European actions to promote and coordinate the use of analytical techniques for cultural heritage studies

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This article gives an overview of past and current European research activities in the conservation of Europe's vast cultural heritage with specific focus on the use of analytical techniques.

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1. Introduction

Europe has a particularly rich, diversified cultural heritage, including buildings, monuments and objects of all sizes and comprising a great variety of materials. It forms the basis of our present and future cultures, and, through the skills, beauty, and engineering genius it manifests, it is a vital source of inspiration and pleasure. Its exploitation, in the form of displayed objects, is a source of revenue through tourism and, at the same time, the basis for a rich diversity of learning. The conservation of the European cultural heritage is for these reasons both a culturally important activity in its own right and an economic necessity.

Nevertheless, the physical part of the European cultural heritage is deteriorating faster than it can be conserved, restored or studied. Assets are being lost, or at risk, through natural processes of decay (sometimes accelerated by poor environmental control), environmental disasters (sometimes exacerbated by human activity), the direct effects of enhanced public access (without commensurate conservation measures), conservation/preservation procedures the long-term effects of which were and are not understood, and simple negligence.

The research required to alleviate this huge class of problems and at the same time progress the study of the European cultural heritage is interdisciplinary, needing the expertise of people directly involved with the cultural heritage (i.e., art historians, archaeologists, curators, conservators) as well as analytical scientists and other specialists at a basic research level.

2. Analytical techniques

Advanced analytical methods and techniques are an essential prerequisite in this field, as they provide the means to understand the objects under investigation. By identifying materials and processes, we can reach back through time and develop a deeper understanding of the craftsmanship and the technology used. Advanced analytical methods also allow us to perform authenticity studies or contribute to the development of simple diagnostic techniques necessary for practical applied conservation. The techniques concerned include: electron microscopy (both scanning and transmission); scanning-probe microscopy; ion beam; neutron; mass spectrometry (MS) (including accelerator MS (especially 14C dating)); lasers, X-rays (including synchrotron radiation); electrochemistry; high-performance liquid chromatography

(HPLC); gas chromatography (GC), and; microchemistry (imaging) that requires only microscopic samples [1–3].

The analytical methods used in this field of research are identical with those used at the cutting edge of modern materials science. Methods developed for advanced physics and chemistry, semiconductor and aerospace research and development, medicine and environmental research can be applied to ancient and modern materials, as the problems encountered in the areas of advanced technology and cultural heritage are surprisingly similar. However, there is one essential difference – an art object or ancient artefact cannot be replaced, and consuming or damaging even a small part of it for analytical purposes must be undertaken only where there is great need. This leads either to development, use and improvement of truly non-destructive techniques (e.g., ion-beam analysis and optical spectroscopy [4–6], which do not require a sample to be removed from the object, and which leave the object in the same state before and after analysis. Where a sample must be removed, one should aim at maximizing information, and minimizing the volume consumed. This brings us to the need for the design of pathways that allow multi-instrument analytical approaches, including sample-preparation schemes that have been thought through (e.g., removal from the object, preparation, and packaging for transport). Clearly-established schemes lead to a better integration of activities and to improvement in the representivity and the reproducibility of analytical results.

In non-destructive techniques, portability is a further consideration. It is often undesirable (or even impossible) to move an artefact to a laboratory where large-scale analytical equipment is housed. Alternatively, it may be the environment of an object that requires monitoring in a non-invasive way, so as not to disrupt visitor experience (e.g., X-ray fluorescence (XRF) [7,8] and micro Raman spectroscopy [9,10]).

Lately, there has also been increasing interest in the development of new or improved sensors (optical, mass and electrochemical) for monitoring various deterioration processes. The use of these sensors is beneficial in preventive conservation issues. An example of a representative topic is risk assessment in museums [11].

3. European cultural area

The ''European Cultural Area'' concept is also important because it creates a framework for all activities associated with cultural heritage and it highlights at the same time the multi-faceted character and variety of European cultural heritage. No doubt we should appreciate the few national programmes available, but they serve only local needs, thus leading to loss of strategic output, risk of duplication, reduction in the international competitiveness of the research. A Europe-wide approach is therefore essential. If too many projects are managed at national level only, their importance for Europe as a whole may be overlooked, and vital synergies missed [12].

Bilateral cooperation projects between various countries, which are usually funded by their research and science ministries, facilitate direct contact and exchange of knowledge. Overall, European research in cultural heritage has been funded for the past 15 years through the Framework Programmes 1–5 (FP 1–5) within the scope and objectives of the ''Environment'' R&D Programme of the European Union (EU) [13]. Fig. 1 shows the total number of cultural heritage projects funded by the Environment R&D programme. Through the years, the focus has shifted from research on historic stone buildings and the damage by acid rain to a far broader range of threats, including deterioration of leather, paper, wood, paintings and metals. Many of these projects involve the use or the development and the validation of appropriate technologies and methods but are not specifically orientated towards promoting their use in the field (see Fig. 1). The results of these research projects are published in a series of reports ''Protection and Conservation of European Cultural Heritage'', which had matching, parallel conferences that began in 1989. These conferences gave the opportunities to present much of the output from EC-funded projects.

