

## Art for Physics Teachers – from an Optical Point of View

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### Abstract

*Browsing in the history of art, we can find that some of the physical concepts appear in art in a lot of different aspects. In books of art sometimes we can meet names of physicists. These concepts and names that offer connecting points can make some fields of physics more interesting to our students, and giving associations helps them to recall their knowledge.*

*This paper wishes to highlight some of the connecting points which can help the physics teacher. The three main topics are the following:*

- *The painting as a model in physics*
- *Light, space and time in painting*
- *Secrets in techniques of arts.*

### Introduction

Optics, mirror, projection by lenses, or model, duality, space and time, - these are well known ideas of physics. We can be surprised if we meet these concepts and names of physicists, like Kepler, Huygens, Maxwell, etc. in books of art. Such a result of browsing in the history of art makes the physics teacher able to increase the interest of the students in science just like in art. At the same time this browsing can be a nice challenge for the physics teacher.

### 1 The painting as a model in physics

The painter puts different colouring matters onto a sheet of paper, and we recognize figures, a landscape, or a face of a man in them. We can say that the artist creates a *model* about nature, or any part of the real world. The picture, which we realize, depends on our perception, the customary interpretation and the level of our knowledge. This is similar to the known optical example, when looking at a plane mirror, we have an illusion that we see our face in its natural size, while the image of our face is just the half size of the real face, – there is something that appears in the mirror and something else that appears in our mind.

We can show the model of the dual wave-particle nature of light by Dali's painting: "Slave market with invisible bust of Voltaire". Here the colouring parts of the canvas can interpret for us a bust of Voltaire, or sitting

figures, similarly light behaves as a wave, or as a particle, meanwhile it is neither a wave, nor a particle, but "light".

### 2 Light, space and time in painting

#### 2.1 Light and colours

The impressionists discovered the special effects of colours. They used many times complementary colours. There is an example on Renoir's painting: "Boating on the Seine", where we can see the orange boat on the blue water, the two colours emphasize each other. Maxwell discovered that the colours can fuse also in the eyes, not only on the canvas. This thought inspired the idea of an American painter and scientist that putting several colours in form of lines and points beside each other, the optical influence will be similar. Seurat and Signac applied this method.

#### 2.2 Colour and space – light, as a tool of the impression of perspective

We can say that the creation of perspective, as a science is near to optics. The colour and the light are effective tools to create the illusion of the 3D world on the 2D surface.

The painters often use an optical effect to reach the illusion that the red objects seem to be in a smaller and the blue ones in a greater distance instead of the real ones. We can see it in The Wivenhoe Park, Essex, painted by Constable, where in the foreground there is reddish colouring and there is blue colour in green in the background. So we can understand the deep perspective in this picture.

We can find some special perspectivistic paintings, like Hoogstraten's View of a Corridor, where he painted an illusionistic corridor, like a perspective from a threshold.

The concept of perspective can provide an explanation of the position and proportion of effects of light or colours.

Pieter de Hooch seems to have constructed the linear foundations of his spaces with a practical method – he placed a pin with a string attached to it at the vanishing point to assist in sighting the orthogonals. While the experience of his spaces is not correct by any standard of Keplerian optics, de Hooch made an attempt to

accommodate the moving eye in his evocation of the illusion of space – as it is written in an art historic book.

Space and time can be found together on de Hooch's painting: Portrait of a Family in a Courtyard in Delft. The perspective and the 3 generations of a family can be discovered on it.

### 3 Secrets in techniques of arts

#### 3.1 The use of optical tools in creating paintings

Investigating the old painters' paintings, the assumption seems to be confirmed that they could study the image of the 3D world with its lively colours by projection onto a plane surface.

How did it begin? At first the Flemish masters used optical tools in the 15<sup>th</sup> century. Mirrors and lenses were well known by Campin and Jan van Eyck, they painted these things in their works (at that time the Flemish painters and mirror makers belonged to the same corporation). We see a convex mirror in Campin's picture (Heinrich von Werl's triptych), there are spectacles in van der Paele canon's hand in van Eyck's painting, and the convex mirror is a characteristic part of his "Arnolfini Wedding".

It is said by the English painter, David Hockney that the old masters probably not only painted, but used the lenses and mirrors to create their pictures to make them more vivid and photographic. To prove this statement, he made an experiment: arranged a model outside the window, in the garden, bathed in light, and (with a concave mirror) projected his image in the dark room onto a paper on the wall. Then the painter traced it. So he has got a similarly lifelike picture, like Campin's Portrait of a Man, or Roger van der Weyden's Portrait of a Lady, moreover in the same size and lighting.

Looking at Holbein's The Ambassador, it can be supposed that the photographic picture of the curved surfaces and the globes came from using a lens: the painter projected the image of a 3D object to a 2D surface and traced the shape of it.

That time suddenly a lot of left-handed people showed up in paintings. Using a lens alone, left becomes right and vice-versa. Frans Hals's drinking boy and the same picture reflected by a mirror can illustrate Hockney's assumption: the latter picture makes much more natural impression.

Some researchers may suppose that some of the well known painters used **camera obscura**, and in most cases they were secretive.

At first Aristotle wrote about the image which could be made by camera obscura: at a time of a solar eclipse, in a forest he observed special images of the Sun, when the light came between the leaves of the trees.

Kepler painted a landscape by a self-made camera obscura, in the hole of which was a long telescope with convex and concave lenses at the two ends of it, and projected the light to a paper, where he copied the picture.

How much did Dutch artists know about the lenses or the camera obscura in the mid-17<sup>th</sup> century? Vermeer's 'optical consultant' could be Leeuwenhoek, the pioneer of microscopy. Christian Huygens and his brother were his contemporaries, and being in correspondence with a lens maker in Delft, probably they knew the painter. We can point out Vermeer's 'photographic perspective', the fact that he depicts real objects with extreme fidelity. There are several Vermeer's paintings, where we can suspect the use of a booth-type camera obscura, with its lens at the painting's viewpoint and the screen on the wall. The image is the same size as Vermeer's canvas, because Vermeer has traced it (e.g. The Music Lesson).

Finally let me mention Quentin Massys's painting: The Portrait of a Scientist. We can think of physics seeing the scientist and the eyeglasses in his hand, and suppose the use of the optical tool because of the lifelike image. The painting itself reminds us of the connection between science and art.