Lasting Support

An interdisciplinary research project to assess the structural condition of the Ghent Altarpiece

Final project report
October 9, 2011

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Please note that an Executive Summary is provided as Appendix I.

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1. Introduction and background

The Ghent Altarpiece

The Ghent Altarpiece by Hubert and Jan van Eyck in Saint Bavo Cathedral in Ghent, Belgium, is the single most important work of Early Netherlandish painting in existence, and is generally accepted to be among the most important surviving artworks in the world. The enormous cultural and art-historical impact of the polyptych, which was completed in 1432, is unparalleled in Northern European art of the fifteenth and sixteenth centuries. The Ghent Altarpiece is the ultimate example of the late-medieval *Ars Nova* in painting, when significant advances were made in illusionism in order to depict highly complex iconographical programs. The huge scale of the work, which measures 340 x 440 centimeters when opened, makes the polyptych one of the largest surviving fifteenth-century altarpieces in Northern Europe.

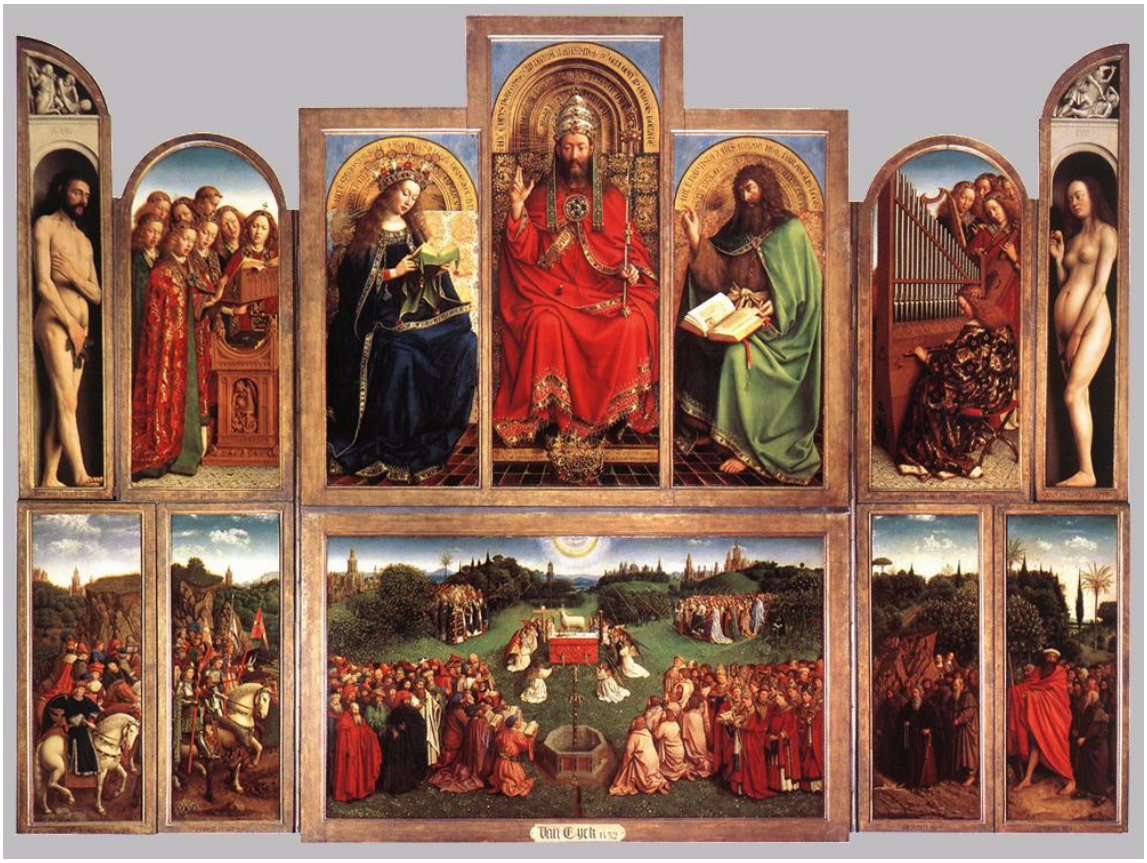


Fig. 1a. The (opened) Ghent Altarpiece.

The Ghent Altarpiece is a highly complex object in regard to its iconography as well as its material history. Over time, its individual oak panels have been repeatedly separated from each other for long periods of time, and groups of panels have been subjected to distinctly different climate conditions and restoration treatments. Only two panels, *Adam and Eve,* have retained their original shapes and frames, still being painted on both sides. The other six wing panels were split lengthwise in nineteenth-century Berlin, where the resulting twelve panels were cradled at the back. The three panels at the top center were all cropped at the top when their original, relief frames were removed, probably in the eighteenth century. This intricate material history will have to be the guiding principle for any future

conservation and/or restoration treatment of the work. Its complex material history made an in-depth study of structural aspects of the now eighteen separate panel paintings in the context of the history of past restoration treatments necessary in order to devise individualized treatment protocols for the panels, and to develop safe conditions for the future care of this structurally complicated work of art.

This project centered on the detailed assessment of the polyptych's current structural and aesthetical condition, and offered a truly unique opportunity for an exchange of expertise in an interdisciplinary collaboration among specialists in Early Netherlandish painting. It also provided ample training opportunities for younger conservation specialists to work alongside leading experts in the field of panel painting conservation and technical art history. Special efforts were made to inform the public visiting the cathedral about the ongoing research and urgent conservation treatment.

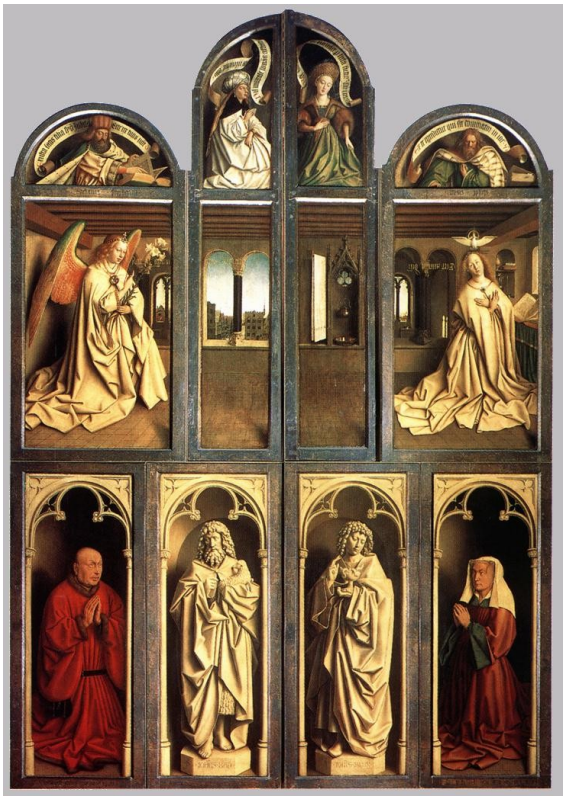


Fig. 1b. The (closed) Ghent Altarpiece

The main issues: climate, current condition, and rehousing

During 2007, serious concerns emerged about the state of conservation of the altarpiece. The polyptych is currently housed in a large, bulletproof glass box, the climate conditions of which were highly inadequate. The need for an urgent conservation treatment of the panels was first signaled by the organization Monumentenwacht Vlaanderen and by the Belgian Royal Institute for Cultural Heritage (KIK/IRPA) in Brussels. From initial

examinations by an international group of experts the urgent need for a conservation treatment within an interdisciplinary context has indeed become apparent, since areas of lifting and tenting paint needed to be secured quickly in order to avoid permanent damage. Since the summer of 2008, a small group of international specialists in the conservation and restoration of panel paintings and in technical art history have united with representatives of the administrative bodies from the province of East Flanders in an advisory committee to aid the responsible clergy of Saint Bavo Cathedral in this process.

