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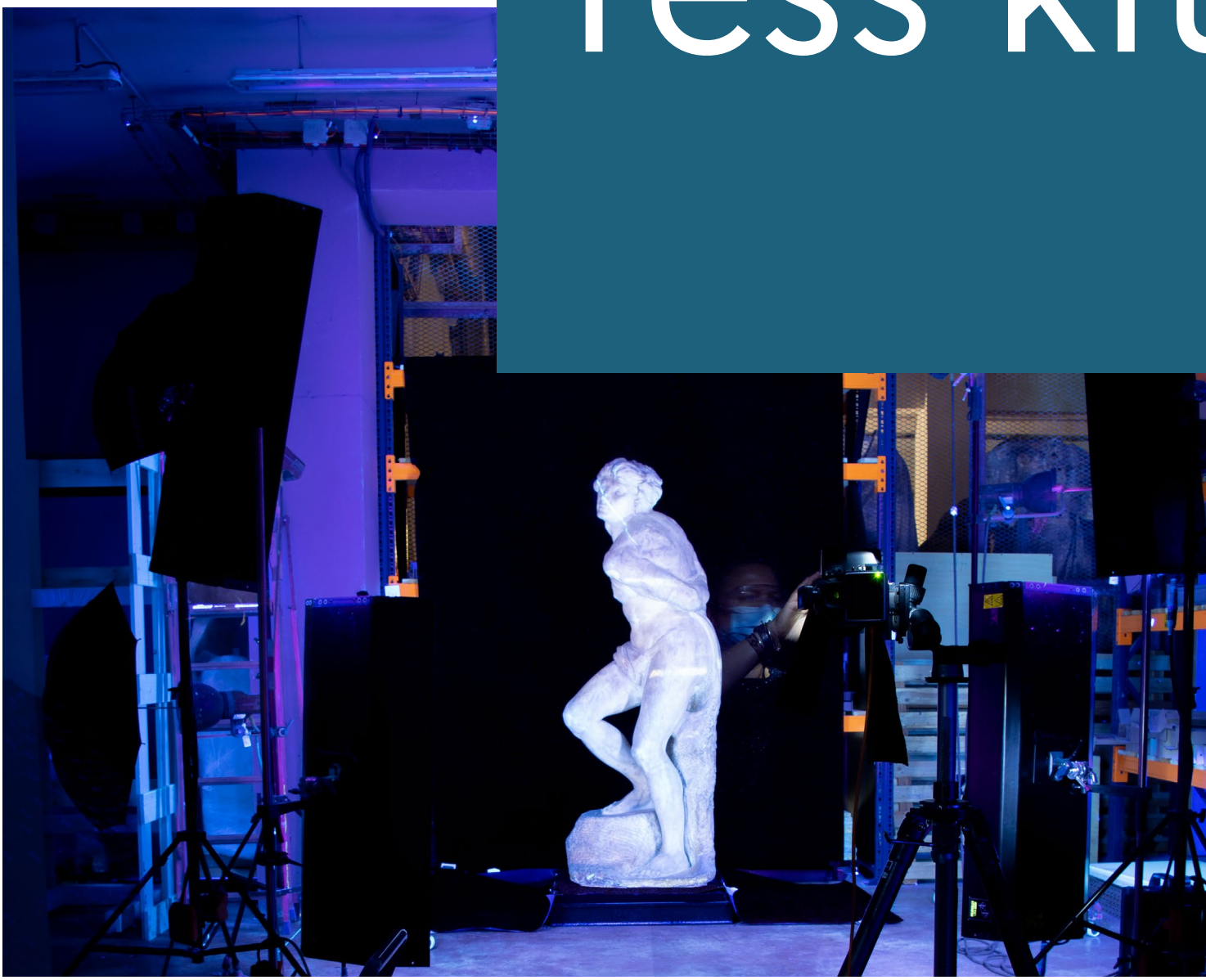
CENTRE DE
RECHERCHE
ET DE
RESTAURATION
DES MUSÉES
DE FRANCE

Press kit



THE CENTRE FOR RESEARCH AND RESTORATION OF THE MUSEUMS OF FRANCE (C2RMF)

SUMMARY



LE CENTRE DE RECHERCHE ET DE RESTAURATION DES MUSÉES DE FRANCE

The Musée d'Amiens mummy, the Moulins Cathedral triptych, a Greco canvas from the Musée Bonnat-Helleu de Bayonne, Van Eyck's *Madonna and Chancellor Rolin* in the Musée du Louvre, Louis XV's microscope in the Palace of Versailles... These works drawn from the "Musées de France" and public collections are present in C2RMF's premises on an exceptional, temporary basis for the purposes of scientific analysis and, in some cases, for restoration by specialist teams.

C2RMF's scope extends to everything related to the knowledge of cultural assets: from the materiality of the works, to the creative techniques employed, to their conditions of conservation-restoration. The extent of its role is given by the acronym: "C" for Centre, 2 "R"s combining Research and Restoration, and "MF" standing for "Musées de France".

C2RMF is a driving force and a major player in heritage research. Its expertise is recognised both within France and on the international stage.

C2RMF is is a national department

under the French Ministry of Culture. Its role is to support the 1,220 State-approved museums bearing the name "Musée de France". Its tasks were defined by the Order of 16 December 1998, which created the Centre by bringing the Musées de France Research Laboratory (LRMF) and the Musées de France Restoration Service (SRMF) under the same umbrella.

C2RMF is a unique institution

in a number of ways, including its status, the diverse range of its teams' expertise, the scope of the technical resources available to these teams, and its ability to offer a global approach to the conservation of cultural assets within a single structure. At C2RMF, we handle both brushes and lasers, screwdrivers and proton beams... We take X-rays and photographs across the range of the electromagnetic spectrum; we dust, we restore and we archive. We speak both the language of art history and that of the hard sciences: physics and chemistry.

C2RMF's areas of competence and expertise

- Scientific study and analysis, dating.
- Research on materials and techniques.
- Preventive storage.
- Conservation-restoration.
- Contribution to the French State's Scientific and Technical Control (CST).
- Documentation and archiving.
- Dissemination of knowledge.

C2RMF AND ITS TASKS

"Working together with the curators responsible for the collections, the Centre's task is to implement the Musées de France Directorate's policy in terms of research, preventive conservation and restoration of the Musées de France collections. It compiles and maintains documentation on the materials, techniques and restoration of the museums' works."
Excerpt from the Order of 16 December 1998.

C2RMF combines multiple actions that support heritage assets:

- It provides solutions that enable museums to fulfil their core roles, regardless of their size, their reputation, or the nature of their collections: enriching and preserving cultural assets to ensure their transmission to future generations.
- It restores the works entrusted to it.
- It leads heritage science research programmes on creative techniques and the materials comprising the works. The aim of these programmes is to further our knowledge of heritage objects, their attribution and their history.
- It studies alteration processes.
- It provides support for institutions and collection managers with preventive conservation issues.
- It develops new instruments and methods for examination and analysis, and suggests practices and treatment protocols leading to a respectful, sustainable conservation-restoration methodology.
- It manages and coordinates the network of national museums' libraries.
- It performs documentary monitoring of the analysis; study and restoration operations for the works entrusted to it, and archives the resultant data.
- It makes data accessible to professionals and shares knowledge and experience in publications and via meetings (seminars, study days, conferences).
- It actively develops partnerships with academic institutions, laboratories and regional restoration centres; and it initiates and involves itself in domestic and international research programmes.

To carry out its missions, the C2RMF has

Spaces on three sites: the Carrousel, the Pavillon de Flore, and the Petite Écurie du Roi in Versailles

A team of 150 employees, all part ofthe French Ministry of Culture, with a varied and complementary range of know-how and skills.

An analytical platform with high-performance technical equipment, whose diverse capacities cover a very wide range of analytic fields. Comprehensive examinations using imaging, material analysis and dating techniques can be carried out in a single location.

Documentary and iconographic databases that are accessible to professionals, researchers and students.

C2RMF's OPERATIONS IN FIGURES

- 13,000 m² total floor space
- 3 sites: Carrousel, Pavillon de Flore, Petite Écurie du Roi in Versailles

The LABORATORY is located under the Jardin du Carrousel. Its 5,900 m² split over three levels include the technical platform, and in particular the NewAGLAE particle accelerator; the works examination rooms; the documentation centre; an 80-seat auditorium; offices; and storerooms.

THE RESTORATION WORKSHOPS are divided between the Petite Écurie du Roi in Versailles (4,500 m²) and the four levels of the Pavillon de Flore in the Palais du Louvre (2,600 m²).

- 150 permanent agents / approximately 50. / 100 freelance restorers -
1,000 works (approximately) received per year.
- 200 scientific publications per year.
- 435,000 images referenced and 100,000 documents in the EROS database.

WHO REQUESTS C2RMF's SERVICES
HOW AND WHY?

C2RMF is a service operating under the French Ministry of Culture. As such, it responds to requests from "Musées de France" and participates in the French State's regional Scientific and Technical Control (CST). Its activities are governed by the French Heritage Code and the Musées de France Act.

When do museums call on the Centre's expertise?

Heads of "Musée de France" collections request C2RMF's services via the OSCAR platform (see box). Other institutions receive C2RMF assistance due to the status of their collections (historical monument conservation services and regional archaeology services).

C2RMF experts are called on:

In the event of a one-off problem: disaster, flooding, fire, biological contamination.

