THE SCIENCE OF MAKING COLOUR

Today artists are spoilt for choice by the vast array of synthetically manufactured paint colours.

However, journey back in time and you'll discover that the materials used to make paint pigments were often as creative as the great works of art to which they contributed. Some of the many examples include rich ultramarine blue, made from grinding the semi-precious stone lapis lazuli, the red, pink and orange produced by crushing cochineal insects, and verdigris, a green copper-based pigment.

The chemistry of creating colour also gave rise to a number of health risks, particularly if you were the sort of artist prone to putting the end of a brush in your mouth while concentrating. This ranged from the use of mercuric sulphide in vermilion red, chromates in orange and yellow, and lead carbonate in white.

This story illustrates the inextricable link between artistic and scientific endeavour. It is being celebrated at the National Gallery in the first exhibition of its kind in the UK. Called 'Making Colour', it provides an insight into how artists in the past used pigments to create visual illusions such as depth, reflection and texture, and how our brains and eyes respond to paintings when we view them.

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The science behind 'Making Colour', and the overall conservation work at the National Gallery, has benefited from the support of the Engineering and Physical Sciences Research Council. The partnership between EPSRC and the National Gallery began in 2010. It highlights the contribution that science and scientists make to the world of art, and the intellectual value that emerges when scientific and artistic traditions come together.

Identifying the material used to make up a pigment provides information on aspects such as the age of a picture and the painting technique used. Being able to harness latest advances in imaging technology is of obvious benefit for conservators at the National Gallery.

However, making use of the latest digital imaging technology can be a tricky business when dealing with an object on the scale of a huge painting. The partnership with EPSRC has provided a solution to this, as Ashok Roy, the Director of Collections at the National Gallery, explains:

"With EPSRC's support we've been able to acquire a very advanced computer controlled micro-positioning easel, which is capable of safely holding a very large painting and moving it incrementally in minute steps. We are able to put in front of a picture a series of different imaging devices. We can use digital imaging to build up a very high resolution image of that object. We're going to be able to use different sensors in the future to scan pictures and learn more about their structure, the way they're made and indeed what needs to be done for their preservation. We will be able to acquire very high resolution images in various parts of the spectrum that would be unobtainable without this technology. It is a real advance in our imaging capabilities."

Claude Monet, 'Lavacourt under Snow', about 1878- 81
(copyright: The National Gallery, London)

This latest example of EPSRC support is shedding new light on old masters. It continues a long tradition of scientific endeavour at the National Gallery whose Scientific Department was founded in 1934. It is a world leader in the study of the materials and techniques of Western European paintings. Infrared imaging, X-ray imaging, electron microscopy and mass spectrometry are all used to discover more about the materials used by artists in the past and how they are likely to change over time.

This new state-of-the art aluminium easel is over six metres long and capable of holding a painting up to 2.8 metres high and wide. As well as its impressive size, the fact that it gives the ability to put any type of camera in front of a painting provides the National Gallery with tremendous flexibility. The same precisely pinpointed area of a painting can be analysed with the different techniques. In addition less space is needed because you do not need a separate room to accommodate each of the different imaging devices.

This flexibility also opens up the opportunity to try out new types of research using other techniques such as hyperspectral imaging, which collects and processes information across the electromagnetic spectrum. "We are able to capture the whole reflected spectrum, so the whole colour is accurate", says Joseph Padfield, a conservation scientist at the National Gallery. "You can take a picture of the painting and map where different materials have been used. This is not something you can now do easily. It is

Sassoferrato, 'The Virgin in Prayer', 1640-50
(copyright: The National Gallery, London).

an area of research that we are hoping to get into in the future."

Spanning the period from the Middle Ages up to the 19th century the exhibition has a wealth of great works of art to choose from. An example is Sassoferrato's *The Virgin in Prayer* (1640-50), where the gentle serenity of Mary's features, as she holds her hands together in worship, are enhanced by the soft drape of her cloak which is painted in a rich, spectacular, deep, royal blue of natural ultramarine, extracted from ground lapis lazuli. The observer feels they could almost reach out and touch the folds of the cloak, because they are so convincing. Moving forward to Claude Monet's *Lavacourt under Snow* makes use of cobalt blue developed by French chemist Louis Jacques Thénard. The picture shows a group of cottages in a French hamlet surrounded by snow. It is a picture that gives meaning to the expression 'blue with cold', as the colour