Simultaneously, the church wardens expressed a wish to consider possible alternatives for the current location of the Ghent Altarpiece in the Villa Chapel (no. 5 on the floor plan; fig. 2), in order to examine whether other locations within the cathedral (such as the Sacrament Chapel, no. 27, or the Vijdt Chapel, the original location of the altarpiece, no. 29) might better serve the need for improved and updated visitor services than the Villa Chapel.

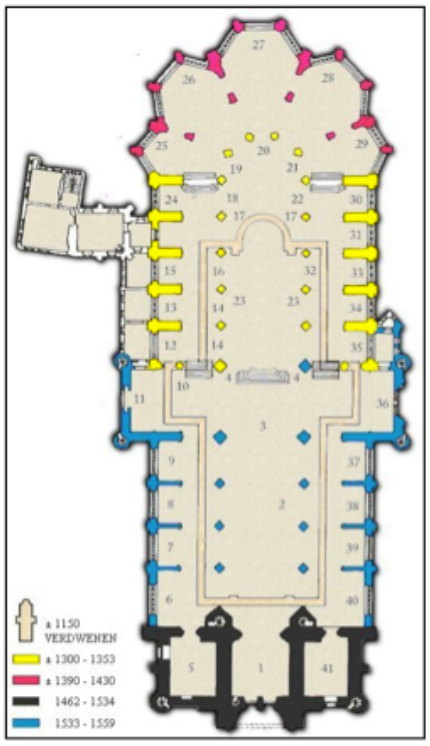


Fig. 2. Saint Bavo Cathedral, floor plan

The advisory committee met several times in 2008 and 2009. The cathedral was advised to postpone the discussion about a possible rehousing of the altarpiece to a later date, in order to facilitate the planning of an urgent conservation treatment. It was also recommended that the urgent conservation treatment be accompanied by a research program in order to provide the necessary information on the following questions:

- What is the present state of conservation of the eighteen individual panel paintings that together form the Ghent Altarpiece?
- What is the structural condition of the individual panel supports, and what are the long-term effects of their different treatment histories?
- Does the current state of conservation of the altarpiece warrant a new restoration treatment in the immediate future?

- What are the parameters for better passive conservation? Can the climate within the glass enclosure be easily improved with low-tech, low-budget means, even if only temporarily?
- What new information concerning the production process and material history of the altarpiece can be gathered by applying state-of-the-art imaging and analytical equipment?

The proposal, *Lasting Support: An interdisciplinary research project to assess the structural condition of the Ghent Altarpiece,* was submitted to the Getty Foundation for consideration, since the proposed project offered unique possibilities for research and knowledge transfer, key objectives of the Getty's Panel Painting Initiative. The proposal consisted of three main parts: 1. the urgent conservation treatment, which was coordinated by Prof. Anne van Grevenstein (University of Amsterdam), reported upon in the following section; 2. the assessment of the structural condition of the panel supports and frames, directed by Jean-Albert Glatigny (independent panel painting conservator, Brussels), which is reported on in section 3; and the campaign of supporting technical documentation and instrumental analyses that was coordinated by Prof. Ron Spronk (Queen's University, Kingston, Ontario and Radboud University, Nijmegen), discussed in section 4. Combined, these activities would indeed provide enough information to establish the state of conservation of the polyptych and to determine whether a new, full restoration of the Ghent Altarpiece is necessary.

Funding

The Getty Foundation generously funded the assessment of the structural condition of the altarpiece as well as the campaign of supporting technical documentation. The Netherlands Organisation for Scientific Research kindly administered the grant of the Getty Foundation.

The urgent conservation project was financed through generous support of the Flemish Government and the province of East Flanders, with support in kind of several other institutions (FARO – Vlaams steunpunt voor cultureel erfgoed vzw; Instituut Collectie Nederland [now Rijksdienst voor het Cultureel Erfgoed]; Vlaanderen-Nederland, vzw; the Propaint project [Improved protection of paintings during exhibition, storage, and transit]; KIK/IRPA (Royal Institute for Cultural Heritage); the Royal Museums of Fine Arts of Belgium, Brussels; Ghent University; University of Amsterdam; and others). The instrumental analyses were performed as an intervention of CHARISMA/MOLAB (Cultural Heritage Advanced Research Infrastructures, Synergy for a Multidisciplinary Approach to Conservation/Restoration-Mobile Laboratory), a project cofunded by the European Commission.

2. Report on the urgent conservation treatment

Introduction

All conservation activities had to take place within the Villa Chapel in Saint Bavo Cathedral to maintain a certain visibility of the altarpiece during the six-month period of conservation and technical documentation. The chapel was outfitted as a temporary studio in April 2010 by Jean-Albert Glatigny and Jos van Och (Stichting Restauratie Atelier Limburg [SRAL], Maastricht), who were aided by three junior conservators: Aline Genbrugge (KIK/IRPA), Jessica Roeders (Frans Hals Museum, Haarlem), and Renzo Meurs (independent restorer, Amsterdam). The work space was temporary closed off from visitors by means of a glass wall (figs. 3a,b).

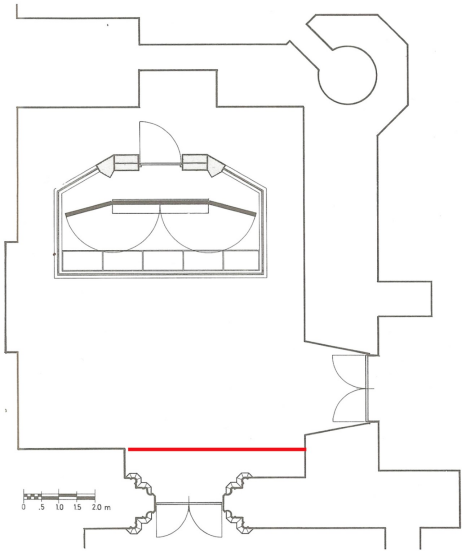


Fig. 3a. Floor plan of the Villa Chapel, position of glass wall

Fig. 3b. Glass wall separating the Villa Chapel from the visitor gallery

The dismantling and remounting of the panels took place in four distinct campaigns, carried out by Mobull Art Transport under supervision of Daniel Bulinckx (fig. 4). The general conclusion from these operations was that the altarpiece's current housing in a heavy steel auxiliary frame within a glass enclosure represents serious risks and liabilities. This installation was successfully designed for protection against theft and vandalism, but in case of a calamity such as flood or fire, this protection is likely to become a mere liability, since it is currently impossible to remove the altarpiece from its location swiftly and safely when necessary.

Fig. 4. Mobull personnel dismantling the polyptych's central section

After the heavy flaking of the painted surface was secured with a facing of tissue paper, the panel of the Just Judges was transported to KIK/IRPA in Brussels for restoration (see further, Appendix II).

The urgent conservation treatment

Under the leadership of Anne van Grevenstein, a detailed study of the paint layers was executed by Hélène Dubois, Marie Postec (both KIK/IRPA), Griet Steyaert (Royal Museums of Fine Arts of Belgium, Brussels), and Gwen Fife (SRAL). All surfaces were examined in normal and raking light to find areas of flaking or delaminating paint, and examination in UV fluorescence was used to detect areas of retouching or overpaint and various layers of varnish. The paint surfaces were examined with a binocular microscope (kindly provided by Prof. Maximiliaan Martens, Department of Art History, Ghent University; fig. 5).

