Researching the components and technology of Western Manuscript Illuminations in the laboratory has become more widespread during the last decade. The great diversity of techniques, materials and tools used by illuminators to illustrate and decorate texts has become a challenging topic for scholars of manuscripts and medieval painting. Art technical research on illuminated manuscripts provides insights into provenance, workshop practice and the interrelationships between painting on parchment and painting on panel, wall and cloth. For conservators of manuscripts, moreover, collaboration with laboratories of scientific imaging and non-destructive material testing has become an important factor in making decisions about treatments and interventions. The conference *Inside Illuminations* is intended to advance interdisciplinary research on technical art history and the medieval illuminated manuscript by providing a forum for scholars working on specific manuscripts, on illuminators’ practice and on recently developed research tools and databases.
Stella Panayotova

Fitzwilliam Museum, Cambridge

Inside the *Grandes Heures* of Philip the Bold
The Parisian Campaign of Illumination

**Part I: The Artists**

The *Grandes Heures*, one of the most richly illuminated and complex manuscripts in the library of the Burgundian dukes, was produced in two major campaigns. The original one was initiated by Philip the Bold in 1376 and the second was completed for Philip the Good in 1451. This two-part paper will focus on the first, Parisian campaign, dating to 1376-1379.

Part 1 will examine the work of the two main artists, the Master of the Bible of Jean de Sy (active c.1350 – 1380) and the Master of the Coronation Book of Charles V (active c.1355 – 1380). The art-historical analysis will formulate questions for the technical examination.

Paola Ricciardi

Fitzwilliam Museum, Cambridge

The *Grandes Heures* of Philip the Bold

**Part II: The Materials**

Part 2 will present the results of an in-depth technical study of the manuscript, carried out using only non-invasive imaging and spectroscopic methods. Infrared reflectography reveals numerous *pentimenti* as well as elaborate underdrawing in two different styles. The artists’ palette, investigated by means of UV-vis-NIR reflectance spectroscopy and X-ray fluorescence, is largely based on organic colourants, including indigo and an insect-based red dye.

The comparative analyses of the materials and techniques of illumination, and the integration of art-historical and scientific data, will aim to establish the nature of collaboration between the two artists and the degrees of exchange, emulation or competition.
Over the past thirty years, X-ray fluorescence (XRF) spectroscopy has been one of the most frequently employed methods for the technical study of painted illuminations and manuscripts. Until the development of two-dimensional mapping technology used in concert with an XRF spectrometer, X-ray fluorescence analysis had been limited to point analyses, requiring the collection of dozens or hundreds point spectra, all of which had to be analyzed individually. The resultant data would be collected into tables and indicated on spot maps, but the distribution of any given element (and hence pigment) was difficult to ascertain across the full painted or written design. Macro-XRF scanning enables the distribution of individual elements across a large area to be visualized. This technique has been employed for a number of years using synchrotron radiation sources (e.g., the Archimedes palimpsest). However, a mobile macro-XRF scanning spectrometer, which allows studies to be conducted in-house (and in-gallery), has recently been developed by scientists from the Technical University, Delft and the University of Antwerp, and commercialized by Bruker Nano GmbH as the M6 JETSTREAM. The sensitivity of the instrument is sufficient to produce comparable data to that collected using synchrotron radiation sources. The instrument can scan areas as large as 800 x 600 mm relatively quickly (a typical manuscript illumination taking on the order of 8-12 hours) and with sufficient spatial resolution (selectable, down to ~50 μm) to resolve some of the most finely painted details. The resulting data are presented as multiple images (one for each element). These element maps, visualizing both surface and sub-surface elemental distributions, can be examined and overlaid using simple image software (e.g., Photoshop) to aid in interpretation of the relative distributions of elements for more conclusive results. This paper will present a recent survey of illuminations, mainly from the collection of the J. Paul Getty Museum, showcasing the methodological improvements offered by the macro-XRF scanning spectrometer. With its capability for visualizing the distribution of the complete suite of elements present in a painted illumination, a clearer understanding may be obtained of how any given pigment was employed by the artist, how combinations of pigments were employed within mixtures, the extent to which pigments were layered, and even the use of unusual or unexpected materials. The element maps also can visualize damages and interruptions to the paint surface from loss or wear, along with areas of retouching, more clearly than traditional UV photography, thereby facilitating future conservation treatments. Furthermore, element maps can also provide the researcher with information regarding the materials used for writing texts. For instance, the ability to visualize the distribution of minor elements, such as potassium in some iron gall inks, can help differentiate intentional application from background occurrences. Likewise, whereas X-radiography provides some visualization of underlying layers, greater elemental specificity is provided by macro-XRF scanning, enabling, for example, the visualization of application techniques for gold leaf. Finally, macro-XRF scans also can be used as an alternative or correlative method for visualizing underdrawing materials, such as iron gall ink, that would otherwise not be detected by standard infrared reflectography (IRR) cameras. Overall, this new analytical technique can help reveal visually compelling hidden features in manuscript illuminations, providing the researcher with an unprecedented understanding of materials and techniques of scribes and illuminators.
Inside an early 14th century Franciscan Antiphonary
Documentation and Analyses of a Flemish Choir book