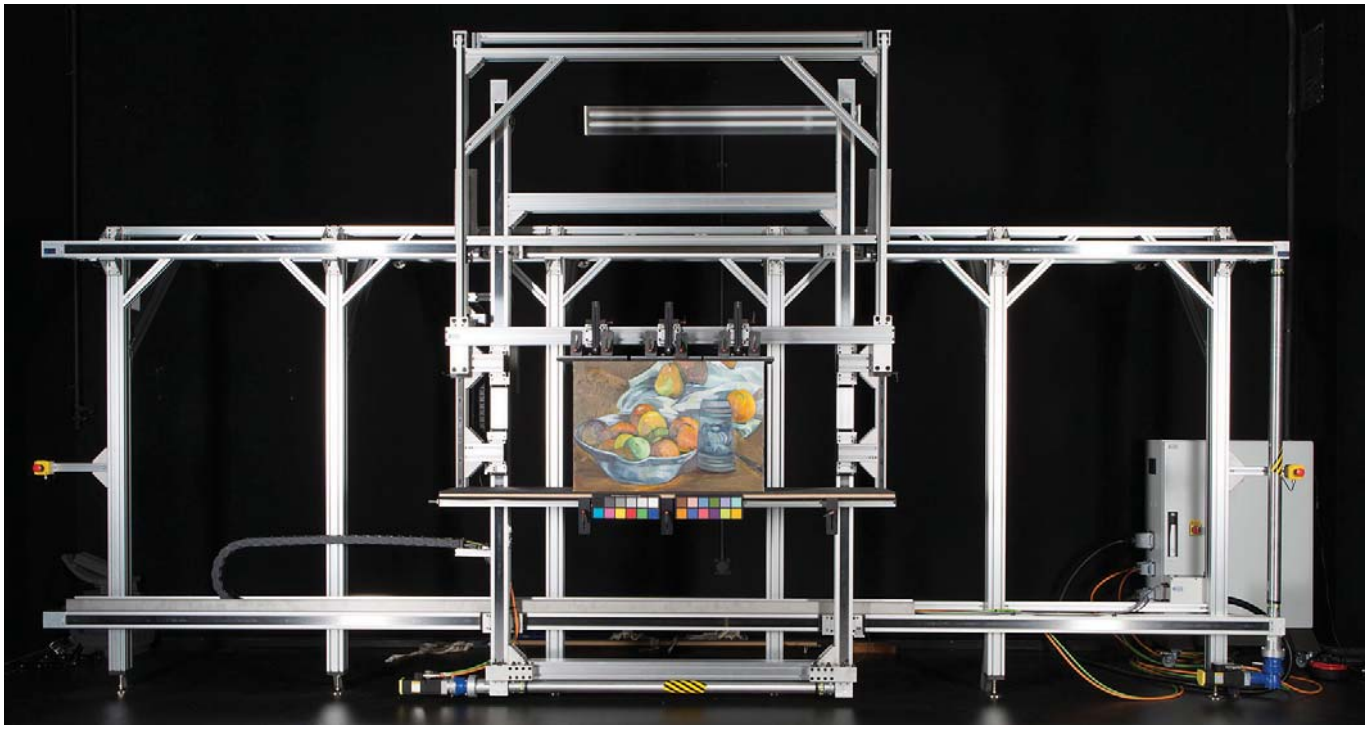
... gentle serenity of Mary's features ...

is reflected everywhere: the snow, the building brickwork, roofs and the surrounding sky and landscape. It was also painted when Monet was short of money, so a hard winter would have been especially difficult and bleak, and this composition conveys a strong sense of desolation. A severe case of what we would call the 'blues'!

Normally close examination of a Sassoferrato or a Monet is the preserve of a select few scientists working with a microscope sitting in front of a painting. Hyperspectral imaging will allow the accurate and reproducible measurements of the colour of paintings and open up the possibility of closer examination of such works of art to many more people.

The easel has also helped to inspire another part of the 'Making Colour' exhibition. This gives visitors a more detailed understanding of how we perceive hues and pigments. It includes an area where you can view a picture under different lighting conditions using tunable LEDs. This is part of an interactive computer-controlled experiment on how the brain and the eye respond to colour, and will contribute to future research at the National Gallery.

If you want to get a new perspective on an Old Master then this exhibition is the ideal opportunity to do so. 'Making Colour' is at the National Gallery until 7th September. You can also find out more about the scientific endeavour in this exhibition in an audio slide-show on Youtube. Put 'EPSRCVideo + The Science of Making Colour' into the YouTube search area.



The new state-of-the-art easel is literally shedding new light on the science behind pigments used in great paintings (copyright: The National Gallery, London).