European Actions that specifically promote and coordinate the use of analytical techniques in the field are

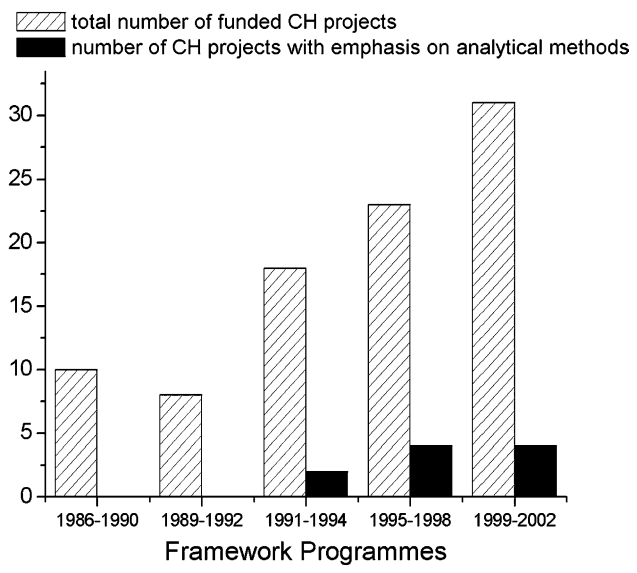

Figure 1. Histogram of cultural heritage projects funded by the Environment R&D Programme of the European Commission since 1986 (FP 1–5).

found in other EU programmes and initiatives that include:

- the Standards, Measurements and Testing Programme including the specific objective ''Protection of the Cultural Heritage'' (1994–1998) [14];
- EUREKA, a pan-European network for market-oriented industrial R&D bringing together industry and research institutes [15];
- the Culture 2000 programme (2000–2004), which grants support for cultural cooperation projects in all artistic and cultural sectors [16]; and,
- the intergovernmental framework for European cooperation in the field of scientific and technical research (COST) [17].

COST allows the coordination of nationally funded research at a pan-European level and its activities are based on so-called Actions that are networks on specific topics covering basic and pre-competitive research. Today, COST has almost 200 Actions running, involving 34 Member Countries and participating institutions from nine non-Member Countries.

Action G1 ''Application of Ion Beam Analysis to Art or Archaeological Objects'', launched in 1995, was the first COST Action specifically devoted to cultural heritage research. The Action ran for five years and involved the participation of 12 Member Countries. Its focus was the development of non-destructive analysis methods for the study of art and archaeological objects using particle irradiation. Six working groups were established, allowing close collaboration on specific topics that were either material oriented (e.g., paint layers, silicate materials, metals and organic materials), or involved the study of radiation damage. Within G1, a total of 24 short-term scientific missions were performed between the laboratories involved. Short-term scientific missions provided researchers with opportunities to work for short periods (up to one month) at an institution of another Member Country with the main objective of obtaining hands-on experience in a particular field or technique. Two monographs [18,19] and about 30 joint publications were published as a result of this Action.

The success of this Action was inspiring, and two new Actions followed: COST Action G7 ''Artwork Conservation by Laser''; and, COST Action G8 ''Non-destructive Analysis and Testing of Museum Objects''.

Action G7 (2000–2005) was set up to address challenges in three main areas:

- laser systems for investigation and diagnosis;
- laser systems for real-time monitoring of environmental pollution; and,
- laser systems for cleaning applications.

Specific attention is being given to the prevention of deterioration in our cultural heritage (e.g., development of monitoring techniques for the quality of indoor and outdoor atmospheres in parallel with restoration and conservation work [20]).

The main objective of Action G8 (2000–2005) is to increase the knowledge of museum objects through non-destructive analysis and testing, thereby trying to achieve better preservation and conservation methods for our cultural heritage [21]. Today, many questions within this field remain unanswered, not only because of the lack of exchange of knowledge and the difficulty in following up collaborative initiatives in this multidisciplinary community, but also because several investigative techniques or treatments still need to be introduced or established. For these reasons, Action G8 seeks to create a Europe-wide environment, in which people directly concerned with the maintenance of our cultural heritage and their colleagues in analytical science can exchange knowledge. In addition to annual workshops in collaboration with museum and conservation institutes [22] and short-term scientific missions between participating groups, separate working groups have been created to address research themes in the field of materials culture and conservation.

4. Future possibilities

For all research activities, it is important to emphasize that action is required by a multidisciplinary community. In the current economic climate, it is extremely difficult for museums to develop new analytical methods or techniques. Collaboration with experts in state-of-the-art analytical instrumentation is therefore really essential and can tap in to sources of knowledge and sophistication of equipment, which would otherwise be impossible for the small conservation and science groups in museums to develop alone.