For global issues relating to collections: risk identification; assessing the works' environment to improve conservation either in situ or prior to the design, renovation, or upgrade of exhibition spaces or storerooms.

For assistance and advice with drafting documents: service specifications, market analyses, architectural projects, preparation of a Cultural Assets Safeguarding Plan (PSBC), a Flood Protection Plan (PPCI) or a Scientific and Cultural Project (PSC).

For a specific work or a body of work: dating, pre-acquisition expertise; research, preliminary studies, strengthening of the support or structure, more or less complex restoration work to re-establish the work's aesthetic qualities for presentation to the public.

Depending on the nature of the request, the C2RMF teams

- Work remotely to draft, communicate reports, and send out recommendations.
- Work *in situ* for condition reports, works inspections, restoration scheduling, and environment diagnostics.
- Receive works on C2RMF premises, in the laboratory and restoration workshops.

Requests may require one-off operations as well as long-term support for large-scale projects (museum renovation, restoration schedule for a work or a set of works, complex operations).

OSCAR,
Conservation, Archives and Research Monitoring Tool
(*Outil de Suivi de la Conservation, des Archives et de la Recherche*)

OSCAR is the mandatory intermediary between the museums and C2RMF. This Internet counter was set up in 2016 to enable online entry of intervention requests from Museums of France, whether for interventions on a cultural asset or requests for advice and assistance.

C2RMF's role in the French State's Scientific and Technical Control (CST)

All Musées de France are subject to compliance with the provisions of the French Heritage Code* and the State's CST. In the regions, this falls under the Regional Directorates for Cultural Affairs (DRAC), which is tasked with implementing the French State's nationwide cultural policy.

When museums have acquisition, conservation or restoration projects, these issues are discussed at regional scientific commissions**, in which C2RMF representatives participate as of right, to provide advice and opinions in response to and in support of curatorial requests, and also to help museums draw up their Scientific and Cultural Project (SCP), a strategic document to which they are bound.

Most regions schedule two to four meetings per year, which represents a significant time investment for C2RMF officers.

**"Any restoration of an asset that forms part of a Musée de France collection is subject to prior consultation by the scientific bodies provided for in Article 10.3"*

***Established by France's 2002 Museums Act.*

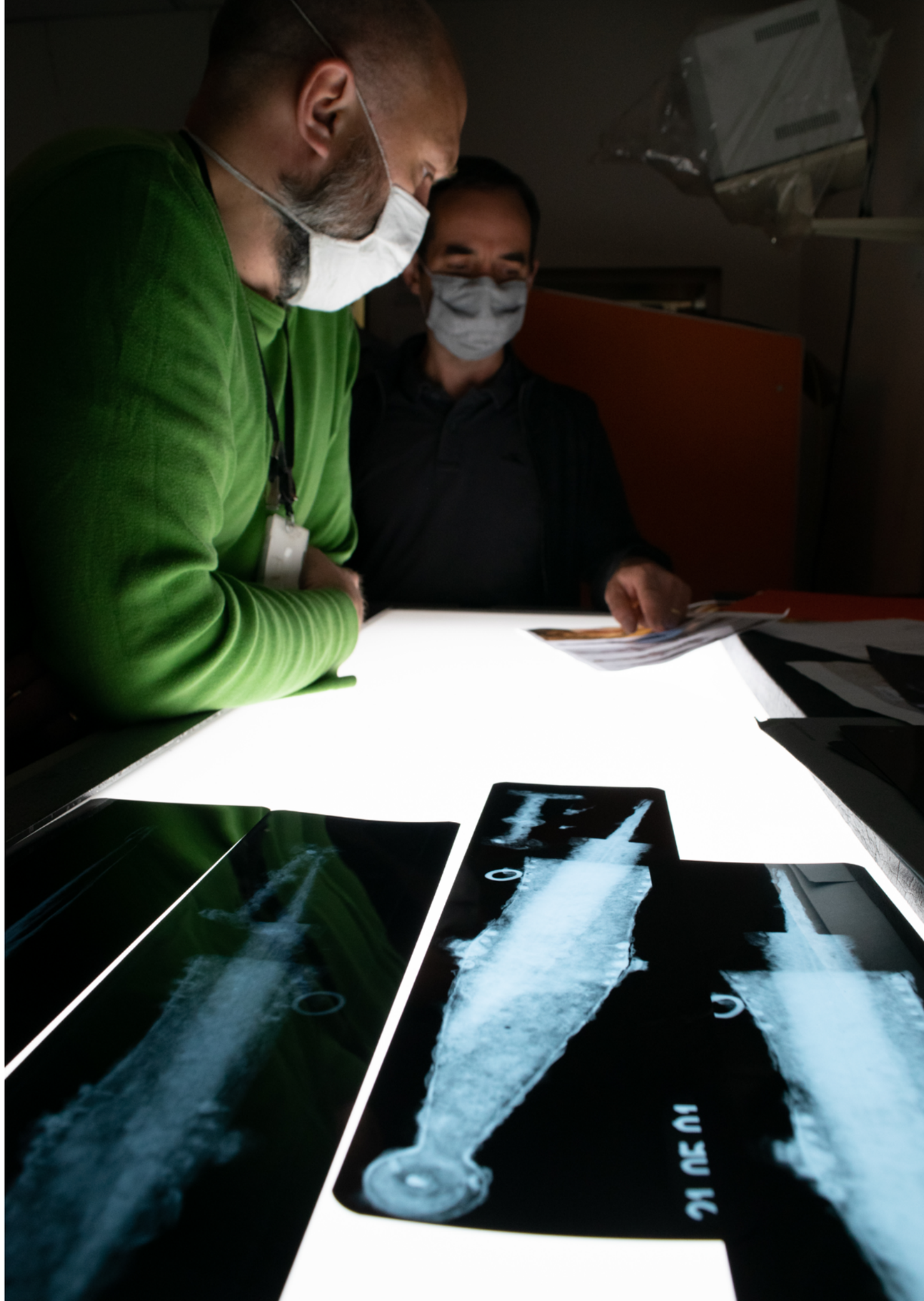
ETHICAL FRAMEWORK

C2RMF's work in the field of preventive conservation and in restoration and research is strictly governed by France's national Codes (French Museums Act of 4 January 2002, French Heritage Code*, International Council of Museums (ICOM) Code of Ethics).

The conservation and restoration of cultural assets has become more professional during the 20th century with the establishment of specific training programmes and an ethical framework. Under article R452-10 of the French Heritage Code, only restorers holding a master's degree awarded by one of the four recognised public degree-awarding institutions, or those holding accreditation of sufficient experience, or, in the case of European nationals, those having recognised qualifications issued by the Ministry of Culture, are authorised to work on Musées de France collections.

*"Any restoration work is carried out by specialist restorers under the direction of the curator, within the meaning of Article L. 452-1 of the French Heritage Code. Any conservation and restoration procedure must be documented, and as reversible as possible. Any transformation of the original object or specimen must be clearly identifiable. The curator shall ensure that the integrity of the work is respected. However, valid arguments from a conservation, historical or aesthetic perspective may justify the removal of certain elements during the procedure. If any historically relevant fragments are removed, these are stored and identified. The procedure must be fully documented."

* Circular of 26 April 2007 containing the Ethical Charter for Musées de France heritage curators and scientific managers, pursuant to Article L.442-8 of the French Heritage Code.



MULTI-FACETED SKILLS
EFFICIENT TECHNIQUES

C2RMF combines unique technical resources and multi-faceted skills to meet the requests of the Musées de France and to be able to handle a wide variety of cultural assets, some of which are extremely prestigious.

A dialogue of experts

A team of more than 150 agents operating under the French Ministry of Culture combines a diverse and complementary range of know-how and skills. These include imaging specialists, radiologists, photographers, technicians, chemists, physicists, geologists, dendrochronologists, floor directors, installers, prevention officers, heritage conservators, restorers, art historians, documentalists, librarians, reception agents and administrative staff.

The range of professionals represented within C2RMF is extremely wide. Some of these may seem removed from the art world. However, they form part of an ongoing dialogue that blends knowledge and experience.
Art historians and curators present the life of the work in context. Radiologists' and photographers' images reveal the hidden aspects of the works, and secrets relating to their manufacture, creation and fragility. Chemists and physicists identify and analyse the components from a scientific perspective. Finally, the restorers' experience uses all this data to draw up a restoration protocol that is best suited to the materiality and condition of the objects (paintings, sculptures, decorative arts, furniture, graphic arts, ethnographic and archaeological objects). From Paleolithic ivory to 20th century plastics, C2RMF is entrusted with works made from a wide variety of materials, some of them composites.

The capacity of the technical platform

MEB, XFR, DRX, LA-ICP-MS, OCT, C14*... these acronyms, which are all familiar to C2RMF engineers, correspond to instruments and methods used for the imaging, dating and analysis of heritage objects.

The first tool is the eye. However, since the creation of the Laboratory and the first X-rays of paintings in 1931, technologies, in particular those adapted from the medical and industrial spheres, have made spectacular advances in several directions via instrumental development, specifically in terms of high sensitivity, efficiency, non-invasiveness and miniaturisation.

The digital revolution has also opened up new fields including the chance to reconstitute objects in 3D and to share data.

