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1 Introduction

Works of art are subject to continual change: their material composition alters as a result of chemical and mechanical processes, the physical context changes and each successive generation of observers views the works through different eyes. Art and art appreciation are therefore determined by an extremely complex interplay of material and immaterial conditions. This influences the way art is dealt with, both theoretically and in actual practice, and thereby the views and considerations regarding degradation, conservation, presentation and the communication of various values. The Science for Arts research program aims to investigate changes in artworks with regard to an object's chemical and physical dynamics, significance and substance as well as its frame of reference. Collaboration between specialists in the fields of conservation, humanities, physical and chemical sciences is pivotal as they collectively investigate an object or group of related objects in a museum environment. The program aims to develop and strengthen interchange between the research of various research institutions and the museological field.

The research program is an initiative of the NWO (The Netherlands Organization for Scientific Research) and follows on from earlier NWO programs in the field of interdisciplinary art-technological and scientific research as applied to conservation, namely Molart (1995–2002) and De Mayerne (2002–2006). The rich harvest of material data from these programs has proved how relevant interdisciplinary collaboration can be for the preservation of cultural heritage. This needs to be expressed in terms of contemporary conservation practice, both nationally and internationally. As well as operating nationally, there is a strong international collaboration foreseen, particularly regarding the USA (National Science Foundation).

Two areas of research are central to the program, namely ancient art and modern and contemporary art. Ancient art is in this case a collective term for visual and applied arts and works on paper before 1880. Modern and contemporary art covers the same categories from 1880 onwards, but additionally includes all facets of installation art, conceptual art and new media art. The differences in the use of materials, aesthetics, ethics and presentation between these two areas demand different approaches to conservation. The Netherlands plays a leading role in both the conservation fields. This program aims to strengthen and expand this prominent position, not in the least by integrating the results from both research areas where possible.

Science4Arts aims to make a substantial contribution to the conservation professions. Additional to its research aspect, the program intends to build an interdisciplinary community of experienced researchers who can collaborate extensively and create a framework for the future demand for well-trained professionals.
2 Aim

An integrated approach to a given object whereby the collaboration of the various disciplines – namely, the natural sciences and the humanities in the context of conservation – is central. This collaboration should lead to more integrated and objective opinions concerning conservation and should stimulate theoretical development in this field.

Science-based conservation practice requires physical and chemical research into materials, the aging processes and the consequences of conservation. The disciplines mathematics and computer science can offer support by developing models for ageing processes and visualisation methods. In this way, well-grounded answers can be given to a large number of questions concerning the artistic identity and integrity of an object, its original, present and future context, the consideration of conflicting values and the justification of decisions made. Such questions can be resolved only through interdisciplinary collaboration. Alongside the natural sciences, expertise in the humanities (namely arts and culture, history and philosophy) is indispensable in the conservation context.

Scientifically based conservation practice is impossible without the recognition that the investigation into an object or group of objects can take place on various levels. Three levels may be defined, although these will be partially overlapping and exchange knowledge and ideas.

2.1 Research levels

2.1.1 Function, context and significance

The essence of this level is represented by the function, context and significance of an object whereby the object is not subject to invasive investigation. The goal of research at this level is a better understanding of the object itself and the context within which it holds a certain significance. This applies to both ancient and modern and contemporary art. Some paintings originally formed part of a much larger painting or altar-piece. The original function and significance of such paintings have been partially obscured. The function and meaning need to be reconstructed in the mind’s eye of the conservator before any intervention can be considered or implemented. Or take paintings in historic interiors, the purpose of which is fixed. In the case of modern art, one needs to take into account that change may be a feature of the artwork or may even be unavoidable. This can, for example, result from the temporary nature of the installation at a particular location for which it has been specially designed, or from the use of more-or-less impermanent materials. Should such changes not be noticed and registered, then the artwork will alter without anyone being aware of this.

