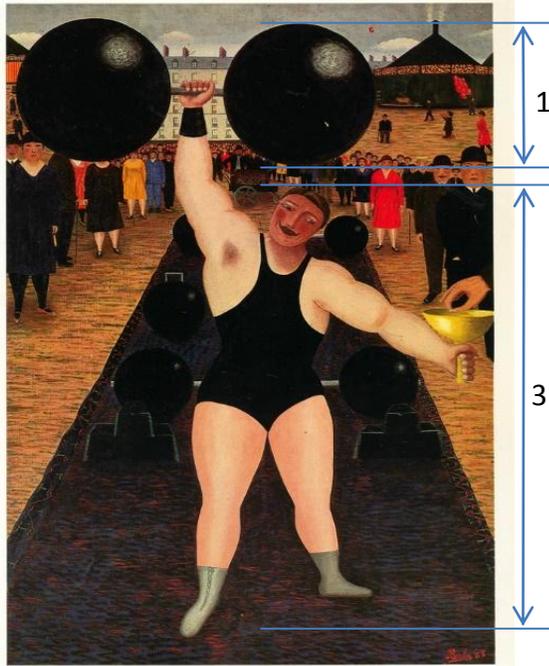


Fig. 1. "The athlete" by Camille Bombois, 1930.

He is probably the Hercules of fair that we admire in his painting "The athlete" in 1930. In this painting, he maintains an iron dumbbell at the end of his right arm. But was this performance realistic? To answer that question we need to estimate the mass of the dumbbell. Ferdinand Florent Fels, journalist and writer for French art magazine, reports that Camille Bombois is "medium-sized but has Herculean stature". Taking a Bombois's height of 1.74 m we can then estimate that the diameter of the balls is of about 1/3 the size of Camille Bombois, i.e. about 0.58 m. Assuming that dumbbells at that time were made of cast iron we can then calculate that the Bombois dumbbell "only" had a mass of about 714 kg.

2) In the beginning of 19th century, the Japanese artist Hokusai had also illustrated scenes of daily life, with unparalleled realism and finesse. One of these scenes is a "man lifting a barrel of sake."



Fig. 2. "Man lifting a barrel of sake" by Katsushika Hokusai, between 1804 and 1818.

Knowing that in the 18th century the Japanese height was about 1.50 we can estimate the length of the barrel raised was about 0.6 m and that its radius of about 0.24 m (about 40% of the length). With a barrel of sake at 15 percent alcohol a mass of about 105 kg can be calculated for the barrel full of sake.

3) In the painting "The circus", Georges Seurat illustrates the movement, rhythm, lights and colours experienced in circus shows at the end of the 19th century. At that time great circus acts were performed by squires in circus rings of about 7.5 meters radius (corresponding the length of the whip or the trainer and to reasonable dimensions for circus tent). In order to counterbalance the centrifugal force due to the curved path of the horse, the squire of the painting inclines her body of about 28° from the vertical direction (indicated by spectators).

Knowing the inclination of the squire and the radius of the ring and applying kinetics of rotational movement it is then possible to calculate the radial (centripetal) acceleration and the running velocity of the horse that are necessary to maintain the squire in equilibrium. For an inclination of 28° the radial acceleration of squire should be 5.3 m.s⁻² and the horse velocity of 2 m/s (or 7.2 km/h or 4.5 mph).