The dialogue between art, science and technology is well established and widespread. C2RMF's analytical instruments now make it possible to view the invisible, identify components, determine their origin, date works, and better understand the techniques used in their creation and manufacture. Non-invasive analyses and minimal-impact techniques are a priority. Finally, the portability of instruments means examinations can be carried out *in situ*. This is a valuable resource for diagnosing works that cannot be moved due to their size, state of conservation, fragility or reputation.

** MEB (scanning electron microscopy), XFR (X-ray fluorescence spectrometry), C 14 (carbon 14), DRX (X-ray diffraction), OCT (optical coherence tomography), LA-ICP-MS (plasma mass spectrometry by inductive coupling and laser ablation).*

The C2RMF technical platform has instruments that can perform several types of examinations:

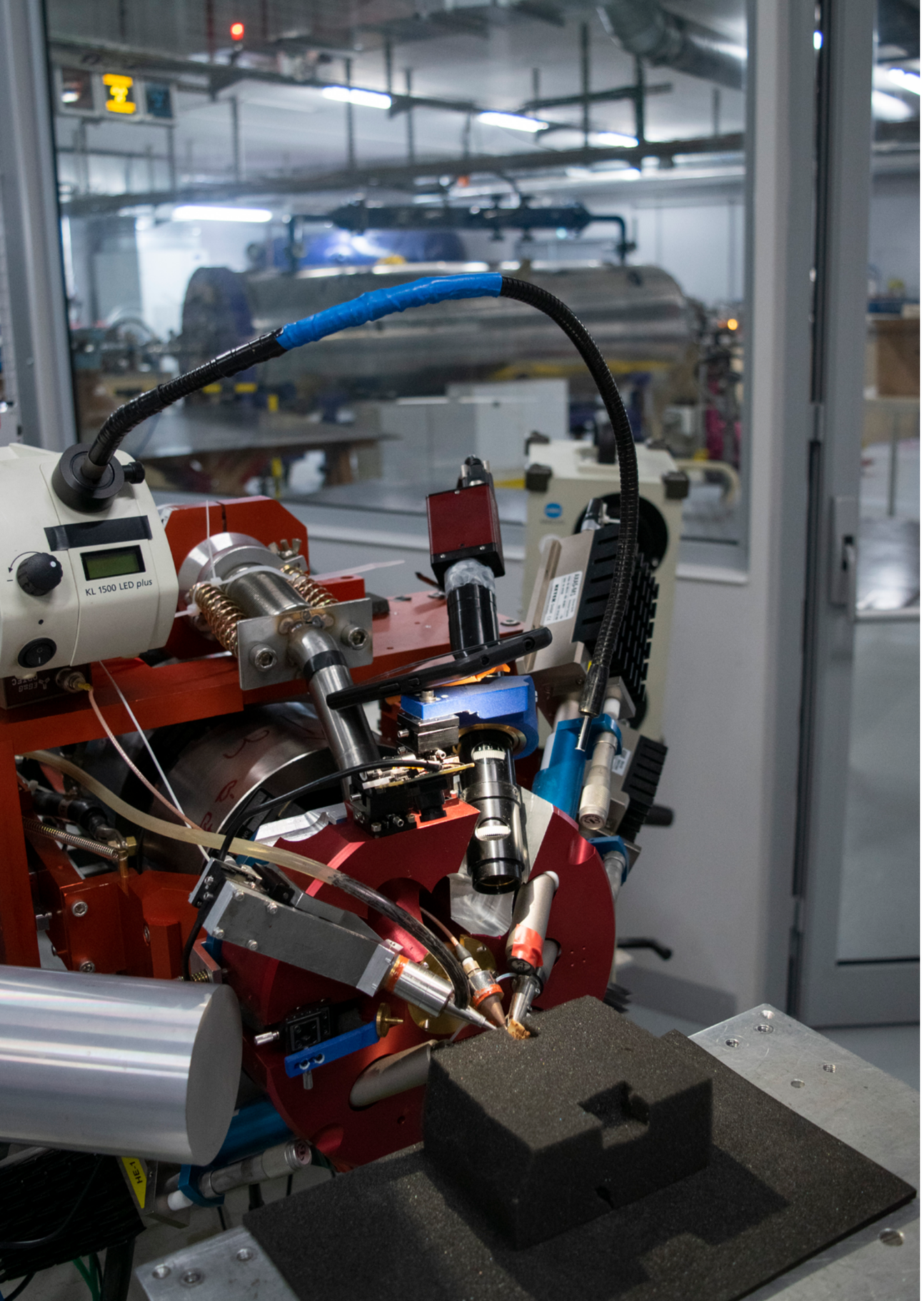
- Photographs of different wavelengths, with each wavelength providing specific information.
- X-rays for structural analysis.
- Imaging equipment at different scales, from macro to nano (conventional or digital optical microscopes, scanning electron microscopes, optical microtopography systems, 3D microscopy), all which provide information on the object's surface from the micrometre down to the nanometre.
- 3D X-ray tomography and 3D scanning systems to collect all data relating to an object's shape, structure and appearance.
- Non-invasive analysis and chemical imaging protocols: XRF-2D, OCT, DRX, archaeodendrometry, ion beam analyses - NewAGLAE (see box).

Exploration: from the artwork's external appearance to its core

Visualising the invisible. Photographs taken under different radiation conditions and X-rays provide information about the structure and life of the work. They reveal the stages of the creative process, accidents, tears to the canvas, ceramic breakages, the metal fastenings of sculptures, changes in format, and the repainting and retouching of paintings. However, they do not provide complete information about the chemical or molecular composition of materials, or their age.

Reducing uncertainty. When not all problems have been resolved, or when there are issues of restoration or understanding of the work, different methods of examination are combined. For example, micro-samples, taken in consultation with the collection managers, are analysed using scanning electron microscopy, infrared thermoluminescence, or mass spectrometry. In most cases, these samples are stored in a materials library.

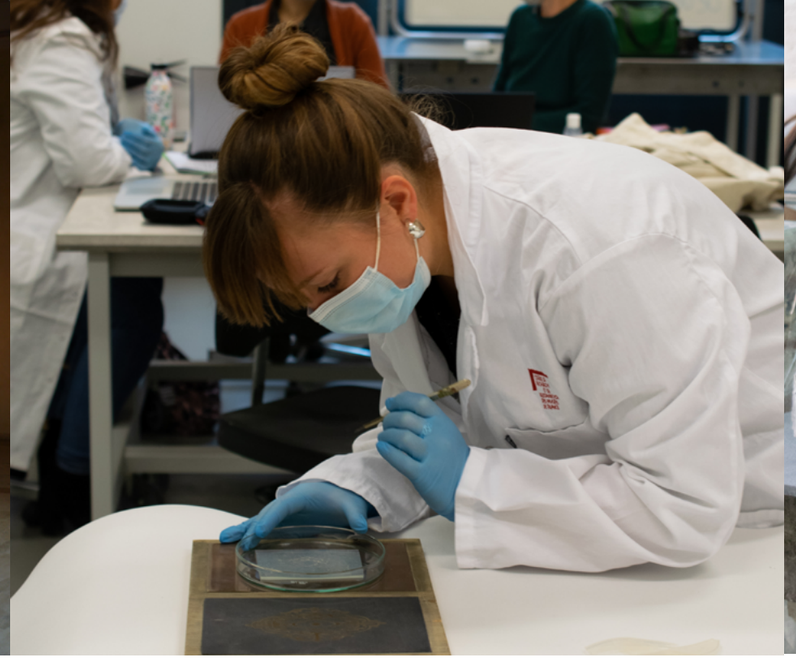
A new method of elementary chemical analysis, LA-ICP-MS, combines laser ablation and mass spectrometry to analyse traces and ultra-traces in a wide range of heritage materials (pigments, glasses, metals, metallurgical scoria, terracotta, rocks and hard animal materials). The laser's high lateral resolution (a few microns) and depth can track inclusions, deposits and faint coatings. This new device is a significant addition to the techniques available in Ile-de-France, in particular the chemical imaging techniques offered by NewAGLAE. It plays a decisive role in exploring new challenges relating to our knowledge of old materials (origins, detailed characterisation of techniques, relations with the environment, alteration of materials, etc.).



Imaging used for paintings. Direct light shots reproduce the work as faithfully as possible at Time T. Razor light photographs highlight the condition of a painting's surface, the tension of the canvas, the elevation of the brushstrokes, and reveal any possible cracks. Ultraviolet photographs reveal the surface condition of the varnishes and any gaps. Infrared images provide information on traces of preparatory work, underlying drawings, and workshop markings. False-colour infrared uses digital composition to highlights certain pigments and their distribution. Finally, X-rays show the painting's structure and condition, and sometimes any underlying compositions. Additional examinations are performed on top of this basic protocol, depending on the initial problems or those encountered later.

WHAT DŒS NEWAGLÆ DO?

The installation of the Grand Louvre Accelerator for Elemental Analysis (*Accélérateur Grand Louvre d'Analyse Élémentaire*, or AGLAE) in C2RMF's new premises in 1998 was a landmark event. At 27 m in length and weighing 5 tonnes, AGLAE is one of a kind in terms of size. It is the only active particle accelerator in the world used exclusively for heritage assets. Its non-invasive, physicochemical analysis of materials comprising the works is performed using ion beams.
AGLAE is not just a machine. Rather, it is a body of operators whose multi-disciplinary skills ensure that it is properly maintained, and who understand how to make it "talk". In 2017, its performance was optimised with more sensitive detectors and more stable ion beam and line automation, allowing it to perform analyses both during the day and at night. AGLAE thus became NewAGLAE. It is not exclusively for use by C2RMF, and is open to researchers from other French and European institutions. Applying to use NewAGLAE is subject to several criteria. The issue in question must relate to heritage sciences, and the objects being studied must be in the public domain. Finally, any data produced by NewAGLAE must be shared prior to publication, in compliance with the embargo periods in force. The Euphrosyne platform is being developed to ensure the widespread application of this standard.