The illuminations of these large antiphonary leaves from a private collection are impressive examples of the of Gothic manuscript painting in the Ghent-Bruges area. The manuscript was most probably made in the early 14th century for a Franciscan house. Its historiated initials are peopled by elegant and expressive figures, with large faces, painted in balanced, well planned colors.

The leaves of the large choir book (460 x 310 mm) contain the music for the Divine Office. The manuscript has 28 single illuminated leaves, bound together in an album at the end of the 18th century. The condition of the manuscript is fragile, with losses of pigment and gold, oxidized silver layers, tears, undulation and several 18th-century repairs.

For the documentation and the conservation treatment, started in spring 2014, a multidisciplinary approach was developed. The documentation of the manuscript incorporates detailed codicological descriptions, high resolution photographs with direct and transmitted light (Phase One camera, 80 mp) and macro photography. With RTI, the illuminations were digitized with omnimulti-directional lighting (28 mp) and exported to 2D+. The technique is based on polynomial texture mapping, a method of imaging and interactively displaying objects under varying lighting conditions to reveal surface phenomena. Fine details are highlighted by the use of specific digital filters (e.g. shade, contrast, sharpening and sketch filters) to bring out structures that would not be visible under single illumination.

To complement the visual investigations, ink, pigment and metal analyses were done in the laboratory of KIK-IRPA with XRF, XRF-µmapping (Artax, Bruker GmbH) and µRaman (Renishaw InVia) to define the palette. Iron gall ink, with almost no copper or zinc, was used for writing the letters, for drawing some decorated black letters and for the musical notes. Blue letters are azurite based, while vermilion was used as red ink (both for writing and for ruling the staff). The blue color, present in a wide variety of hues in the decorated initials and the border decoration, is based on lead white, azurite and indigo. Red lead was used for all orange-red tints, including the carnations. On top of the red lead layer, an organic glaze was often applied. Organic red pigments and brown glazes were also used; vermilion, however, was employed in none of the painted decoration. Copper green and carbon black are further components of the palette. In addition, gold leaf on a white calcium-based ground, whether or not with punched dots, is abundantly present. And finally, a silver alloy leaf, also partly patterned, enhances the splendor of the decorations.

The combination of visual and analytical data allowed us to survey, describe and document in depth the condition and art technical features of the choir book. The comparison with data from a late 13th-century Ghent manuscript (The Missal of Saint Pieter’s Abbey) and from 14th-century manuscripts, collected in earlier projects, enabled us to pinpoint the individual features of one of the few surviving manuscripts produced in Ghent or Bruges (?) in the early 14th century. Moreover, the combination of visual and analytical techniques gives the technical art-historian and conservator reliable tools for revealing and assessing hidden yet visually compelling characteristics in manuscript illuminations.
The scriptorium of the Reichenau (Lake of Constance) is considered to be one of the most prolific scriptoria of the Ottonian period. Different groups have been distinguished, working between the last quarter of the tenth and the middle of the eleventh century. None of the preserved luxury manuscripts were produced for the Reichenau monastery itself but only for external patrons, and in some cases illuminators were working outside the Reichenau. This has caused dispute on the attribution of several manuscripts and it has even been questioned if there was a scriptorium on the Reichenau at all producing illuminated manuscripts.