The conservators consolidated flaking paint, and removed surface dirt and grime with microfiber cleaning tissues. This dry cleaning method enabled the team to avoid introducing any additional impact of humidity on the painted surfaces. The presence of multiple layers of Talens Retouching Varnish, applied at different times during the last

half-century, was established. The ongoing degradation of these ketone resin varnishes can cause paint to lift and delaminate, and therefore these varnishes will need to be removed. Since it will be impossible to remove them without affecting the (also

Fig. 5. Hélène Dubois inspecting *The Angel of the Annunciation*

degraded) natural resin varnishes that were applied during the 1950–51 restoration, the unanimous advice of the conservators is to perform a new, full restoration in the immediate future. The solubility of the varnishes was tested in areas where the impact of varnish removal on the tonal values of the painted surfaces could be experienced visually with clarity. In some locations the degradation of the varnish layers is indeed dramatic (fig. 6). The cotton swabs used were analyzed at the Cultural Heritage Agency of the Netherlands (Rijksdienst voor het Culturele Erfgoed [RCE, formerly the ICN]) and Monumentenzorg, by means of gas chromatography–mass spectrometry, or GC–MS, by Dr. Henk van Keulen, to check for the possible presence of traces of copaïva balsam, which would have evidenced a varnish regeneration by the Pettenkofer method in Berlin, but no such markers were found.

Fig. 6. Cleaning test in *The Adoration of the Lamb*
(Photo: Luc Van Muylem for Lasting Support)

The polychromy of the frames was examined under the stereo-microscope and the stratigraphy of layers documented by Anne van Grevenstein and Anne-Sophie Augustyniak (KIK/IRPA). For the full, detailed results and documentation of the urgent conservation treatment, see further Appendix II.

Climate

All climate control issues were coordinated for the advisory committee by Leon Smets (FARO) and Anne-Cathérine Olbrechts (Monumentenwacht Oost-Vlaanderen). At the start of the project, analyses of the air quality in the cathedral and within the vitrine were coordinated by Jørgen Wadum (National Gallery of Denmark, Copenhagen), in collaboration with Birkbeck College in London. The Klimaat Netwerk Vlaanderen/ Nederland, with participation for Flanders of FARO, Ghent University, KIK/IRPA, Monumentenwacht, and the University of Antwerp, and, for the Netherlands, of the RCE and the Universities of Eindhoven and Delft, provided excellent opportunities for interdisciplinary collaboration. The visit of Shin Maekawa (Getty Research Institute) in April was combined with a meeting of this group, where urgent interventions and issues for further research were fruitfully discussed.

Continued monitoring of the climate was established and the information about climate control, expert meetings, and research was made available to all members of the working group and to the advisory committee with a wiki-link on the Internet. Professor A. Janssens and Prof. M. De Paepe (Ghent University) started a research program into the technical aspects of the climate environment in the current glass enclosure. A forthcoming joint research program of RCE, the University of Amsterdam (UvA), and the University of Eindhoven, on the response time of panel supports to fluctuations in climate, will includes analyses of the Ghent Altarpiece through the use of reconstructions of the three different types of panel supports (those painted on both sides, those with cradles, and those painted on one side and impregnated with wax).

Fig. 7. Inspection of the ventilation system on top of the glass enclosure

Two junior panel conservators, Jessica Roeders and Renzo Meurs, under supervision of Herman den Otter (UvA) and Bart Ankersmit (RCE), will work closely together on this issue, which will be presented as part of a proposed NWO "Science4Arts" project. The topic of adequate climate boxes will also be addressed in this project.

The climate within the glass enclosure now remains actively monitored. The dramatic variations in temperature and relative humidity were significantly reduced by assuring a minimum temperature in the Villa Chapel of circa 14°C through replacing heat-emitting spotlights with cooler daylight lamps, sealing seams between the panes of glass of the enclosure, installing a climate barrier of Marvel Seal in the ceiling of the enclosure, and using portable humidifiers.

Rehousing

The discussions about the possible relocation of the altarpiece have been ongoing for some years, but have intensified with the start of the current project. At the proposal of the advisory committee, the cathedral has agreed to postpone this discussion until the full restoration treatment commences.

In such a discussion, the following topics (placed in random sequence) should be addressed:

- Risk analyses in regard to vandalism, accidents, theft, and calamities
- Adequate permanent climate control
- Alignment of the multiple functions of the work (i.e. as a religious object, as a historical object, as a work of art, and as a key tourist attraction)
- The optimal aesthetic appreciation of the work
- The place within a functioning religious institution (i.e. in regard to flow of visitors and crowd control)
- The fact that the church building is currently undergoing a large-scale, long-term restoration

Within such discussions it should be acknowledged that all of these different (and sometimes competing) demands on the altarpiece are legitimate and valid. It appears that a weighed, informed choice will have to be made between four distinct options:

1. Temporarily (2–4 years) maintaining the current location in the Villa Chapel; installing some improved climate conditions with portable equipment and lighting systems
2. Maintaining the current location in the Villa Chapel long-term; installing new, more permanent climate control equipment and replacing the glass enclosure with a visually less intrusive setup (fig. 8)

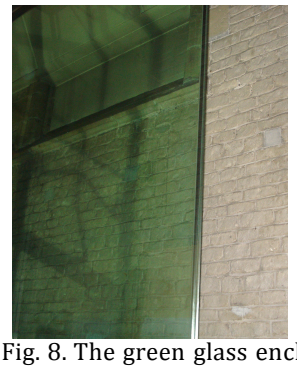


Fig. 8. The green glass enclosure

3. Rehousing the altarpiece in its original location in the Vijdt Chapel after outfitting it with newly designed climate boxes
4. Rehousing the altarpiece in a new, more museumlike building on the cathedral grounds, with optimal security, climate control, and accessibility

Conclusions

The urgent conservation treatment was fully completed as of October 1, 2010. Since then, the altarpiece has been safely replaced in the glass enclosure in the Villa Chapel. Anne van Grevenstein and the team of conservators have compiled their final report on the findings from the urgent conservation treatment, also using materials from the technical documentation. This report (a digital copy of which is provided as Appendix II) was discussed in the advisory committee meeting of March 16, 2011, and the committee accepted the conclusion of the report that a new, full restoration of the Ghent Altarpiece is indeed warranted. Although the structural condition of the panels is largely sound (see Appendix III), the presence on the paint surfaces of multiple layers of ketone resin varnish is reason for concern. Such varnishes keep yellowing and hardening over time, and this continued process of degradation can cause further delamination of the paint layers, and can thus result in loss of original paint. The fact that these varnish layers need to be removed in the near future necessitates a full restoration.

The preparations for the full restoration are now well underway and the cathedral has formally appointed Anne van Grevenstein as its advisor for this project. Financing for this five-year undertaking is largely in place thanks to financial commitments of the Government of Flanders and a private fund. In agreement with the Belgian regulations for tendering government commissions, a document describing the practical parameters for this restoration has been compiled (Appendix IV), based on which conservators or conservation institutes can bid on the work. Pending the selection of a suitable location for the restoration, the restoration could start as early as December 2011.

3. Report on the research into the structural condition of the panels and the frames

Jean-Albert Glatigny, with assistance of three junior panel conservators, has examined and documented the condition of the panel supports. The three junior conservators were Aline Genbrugge (junior painting conservator, KIK/IRPA), Jessica Roeders (junior painting conservator, Frans Hals Museum, Haarlem), and Renzo Meurs (independent wood and furniture conservator, Amsterdam). The contributions of these three conservators (fig. 9) were organized as a postgraduate training program.