SCIENCE

SUPPORTING HERITAGE

The technical platform's resources and the teams' wide range of skills can respond to collection managers' questions on the highly diverse range of the heritage objects under their care. They can also initiate, support and participate in research projects as part of a partnership policy.

Every object is a potential research topic

Each heritage object generates questions according to its typology and condition. Some objects have become fragile or simply aged; others are puzzles whose manufacturing processes, or the nature and origin of their components, are unknown. Beyond the requirements of a pre-restoration study, a work may require more in-depth research due to its complex nature, its unique status, or its belonging to a larger body of work. Each work demands a specific approach and raises its own questions: Which instruments to use? Which method to select? Which internal or occasionally external skills to call upon? The results of these examinations and analyses allow for a more effective response to the questions raised by the Musées de France collections managers, as part of an ongoing dialogue. They also contribute to the progress of heritage science.

Research areas

C2RMF develops research programmes that span a wide variety of fields and reflect a broad range of questions. They involve teams from the Center and partner institutions over long periods of time.

1. The study of manufacturing processes, the history of creative techniques, artistic and artisanal know-how, creation centres and the provenance of materials.

The ISLAMETAL programme covers a set of 200 Indo-Persian metal objects dating from the 10th to the 14th century. The collection is housed in the Musée du Louvre's Department of Islamic Arts. The ISLAMETAL programme focuses on a collection of 200 metal objects from the Indo-Persian world of the 10th to 14th centuries, from the objects collection of the Islamic Arts Department of the Musée du Louvre. The purpose of the scientific analyses is to determine the composition of the alloys, to define the manufacturing processes and decorative techniques, and to characterise the production centres.

The PILINA project studies the Greek clay figurines in the Musée du Louvre's Department of Greek, Etruscan and Roman Antiquities. **The ESPRIT programme** is focused on the polychrome stucco of the Italian Renaissance. **The APPEAR project** addresses the use of colour in the Fayoum mummy portraits dating from the 1st to the 4th century AD.

The Boulle project. The redevelopment of the Louvre galleries dedicated

HERITAGE SCIENCE

"Heritage science" is not, strictly speaking, a new discipline. The generic term underlines its necessarily multidisciplinary nature, which encompasses all disciplines contributing to conservation-restoration and the understanding of heritage assets, bringing together a wide range of professions within the scientific and technical communities, from art historians to engineering experts.

EXAMINATIONS AND ANALYSES PERFORMED AT C2RMF

The various examinations performed on the works provide information on:

- The composition and origin of materials from an elementary and structural perspective.
- The structure and assembly of objects.
- Creative techniques.
- Factors leading to deterioration.
- Dating.

Analysing these results improves recovery, conservation and restoration by:

- Developing new cleaning methods and products.
- Trying out new conservation materials.
- Developing new conservation-restoration protocols.

to the 18th century led to a study of Boulle furnishings and a significant body of fragile items, including furniture and decorative objects. These sophisticated, composite works combine various species of wood, brass, gilded bronze, tin, tortoiseshell and animal horn. Time has taken its toll on these items over the past three hundred years (marquetry inlays lifting, oxidation of the metal parts), and they have sometimes been modified by additions and repairs. Current research seeks to develop less aggressive methods for cleaning metal parts, to design innovative protocols for repairing marquetry inlays, to come up with new recipes for glues, varnishes and protective waxes, and to rediscover long-forgotten formulations.

The study of a body of paintings by the same artist. During restoration work or at the request of a curator, the works of a painter displayed in public collections can be examined and compared. The aim is to shed light on their creative techniques from a scientific perspective, as was the case for works by Leonardo da Vinci, Jean-Baptiste Oudry, James Tissot, Raphaël, Goya or Amadeo Modigliani.

2. Studying alterations

Each pigment reacts differently and interacts with the undercoat; each canvas or wood substrate changes differently over time. A better knowledge of the mechanical and chemical behaviour of constituent materials allows us to measure and predict the risks incurred to the works, and to tailor conservation-restoration methods to their specific context.

The **MARCS project** (Mechanism for the Alteration and Digital Reconstitution of Smalt Colouring) studies smalt: a synthetic pigment (cobalt-tinted blue glass with a high potassium content) used from the 15th to the 18th centuries, which changes from blue to grey-yellow as it ages. The aim is to identify the factors behind these alterations and produce digital reconstructions of the original appearance.

The ZOoMM project (Zinc Oxide from Micro to Macro) studies the white zinc pigment developed for painting in the 19th century as an alternative to traditional – and toxic – white lead. Zinc white, however, has issues with alteration that can lead to storage problems. Understanding its use and

the origin of these alterations will help prevent future damage.

3. The study and development of new conservation-restoration strategies

Ongoing research is being carried out into restoration products and protocols, cleaning methods, and the choice of adhesives, waxes and varnishes*. These are fundamental issues for restorers seeking **improved efficiency, safety, stability, durability and re-treatability.**

Research projects are underway into **“metal gels”** and **“stone gels”**: cleaning products that are less aggressive and less toxic than some solvents. As part of the transparency requirement, research into gold leaf restoration led to the development of a specific gold alloy, incorporating a detectable chemical marker to distinguish between original and restored gilding.

**Varnishes are vital for both conservation and restoration. A major research topic involves assessing their effect on the appearance of the work, depending on the type of resin used. “The optical properties of restoration varnishes on easel paintings”, Study Day, May 2022, accessible on c2rmf.fr.*

4. Instrumental and methodological research and development

More effective examination techniques allow us to better fine-tune our knowledge of works and materials. Improving existing instruments to update innovative examination and analysis techniques is an ongoing process. This is supported by methodological research to best tailor the instruments to specific problems, conceive scenarios combining several instruments, vary the methods, and compare the results obtained.

5. Taking account of climate change

Rising temperatures, weather variations and climate-related accidents are a priority for heritage research, particularly for preventive conservation actions.

Using IPCC climate databases, correlated with data on the weathering and behaviour of materials used in buildings and heritage objects, studies are underway to analyse climate/material interfaces. The long-term goal is to create preventive diagnostics and **develop new practices**, both in terms of protocols and products, that will reduce, halt or stabilise the effects of weather variations on the works’ constituent materials or the products used in their conservation and restoration.

These new practices - which will need to be implemented, tested, evaluated and disseminated - will generate feedback and data that can in turn feed into new research.

DATING METHODS

Dating requests are an important aspect of research. Three complementary methods are used:

- Luminescence, for certain minerals (such as quartz): this technique is mainly used to date objects that have previously been heated (pottery, bricks, etc.).
- Dendrochronology, to date wood from temperate areas with distinct seasons (non-invasive method).
- Carbon 14 dating, for organic materials (bone, wood, feathers, wicker, leather, parchment, etc.).

PLASTIC... IT'S ALSO AN ART FORM

At C2RMF we are interested in the pigments used by the great painters, the masters of gilding on wood, as well as 20th and 21st century creations involving chemical components from the industrial sphere, in particular plastic – a material used in many types of everyday objects. Plastic objects are now part of museums' collections. These include celluloid dolls, collectible glasses, creations by couturiers and designers, installations by contemporary artists, etc. However, plastics are susceptible to specific types of damage including seepage, shrinkage, reticulation, micro-cracks, discolouration and the exudation of additives (odours). Their conservation and restoration is a relatively new topic and, hence, a challenge. Our knowledge is a work in progress, in conjunction with the petrochemical industry.

Three meetings co-organised by C2RMF show the interest in these materials, which are steadily evolving:

- "Cellulose acetate", Study Day, May 2018.
- "Polyurethane in all its forms", Nov. 2019.
- "PVC in all its forms", October 2021.

C2RMF is integrated into the French and international scientific landscape

Research is a networked process, and C2RMF is involved in many projects in collaboration with other partner institutions. Domestically, it works with the French Historical Monuments Research Laboratory (LRMH). It is also associated with three French National Centre for Scientific Research (CNRS) teams: the Physico-Chemistry of Historical Evidentiary Materials (PCMTH) team at the Institut de Recherche de Chimie-Paris (IRCP), the Technology and Ethnology of Prehistoric Worlds team (UMR-Temps), and the NewAGLAE Research Federation team, which develops and operates the analysis system linked to the particle accelerator.

C2RMF coordinates **the ESPADON-PATRIMEX project** and **manages the European Research Infrastructure for Heritage Science (E-RIHS)** – two structures that give European heritage science stakeholders access to databases, material libraries, and fixed or portable digital and instrumental platforms.

Internationally, C2RMF's integration into the scientific landscape is reflected in its participation in numerous international programmes, in particular the **Integrated Platform for the European Research Infrastructure on Heritage Science (IPERION-HS)**, and **Sensmat** (a European programme on preventive conservation). C2RMF is also a member of the Heritage Science Foundation (FSP), which supports research projects.