These are questions which can only be solved by an interdisciplinary approach. Art technical research can contribute information on the division of labour and on continuity and changes of workshop practice. In an ongoing research project the painting technique and materials of several Reichenau manuscripts have been analysed. The paper will present some preliminary results and discuss them with special regard to the question of technical characteristics or innovations within the Reichenau groups.
Anne Dubois

UCL, Louvain-La-Neuve

Some technical notes on the *Fleur des histoires* (Brussels, KBR, ms. 9231-9232) by the Mansel Master, the Thérouanne Master and Simon Marmion

The *Fleur des histoires* in Brussels (KBR, ms. 9231-9232) is one of the earlier manuscript on which Simon Marmion worked, probably around 1455. He illustrated the last part of this two-volume manuscript. The rest of the illumination was made by the Mansel Master and the Thérouanne Master. Could technical research bring informations on the working method of those three illuminators and their possible interrelationship?
Medieval manuscript illuminations are a most precious and irreplaceable part of our cultural heritage. Through a focus on colour use, colour interpretation and colour materials, access to these artworks can be greatly enhanced, their social and material context revealed, and for such treasured cultural objects, this focus has the potential to rewrite a past in which a multicultural Europe and its leadership was born. Our team integrates contributions from art history, codicology, molecular and conservation sciences [1], and in this communication we will present the main results of a 10 years study on the history, materials and techniques of three of the most important Portuguese Romanesque manuscript collections. These manuscript illuminations were produced in the scriptoria of Lorvão, Santa Cruz and Alcobaça monasteries, during the end of the 12th and first quarter of the 13th centuries. We will examine the molecular characterisation of colours and we will discuss the importance of colour mapping, a new tool that we developed for the study of colour meaning. Colour mapping is based on a systematic quantification of the main colours present in a codex, and it allowed us to reveal a unique colour palette for each of the three scriptoria, based in three dominant colours: red, green and blue [2]. As will be seen, these colours have symbolic meanings, which will also be discussed.

Monitoring Pigment Stability in the Illuminated ‘Treasures’ of the British Library

Those items in the British Library’s collection which are considered to be of the greatest cultural significance, and which are suitable for display, are exhibited in the Treasures Gallery. These ‘Treasures’ include over 200 items: sacred texts from many faiths, maps and views, early printing, literary, historical, scientific and musical works. Many of these works incorporate illuminations, in the form of incipits, portraits and pictures, cannon tables, carpet pages and other images. These illuminations are found in a variety of conditions, and many of them are in a remarkably good state; given the iconic status of the items in which they are found, is it important to ensure that they remain in the best possible condition. Programmes of systematic assessment have been developed for such high profile items, the results of which are reported to the Library’s governing board. In particular, schemes been developed to determine the stability of the pigments in terms of both colour and physical integrity, utilising modern non-invasive analytical techniques including high resolution digital microscopy, multispectral imaging, visible reflectance spectroscopy and colour space analysis. These assessments take into account the display schedules for the artefacts, with those illuminations on most recent display receiving particular attention. This has enabled existing areas of pigment micro-fracturing, loss and discolouration to be identified, allowing them to be highlighted as regions of particular concern, and will permit any future changes to be rapidly identified, as well as informing future display and handling policies, and our overall strategy of care.
Multidisciplinary study of medieval illuminations of the Marcadé Collection
( Treasury of Saint-Andre Cathedral of Bordeaux, France)

The collection Marcadé includes among other objects (paintings, sculptures, liturgical ornaments and silver objects) a set of forty two illuminations, which was among the art objects offered in 1947 to the cathedral of Bordeaux by the canon Marcadé. These cut illuminations, little studied so far, will be exhibited in 2014 in a room specially designed for the collection. Within the framework of the enhancement of this collection, restoration actions were undertaken and a three years project is conducted with the objectives of historic, stylistic and physico-chemical analysis of this set of miniatures dated from the 13th to the 16th century. The project brings together experts from different disciplines (archaeometrists, physical chemists and conservators) providing a platform for exchange of knowledge and practices implemented around this particular type of heritage objects.

