1. Introduction

New scientific approaches of paintings have led to new insights into the artist’s creative process, and the way he may have solved problems during designing and painting.

In the course of the previous century a number of techniques have been developed, each in its own way providing art-historians and conservators of museums with tools enabling them to look behind the surface of paintings. The different varnish and paint layers, pigments, colours, underdrawings, canvases, panels, and stretchers can be studied, revealing details invisible to the naked eye. In this way art-historians and, depending on the presentation of data, the public as well, are able to look, so to say, over the shoulder of the artist.

Of course sometimes the dataset obtained is merely interesting, not more than that. Sometimes, however, difficult arthistorical problems come to a solution. Under certain circumstances this may have a tremendous impact. In this respect one may think of false attributions and forgeries being discovered, often involving great amounts of money. Reputations might be damaged, artistic value could vanish.

Modern scientific methods of investigating paintings, although they may reveal invaluable data, are not as common in every modern country. The Netherlands have to travel a long journey before reaching appropriate standards. This paper is concerned with a Dutchman that has achieved a tremendous progress in this field mainly abroad.

2. Biography

Born in 1957 in Zaltbommel, The Netherlands, Ron Spronk, initially begun as a social worker, studied History of Art from 1988 – 1993 at the University of Groningen
under the guidance of prof. dr J.R.J. van Asperen de Boer. In his last year he also studied at the Indiana University, Bloomington, Ma, USA.

On December 17, 1990, he paid a visit to the Boymans van Beuningen Museum in Rotterdam. There he was stimulated by his professor to make an infrared study of Jan Provoost’s ‘The disputation of St. Catherine’. At that occasion he realised the enormous impact this study could have for a better understanding of paintings. Therefore, as a qualified art-historian he returned to Bloomington (prof. Molly Faries) to continue his studies concerning technical methods used to ‘look behind the paint’. Having acquired his doctoral candidacy in 1994 he went to Harvard University Art Museums and is working as an associate research curator at the Straus Center for Conservation and Technical Studies.

Ron Spronk wrote more than twenty scientific articles and two books, and held more than fifty presentations on the topic. He and Harry Cooper - an associate curator of modern art at the Fogg Museum and a Mondrian scholar – acquired worldwide fame by their study of Piet Mondrian’s ‘transatlantic paintings’, works that were painted in Europe and reworked in the United States during World War II.¹ For this work they received the College Art Association/Heritage Preservation Joint Award for Distinction in Scholarship and Conservation in 2002. In 2005 he finished his PhD thesis: Examining Materials and Techniques of Easel Paintings: Ten Technical Studies (1996-2005).² For his studies he had to travel a lot and to cover the expenses he collected a number of impressive grants. In the course of his studies he acquired a great deal of knowledge in digital analysis and made some interactive websites,²,³ including one on Mondrian’s reworked paintings. At present he is a Lecturer at Harvard University, Department of History of Art and Architecture.

3. Historical background⁸

In November 1895 Wilhelm Conrad Röntgen discovered a type of electromagnetic radiation, which he called X-rays, later known as roentgen rays. Soon afterwards these rays were applied not only in the medical field but also on paintings in Würzburg and other cities in Germany. In the beginning of the 20th century a special German technique was patented, which withheld the development in other countries until 1928. By that time in the USA the Fogg Art Museum (renamed in 1966 Straus Center for Conservation and Technical Research) at Harvard University established an independent department for research regarding the conservation and restoration of paintings. This Department for Technical Studies (renamed in 1931 and 1996) at that time presented this research as a new academic discipline. In its history four men played a crucial role, including Alan Burroughs (1897-1978, art-historian and radiographer), and Edward W. Forbes (1873-1965, director of the museum), who traveled extensively in Europe and Asia. The other two men were art-historian and conservator George L. Stout (1897-1978), and the chemist Rutherford J. Gettens (1900-1974). In 1910, Forbes already had started to collect “examples of minerals used by the early painters” to study the painting techniques of the old masters. With his group he was especially interested in the research of Netherlandish paintings, both to prevent buying forgeries and for restoration. Forbes was fascinated by the enigma of the so-called ‘mixed technique’ used by Jan van Eyck (tempera and oil). He copied early paintings in order to understand the old painting methods. He had a great influence on the development and practice of conservation techniques. Furthermore he paid attention to changes in relative humidity and toxic substances degrading the quality of paintings. In the meantime Burroughs had set up a radiography project and made hundreds of radiographs, acquiring a gigantic experience in this field. In 1932, the first issue of their journal, Technical Studies in the Field of the Fine Arts, was published, where they could present the results of their research.
Together, these four giants in the field form an early example of successful multidisciplinary scientific research of paintings during the two decades preceding the Second World War.