Fig. 9. Renzo Meurs, Jessica Roeders, and Aline Genbrugge in the Villa Chapel

All panels were studied and documented in detail, and all cradles were checked. In addition to providing critical information on the condition of the support panels and the frames, this process also resulted in significant knowledge transfer between the senior conservator and his junior colleagues, as well as among the junior conservators themselves. The close interdisciplinary collaboration between two painting conservators (Genbrugge and Roeders) and a furniture conservator (Meurs) created a distinct added value to the project.

The documentation focused on the history of interventions, the presence of tool marks, and the analyses of conservation issues such as the current condition and functionality of the cradles that were applied in Berlin. Earlier states of preservation of the altarpiece could be studied through research of archival materials in the Friedländer Archive at the Netherlands Institute for Art History (RKD) in The Hague, the Gemäldegalerie in Berlin, and at the KIK/IRPA in Brussels. Such old photographs also provided a sound historic footing for a better understanding of traces of now-lost hardware elements on the frames (fig. 10). For the detailed results and documentation, see further Appendix III.

Fig. 10. Archival photograph (Friedländer Archive, RKD, The Hague) of the *Annunciation* panels with original hardware, now lost

Two Panel Expert Meetings were organized as consultation meetings for Glatigny and his team (fig. 11). These meetings also served as unique opportunities for the exchange of expertise between senior panel conservators and their mid-career and junior colleagues.

Fig. 11. George Bisacca, José de la Fuente, and Ray Marchant

The three junior panel conservators fully participated in these expert meetings and recorded the discussions about the panels' condition, production processes, and necessary conditions for climate control and possible rehousing. The close interdisciplinary collaboration of painting conservators and panel experts resulted in two highly fruitful meetings.

Participants of one or both of the panel expert meetings were: George Bisacca (Metropolitan Museum of Art, New York), Al Brewer (Royal Collection, London), Sue Ann Chui (J. Paul Getty Museum), Livia Depuydt (KIK/IRPA), Hélène Dubois (KIK/IRPA), Paul van Duin (Rijksmuseum Amsterdam), José de la Fuente (Prado Museum, Madrid), Aline Genbrugge (KIK/IRPA), Anne van Grevenstein (UvA), Ingrid Hopfner (Kunsthistorisches Museum, Vienna), Ray Marchant (Hamilton Kerr Institute, Cambridge), Renzo Meurs (Amsterdam), Alan Miller (Metropolitan Museum of Art, New York), Béla Nagy (Budapest), Britta New (National Gallery, London), Anne-Cathérine Olbrechts (Monumentenwacht Vlaanderen), Jessica Roeders (Frans Hals Museum, Haarlem), Andrea Santacesaria (Florence), Ron Spronk (Queen's University, Ontario, Canada; Radboud University, Nijmegen), Hélène Verougstraete (Université Catholique de Louvain-la-Neuve), Jørgen Wadum (National Gallery of Denmark, Copenhagen), and, as observer, Antoine Wilmering (The Getty Foundation).

The main preliminary conclusion from the panel expert meetings is that, in spite of the numerous traumatic events in the past, the general condition of the wooden support is surprisingly sound. Nevertheless, several suggestions for interventions were made and discussed. A broad variety of issues related to the conservation and (re)housing of the altarpiece were discussed, such as function, aesthetics, history, climate control, and safety. For the detailed report on these recommendations and discussions, see further Appendix III.

4. Report on the technical documentation

Coordinated by Ron Spronk, the following methods of documentation and analyses were performed on some or all of the eighteen individual panels of the polyptych: dendrochronology; high-resolution macrophotography in visible light; high-resolution macrophotography in infrared light, high-resolution macrophotography in raking light; infrared reflectography (IRR); and X-radiography. In addition, in close collaboration with CHARISMA/MOLAB, the four center panels were documented with multispectral infrared reflectography scanning (MSIRRS), and examined with the following nondestructive methods of analyses: fiber-optic near Fourier-transform infrared spectroscopy (FT-IR); ultraviolet-visible fluorescence spectroscopy (UV-Vis); X-ray fluorescence (XRF); and integrated X-ray diffraction/X-ray fluorescence (XRD/XRF).

An expert consultation meeting was organized at the onset of the research campaign, in which participated J. R. J. Van Asperen de Boer, Till-Holger Borchert, Véronique Bücken, Lorne Campbell, Christina Ceulemans, Christina Currie, Hélène Dubois, Bart Fransen, Melanie Gifford, Anne van Grevenstein, Maximiliaan Martens, Costanza Miliani, Catheline Périer D'Ieteren, Marika Spring, Ron Spronk, Griet Steyaert, Cyriel Stroo, Hugo van der Velden, Hélène Verougstraete, and Jørgen Wadum.

Dendrochronology

Thanks to Lasting Support, dendrochronological data is now available for all panels of the polyptych, providing important new information for art historians and conservators alike about the genesis of the Ghent Altarpiece. Six of the eight original wing panels were analyzed with dendrochronology in the 1980s by J. Vynckier (KIK/IRPA), who determined that the latest growth rings of these panels date from 1404, 1405, and 1406. The remaining two wing panels, *Adam and Eve,* were examined by Pascale Fraiture (KIK/IRPA), but it was not possible to establish a reliable dendrochronological dating directly from the panels. Peter Klein was then commissioned to measure the growth rings on these two panels from the X-radiographs at the KIK/IRPA.

Fig. 12. Pascale Fraiture

Fraiture analyzed the four center panels (fig. 12) for Lasting Support, and Klein compared all data from the Ghent Altarpiece with the results of his earlier analyses of other works by Van Eyck in his extensive database. All results of the dendrochronological analyses will be integrally posted on the dedicated website for this project (http://colosertovaneyck.kikirpa.be/) that is currently under construction.

Infrared reflectography (IRR)

The entire altarpiece has been documented with IRR for Lasting Support by the KIK/IRPA, using its Inframetrics FLIR camera, which is outfitted with a platinum silicide (Pt-Si) detector. A 1500–1700-nanometer band filter was used. The resolution of this detector is relatively low (256 x 256 pixels), but its limitations in this regard were fully overcome by utilizing a very short working distance. Each 4-x-4-centimeter area of the paint surface was captured individually. Tens of thousands of individual close-up images were captured by Sophie De Potter, who also manually assembled these into eighteen overall images in Adobe Photoshop.

Fig. 13. Infrared reflectogram detail of the *Singing Angels*. (IRR: KIK/IRPA for Lasting Support)

The overall quality of the IRR documentation is excellent (fig. 13), allowing for a new and comprehensive comparative study of the underdrawings of the eighteen panels of the polyptych. Such a study might well determine whether multiple hands were involved in the execution of the underdrawings, which is a highly significant question in regard to the "Hubert and/or Jan" problem. All infrared reflectograms are already made available free of cost for study and download at full resolution at http://vaneyck.kikirpa.be/.

Macrophotography

The entire altarpiece has been documented in high-resolution digital macrophotography with a SINAR technical camera, both in visible light and in infrared light (figs. 14a,b). Each 16-x-22-centimeter area of the paint surface was captured with a 32-megapixel camera back from which the IR blocking filter was removed, allowing for a spectral response to circa 1,000 nanometers. Details from the press brocades in the background of the upper center panels were documented in raking light at this "standard" resolution as well. All images were captured by photographer Luc Van Muylem in four-shot mode, resulting in around 1,000 individual files of 200 megabytes at 16 bits (in TIFF format) of unsurpassed quality.

