Arts & Humanities Research Council

Science and Heritage Interdisciplinary Research Grants

The Detection of Archaeological residues using Remote Sensing Techniques (DART) **Professor AG Cohn,** University of Leeds

Amount Awarded: £534,833.00, 3 Studentships

This project will increase the knowledge about, and build transferable expertise in, the remote sensing (RS) of archaeological residues (AR). Current archaeological RS techniques have evolved with variable understanding of the physical, chemical, biological and environmental processes involved. Thus current detection strategies do not allow systematic AR assessment leading to sub-optimal heritage management and development control. This project will focus on analysing the physical and environmental factors that influence AR contrast dynamics with the overall aim of improving site and feature detection.

This project will impact on and develop:

- Baseline understanding and knowledge about AR contrast processes and preservation dynamics:
  a) leading to better management and curation
  b) providing data to model environmental impact on ARs
  c) enhancing the understanding of the resource base

- The identification of suitable sensors and conditions for their use (and feedback to improve sensor design)

- Data fusion techniques (physical models, multi-sensor data and domain knowledge) to improve AR identification

- An Interdisciplinary network between remote sensing, soil science, computing and heritage professionals

- Techniques for researchers to access data archives more effectively

PARNASSUS: Ensuring integrity, preserving significance: value based flood resilience for protection of cultural heritage from climate change impact **Dr D D'Ayala,** University of Bath

Amount Awarded: £531,289.00, 3 Studentships

The proposal develops an interdisciplinary system to quantify risk to historic buildings and archaeological sites of driving rain and flooding as caused by climate change; it will evaluate structural vulnerability by defining adequate impact indicators and propose adaptation strategies classified by increased resilience against loss of significance. Project activities are set within the framework of risk management and uncertainty methods.

The proposal addresses how the causes of damage or material change to cultural heritage can be better understood, and when is material change acceptable and damage unacceptable.

The objectives of the proposal are:

- Definition of criteria and protocols to identify acceptable limits of damage; define consistent protocols for modelling material change; use of risk, monitoring and simulation to inform life-cycle and cost/benefits studies and new or improved conservation interventions.

- Impact of flooding, rising water level, driving rain and thermal cycles on structural integrity of historic buildings and archaeological sites

- Assessment of novel adaptation techniques to be implemented to enhance resilience of historic buildings and sites to climate change impacts.

The collaboration of structural and environmental modellers and specialists in cultural heritage, working on specific case studies and supported by professional practitioners and the heritage institutional bodies, ensures robust results applicable in practice.

Heritage Smells! **Dr L Gibson,** University of Strathclyde

Amount Awarded: £537,123.00, 2 Studentships

Experts in science (chemistry, physics, statistics), heritage science and sensor technology will drive an ambitious but realistic proposal to develop diagnostic olfactory tools for heritage science. The new devices will be non-invasive, non-contact, portable and simple to use providing real-time data; making them well suited to address cultural heritage questions and survey collections, particularly for objects where potential hazards, access issues or sampling restrictions have precluded study to date.

By merely 'sniffing' the air, questions regarding the environmental and conservation history, composition, condition or stability of objects will be answered. This will empower collections custodians and allow informed decisions about the acquisition, storage, conservation, display and long-term preservation of items, whilst also ensuring the health of those accessing public and private collections.

This proposal seeks to develop volatile organic compound (VOC) sampling tools to address these challenges without the need for complex or costly instrumentation. Indeed very few heritage institutions have access to laboratory equipment and such studies are impossible to implement. The outcome of this research (development of hand held portable low cost sensors) will be of wide benefit to heritage-users and open the research door to thousands of smaller institutions (museums, galleries, libraries, historic houses) and private collectors.

The Next Generation of Optical Coherence Tomography (OCT) for Art Conservation - in situ non-invasive imaging of subsurface microstructure of objects **Dr H Liang,** The Nottingham Trent University

Amount Awarded: £661,419.00

Scientific examination of works of art is essential for conservation, preservation and understanding of material change. Ideally non-invasive methods of examination need to be used. Optical Coherence Tomography (OCT) is a non-invasive, non-contact imaging technique designed for in vivo imaging of the eye and other biological tissues.
Our current research has shown that OCT has the potential to become a routine non-invasive tool in museums allowing cross-section imaging anywhere on an intact object where there are no other methods of obtaining subsurface information. OCT can go beyond qualitative imaging toward quantitative measurement of optical properties giving information on ageing processes and assisting material identification.