RESTORATION
THE FINAL STEP OF THE OPERATIONAL SEQUENCE

Restoring a work is a beginning-to-end process, not simply a technical act. It is the result of constant dialogue between curators, researchers and restorers. Before any work can begin, a diagnosis is carried out based on a systematic preliminary study. Every step of the process is rigorously documented.

Which works are restored as a priority?

While all public collections and the 1,220 Musées de France may be referred to C2RMF, most requests come from around 60 museums or institutions each year. In terms of the nature of the works entrusted to the Centre, **70% of requests concern paintings.** Then, in descending order: sculpture, decorative arts, archaeological and ethnographic objects, graphic arts and contemporary art.

C2RMF supports museums at every stage of their projects, from diagnosis to completion, either by entrusting the works to its in-house restorers or by employing freelance restorers in its workshops.

Restoration: a process that constantly poses new questions

The effects of natural ageing mean that all works experience **changes to their original condition**, to varying degrees. Gilded wood becomes tarnished, mechanisms seize up. Marquetry inlays lift, stone statues blacken and paintings accumulate dirt. Colours lose their brightness due to oxidation; varnishes are subject to yellowing or opacification through changes to pigments. Mountings shift, wood panels come apart, blisters and cracks appear on canvases.

Added to this is occasional voluntary or involuntary damage caused by human actions, including accidents, vandalism, improper cleaning, hazardous reconstructions, reframing, dismantling, changes to the format or support, repainting of various origins (repainting for the sake of decency, over-bright repainting, repainting that becomes discordant over time, and also repainting by the artist's own hand). **The works never return to their original state.** Restoration is not an exact science. Beyond any specific doctrine, it is the expression of the tastes and principles in force at a given time, and its execution reflects the existing state of knowledge and available technical resources.

Restoration protocols are constantly evolving. A more precise, more selective laser, used initially for cleaning stone, is now employed for decorative arts and paintings. Specifically, it was used for the painted frames of the Issenheim Altarpiece. Cleaning gels are likewise now preferred to solvents, reducing toxic emissions. When it comes to choosing adhesives, we now prefer natural adhesives that are easier to remove and, generally speaking, the most neutral and eco-responsible products.

The operational sequence

First step: the preliminary study. Information comes from several sources:

- The condition report, which is carried out on arrival by the works' management. These examinations are performed with the naked eye, a magnifying glass and a flashlight.
- The imaging file (X-ray, direct light photography, razor light photography, infrared imaging, ultraviolet imaging).
- This data is available in the C2RMF database, EROS, or in the archives. It documents the life of the work

ORGANISATION BY SPECIALIST SECTORS

The Restoration department has six sections:
Archaeology and ethnography, decorative arts, graphic arts and photographs, painting, sculpture, 20th century - contemporary art.

It employs 30 people:

- 13 heritage curators.
- 1 documentary studies officer.
- 2 study engineers.
- 3 art technicians.
- 9 heads of artworks.
- 1 administrative staff.
- 1 scientific contractor.

and its history, and gives access to valuable reports on any earlier restoration work.

- Restorers' experience and art historians' and curators' knowledge.
- Additional examinations, if necessary, for the physicochemical characterisation of the materials and the degradation process.

Diagnosis and definition of the protocol. A diagnosis is made based on all these data. Next, a protocol is drawn up in collaboration with the manager of the museum's collections where the work is housed. Depending on the type of work, a specialist in the field known as the "case manager" will coordinate the process.

The operations to be carried out will then be specified: the cleaning method according to the nature of the materials (mechanical or chemical releases, with solvents or gels, possible use of laser, etc.), dismantling in the case of furniture or decorative art objects, replacement of missing parts, restoration of mechanisms and, for easel paintings, consolidation of the support, filling in paint gaps, and re-varnishing.

Restoration: support and monitoring. Only works from the following sectors are handled by in-house restorers or, if necessary, freelance restorers: archaeology (metal and ceramics), cabinetmaking, gilded wood, modern metal, sculptures (stone and wood). For graphic arts, photographs, contemporary art, textiles, ethnographic objects and paintings, the work is carried out entirely by authorised private restorers* in the workshops of the Pavillon de Flore or the Petite Écurie du Roi in Versailles, or *in situ* when the works cannot be moved. In this case, C2RMF's role is to support the restoration at all stages: from drafting specifications, steps prior to the call for tenders to select the restorers, through to monitoring and compliance with the chosen protocol.

**The department uses approximately 100 contracted freelance restorers per year, nearly half of which are painting restorers.*

Caution and surprises. Throughout the operational sequence, the works may reveal specific problems or discoveries that sometimes require additional examinations, or the adaptation or modification of the restoration protocol. In the case of prestigious works or delicate procedures, a monitoring committee or scientific council made up of leading specialists in the field (art historians, curators, scientists and restorers) is set up to make the best decisions as a collective. By way of example, the following restorations were performed under scientific advice: the Issenheim Altarpiece in the Musée Unterlinden in Colmar; the Apostles in the Musée de Cluny, Louis XIV's desk in the Palace of Versailles, Eugène Delacroix's large-scale paintings, the Triptych in Moulins Cathedral, Michelangelo's *The Slaves*...

A TEAM DEDICATED TO RECEIVING AND CONSERVING THE WORKS

C2RMF is entrusted with approximately 1,000 works every year.

The length of their stay can vary greatly: from a few days (for an expert assessment prior to acquisition) to several years for a complex restoration. A dedicated team – the works management team – is in charge of conserving and managing the movement of these objects.

Seven directors and three installers work between the sites in Paris and Versailles. They monitor the works by coordinating departures and arrivals, overseeing the movement from the technical platform to the Pavillon de Flore workshops, writing status reports, and performing administrative monitoring.

The works that enter C2RMF are unique, fragile and sometimes extremely prestigious heritage assets. They are subject to handling and to environmental changes in the course of their stay. The works management team guarantees optimal conservation conditions and ensures that mechanical, climatic and infestation risks are prevented in all areas of the Centre (examination rooms, workshops and storerooms). A regularly updated Flood Prevention Plan (PPCI) and a Cultural Assets Protection Plan (PSBC) have been drawn up for the Centre's sites. These reflect the equivalent plans in force in the museums. Reflective stickers bearing the "Blue Shield" logo identify priority works in the event that evacuation is required.

ANTICIPATING

PREVENTIVE CONSERVATION

The condition of heritage assets depends on their age and their environment. What are the effects of changes to the climate? Flash photography? CO_2 release? Vibrations during transportation? All of these issues fall under the scope of preventive conservation. It includes all matters that have, or may have, an impact on the integrity of a collection or a work of art, and which may ultimately threaten their existence.

A new and growing discipline

Preventive conservation emerged in the 1970s (the expression was first used in 1975). It gradually became an established part of France's cultural policy from the 1980s onwards, with the creation of a specific department. Created at C2RMF in 1999, it was called the "Prevention Department". The discipline has expanded over the years, as evidenced by the strengthening of the dedicated team. It was reinforced by legislation in the 2000s (French Museums Act 2002, French Heritage Code 2004) and driven by new needs, in particular by the increased movement of works (exhibitions, loans). Heads of collections likewise became alert to the effects of global warming or the possibility of disaster, as shown by the Notre-Dame de Paris Cathedral fire in April 2019. Today, preventive actions are not simply about sheltering isolated cultural assets. Rather, it is a question of addressing works:

- Within their environment as part of a broad approach.
- Pragmatically, to identify risks and come up with tailor-made solutions.
- Sustainably, by choosing environment-friendly solutions and paying attention to the products used and to staff health.

Considering multiple factors

The life of works in a museum depends on multiple factors, both in the exhibition spaces and in storage. These include environmental data with cumulative effects, the immediate consequences of natural disasters, and repeated or unfortunate human actions (handling, poor procedures).

Action levers are therefore multi-faceted. They take account of sustainable development requirements and relate to:

- Thermal-hygrometric conditions (temperature and humidity levels) within the museum and in the display cases.
- Light: natural light and museographic lighting, both within the exhibition spaces and in the display cases and storerooms.
- Vibrations due to window instability, transmission via the ground, or proximity to cars in urban areas.
- Indoor pollutants (gases, dust).
- Causes of biological degradation, mould, infestation by insects and small animals.
- Location-specific risk factors: floods, fires, seismic events, urban pollution, proximity to the sea.
- The condition of the building's structures, in particular the roofs.
- The number of visitors.
- Handling and transporting works.
- Supports, marking products, packaging materials.

ICOM DEFINITIONS

Preventive conservation covers "Actions aimed at slowing down the rate of deterioration and reducing the risk of damage to collections."
Curative conservation involves stopping an active process of deterioration.
Restoration is work carried out on a stable asset to improve its appearance, understanding or use.

C2RMF's role: expertise, recommendations and support

The team in charge of preventive conservation responds to requests from Musées de France made on the OSCAR platform. An online self-assessment questionnaire with 100 questions is used to assess the museums' specific data, their strengths, and their prevention needs.