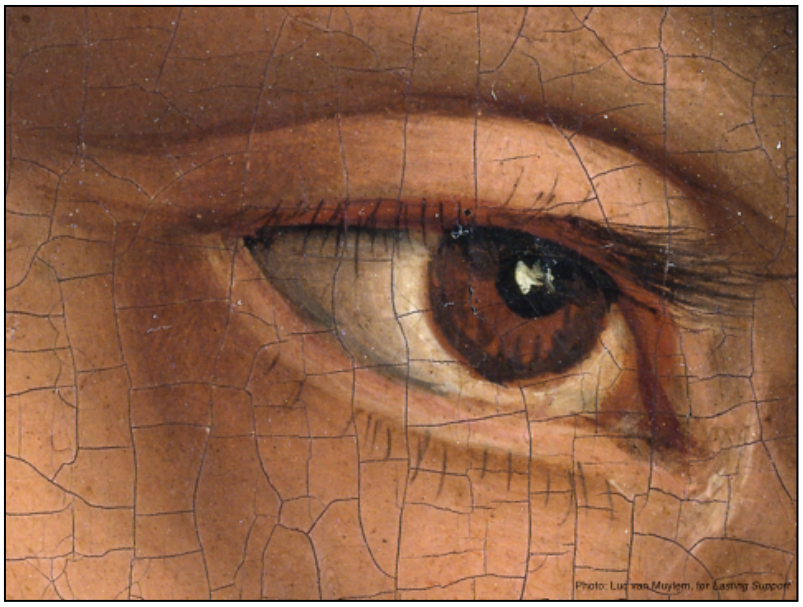


Fig. 14a. Image 01MCPVIS0011, Adam's eye in visible light, "standard" resolution
(Photo: Luc Van Muylem for Lasting Support)

Fig. 14b. Image 01MCPHIR0011, infrared photograph, "standard" resolution
(Photo: Luc Van Muylem for Lasting Support)

This resolution allows for substantial magnifications of the paint surface, also in the infrared. Although the spectral response of infrared photography (<1,000 nanometers) is noticeably lower than that of IRR, these images will still reveal underdrawings, especially in areas of flesh tones, red lake, white paint, and light earth colors. Figure 14b shows how the position of the eyelid was initially placed significantly lower, for example. The superior resolution of IR photography over IRR makes these methods of documentation complementary, since IR allows for a much more precise study of underdrawing materials, and of the correlation between underdrawings and the paint surfaces.

In addition, around 1,000 additional captures were taken in what was termed "extreme close-up," for which areas of 6 x 8 centimeters of the paint surface were captured in the visible and in the infrared, also in 16-bit, 200-megabyte (TIFF format) files. This resolution allows for microscopic magnifications, also in the infrared (fig. 15), making this documentation an especially important complementary method to IRR.

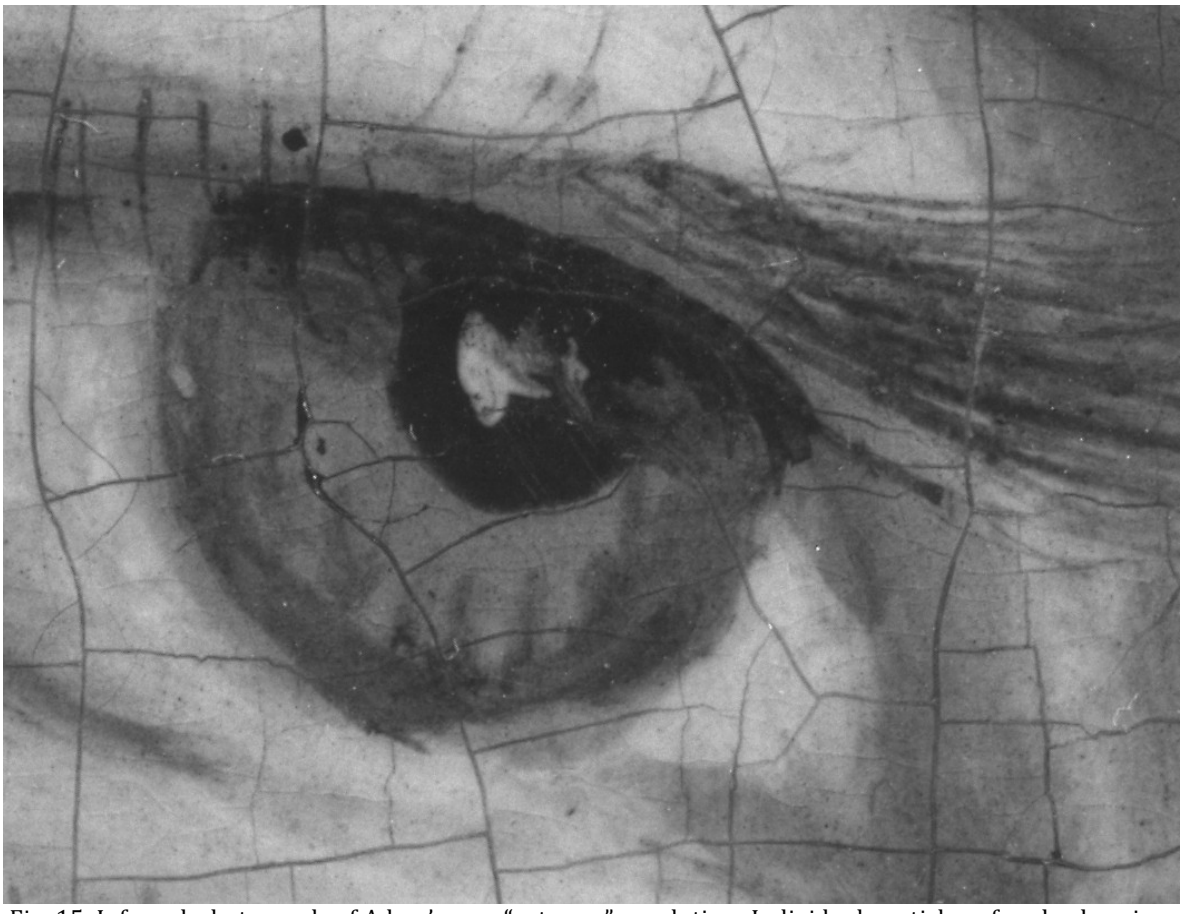


Fig. 15. Infrared photograph of Adam's eye, "extreme" resolution. Individual particles of underdrawing material are visible at these magnifications. (Photo: Luc Van Muylem for Lasting Support)

The IRR detail of Adam's face at full resolution (fig. 16) obviously shows much less detail. It is our intention to document numerous details with IRR in a (significantly) higher resolution during the forthcoming restoration; for example, with an OSIRIS IRR camera that is outfitted with a macro lens.