2.1.2 The physical object

This is research at the level of the object itself, directed towards knowledge of past materials and production techniques, understanding of material deterioration and underlying degradation mechanisms, as well as insights into the physicochemical dynamics of such processes. Characterization of the material can lead to a different interpretation of the object or can provide information valuable for conservation. The conservator and scientist collaborate closely in this (preliminary) research. The latest scientific investigative techniques from the fields of computer science and mathematics can, for example, be employed to shed new light on the determination of an artwork’s authenticity. Investigation is carried out at the macro and micro levels and it is recognized that the treatment of an object directly influences environmental factors and their monitoring. Research at the level of the physical object must be carried out before a valid course of treatment can be established. The preservation of the existing (or still existing) visual material is often the prime reason for taking action.
Innovative technologies in materials research
In addition to the development of computer visualization techniques and the measurement of surface coarseness, there are also methods important for art-technological and conservation research that are non-intrusive and non-destructive and offer high information density. One may think of the characterization of historic material and use of materials as well as the study of chemical, physical and/or mechanical degradation processes. This type of research often demands the utmost in analytical expertise, considering, for example, analytical and spatial resolution, the amount of sample material available, access and convenience for museum visitors, portability of apparatus for in situ analysis, and so forth. Innovative, ingenious analytical concepts are required for this, for example by adaptation of existing instruments or by access to so-called Large Facilities, i.e. synchrotron or neutron facilities in Europe. In all of this, too, collaboration between the conservator and scientist forms the basis of the investigation.

2.1.3 Future conservation strategies
Research into conservation is of great importance for possible future treatment of objects within a preservation and conservation framework. Included in such conservation strategies are new digital documentation and visualisation methods, the development of new preservation and conservation protocols which address both ethical considerations and the range of the various art forms. Here, too, the unified concept of the function, the context, the material and the degradation of an object is pivotal in the formulation of a conservation strategy, which may also lead to a supportive non-intervention or to recommendations for adaptation of the surroundings.

2.2 Program outline
2.2.1 Research areas, research themes and questions
As mentioned in the Introduction, two areas of research are central to the program, namely ancient art and modern and contemporary art. Within these two research areas, research projects may be proposed by interdisciplinary research teams. Collaboration between the conservator, humanities researcher, scientist is one of the conditions. The program is explicitly not aimed at mono disciplinary research proposals lacking an interdisciplinary approach. In addition, the objects to be investigated must in all cases form part of a museum collection.

To lend additional focus to the research program, a number of themes and research topics within the two research areas have been selected that are relevant to current conservation practice or to technical art history. The themes connect with the various levels described above, which constitute a sound base for scientifically based conservation practice. In view of the mandatory multidisciplinary nature of this research program, research proposals will always involve at least two of these research themes. The themes are as follows:

- Understanding of the function, context and significance;
- Understanding of the physical condition and of materials and their degradation, whereby a distinction is made between research topics that involve the production process, the ageing and degradation of materials and the evaluation of current conservation practices and those from the past;
- Conservation and treatment strategies, whereby a distinction is made between topics concerning considerations made in conservation and the actual strategies employed.

Understanding of function, context and significance
This theme covers topics that lend insight into the artist’s intentions, the object’s significance and its historical development in relation to location and time. This research is highly relevant to the conservation of works of art. The material, the production process, the history of past interventions and the changes in environmental factors determine an artwork’s present appearance. How can the production process, the presentation and the conservation history of objects be deduced by means of historical and technical reconstructions, information from
source research and technical and digital analysis of materials? Questions regarding authenticity are included in this theme. Is an object of art authentic? What is the importance of authenticity for the worth and appreciation of an artwork and how this has developed over time?

**Understanding of physical condition, the materials and their degradation**

**Art-technological research**

From materials research, answers can be found to the questions posed regarding ‘the concept of function, context and significance’. Conversely, knowledge of the materials used raises new questions as to function, context and significance. This type of research also contributes to a better understanding of material degradation or ageing, the possible conservation strategy and the conservation history. In this it spans all three research themes.