Depending on the nature of the request, C2RMF:

- **Takes action when museums are faced with emergencies**, both pre- and post-accident (fire, flood, infestation). If necessary, it performs an on-site intervention and can provide emergency equipment.
- **Assists and advises museums** after examining sent data or by carrying out an *in situ* operation. It drafts a report including technical or methodological recommendations.
- **Helps with drafting specifications for a preventive conservation study** in connection with a collection site, a renovation project, or a temporary exhibition.
- **Provides assistance with drafting the Preventive Conservation Plan and the Flood Protection Plan (PPCI).**
- **Since 2019, C2RMF has been working on a Cultural Assets Safeguarding Plan (PSBC) project** to make museums aware of the need to anticipate the management of major risks. In 2018, only 17% of museums had a PSBC, rising to 35% in 2022. There is no obligation for institutions to have a PSBC. In a notice published on 10 June 2016 and again in 2018 as part of the National Climate Change Adaptation Plan (PNACC-2), the French Directorate-General for Heritage stated that museum stakeholders "will take steps to integrate the impacts of climate change into cultural heritage asset management plans".
  PSBC support workshops were set up in different regions in 2019, bringing together a group of museums. One day every two months, for a whole year, participants received step-by-step assistance with drafting of their own PSBC. This work led to the production of the online "Cultural Assets Safeguarding Plan" manual (see box). This educative work continues with the creation of a series of PSBC training webinars from March 2023 to February 2024. The programme involves six half-day sessions every two months, either in person at the C2RMF auditorium or by videoconference, under the same principle as for the workshops.
- **Contributes to the French State's scientific and technical control and issues technical opinions on**

preventive conservation projects presented to the collections' regional scientific committees (acquisition of measuring equipment and packaging material, studies in preventive conservation relating to collection sites or transfer projects, etc.). This includes checking that the "preventive conservation" component is properly factored into the Scientific and Cultural Projects (PSCs) submitted by museums, which has been mandatory since the introduction of the 2016 law. C2RMF's opinion is included in the opinion issued by the Regional Directorate of Cultural Affairs (DRAC) on the PCS of the museum in question.

- **Spreading best practices by making methodological tools available on the C2RMF website** (technical data sheets, tools, guides, questionnaires to assess best practices in preventive conservation).
- **Leading basic and further training initiatives**, organising themed days, and raising awareness about the need for prevention among collection managers and restoration professionals.
- **Developing and taking part in studies or research programmes** on deterioration factors and their mechanisms to better prevent risks, in particular for decolorimetry, to adapt the lighting policy for light-sensitive cultural assets. C2RMF took part the European "SENSMat" project involving 18 countries that resulted in the design of efficient and easy-to-use prototype sensors to measure environmental data, working as closely as possible to the objects, and then analyse these data as a way for museums to implement appropriate conservation strategies.

DRAFTING A PSBC: A GUIDE

The "Cultural Assets Safeguarding Plan" manual summarises all the work undertaken since 2019 by the various parties involved in preventive conservation. These include C2RMF, DRAC, the emergency services (Paris Fire Brigade [BSPP] and the Departmental Fire and Rescue Service [SDIS]), the Service des Musées de France (SMF) and local stakeholders. This document, written by the Department of Preventive Conservation and published with the support of the Service des Musées de France (SMF), has been online since October 2022, and is designed as a step-by-step guide to the key stages involved in drawing up an operational document.

DOCUMENTATION

MAKING DATA ACCESSIBLE

All work performed within C2RMF is documented. As such, the Centre holds considerable volumes of valuable data in thousands of project files and its extensive archive space. These reference data are made available to heritage professionals, researchers and students.

Documenting: a crucial task

"C2RMF compiles and maintains documentation on the materials, techniques and restoration of museum works." This task, as defined by the 1998 Order, is an integral part of the conservation-restoration process. Any procedure is preceded by a documentary search of the work in question's history using existing files created during studies or as part of earlier restorations. Any work performed generates new data. This precious collection of reference data for the study of materials, techniques, and types of alterations and treatments is hence constantly being compiled and enriched.

Data collection involves a team of documentalists specialising in the following fields: painting, sculpture, decorative arts, archaeology, contemporary art and graphic arts. Armed with knowledge of their field, and according to the type of object, the documentalists are involved throughout the conservation-restoration process. They work upstream to review the available documentation, and they collect the data produced as the analysis, study and restoration operations on the works entrusted to C2RMF proceed. The documentalists are in particular responsible for organising photo shoots during conservation-restoration operations and for collecting the resultant photographs.

Artworks files. Collecting, classifying, describing, packaging, providing access... All the documentation produced is included in the artworks files. In the same way as medical files, these describe the disorders, gather the analyses and X-rays, and report the diagnosis and the prescribed treatment. For artworks, these are condition reports, upstream study reports, analysis reports, scientific imaging (in both paper and digital format), and post-operation reports.

These data are stored in paper format. The documentalists also compile digital files that can be consulted on the EROS database. For now, this is only available in the reading room, but it will be accessible online in the future.

DOCUMENTARY RESOURCES

C2RMF has extremely rich documentary resources. These consist of:

- Documentation about the works: the works files and the "geographical resources" relating to operations carried out in the museums.
- Archives documenting the history and operation of the Centre and its services. These archives are intended to be transferred to the National Archives. They are supplemented by private archives, in particular those of freelance restorers. The list of resources in the Archives will be published on the C2RMF website following an inventory.
- Specialist resources from the resource centre.

Access to data: EROS and Euphrosine

Making data accessible to all: this is the challenge of the future. The outlook has improved with the development of digital tools and with the introduction of France's 2016 Law* for a Digital Republic. Progress is driven by new uses including remote working, access to study days and conferences by videoconference, and the development of data sharing platforms as part of European-scale projects. C2RMF is a massive producer of information, which is currently being digitized and made partially accessible via the EROS database, which will be connected to EUPHROSYNE in the future.

EROS (EUROPEAN RESEARCH OPEN SYSTEM) is a database created in 2002. It is a multilingual platform with multiple search engines. EROS lists nearly 80,000 works files. As of January 2023, this comprised some 90,000 documents and 435,000 referenced images.

However, EROS does not give access to data provided by the following scientific equipment: NewAGLAE, X-ray fluorescence, scanning electron microscopy, mass spectrometry.

The "Euphrosyne" project (AGLAE's sister, in Greek mythology) aims to open up the data produced by NewAGLAE to the European community of scientists, restorers, curators and art historians. Euphrosyne falls under the pillars of Open Science and the "FAIRification" of data. The investigation phase was carried out between January and April 2021 in the French Ministry of Culture's incubator, the Digital Workshop.

**C2RMF is required to comply with France's Law of 7 October 2016 for a Digital Republic, supplemented by the 2018 National Plan for Open Science, the aim of which is to promote "the circulation of data and knowledge" and to open up data to all heritage stakeholders in the spirit of open science, i.e. to provide FAIR data that is "easy to Find, Accessible, Interoperable and Reusable", without encumbrance, delay or in return for payment.*

THE RESOURCE CENTRE

Located in the Carrousel, the reading room is open to visits by appointment. Researchers, students, heritage professionals and restorers make up the majority of visitors. Here, they can consult works, periodicals, memoirs and theses* free of charge. They can also enter queries into the EROS database and access non-digitised documentary files and archives on request. In addition, documentarians and librarians offer three types of remote services: research assistance (scientific guidance), sending documentation in digital form, and digitisation on request (except X-rays).

* These resources include 3,355 case studies, 2,084 memoirs and theses, and 53 periodicals. The Catalogue is accessible on the Collective Catalogue of Museum Libraries (CCBMN).

What does a works file consist of?

Example: the thick file belonging to *The Virgin and Child with Saint Anne* by Leonardo da Vinci

This painting is more than five hundred years old. Work has been done to it at various intervals throughout its life, as revealed by its particularly thick file. The file contains:

516 images (direct light, razor light, infrared, ultraviolet and X-rays),

146 documents: study reports, journal articles, status reports, restoration reports (not all of which are digitised),

1 health data sheet listing the procedures carried out before the creation of C2RMF.

The latest documents were produced while the painting was at C2RMF in preparation for the Leonardo da Vinci exhibition at the Musée du Louvre in 2019/2020.

A NEW TASK: COORDINATING THE NATIONAL MUSEUMS LIBRARIES NETWORK

Since 2016, C2RMF has been in charge of running the National Museums Libraries Network (RBMN), which brings 32 libraries of 28 national museums together under one umbrella. The libraries network extends across the whole of France, and includes in particular those of the Musée du Louvre since 2018 and the Musée Picasso-Paris since 2022. The rich collections of these specialist libraries are featured in their online bibliographic catalogue. The database covers art history and archaeology. It documents works conserved in the national museums. This shared catalogue makes it easier for users to perform searches, and increases the visibility of the national museums libraries' collections.

DISSEMINATE, EDUCATE, TRAIN

PUBLICATIONS, CONFERENCES, SEMINARS, STUDY DAYS, ETC.

Study days on the theme of "Actions against floods", a seminar on Galuchat, an issue of the journal *Technè* dedicated to the painter Goya, scientific publications, international debates... C2RMF shares, disseminates and transmits the knowledge acquired in its areas of expertise. Its target audience are conservation and restoration professionals, students, researchers and art lovers.

Meetings

Conferences, study days and seminars are all opportunities to raise awareness among heritage stakeholders about conservation and restoration issues, to review completed or ongoing research projects, and to exchange ideas with heritage professionals both in France and on the international stage.

These meetings cover a wide range of topics.

Restoration products and techniques:

- "The optical properties of restoration varnishes", Study Day, 21 May 2022.
- "Metal gels", Study Day, 22 May 2022.