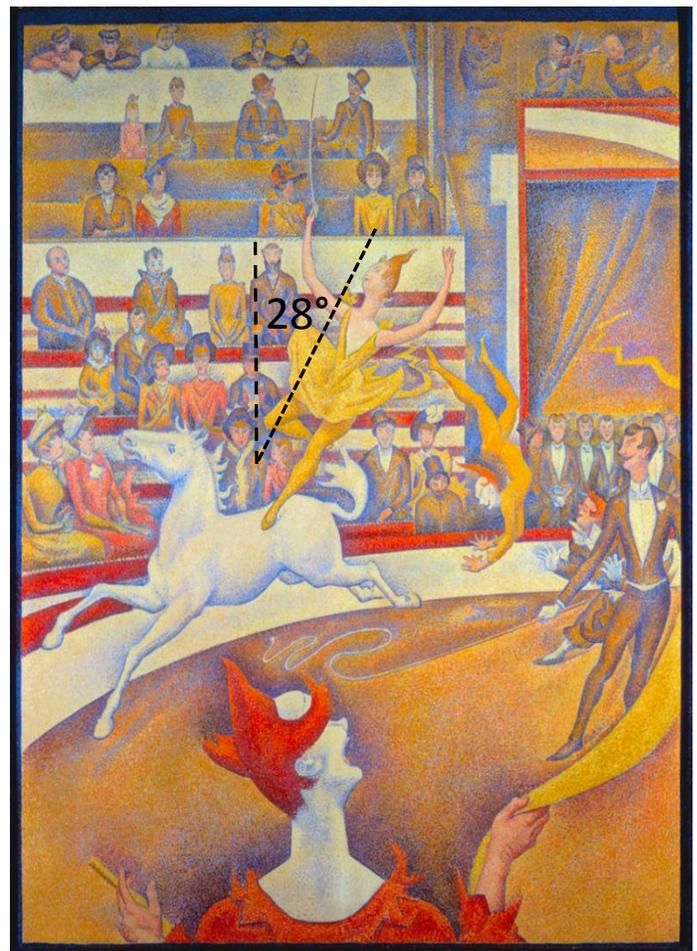


Fig. 3. « The circus » by George Seurat, 1891.

4) In one of the most famous paintings of Sandro Botticelli, "The Venus" is emerging from the waters, standing in a giant shell that is floating on the sea agitated by the wind. Her posture is a "contrapposto", a typical posture from the ancient Greek statues: her hips are in an inclination opposite to her shoulders. The

“contraposto” highlights her slender and graceful figure. To her left, Zephyr is blowing the soft wind of spring. Air, represented by clear straight lines, escapes from his inflated cheeks. Venus seems to wake up from a dream and to be in perfect balance with the surrounding world.



Fig. 4. « The Venus » by Sandro Botticelli, 1884-1885.

We could also examine the balance of Venus from a mechanical point of view. Because of Zephyr's wind, the upper part of the body of Venus is pushed to the right part of the scene. Venus could compensate the wind force by tilting his body to the left, but due to her “contrapposto” attitude, she is doing exactly the opposite. The right foot, which support the body weight, is standing to the left of the centre of mass of the body of Venus (corresponding approximately to the navel of Venus). Therefore, an additional clockwise torque is exerted by the combined actions of shell reaction force and body weight. Venus is certainly falling! Fortunately, to the right side of Venus, the spring divinity will cover her nudity and probably will help her to recover her stability.

DISCUSSION

In Hokusai's painting the 105 kg of the sake barrel is compatible with the maximal lifting capability of maximum 120 – 150 kg usually reported for adult man, and support the accuracy of the

descriptions of daily life claimed by Hokusai in the Edo period. On the contrary the 714 kg of the dumbbells of Bombois's painting are clearly not realistic but in agreement with the naïve vision (or Primitivism art) of this painter.

In Seurat's painting the acrobat balance is compatible with the possible running (but not galloping) velocity of horses in circus, and could be related to the “Pointillism art” developed by Seurat in order to represent the reality from physics laws of light. The Venus of Botticelli is a typical example of the theoretical beauty painted by this “Renaissance” artist, and it does not have to be real and compatible with anatomy and physics laws.

CONCLUSION

Painting masterpieces could be considered from both art and science perspective and these combined approaches could be also a source of original interdisciplinary researches.

Acknowledgement

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References

- [1] “The athlete” by Camille Bombois, 1930, Pompidou Center, Paris, France.
- [2] “Man lifting a barrel of sake” by Katsushika Hokusai, between 1804 and 1818.
- [3] “The circus” by Georges Seurat, 1891, Orsay Museum, Paris, France.
- [4] “The venus” by Sandro Botticelli, 1884-1884, Firenze, Uffizi Gallery, Firenze, Italy.