**Ageing and degradation of materials**

Artworks are complex structures, composed of many different materials, each with its own properties. Reactivity is strongly dependent on the choice and application of the materials. How can we gain insight into the degradation processes, both in the past and for future ageing? In the first place it has to do with the characterization of the materials that can lend insight into chemical and physical ageing processes. Mathematical, dynamical models of degradation processes can lead to the development of computer simulations to estimate and visualize the progress and impact of the degradation of materials. Investigation at the microstructural and molecular level, into the reaction kinetics and the influence of various parameters (temperature, relative humidity, light, quality of materials) and into past interventions is necessary. How do these factors impact on the condition, original appearance, authenticity and value of an object? How can we quantify the changes due to both ageing and human interference?

**Evaluation of past and contemporary conservation practices**

Some aspects of conservation practice have changed little over the past hundred years. A good example is the use of solvents on painted surfaces and oil paintings. To date little is known about the impact of solvents at microstructural and molecular level. This theme encompasses questions such as the role played by an object’s conservation history with regard to its present condition and the significance of this. What, for example, is the visual impact of the frequently used wax/resin lining on the appearance of an oil painting? On what basis were such decisions as to the implementation of particular treatments made in those days? But also questions as to, for example, the consequences of ageing processes and of conservation for the perception of the work; how must perception be regarded within the universal concept of the work’s reception (alongside, for example, interpretation, worth, use) and what types of investigation lend themselves to the study of that aspect? What are the consequences of differences in conservation traditions (at national or museum level) for the present and future condition and significance of works of art?

**Conservation and investigation strategies**

There is a long global history of conservation of ancient art in the entire world. Between the various museums, both national and international, there are also great differences in conservation practice and in the approach to these. This also applies to the disciplines involved. In past centuries it was more a question of repairing artworks as opposed to conservation according to a previously determined treatment strategy in the modern sense. Much of the current treatment of ancient art is an inevitable consequence of past interventions. In contrast, conservation of modern and contemporary art is a relatively new discipline. Initiatives such as the international symposia Modern Art: Who Cares? (Amsterdam 8–10 September 1997) and the recent Contemporary Art: Who Cares? (9–11 June 2010) are of great importance in this respect.
Considerations
Conservation of ancient, modern and contemporary art involves many pivotal moments, complex problems and dilemmas. Various kinds of artwork and ethical considerations must be taken into account. How can the determination of an artwork’s authenticity support conservators in their endeavours? What aspects of the artistic concept, the production process and the historical, societal and cultural context are relevant, and how must these be investigated, rated and weighed in the decision process surrounding presentation? What consequences do research, procedures and processes in conservation have for the identity, appearance and function of works of art? Or what are the long-term consequences of withholding treatment?

Strategies
On the basis of the considerations described above, improved strategies for preservation and/or conservation can be developed. The establishment of guidelines and protocols and the development of documentation techniques form part of this process. Alongside strategies aimed at physical maintenance or recovery, such as replacement, simulation, reproduction and reconstruction, strategies can be developed that do justice to other properties of the object. Such properties of significance for an object are aesthetic appearance and religious and/or societal significance plus function and functionality. The question then also arises as to when physical modification of an artwork is desirable and acceptable and when not? When does damage demand repair and when not? Is that applicable in different ways to various types of damage and types of artwork (paintings, furniture, textiles, assemblages, applied art) from various periods throughout history? How can the possible consequences of decision making be clarified with the aid of simulations? Can mathematical and chemical/physical models reflect the ageing processes? Can these models also support decision-making in practice? How can these models support classification of works of art on the basis of statistical techniques?

2.2.2 Research methods
The nature of research into art technology, conservation requires a multidisciplinary approach and the application and development of new technologies and methods taking into account international initiatives. A broad spectrum of possible methods of investigation may then be conceived, such as (art)historical and technical reconstructions, archive and source research, societal/ cultural research, simulation and computer imaging studies, development of so-called non-invasive analytical methods, advanced microscopic techniques, analytical techniques and advanced analytical techniques including synchrotron radiation. In the case of contemporary art one may also envisage interviews with artists, documentation and information from the artist himself/herself.