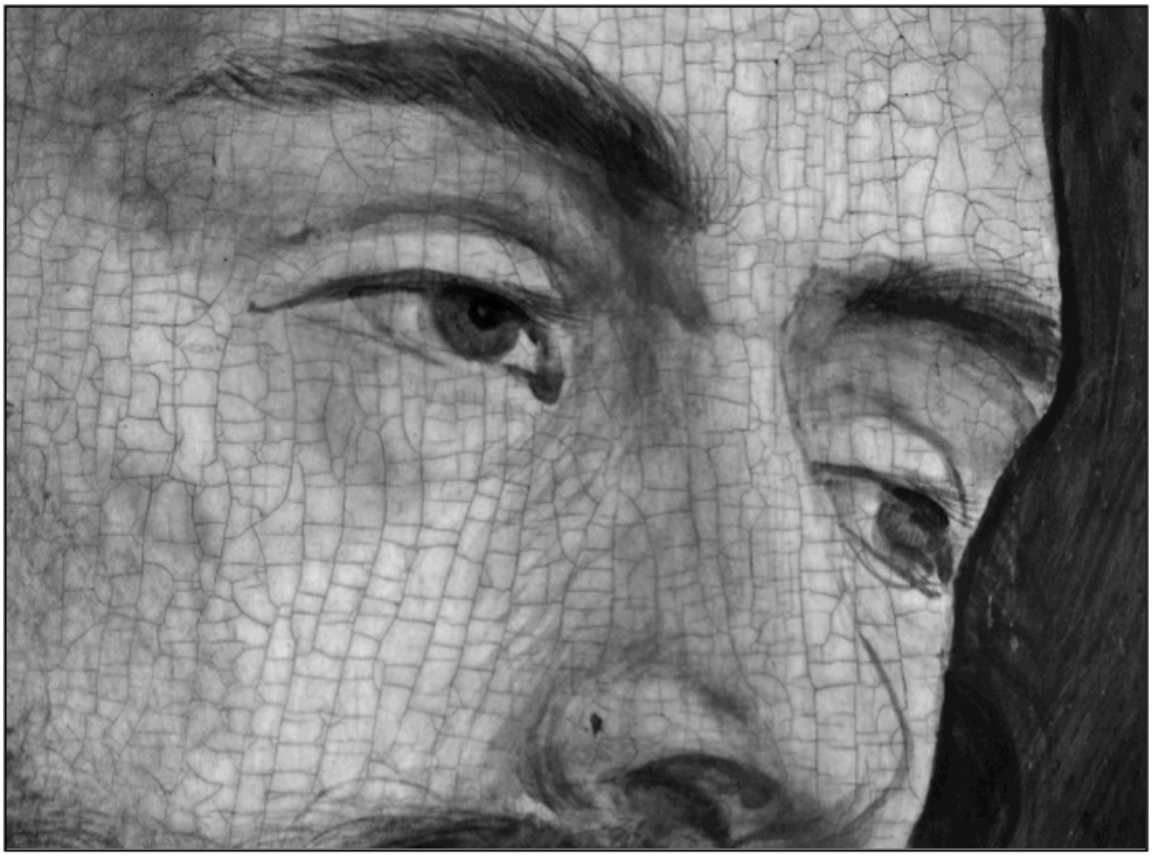


Fig. 16. IRR detail of Adam's face (IRR: KIK/IRPA for Lasting Support)

X-radiography

All eighteen panels of the polyptych were documented with X-radiography by the KIK/IRPA in 1986. For Lasting Support, twenty details of the left wing panels and the central panels were X-radiographed again, by Catherine Fondaire (KIK/IRPA; fig. 17), to compare these with the older documentation, in order to detect any possible changes at crack level. Both the 1986 X-radiographs and the new X-ray films were digitized at relatively high resolutions and compared visually at high magnification at the KIK/IRPA.

Fig. 17. Catherine Fondaire X-raying *St. John the Baptist in Grisaille*

No differences were detected between these different X-radiographs, providing further tentative confirmation of the observations of the panel experts (see above) and the conservators/restorers that the condition of the altarpiece has been surprisingly stable, especially when one considers the poor microclimate to which it was exposed within the glass enclosure. Preparations are currently underway to develop a computerized method for a full comparison of the available materials, in order to discover whether deterioration occurred at microscopic levels between 1986 and 2010.

CHARISMA/MOLAB

Lasting Support successfully applied for a CHARISMA/MOLAB intervention within the European Knowledge Exchange Network. This resulted in the documentation of the four central panels with multispectral infrared reflectography scanning (MSIRRS), and the study of these panels with nondestructive fiber-optic near- and mid-infrared Fourier-transform infrared spectroscopy (NIR/MIR); ultraviolet-visible fluorescence spectroscopy (UV-Vis); X-ray fluorescence (XRF); and integrated X-ray diffraction/X-ray fluorescence (XRD/XRF).

The documentation with MSIRRS by a team from the Italian National Institute of Applied Optics (INOA) and most instrumental analyses by the University of Perugia (NIR/MIR; UV-Vis, and XRF; fig. 20) and the Centre de recherche et de restauration des musées de France in Paris, or C2RMF (XRD/XRF; fig. 21) were highly successful. We will therefore reapply to CHARISMA/MOLAB for renewed interventions, in order to have the remaining panels be examined as well during their restoration. Such a timeline will have the added benefit that the paint surfaces can be analysed after the varnish layers are removed.

Multispectral IRR scanning

The team from INOA in Florence that performed MSIRRS was led by Claudia Dafarra (fig. 18). The multispectral images produced by the INOA prototype are very informative, not only for the study of underdrawings and painting materials, but also for the precise mapping of retouches.

Fig. 18. Claudia Dafarra (INOA) and the multispectral IRR scanner at work on the *Enthroned Virgin*

The linear scanner is equipped with fifteen separate detectors: for the red, green, and blue bands in the visible light, and for wavelengths of 925 nm, 1030 nm, 1112 nm, 1200 nm, 1300 nm, 1400 nm, 1500 nm, 1600 nm, 1700 nm, 1820 nm, 1930 nm, and 2265 nm in the infrared. The superimposed images in the resulting data block are perfectly aligned because of the linear scan; the vertically moving scan-head is equipped with a laser-guided autofocus. The images are of very high quality, although working with the prototype was not without difficulties. Data acquisition required much more time than expected because the computer collecting the output data crashed regularly, after which the acquisition had to be started from the last saved section. This was resolved by saving smaller strips of imaged data, which later had to be reassembled. All in all, since the total number of days for documentation was set, we resolved to work very long days to ensure that all four center panels were documented in full. We will reapply for a MOLAB intervention to make certain that the wing panels can also be documented with MSIRRS.

NIR/MIR and UV-Vis

Near- and mid-infrared spectroscopy (NIR/MIR) and UV-Vis are analyses that are used to gather data on binding media and on (red) lakes, respectively, but the resulting data from the four central panels remained largely tentative. The omnipresence of multiple varnish layers and beeswax from the impregnation from the 1950–51 restoration interfered strongly with these relatively sensitive surface measurements. It is to be expected that NIR-MIR and UV-Vis examination will especially benefit from the removal of the varnish layers during a forthcoming restoration.

X-ray fluorescence (XRF) and integrated X-ray diffraction/X-ray fluorescence (XRD/XRF)

Hundreds of measurements were performed with XRF and integrated XRD/XRF, resulting in a wealth of data on the original painting materials, as well as on those that were used for retouching. The two methods of examination complemented each other very well, with the XRF being executed before the XRD/XRF, and the former resulting in concrete research questions for the latter. This body of findings will be particularly useful during the forthcoming restoration. In addition, a surprising find was the presence of silver leaf under the thin paint layers of the tile floors in the lower sections of the Enthroned Virgin; Christ; and the Enthroned Saint John the Baptist. The presence of silver leaf had also been established earlier under the overpaintings of the frames, by hand-held XRF (figs. 21a,b).