Materials:

- "Analysis of gold and its uses as a pictorial material in 16th to mid-17th century Europe", International conference as part of the AORUM project, June 2022.
- "Galuchat: materiality, uses and condition of the collections", Seminar, 30 September 2022
- "Gilded and enamel Renaissance glass", Conference, March 2022.

Artists' creative techniques:

- "Jean-Baptiste Oudry: art and materiality", 20 June 2022.
- "Leonardo da Vinci: the experience of art", October 2019.

Preventive actions:

- "Actions against floods", Study Day, 13 October 2022.
- "Heritage challenges in the face of climate change", Seminar, 2 December 2022.

Focus on remarkable objects:

- "Fundamental restoration of the pointed amphora by the Achilles Painter", Seminar, 18 November 2022.
- "*The Charioteer of Delphi* and large-scale Greek bronze statuary art", Symposium in Athens and Delphi and by webinar, from 1-4 December 2022.

C2RMF teams are taking part in major international events organised by the International Council of Museums (ICOM) and UNESCO. As such, C2RMF will be present at the "Ceramic and Glass in Cultural Heritage and Art" symposium at the European Ceramic Society Conference in Lyon from 2-6 July 2023, and at the International Committee for the History of Art (CIHA) in Lyon in 2024.

** Palissy Amphitheatre, one seminar per month on Fridays from 11 a.m. to 12 noon, schedule on c2rmf.fr*
Information on conferences and study days can be accessed on c2rmf.fr

Publications

C2RMF publications address all issues relating to conservation and restoration research. These include reference books, scientific articles, information for professionals on the website and the renowned journal, *Technè*.

The site includes activity reports, technical fact sheets and methodological guides written by specialists in preventive conservation for professionals, available online in PDF format.

C2RMF publishes specialist works including conference proceedings, Study Day reports, and case studies. Scientific publications (around 200 per year) in national and international journals are available on the HAL open science website (hal.archives-ouvertes.fr).

Education and training

C2RMF is not an educational institution. However, its teams make a significant contribution to the basic and further training of heritage professionals by offering general and specialised courses at the Ecole du Louvre, the National Heritage Institute (INP) and universities. The Centre also welcomes interns, PhD students and post-doctoral students in materials science, as well as apprentices, particularly in its workshops.

TECHNÈ

Launched in 1994, *Technè* is a twice-yearly scientific publication aimed at specialist professionals and art lovers. It covers all heritage collections, including museum collections of art and archaeology, ethnography and natural history, and spanning all periods from prehistory to contemporary art, from ancient civilizations to modern Europe and beyond. *Technè* issues alternate between those dedicated to the great painters, and technical matters. For example, Issue 1 was on "Poussin and 17th century French Painting", Issue 18 was on "Metal", Issue 26 was on "Painters' use of colour", Issue 49 was on "Boulle furniture", Issue 52 was on "Dating: a multi-discipline challenge", and Issue 53 was on "Goya".

***Technè* exists in paper format (€25 from the Comptoir des Presses d'Universités, lcdpu.fr) and its content is accessible in digital format on OpenEdition.org. The latest issues are under embargo for 12 months.**

EXAMPLES

THE MUSÉE BONNAT-HELLEU
Long-term support

THE MUMMY OF AMIENS:
Setjaïmengaou in intensive care

THE TRIPTYCH OF THE GLORIOUS VIRGIN OF MOULINS CATHEDRAL
Long-term support

LOUIS XIV'S DESK
A technical feat to reconstruct a national treasure

JEANNE DE BOURBON AND CHARLES V
Laser cleaning of medieval sculptures

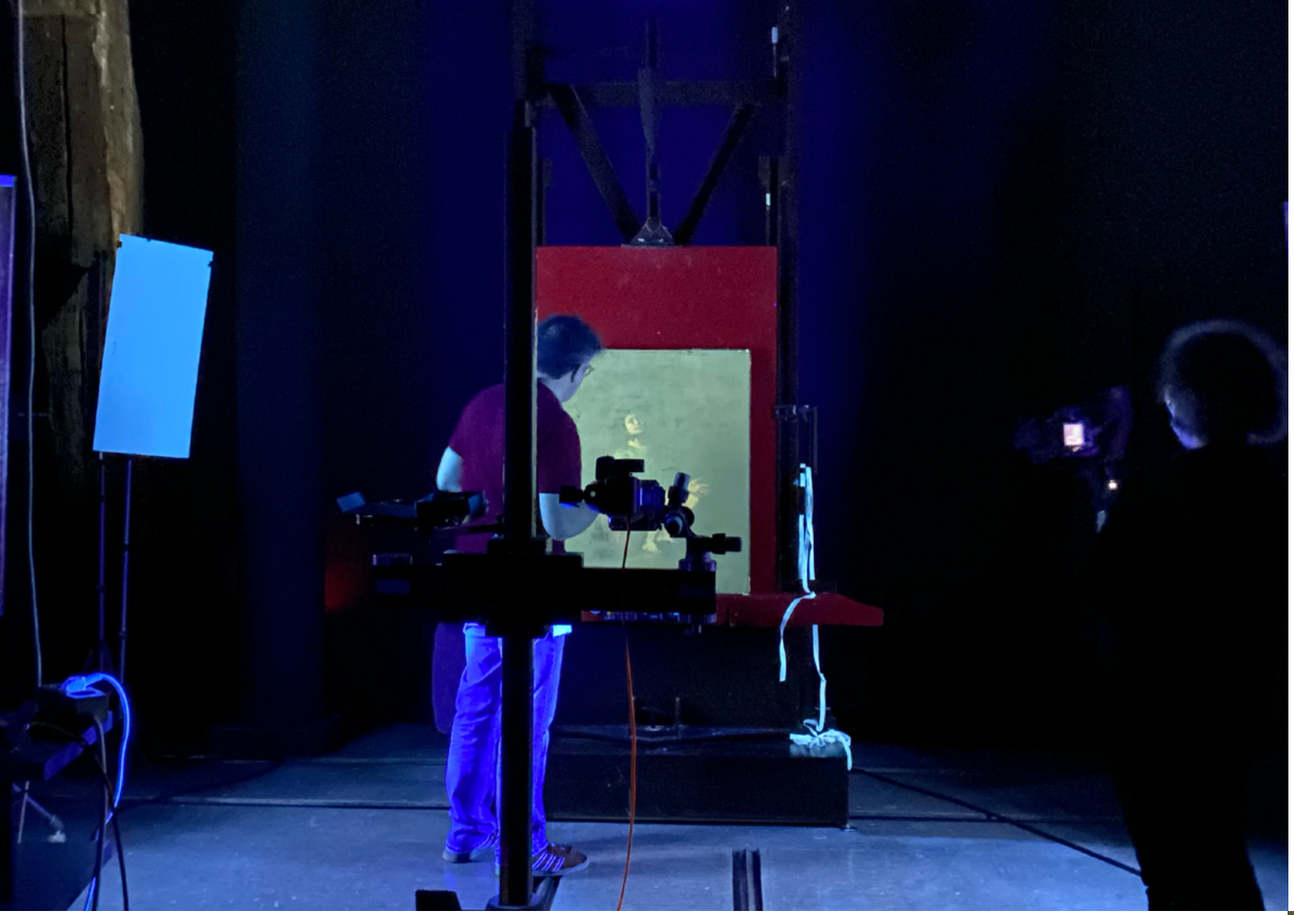
THE CHARIOTEER OF DELPHI
Manufacturing secrets of a Greek icon

WOMEN IN THE GARDEN
Monet discovers new colours

THE DEATH OF SARDANAPALE
BY EUGÈNE DELACROIX
A major masterpiece studied and restored *in situ*

THE *MAYS* OF NOTRE-DAME DE PARIS CATHEDRAL
Large-scale preventive restoration work

***FISH* BY KAREL APPEL AT THE DUNKIRK MODERN ART MUSEUM (LAAC)**
A contemporary work in steel experiencing discolouration



THE MUSÉE BONNAT-HELLEU
LONG-TERM SUPPORT

This museum in Bayonne is closed for works until 2025. A vast restoration programme is planned, with several campaigns staggered between 2021 and 2024 addressing more than 80 artworks.

This is an opportunity to showcase a high-quality collection that includes paintings by Rubens, Greco, Poussin, Girodet, Van Dyck, etc. This remarkable ensemble was bequeathed by Léon Bonnat (1833-1922), a figure from the artistic world of the Third Republic. Director of the École des Beaux-Arts, he also painted two hundred portraits of important figures including Victor Hugo and Adolphe Thiers. C2RMF's long-term support to the Musée Bonnat-Helleu includes reviewing documents provided by project management (preventive conservation), assistance in drafting specifications for the various restoration lots, and receiving works for examination and restoration.

THE MUMMY OF AMIENS
SETJAÏMENGAOU IN INTENSIVE CARE

The star of the Musée d'Amiens, this mummy was acquired in 1839 by the Société des Antiquaires de Picardie and donated to the museum. It is said to contain a 1.75 m-tall, 2,700-year-old woman.

An extremely fragile work, the mummy arrived at C2RMF in February 2022 in a box constructed in the 19th century. The extraction process involved cutting the wood and sliding her out. She then underwent a series of tests to diagnose her condition. This was an opportunity to get to know her better: are the two sarcophagi associated with her really hers? Bandages were also found in the museum. Are they part of the same set? Where do the stones used for her eyes come from? The answers to these questions will add interest to her new presentation at the Musée d'Amiens when she is returned in early 2023, restored and with her sarcophagi solidified.