What are future possibilities of European Actions in the field? No doubt the list of research needed for the study and conservation is long and needs continued support from the EU. However, it is obvious that cultural heritage research is not a priority in FP6 [23], and it now seems likely that the COST programme will remain the most successful in promoting European international collaboration. However, the multidisciplinary community should be aware that the FP7 is currently being constructed now, so it is essential to lobby now to ensure that cultural heritage is not again forgotten or ignored.

References

[1] E. Ciliberto, G. Spoto (Eds.), Modern Analytical Methods in Art and Archaeology, Wiley-Interscience, New York, USA, 2000.

[2] D.C. Creagh, D.A. Bradley (Eds.), Radiation in Art and Archaeometry, Elsevier Science, Amsterdam, The Netherlands, 2000.
[3] K. Janssens, R. Van Grieken (Eds.), Non-destructive Microanalysis of Cultural Heritage Materials, Elsevier Science, Amsterdam, The Netherlands (in press) [Published ?].
[4] G. Demortier, Nucl. Instrum. Meth. B 54 (1991) 334.
[5] K.G. Malmqvist, in: S.A.E. Johansson, J.L. Campbell, K.G. Malmqvist (Eds.), Particle Induced X-ray Emission Spectrometry (PIXE), Wiley, New York, USA, 1995.
[6] K. Janssens, G. Vittiglio, I. De Raedt, A. Aerts, B. Vekemans, L. Vinzce, F. Wei, I. De Ryck, O. Schalm, F. Adams, A. Rindby, A. Knochel, A. Simionovici, A. Snigirec, X-ray Spectrom. 29 (2000) 73.
[7] G. Vittiglio, K. Janssens, B. Vekemans, F. Adams, A. Oost, Spectrochim. Acta, Part B 54 (1999) 1697.
[8] A. Longoni, C. Fiorini, P. Leutenegger, S. Sciuti, G. Fronterotta, L. Struder, P. Lechner, Nucl. Instrum. Meth. Phys. Res., Sect. A 409 (1998) 407.
[9] P. Vandenabeele, T.L. Weis, E.R. Grant, L.J. Moens, Anal. Bioanal. Chem. 2004 (in press) [Published ?].
[10] D.S. Smith, Spectrochim. Acta, Part A 59 (2003) 2353.
[11] M. Odlyha, N.S. Cohen, R. Campana, G.M. Foster, J. Therm. Anal. Calorimetry 56 (1999) 1219.
[12] European Parliament Scientific and Technological Options Assessment Unit, Working paper for ''Technological Requirements for Solutions in the Conservation and Protection of Historic Monuments and Archaeological Remains'', European Parliament (EP/IV/A/STOA/2000/13/04), Luxembourg, 2001. Available from: <http://www.europarl.eu.int/stoa/publi/pdf/00-13-04_en.pdf>.
[13] European Commission, A review of the European Commission Research on Environmental Protection and Conservation of the European Cultural Heritage, May 2002. Available from: <ftp://ftp.cordis.lu/pub/eesd/docs/ka_review_eu_research_env_protection.pdf>.
[14] Available from: <http://europa.eu.int/comm/research/fp4.html>.
[15] Available from: <http://www.eureka.be>.
[16] Available from: <http://europa.eu.int/comm/culture/eac/c2000condition_en.html>.
[17] Available from: <http://cost.cordis.lu/src/whatiscost.cfm>.
[18] M.A. Respaldiza, J. Gomez-Camacho (Eds.), Applications of Ion Beam Analysis Techniques to Arts and Archaeometry, Secretariado de Publicaciones de la Universidad de Sevilla, Sevilla, Spain, 1997.
[19] G. Demortier, A. Adriaens (Eds.), Ion Beam Study of Art and Archaeological Objects, EUR 19218, Office for Official Publications of the European Commission, Luxembourg, 2000.
[20] Available from: <http://alpha1.infim.ro/cost>.
[21] Available from: <http://srs.dl.ac.uk/arch/cost-g8>.
[22] J. Townsend, K. Eremin, A. Adriaens (Eds.), Conservation Science 2002, Archetype Publications, London, UK, 2003.
[23] D. Miles, Preparing for FP6 – Opportunities for Cultural Heritage Research, in: Conference Report of the 5th European Commission Conference on Research for Protection, Conservation and Enhancement of Cultural Heritage, Krakow, Poland, 16–18 May 2002. Available from: <http://www.heritage.xtd.pl/pdf/full_miles.pdf>.

Annemie Adriaens graduated with a PhD in Analytical Chemistry in 1993 from the University of Antwerp, Belgium, where she was involved in optimising new technologies for inorganic micro and trace analysis. In 2001, she became Professor in Analytical Chemistry at Ghent University, Belgium, where she now leads the research group ''Electrochemistry and Surface Science''. She is Chairman of COST Action G8 ''Non-destructive Analysis and Testing of Museum Objects''.