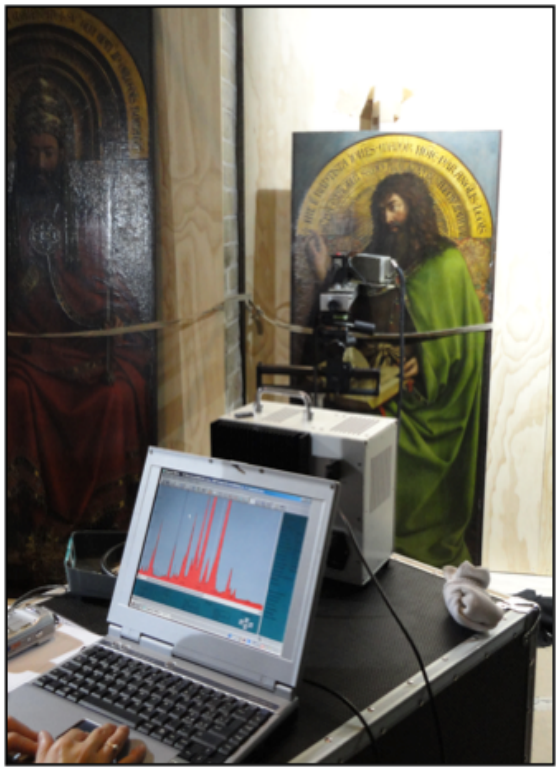
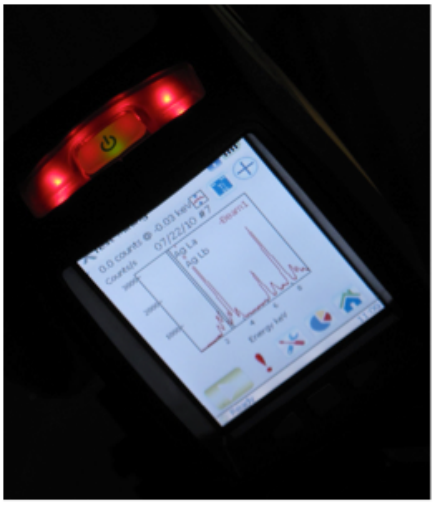


Fig. 19. XRF of the *Enthroned Saint John the Baptist*

Fig. 20. XRD/XRF of the *Adoration of the Lamb*



Figs. 21a,b. Jana Sanyova (KIK/IRPA) and Bart Vekemans (Ghent University) performing hand-held XRF, establishing the presence of silver leaf under the paint surface of the (overpainted) frames

Archiving of data

All images were named and organized by paint surface (using the Coremans numbers to indicate the individual panels), with separate folders for each method of documentation (e.g. visible, IR, IRR, X-radiographs), which has its own letter code. An individual file name thus consists of the Coremans number, a letter code indicating the method of documentation, and a sequential file number. For example, fig. 14a is of image file 01MCPVIS0011, macrophotograph no. 11 in visible light of a detail of the face of Adam (the Coremans number of which is 1) in standard resolution; fig. 14b, of 01MCPHIR0011,

is the same detail in infrared light. These two folders are named 01MCPVIS and 01MCPHIR, respectively. To help access these large numbers of detailed images, the technical reports of the macrophotographs all include thumbnails with the names of the individual files (fig. 22) as well as other pertinent (meta)data. Each group of captures has such a report in its folder.

To further facilitate the practical use of these images, the individual macrophotographs of the small details have been stitched together again in larger blocks by the research team of Ann Dooms and Bruno Cornelis of the Vrije Universiteit Brussel (VUB), using MATLAB. The file sizes of these stitched images can be very large, up to 8 gigabytes, well above the maximum file size that the TIFF format allows and that Photoshop can handle. Downsized overall images for each panel were also created for greater ease of use. The team is also creating registered images, in which the technical images are superimposed with the visible light images. Hence, the digital archive is still being enlarged. Full copies of the archive are also kept at the KIK/IRPA and VUB. After completion, full copies will be offered to Saint Bavo Cathedral, Ghent University, and the RKD in The Hague, as well. It is expected that the final archive will consist of circa 1.5 terabytes of data.

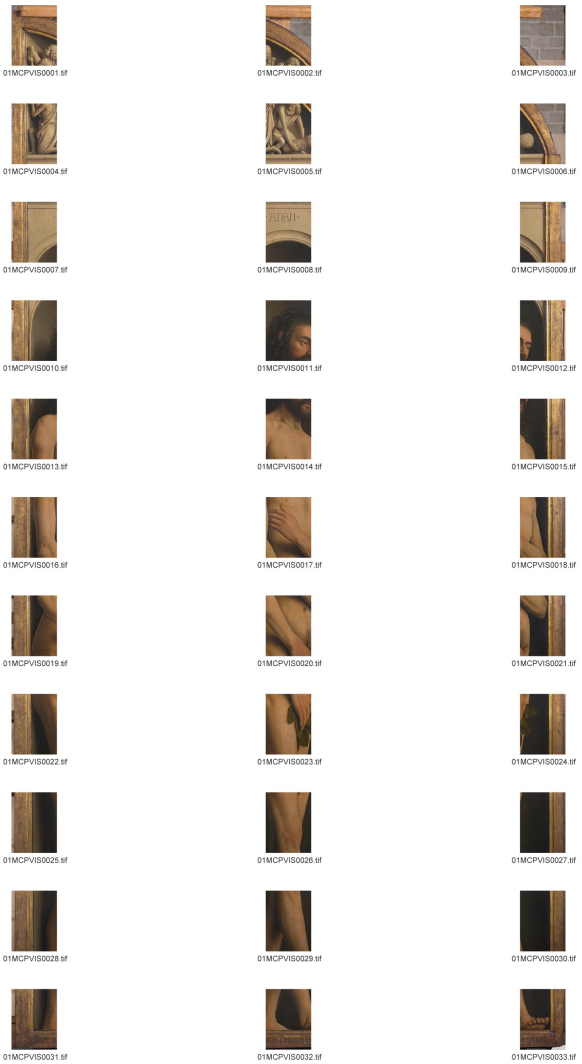


Fig. 22. Page with thumbnails from technical report of folder 01MCPVIS

Dispersal of research results

Since the project's onset, it has been the goal of the organizers to make the resulting images and research reports integrally available to the scholarly community. When individual researchers were contracted to perform documentations, it was therefore stipulated that they would not hold any copyrights to such images, but that these would instead be in the public domain.

Different models for the dissemination of the images were examined and tested. Initially, the Flemish art image web portal Lukasweb (http://www.lukasweb.be/), as the image right holder for the cathedral, was to host the archive of macrophotographs online, but for technical reasons this model could not be realized within the available time. Then, a number of selected institutions (mainly universities, museums, or research archives) were invited to act as "data host" for stand-alone computer work stations where interested visitors could study the archive. While we received many positive responses to this idea, others suggested that a dedicated web application to provide free, general access to the archive would be more suited to these materials.

Thanks to additional generous support from the Getty Foundation, the continued exemplary institutional collaboration of the KIK/IRPA, Vrije Universiteit Brussel, and Lukasweb, and additional support from NWO, the production of this web application has started. The site will be hosted by the KIK/IRPA and is scheduled to be online by January 1, 2012. In the meantime, the eighteen individual IRR assemblies are already available for study and download through the website of the KIK/IRPA (http://vaneyck.kikirpa.be/).

Future research initiatives

The results of Lasting Support will serve in the forthcoming restoration of the Ghent Altarpiece, but will also be critically important for a number of new research initiatives:
–In September 2012, the KIK/IRPA will organize a symposium on the topic of van Eyck underdrawings.
–Jana Sanyova (KIK/IRPA) will be leading the project *The Mystic Lamb in the Laboratory 60 Years after Paul Coremans: The Contribution of New Analytical Techniques,* in which she proposes to reexamine more than 300 existing cross-sections housed at the KIK/IRPA, using new analytical methods.
–Anne van Grevenstein will submit to NWO (with Jaap Boon, Friso Lammertse, and Ron Spronk as coapplicants) the Science4Arts proposal: *Interdisciplinary Van Eyck Studies: Conservation Issues Related to Panel Paintings from the van Eyck Group (1420–40) in Scientific and Art-Historical Context.* The forthcoming full restoration of the Ghent Altarpiece (2012–16), the exhibition *The Road to van Eyck* (2012–13; Museum Boijmans Van Beuningen, Rotterdam/Gemäldegalerie, Berlin), and the related restoration treatments of the *Three Maries at the Tomb* in Rotterdam and the Crucifixion in Berlin will provide a unique occasion for in-depth interdisciplinary research in four main scientific areas of expertise: 1. research into the production process of Eyckian panel paintings; 2. measuring the effects of past conservation procedures on the appearance of panel paintings from the van Eyck group; 3. defining a strategy for their future conservation interventions; and 4. art-historical questions related to issues of attribution and the "Hubert and/or Jan" problem.