4. Methods of scientific examination

4.1 Radiography

The same radiography technique that is applied in medical examinations is used to make X-ray images of paintings. Different materials (paint, ground, canvas, wood, etc.) have different attenuation values for roentgen rays. In addition, the thicker the material the more is radiation absorbed. Also the chemical composition of the paint plays a role. Paint containing lead, for example, has a higher attenuation value for X-rays, resulting in less blackening of the photographic film. To be able to see small differences in absorption in thin layers of paint softer X-rays are used than are necessary to pass through dense thick material.

In the course of years radiography has become increasingly significant, revealing many details beneath the surface of paintings that are invisible to the naked eye. A famous example is the large film of Rembrandt’s Nightwatch that was made in the Rijksmuseum several years ago.

4.2 Infrared Reflectography

In the 1960s infrared light, with wave lengths slightly longer than those of visible light, was discovered as a means of visualising underdrawings. If the upper paint layer is not too thick, infrared light may pass through it, and subsequently reflects against deeper paint layers and the white ground, while some infrared light is absorbed. A special infrared-sensitive camera picks up the differences in absorption of the reflected light. Infrared reflectography proved to be especially useful to depict underdrawings: where the white of the ground is interrupted due to the black charcoal or graphite of the underdrawing, there is no reflection.

Because of the limited spatial resolution of infrared cameras, each particular painting is subdivided into small portions which are captured separately. With the aid of special computer techniques the individual infrared images are assembled afterwards into a composite picture, called an infrared reflectogram.

4.3 Ultraviolet Light

Ultraviolet light, with wave lengths slightly shorter than those of visible light, is absorbed and emitted (causing fluorescence) differently depending on the chemical composition of the surface material. Therefore, its fluorescent properties are used by conservators for the detection of changes of the painted surface after damage or restoration. It can also be used to identify certain varnishes and pigments. Contrary to infrared light, ultraviolet light is not absolutely harmless to the painting and should be applied with caution.

4.4 Dendrochronology

With help of a systematic approach of the rings of felled trees, wood biologists are able to compute the year a tree, planks of which having been used for the panel of a particular painting, was felled. This provides a ‘terminus post quem’: earlier than this year the painting could not possibly have been made. In addition, year rings of a particular tree to a certain extent provide an individual pattern, enabling art-historians to recognise panels consisting of planks from the same tree that may have belonged to the same triptych, diptych, or subsequent painted series.
4.5 Microscopy (surface and sampling)

Magnifying lenses are used to study the surface of paintings, the brushwork, signs of repair and other changes during the lifetime of the painting. Small cracks in the paint layers, even to the canvas, may reveal the artist’s layering technique.

Cross sections of paint samples, the size of a needle’s tip, can be studied by light or electron microscopy. In this way conservators are able to identify pigments, colours, paint layers, varnish, and other aspects of the artist’s technique. In addition, in this way aspects of the history of the painting like signs of reworking or overpainting may be revealed. Chemical analysis of the sample may also be of help in analysing the painting’s history. The method of sampling is used with caution since it involves a permanent loss of a fragment of the paint.

Ron Spronk’s investigations

To provide the reader with an idea of the scope of Ron Spronk’s scientific work, the authors will focus on some of his findings described in articles that were part of his PhD-thesis.

In his treatise on the material history of Rogier van der Weyden’s Saint Luke Drawing the Virgin, Ron Spronk, together with Rhona MacBeth, describes the conservation history of the panel in the Museum of Fine Arts, Boston. He collects data from written documents, inventories, and technical examinations, including radiography, infrared reflectography (IRR), microscopy, paint media and pigment analysis, and dendrochronology. He is aware of the fact that identical copies of the Boston painting exist in Munich, Bruges, and St. Petersburg.

Already in 1932, Burroughs on his radiographs of the Boston painting had found a slightly different position of the Virgin’s head in comparison to the painting itself, a phenomenon not present in the other paintings. At that time he had concluded that the Boston painting must be the original. In 1953, however, the great Erwin Panofsky, possibly unaware of Burroughs publication, had described the four panels as copies from a lost original.