THE TRIPTYCH IN MOULINS CATHEDRAL DEPICTING THE VIRGIN AND CHILD

RESTORATION PRIOR TO A NEW PRESENTATION

**The scientific committee includes the responsible clergy (the Bishop, the Rector of the Cathedral), the contracting authority (DRAC), the Inspectorate of Historical Monuments, figures from the French National Monuments Centre, the Historical Monuments Research Laboratory and C2RM, as well as specialists (Louvre curators, academics, Head of Restoration at the Royal Heritage Institute of Brussels, etc.)*

The triptych is Moulins Cathedral's masterpiece. Rediscovered in 1838 by Prosper Mérimée, in separate pieces but in good condition, its reputation was quickly established. Initially presented to the public in 1889, it was listed as a historic monument in 1898.

In 1960, following X-rays taken in the laboratory by Magdeleine Hours, it was attributed to the late-15th century Flemish painter, Jean Hey. The triptych was the subject of an *in situ* imaging campaign in 2018-2019. The painting's original layer, covered with an oxidised varnish and frequently retouched, revealed an underlying drawing. The triptych left Moulins for C2RMF in November 2022 in three parts. It was stored in insulated cases with humidity control sensors. It will remain at C2RMF for the length of its restoration, under the auspices of a scientific committee*.

Additional studies should allow us to better date the work and analyse its technical components. In the meantime, while waiting for the return of its masterpiece, the sacristy that usually houses the tryptic is starting its own redevelopment project. This work will make it easier for visitors to move through the space and improve the quality of the triptych's environment.

LOUIS XIV'S DESK

A TECHNICAL FEAT TO RECONSTITUTE A NATIONAL TREASURE

This exceptional item of furniture, delivered in 1685 to King Louis XIV by the cabinetmaker Alexandre-Jean Oppenordt, is one of a pair inlaid with tortoiseshell and brass marquetry. Due to the complexity of the work and the impact of the decisions taken, its restoration was carried out under the auspices of an international committee.

In the 19th century, the desk was transformed from a so-called "flat" desk into a "broken" desk. The decision was taken to return it to a state "closest to its original form." The existence of the (un-transformed) second desk at the MET in New York was a valuable reference. Examinations revealed traces of the old hinges and the original assembly methods. They gave an understanding of the composition of the varnishes, the nature and age of the woods used, and revealed the multiple colours underneath the tortoiseshell marquetry. Once the desk was fully disassembled, technical innovations carried out as part of a research project on Boulle furniture were employed, in particular the laser cutting of new (identifiable) marquetry pieces to fill the gaps. The desk has now regained its rightful place in the Salon de l'Abondance at the Palace of Versailles.

THE CHARIOTEER OF DELPHI
MANUFACTURING SECRETS OF A GREEK ICON

How were the great Greek bronzes created from the 6th to 4th centuries BC? What materials were used? *The Charioteer of Delphi*, the star of the Musée de Delphes, was the subject of a Franco-Greek study program.

It was inspected and examined *in situ* during the museum's closing hours by teams from C2RMF and the Musée du Louvre, and specialists from the French Welding Institute. Examinations were carried out between November 2019 and November 2022. The results were announced at an international conference held in Athens from 1-4 December 2022: the Charioteer is composed of 15 separately cast pieces; its lips and eyelashes are in gilt copper; it has four silver incisors; and its eyes are an inlaid mosaic of different stones (the whites are magnesite, the irises are chalcedony). These examinations highlighted the sophistication of the work's manufacture and revealed its possible origin. Analysis of the minerals contained in the statue's modelled clay core identified a blend of minerals from southern Italy and Calabria.

JEANNE DE BOURBON AND CHARLES V
LASER CLEANING OF MEDIEVAL SCULPTURES

These two icons of 14th century sculpture were originally present on one of the façades of the Louvre. They spent time at the Basilica of Saint-Denis before returning to the Louvre in 1904.

Their long life has been punctuated by some infamous alterations. Mishandled during the Revolution, they then lost their royal characteristics, which were inaccurately replaced by Viollet-le-Duc in the 19th century. The statues have experienced black crusting, due in part to their period of outdoor exposure. Following a preliminary study, and under the supervision of a scientific committee, the sculptures were cleaned using laser for the old parts, and micro-sandblasting for the elements recreated in the 19th century (protected spraying of alumina oxide powder). The application of a laponite-based gel (synthetic clay), made it possible to "exfoliate" the limestone pores, in much the same way as a beauty mask. Some colourful touch-ups contributed to the chromatic harmony of the whole by masking the stains and joints.

THE DEATH OF SARDANAPALE
A MAJOR MASTERPIECE STUDIED AND RESTORED IN SITU

This is one of Delacroix's largest canvases. Due to its size (392 x 496 cm) the painting was examined *in situ* at the Musée du Louvre. The only change was to the gallery, so that restoration work on the support and the pictorial layer could be carried out in a space with less visitors than the gallery where the other works by Delacroix are exhibited.

When work is completed, the collection will include *Women of Algiers in Their Apartment*, another painting restored in the C2RMF workshops in 2021, and *The Massacre at Chios*, restored in 2019. These procedures restore Delacroix's virtuosity as a colourist, giving the public the chance to view the works in their full aesthetic harmony.

WOMEN IN THE GARDEN
MONET DISCOVERS NEW COLOURS

Claude Monet was 26 when he completed the large-scale painting on display at the Musée d'Orsay, which was restored in 2021.

The varnishes had yellowed with age and there were ridges on the surface of the canvas, perhaps due to the long-term effects of a remounting in 1921. The imaging file confirmed a tear in the lower-right section of the canvas (which probably occurred when being handled during its completion), revealing the change of position of Monet's signature and his compositional uncertainties, notably regarding the positioning of the woman with the umbrella. The oxidised varnishes were lightened, the supports retouched, the frame restored and the colours refreshed.

THE *MAYS* OF NOTRE-DAME DE PARIS CATHEDRAL

LARGE-SCALE PREVENTIVE RESTORATION WORK

Restoration work on the large-scale works of Notre-Dame de Paris Cathedral began in October 2021. Twenty-two paintings are involved, including the 13 *Mays* – paintings dating from the 17th and early-18th centuries offered as gifts by the Paris Brotherhood of Goldsmiths on 1 May.

Project steering is by Ile-de-France DRAC, drawing on the expertise of C2RMF, which is a member of the monitoring committee. Each painting has its own study file, with photographs in visible light, infrared, ultraviolet, infrared reflectography, and samples analysed using IRTF spectroscopy. The fire did not damage the canvases. However, it presented an opportunity to remove them from the cathedral to carry out checks, reinforce the supports, clean and lighten the varnishes, and fill any gaps. Housed in a large warehouse in the Paris region, the paintings are in the care of fifty freelance restorers for a period of several months.

FISH BY KAREL APPEL AT THE LAAC

A CONTEMPORARY WORK IN STEEL EXPERIENCING DISCOLOURATION

A large fish stands in the gardens of the LAAC* in Dunkirk. More than 3 m high and 4.50 m long, it was created in 1982 based on a small-scale model.

The fish is composed of 304 welded steel plates. Exhibited outdoors, it is subject to discolouration. The existing fish has been repainted twice, in 1992 and 2003. However, these overpaints (identified as glycerophtalic paints during the C2RMF analyses carried out *in situ*) do not guarantee the long-term durability of the colours. There are also problems with adhesion. When restoring contemporary works, the hope is that there can be discussion with the artist, if he or she is still alive, and with his or her suppliers. Appel died in 2006, and a long investigation was carried out to discover the original colours used for his fish; but in vain. Among the various restoration options, repainting after first removing any corrosion seemed the best solution, using the colours of the model fish as a reference. Therefore, aesthetics trump an unknowable historical authenticity... it being understood that in 25 years, when the fish has lost its colour again, the products available on the market to repaint it will no longer be the same...

** LAAC - Dunkirk Museum of Contemporary Art. Karel Appel (1921-2006) was one of the founders of the COBRA group.*

Images

P.2

- View of the Saut du Loup restaurant - Palais du Louvre, Paris - ©C2RMF Vanessa Fournier

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- Gilding test for the CORD'ARGENT research project - ©C2RMF Vanessa Fournier
- Micro-sampling on a pointed amphora by the Achilles Painter (INV 116), BnF, Paris - ©C2RMF Vanessa Fournier
- Reinforcing the face helmet (91866), Musée National d'Archéologie, Saint-Germain-en-Laye - ©C2RMF Vanessa Fournier

P.6-7

- Statuettes in the bronze treasure display case of the Forum Antique de Bavay - ©C2RMF Vanessa Fournier
- Photo shoot of the *Charioteer of Delphi,* Musée Archéologique de Delphes - ©C2RMF Dominique Robcis
- Issenheim Altarpiece (88 RP 139), return to the gallery, panels painted by Matthias Grünewald, Musée Unterlinden, Colmar - ©C2RMF Vanessa Fournier

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- X-ray examination of a puggio at the Musée Gallo-Romain de Saint-Romain-en-Gal - ©C2RMF Vanessa Fournier

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Contacts:
Hugo Plumel
+33 (0)6 83 93 62 94
Hugo.plumel@culture.gouv.fr

Vanessa Fournier
+33 (0)6 23 84 39 36
vanessa.fournier@culture.gouv.fr