Lasting Support

An interdisciplinary research project to assess the structural condition of the Ghent Altarpiece

Executive summary of the project report

(For the full report, see http://closertovaneyck.kikirpa.be/?doc=Final%20project%20report.pdf)

Directors: Prof. Anne van Grevenstein (University of Amsterdam) and Prof. Ron Spronk (Queen's University, Kingston, Ontario, and Radboud University, Nijmegen)

Duration: March 1, 2010 – June 30, 2011

Budget: 172,000 Euros

Grantee: Netherlands Organisation for Scientific Research (NWO)

This project has been made possible with the generous support of the Getty Foundation in Los Angeles.

Introduction and background

The Ghent Altarpiece by Hubert and Jan van Eyck in Saint Bavo Cathedral (Ghent, Belgium) is generally accepted to be among the most important artworks in the world. The polyptych, completed in 1432, is a highly complex object in regard to its material history. Over time its individual panels have been repeatedly separated from each other, and groups of panels have been subjected to distinctly different climate conditions and interventions. Six out of the eight original wing panels that were painted on front and back were split lengthwise and cradled in Berlin in the nineteenth century, for example. This complex material history makes the (now)

eighteen oak support panels of the Ghent Altarpiece uniquely suited for an in-depth interdisciplinary study of structural aspects of panel paintings in the context of the history of restoration treatments, and for devising individualized treatment protocols.

Concerns about the state of conservation of the altarpiece emerged in 2007. The polyptych is currently housed in a bulletproof glass box, the climate conditions of which were highly inadequate. Initial examinations established the need for an urgent conservation treatment, since areas of lifting and tenting paint needed to be secured to avoid permanent damage. In 2008, the cathedral formed an advisory committee, in which representatives of the administrative bodies from the province of East Flanders and international specialists in the conservation and restoration of panel paintings and in technical art history collaborated in devising a plan of action. The advisory committee met several times in 2008 and 2009, and advised the cathedral:

- To postpone discussions about a possible rehousing of the altarpiece to a later date.
- To swiftly improve the climate within the glass enclosure and reduce the large fluctuations in relative humidity with provisional, low-tech improvements.
- To temporarily dismantle the altarpiece and to perform an urgent conservation intervention, as well as an in-depth campaign of research and documentation to determine whether a new, full restoration is warranted and possible.
- To have these activities take place within the Villa Chapel in the cathedral, closed off from the public by a glass wall, to retain visible access to the altarpiece.
- To request support from the Getty Foundation's Panel Painting Initiative, since determining the current state of conservation of the altarpiece required a thorough and urgent study of the structural condition of the panel supports. Such a study would require highly specialized expertise, and would therefore offer unique possibilities for knowledge transfer from senior panel conservators to their mid-career and junior colleagues, a key objective of the Getty's Panel Painting Initiative.

Climate

The air quality within the glass enclosure was examined, and the climate within the glass enclosure is now actively monitored. The dramatic variations in temperature and relative humidity in the enclosure were significantly reduced through: 1. creating a minimum temperature in the Villa Chapel of circa 14°C, which serves as a climate buffer in the winter months; 2. replacing the heat-emitting spotlights with cooler daylight lamps; 3. sealing the seams between the panes of the glass; 4. installing a climate barrier in the ceiling of the enclosure; and 5. using portable humidifiers.

Urgent conservation treatment

Under the leadership of Anne van Grevenstein, a detailed study of the paint layers was executed by conservators from the Royal Institute for Cultural Heritage (KIK/IRPA), the Royal Museums of Fine Arts of Belgium, Brussels, and Stichting Restauratie Atelier Limburg (SRAL), Maastricht. All surfaces were examined with a microscope and in normal and raking light to locate flaking or delaminating paint, and examination in UV fluorescence was used to detect areas of retouching

and various layers of varnish. Flaking paint was consolidated and surface dirt and grime were removed with dry microfiber cleaning tissues. The stratigraphy of the polychromy of the frames was examined and documented, and the copy of the panel of the *Just Judges* was restored at KIK/IRPA.

The solubility of the dramatically degraded varnishes was tested, and the swabs used in these tests were analyzed for traces of copaiva balsam (which would have evidenced a subjection to Pettenkofer varnish regeneration), but no such markers were found. The presence of multiple layers of Talens Retouching Varnish, applied at different times during the last half-century, was observed. The ongoing degradation process of these ketone resin varnishes can cause paint to lift, resulting in delamination. Since it will be impossible to remove these varnishes without affecting the (also degraded) natural resin varnishes that were applied during the 1950–51 restoration, the advice of the conservators is to perform a new, full restoration in the immediate future. The full report of the urgent conservation treatment is provided through.

Assessing the structural condition of the panels

Senior panel conservator Jean-Albert Glatigny, aided by a group of three young conservators, studied and documented all supports, cradles, and frames. In addition to providing critical information on issues of condition and conservation, this process also resulted in significant transfer of knowledge between the senior conservator and his junior colleagues, as well as among the junior conservators themselves. The team studied the history of interventions, tool marks, and the condition of the cradles that were applied during the Berlin intervention.

Two panel expert meetings were organized to provide consultancies for Glatigny and his team. These meetings also served as further opportunities for the exchange of expertise between senior panel conservators and their mid-career and junior colleagues. Several suggestions for interventions were made and discussed, but the main conclusion from the panel expert meetings was that, in spite of the occurrence of many traumatic events in the past, the general condition of the wooden supports is surprisingly good. The full report of the assessment of the structural condition of the panel supports is provided through.

Report on the technical documentation

Coordinated by Ron Spronk, the following methods of documentation and analyses were performed on some or all of the eighteen panels of the polyptych: dendrochronology; high-resolution macrophotography in visible, infrared, and raking light; infrared reflectography (IRR); and X-radiography. In addition, through Cultural Heritage Advanced Research Infrastructures' Mobile Laboratory (CHARISMA/MOLAB), the four center panels were documented with multispectral infrared reflectography scanning (MSIRRS) and examined with the nondestructive methods of instrumental analyses: Fiber-optic Fourier-transform infrared spectroscopy (FT-IR); ultraviolet-visible fluorescence spectroscopy (UV-Vis); X-ray fluorescence (XRF); and integrated

X-ray diffraction/fluorescence (XRD/XRF). We will reapply for MOLAB interventions within the European Knowledge Exchange Network, which should take place during the upcoming restoration. An expert meeting of art historians, technical art historians, conservators, and conservation scientists was organized before the campaign commenced.

The results from the documentations and analyses represent a wealth of new data for art historians and conservators. Thanks to an additional grant from the Getty Foundation and with support of the NWO, all available images and research reports will be made available on a dedicated website that will be hosted by KIK/IRPA (http://closertovaneyck.kikirpa.be). Images such as the high-resolution macrophotographs and the infrared reflectograms are all in the public domain, and will generate scholarly attention from art historians for many years to come. The CHARISMA/MOLAB data will be an important aid in the upcoming restoration and will be made available at a later date, also through the dedicated website.