Ron Spronk now digitises the radiographs and merges them with photographs of the Boston painting. He confirms Burroughs’ description. In addition, on IRR-studies he observes that in the underdrawing of the Boston painting the face of St. Luke is in a slightly lower position and more in profile than on the painted surface. Careful scrutiny of other parts of the paintings reveals similar discrepancies between the infrared reflectogram and the paint surface. The copies in Munich, Bruges, and St. Petersburg, however, do not show these discrepancies. Spronk’s conclusion is that Burroughs was right, the Boston painting is the original.

In his publication Tracing the Making of Jan Provoost’s Last Judgment through Technical Examinations and Digital Imaging, Ron Spronk pays special attention to the trumpets in the angels’ mouths, located centrally in the painting. The radiograph shows an irregular white spot in the area of the right angel, in a lesser degree also in that of the left one. Obviously, the artist has reworked these areas after the initial painting. How to interpret this finding? The infrared reflectogram brings the solution. It shows a total of ten trumpets coming from the mouth of the central angel. Spronk concludes that obviously the artist was not content with this, and saw that it did not work in the whole of the painting. Provoost subsequently repainted the area, using extra lead white, which is responsible for the white spots on the radiographs.

In 2005, a concise article by Ron Spronk describes the reconstruction of a triptych by Jan Provoost for the Jerusalem Chapel in Bruges. The left and right shutters had been long recognised as such. The left is Provoost’s Disputation of St. Catherine of Alexandria, the painting that had caught Ron’s attention when as a student he visited the Museum Boymans van Beuningen, Rotterdam with his professor (see biography). The
right panel is Provoost’s *Beheading of St Catherine of Alexandria* in the Museum voor Schone Kunsten, Antwerp. The two panels share multiple common features and have paintings in *grisaille* on the backside. Spronk now proposes that the same stylistic, compositional, and iconographical features are present in Provoost’s *Crucifixion* in the Groeningemuseum, Bruges. The measurements are in agreement and furthermore, there is dendrochronological evidence. The three planks of both shutters, and three planks of the Crucifixion prove to be from the same tree, felled in 1488. This may not be absolute proof, but provides strong evidence that the three paintings originally had formed a triptych, and were separated later. Also in this case, careful analysis and comparison, together with the results of scientific examinations, have substantially contributed to the solution of art historical questions, especially those concerning attribution and dating.

In his most remarkable study Spronk (together with Harry Cooper, see biography) succeeds in investigating 12 out of the 17 “transatlantic paintings” by Piet Mondrian, an enormous undertaking. He analyses the radiographs and colour photographs of these reworked paintings and compares them to the pre-war black-and-white photographs of the original paintings. From his observations and from conversations with people acquainted to Mondrian in New York, he is able to reconstruct the reworking process. Mondrian scraped away the paint, even to the level of the canvas, sometimes even causing ‘paint bleeding’, and then filled in the ‘empty’ area with paint containing less lead. On radiographs the scraped areas show increased blackening of the film, leaving small dense lines parallel to the black painted bands. This phenomenon is explained by the fact that the scraping stopped just before reaching the black band, pushing up the white paint a little while doing so. In addition to publishing the study, Ron Spronk made an interactive website illustrating these findings.

In an interview with the Harvard University Gazette, Ron Spronk describes his fascination as follows: "Being able to study the correlation of a painting's surface with its underdrawing and underpainting in high magnification on your own computer screen is a dream for the art historian interested in examining actual works of art. We will, of course, never be able to bridge the historical distance between us and the painters whose works we study, but it is fascinating to be granted a peek over their shoulders."

6. How to proceed in the future?

Before we move to the broader scope of things, a few particular applications that in the future can be developed or improve the techniques described above will get attention here.

A very important aspect of all techniques regarding digital or digitised imaging is *signature recognition*. Basically a signature is a pixel selection from one or more imaged datasets that includes an aggregation of all aspects that makes a specific category unique. In making the selection one must be careful not to include too many single factors that are represented in different categories, because these will not provide the unique combination of values that are needed to assemble a certain class automatically by the computer. Similar to image analysis in archaeological remote sensing, producing digital classifications in this fashion allows us to recognise artistic patterns. The more datasets from different techniques - that detect different layers and therefore uncover a great variety of relevant aspects - are combined, the more accurate a signature can become. In this way, rather than looking at the autograph, we form a digital signature of a certain artist or strategy of painting. Using the previously determined classifications we can ascribe works of art to certain individuals or delimited groups by using pattern recognition. Especially in combination with chemical and chronological analysis this may lead to interesting results. This form of analysis would finally give rise to a strategy that includes more than just a characterisation of the entire artwork.