The identification of these illuminations, which is a prerequisite for any study of the collection, has led some characteristics: dates and sources of the paintings (France, Italy, Spain, Germany, and Netherlands).

Ten illuminations were selected to be analyzed by non-destructive methods, without contact and without sampling. The main ones are hyperspectral imaging and fluorimetry.

Hyperspectral imaging can record an image of the illumination and the reflectance spectra associated with each pixel of the image in the visible and near infrared range (400-1000 nm). The combination of images at judiciously chosen wavelengths, the comparison of the reflectance spectra recorded with reference allows the identification, distribution and location of pigments or specific binders. In addition, statistical data processing provides a spectral signature of the illuminations. However, this technique requires, for interpretation, the constitution of a reference spectra database of the components of medieval miniatures, especially by fluorimetry. This last highly sensitive technique is generally used for the identification of organic binders. Recent results have shown interest in the identification of pigments too. A setting using diodes and optical fibers allow miniaturizing the method for direct and non-destructive application on the analyzed objects.

Obviously, other complementary methods (FTIR, XRF, Raman,...) are employed to answer questions unresolved by hyperspectral imaging and/or fluorimetry.

The objectives of the combination of this set of methods and disciplines together around such a collection intend to enrich our physical knowledge, specify any changes in techniques of illumination over medieval times, and helps to guide the choice of restoration treatments.

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1 Coordinated by Floréal Daniel (IRAMAT-CRPAA), supported by the Aquitaine region, University of Bordeaux – Montaigne and the Labex LaScAr8x.
2 Conducted by Charlotte Denoël, curator at the National Library of France.
An interdisciplinary team studied two Books of Hours from the early fifteenth century, which belong to Portugal’s Biblioteca Nacional. Knowledge of the structure of a Book of Hours, together with the aesthetic and materials’ study, led us to the proposal that the *David in prayer*’s illumination, today present in IL15, belongs to IL19. This illumination is very similar to IL19’s *Annunciation*. Besides, the text’s body missing in IL19 may be filled by the *David in prayer* illumination.

The study of materials and techniques of ILs15 and 19 confirmed this hypothesis, advanced by the art history. In fact, both pigments and the way colors are constructed are identical in f.84 of IL15 and all of the IL19. Some conclusive aspects to emphasize are that both f.84 of IL15 (formerly belonging to IL19) as in IL19, e.g. fl.21, present a two-toned red constructed with a mixture of vermilion and minium. In IL15, blue colors are always built with azurite and darkened by indigo. In turn, f.84 of IL15 and IL19 have in common the application of azurite mixed with lapis lazuli. Also, the preparation’s composition used to receive the gold leaf, essentially chalk with about 5 % gypsum in IL19 and in f.84 of IL15, contribute to the same conclusion.

Finally, it was detected the presence of two artists in the illuminations’ implementation, visible in the processing of faces: the *Annunciation* of IL19 (fl.21) was performed by the same illuminator who made the illumination *David in Prayer* of IL15 (fl.84).
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**Analysis of pigments of two manuscripts attributed to the Master of Gijsbrecht van Brederode (Utrecht, ca. 1450-1470)**

The Wittert 13 (1465-1470) and Wittert 34 (ca. 1465) are two Utrecht illuminated books of hours conserved at the Bibliothèque ALPHA de l’Université de Liège. These two manuscripts are notorious examples of Utrecht’s craftsmanship for their fine decoration and their bright and varied colours. Such characteristics illustrate the stylistic evolution of the craftsmanship in Utrecht as the influence from French illuminators and Utrecht’s sculpture. They are testimony of the influence from the southern Netherlands (Van Eyck), the German style in both painting (Lochner) and engraving (Master E.S.) – the books also show the influence of the Italian engraving.

The two books counted with three renowned illuminators: the master of Gijsbrecht van Brederode, the master Evert Zoudenbalck and the master of the London Passional. The master of Gijsbrecht van Brederode illuminated nine out of ten miniatures from the W13 and twelve historiated initials from the W34. The master Evert Zoudenbalch made the tenth miniature of the W13 (folio 39\textsuperscript{v}), and the master of the London Passional executed the decoration of the borders of the W34.