2.3 International framework
2.3.1 National Science Foundation, Washington DC
The National Science Foundation runs a program SciArt (http://www.nsf.gov/pubs/2010/nsf10534/nsf10534.htm). The program focuses on collaborative activities between conservation scientists and chemists and materials scientists to address grand challenges in the field of science of cultural heritage.
NSF and NWO seek to enhance opportunities for collaborative activities in this field. The NSF Division of Chemistry and NWO will accept bilateral research proposals between researchers from the US and The Netherlands who work in academic institutions. On the US side these proposals must fit in the SciArt program solicitation and on the Dutch side these must fit in this Science4Arts program. Both solicitations run in parallel and accept also national applications from the US respectively The Netherlands.
2.3.2 Getty Foundation, Los Angeles

In collaboration with NWO’s Science4Arts program, The Getty Foundation will co-sponsor an experts meeting, as part of the Getty’s Panel Paintings Initiative. This international meeting will take place in December 2010 in Amsterdam and will bring together experts in the field of paintings conservation, conservation science, wood science and technology, and other sciences to discuss a research agenda relevant to the preservation of panel paintings and related works of art. This meeting aims at formulating core research questions on the mechanical and chemical behaviour of the materials found in panel paintings. It will also lay the ground for new interdisciplinary projects and international collaborations, which can be further developed as research proposals. It is the intention to involve the Getty also in further meetings and activities to promote training and knowledge dissemination.

2.3.4 IPANEMA, Soleil, Gif sur Yvette

In order to be able to use the advanced synchrotron research facilities in Europe, being developed by the IPANEMA platform for research into ancient objects and materials at Soleil in France, NWO has entered into an agreement (http://www.synchrotron-soleil.fr/Workshops/2009/IPANEMA).

2.3.5 Other countries

In England the research program Science and Heritage is underway, financed by both the AHRC and the EPSRC (http://www.ahrc.ac.uk/FundingOpportunities/Pages/ScienceandHeritage.aspx). To promote exchange of knowledge, joint meetings will be organized. Possibly also projects funded by the Flanders FWO can be involved in these meetings. The program will strive for maximum availability of apparatus necessary for the research, also via the EU’s Charisma program, which can arrange its mobile apparatus for this kind of research questions.

2.4 Organisation

Science4Arts is a joint initiative of the Netherlands Organisation of Scientific research (NWO), researchers, the museological field and the Netherlands Institute for Cultural Heritage (Instituut Collectie Nederland, ICN). A steering committee and a program committee are responsible for the execution and supervision of the program.

Steering committee

The Steering Committee consist of members of the boards of the NWO divisions Humanities and Chemical and Physical Sciences.

The Steering Committee:
- supervises the program committee in the execution of the research program with regard to progress and cohesion;
- reports annually to financial partners on the progress of the program and the financial situation;
- appoints members of the program committee and the international assessment committee;
- approves annually the budget proposal for the program;
- selects the applications for network grants;
- makes the decisions within the granting procedure based on the advices of the international assessment committee;
- ensures actions to be taken to guarantee the continued availability and sustainability of the program results.
Program committee
The program committee consists of various representatives of the participating museological institutions, as well as the leaders of the various projects that are carried out under the Aegis of the Science4Arts program.

The program committee:
- determines and monitors the course of the research program;
- develops a plan for circulation of knowledge and synthesis of the results of the projects;
- reports annually on the progress of the research program, its budgetary situation and its plans for the next years;
- organizes a midterm evaluation and the end evaluation of the research program;
- sustain the synergy among the Science4Arts projects;
- advise the steering committee on the course of the program;
- ensure the cohesion between the course of research projects and the main objectives of the program.

International assessment committee
The international assessment committee will be appointed by the steering committee and consists of international experts from the relevant research fields and museological fields.

The international assessment committee:
- assesses and prioritises the full proposals and advises the steering committee on the research proposals to be granted;
- gives advice to the program committee on the quality and the course of the program in an international perspective.

NWO is responsible for the secretariat of the steering committee, the program committee and the international assessment committee in close cooperation with the concerned museological and research institutions. The organisation, evaluation and administration of the program follow the general rules of NWO.