In moving away from generality we touch upon one of the most intriguing aspects of art: the cognitive processes that make us produce it. As in archaeology where the study
of stratigraphy (overlying strata of soil and material remains) shows us a sequence of
events on a site, the use of technical investigations that are dedicated to different layers of
paint, might be able to produce a like sequence of events for the creation of a painting in
the future. It is to be expected that this sequence relates well to the subsequent thoughts
that the artist must have had before applying any shapes or materials to his work. If we
can dissect a painting in such way, we not only reveal the exact technical method that
was used for production, but we can follow the process inside the head of the artist as
well. This might ideally allow us to understand more of specific aspects of human
psychology that ground the mere function or reason for the existence of art and the
patterned variations between people and styles.

With the technical analyses of art one might want to contemplate on the
consequences this bears towards society. Since many works of art are clearly in the
possession of an individual, an ethical debate will emerge as soon as it is proven that an
ascription of a work of art to a certain artist is unjust. Each owner would like to be
compensated for any emotional and financial loss he or she suffers. Especially when the
precise actions of obtaining an object are demonstrable, we must define in advance a
good practice to honour the respective rights any party holds in advance. As one can
easily assume that a substantial part of all art is forged, an increase in technical analyses
will soon uncover many fakes. These discoveries need to be taken care of properly in a
publicly acceptable way. Of course this is not to say that we should not pursuit a more
technical future.

Although the techniques applied by Ron Spronk have been available for some
time, the Netherlands did not seem to take much notice nor had a notable part in their
development. Therefore there is some catching up to do from our part. Since techniques
as infrared reflectography and radiography are widely available it would be a good thing
to start immediately with building an archive of such images of paintings from Dutch
collections. An effective way to go about this would be to let all institutions that would
benefit from the results collaborate in carrying out these analyses. The archive in the end
should be available freely for any research or education purposes. The authors would
suggest that the radiology department of the LUMC and the department of art history in
Leyden could initiate activities by analysing the collection of the Lakenhal Museum. A
significant role could be played by the CAAS collaboration between the Technical
University of Delft and Leyden University. They could not only start with making
images, but also with improving the capabilities of the techniques towards specific
research questions.

Furthermore we might consider a treaty of reciprocity with any foreign country
for exchanging archives; some universities in the United States already own quite a
substantial collection of images. Research could benefit considerably from a worldwide
accessible database and in today’s globalising world this should not be too hard to
accomplish. Naturally the issues regarding curtailment of the damage to works of art and
copyright of the images need to be sorted out first. Besides this we might think about
setting priorities. Up to now most analyses have been done on paintings by the most
famous artists. However, some less famous collections could bear more academic or
societal importance, showing us the true events around watershed moments in art history.

Finally there is the aspect of public presentation. Art and academic research
would never exist in the same way without considering the public that eventually
finances it, but also should be able to enjoy the results. Ron Spronk fortunately already
presented us some nice, publicly accessible websites combining artworks and
backgrounds with images of his technical examinations. Other institutions could also
publish their data for the general public. The same link was made in the Harvard
University Art Museums, Cambridge, Ma, USA. So far this has only been done on small
scale, but we would suggest to expand this to be an intrinsic part of any presentation of
art. Art museums would then speak to a more general public as its purpose is no longer to
present only pretty pictures in an optimal way, but also the technical context they were
produced in. This twofold approach assesses art effectively in its entirety, including both
material and its contents. The technical facets of works of art may reveal aspects about its background, which meagre information from documents and the illustration of the art itself cannot uncover. In doing so the historical aspects can be addressed more lively and truly engage the public in the process of producing art on many levels.

7. Conclusions

1. Modern scientific techniques of investigating paintings enable art-historians to unthought-of insights into the artist’s creative process.

2. New, scientifically based arthistorical insights may have tremendous scientific and commercial implications.

3. In the near future Leyden should take the lead in stimulating, favouring, and financing further development and bringing into practice scientific methods of investigating paintings.

4. Computer methods may positively influence the interaction between paintings and public especially with respect to the newly achieved insights.

References