This paper aims to establish a comparison between the materials used by the illustrators of W13 and W34. For this purpose, we have studied the palettes employed in both manuscripts by means of non-invasive non-destructive methods including stereo-microscope, optical microscope, Energy Dispersive X-ray Fluorescence (EDXRF) and Raman spectroscopy. These techniques have allowed to identify the pigments used by the artists and highlighted the occurrence of a pink pigment that, unexpectedly, contained copper.
An unusual pigment in miniatures attributed to Simon Marmion in the Donne Hours (Louvain-la-Neuve, Archives de l'Université, ms. A2).

The *Donne Hours* (Louvain-la-Neuve, Archives de l'Université, ms. A2) are attributed to Simon Marmion and the Master of the Dresden Prayerbook. In the miniatures painted by Marmion, an unusual pigment can be detected by XRF mostly in architectural details: pure copper fillings on top of a layer of white lead.
Monitoring illuminations and gilding characteristics with the RICH mini-dome.

The Bible of Conrad von Vechta (Bohemia, 1402)

The Bible of Konrad of Vechta from the Museum Plantin-Moretus in Antwerp (Ms 15.1 & 15.2), is a superb example of the manuscripts produced in the ambit of Wenceslas IV, noted for their inventive borders as much as their miniatures and for their technical refinement, especially evident in the varied uses of gold. The scribe Laurentius dated the second volume in 1402-1403; it is not known when he started writing or at what date the project was abandoned incomplete. The lavishly illuminated manuscript has historiated initials with full borders of acanthus stems enclosing gold patterned roundels with figures, beasts, birds, grotesques and flowers.

The poster is documenting the finished and unfinished illuminations in the first part of the Bible. Between fol. 161v -176v, in the part illuminated by the Joshua Master, several miniatures are incomplete, as the illuminator didn’t finish his work when the project was abandoned. These miniatures are illustrating brightly the complex sequences in the creation of medieval miniatures. Moreover, the raised gilding present in several illuminations in the Bible of Conrad von Vechta, is tooled in great detail with geometrical and decorative patterns, giving great refinement to the images.

In context of the RICH project, the manuscript was examined in situ in the Museum Plantin-Moretus, Antwerp. The RICH project (Reflectance Imaging for Cultural Heritage, KU Leuven, 2012-2015) is developing a digital imaging tool for researching, studying, and exploring material characteristics of graphic materials produced in medieval and early modern times. For art-historians and conservator-restorers, the imaging module can reveal high resolution images to document art technical theory. The digital imaging device is digitizing with omni-directional lighting and export the result to 2D+. The technique is based on polynomial texture mapping, also known as Reflectance Transformation Imaging (RTI), a technique of imaging and interactively displaying objects under varying lighting conditions to reveal surface phenomena. The module is a hemi-spherical structure with a single downward looking video camera (28 mp). The object to be captured (maximum 180 to 120 mm) lies in the center and is illuminated from computer-controlled lighting directions, through the subsequent activation of multiple white LEDs. The different angles that illuminate the surface of the artifacts are revealing extreme details. Special attention is taken to produce raking light, the illumination of the artifact at an oblique angle or almost parallel to the surface, to provides information on the surface topography of the miniature. For each illumination an image is taken by the overhead camera, in total 260 images for each object. After processing these images, the viewer software enables virtual relighting with light coming from an angle and position you choose. Fine details can be highlighted by the use of specific digital filters, bringing out structures that would not be visible under single illumination (like shading, contrast, sharpening and sketch filters).

RiCH Project (Reflectance Imaging for Cultural Heritage)
http://www.illuminare.be/rich_project;
http://portablelightdome.wordpress.com/category/rich-illuminare/
INSIDE ILLUMINATIONS

Art Technical Research & the Illuminated Manuscript

ORGANIZATION
KIK-IRPA; ILLUMINARE, KU LEUVEN & UCL

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CONFERENCE WEBSITE
HTTP://ORG.KIKIRPA.BE/ILLUMINATIONS/

VISITS, FRIDAY 6 JUNE 2014

Brussels, Royal Library, Manuscript Reading Room
Anne Dubois

Leuven, University Library & Maurits Sabbe Library
Lieve Watteeuw & Bruno Vandermeulen

PROCEEDINGS

The Proceedings of the conference will be published in 2015 in the Series
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