While current OCTs have shown potential in this field, they are optimised for biomedical applications. This project intends to explore new problems in conservation and art history that the next generation OCT for art can help to solve and push the boundaries in near infrared OCT imaging for non-biological material. It will:

- significantly improve the capabilities of OCT through increasing the depth resolution and penetration in order to reduce the need for sampling and enable the subsurface microstructure to be imaged on intact objects where sampling is not possible
- encourage more frequent and thorough examination of the whole object for early warning of deterioration
- improve the visibility and resolution of underdrawing for art historical research
- better inform conservation strategy
- create long term savings in the cost of conservation

This project will firmly establish OCT as a tool for non-invasive imaging in the heritage field.

Representing Re-Formation: Reconstructing Renaissance Monuments
Dr PG Lindley, University of Leicester

Amount Awarded: £497,907.00, 3 Studentships

In 1934, large-scale excavations on the site of the ruins of Thetford Priory produced hundreds of late-medieval and Renaissance sculptural and architectural fragments, which are currently in storage with English Heritage. Many of these are known to be related to two of the Howard tombs in Framlingham parish church, which commemorate the third duke and his son-in-law, Henry VIII's bastard son, Henry Fitzroy, Duke of Richmond.

The tombs as erected at Framlingham are not what they appear: they seem to have been put together from salvaged components and finished off with new materials. Determining what is original and what was added is very difficult. Our research will offer a radical new solution to the problem. Using cutting-edge 3-D scanning and analytical techniques developed for space science, we shall 'disassemble' the tombs into their constituent parts, and recombine those components virtually, to recreate their original appearance and differentiate the later components from the earlier ones. We will be able to recreate the first, lost stages in the existence of the tombs. Further, our scientific investigation and analysis will determine which fragments excavated at Thetford originally belonged to these tomb-monuments and enable us to reintegrate virtually the appropriate fragments into our reconstructions. We shall use the same techniques to recreate

other lost monuments and sculptures once in Thetford Priory, and will bring them back to (virtual) life.

This collaborative project, which will combine research tools from space science, art history, archaeology, museology and computer science will effect a small revolution in our understanding of the late middle ages and early Renaissance in England. The Howards were the most important noble family under Henry VIII and their fortunes provide a fascinating case study into a turbulent period in our national history. This gripping episode, and the detective story of its reconstruction, will prove fascinating to many diverse audiences.

"Collections Demography" On Dynamic Evolution of Populations of Objects **Dr M Strlic,** University College London

Amount Awarded: £610,710.00

Collections of heritage objects have a specifically dynamic evolution: they constantly grow and constantly degrade depending on use, environment and material properties. Understanding of this dynamic is currently lacking, yet it could significantly optimise collection management. To achieve this, the project poses several fundamental research questions:

- How to explain collections as dynamic populations?
- What is the relationship between an object and a group of objects (collection)?
- How to describe the demographics (changes in a population over time) of collections in relation to age, use, environmental influences and values we attach to heritage?

Significant reference points in an object's life need to be defined, particularly the 'point of failure', therefore, a philosophical framework defining (un)acceptable levels of damage is necessary. Given the extent of knowledge and existing data collected in the last decade for paper-based objects, this project will largely focus on library and archival collections.

Demographic statistical tools will be exploited to model changes in populations of objects. The established functions of change based on agents such as environment, use and inherent properties of objects will be overlaid on existing and new collections survey data (census data). The main output, the demographic model will be informed and interpreted through an overarching framework of cultural values. This management tool will, therefore, be based on a holistic understanding of the value of collections.

Evidence-based Condition-Monitoring Strategy for Preservation of Heritage Iron **Mr DE Watkinson,** Cardiff University

Amount Awarded: £364,470.00, 1 Studentship

From archaeological objects through to ships, iron is a ubiquitous heritage metal. Unfortunately, iron readily corrodes and iron objects are thus eventually destroyed during storage and display, especially when contaminated with chloride from burial or marine contexts. Currently, management must either adopt precise and costly no-corrosion desiccation, or allow partial desiccation with unknown preservation outcomes.

This research identifies and tests new ideas for managing the preservation of heritage iron via the concept of 'corrosion control' rather than 'corrosion prevention'. In a world of dwindling resources, not all objects can justifiably merit indefinite preservation. It may be possible to define and assign lifespans to lower preservation costs and energy expenditure.

Experimental work will quantitatively examine long-term corrosion rates of up to 300 samples of heritage iron. These results will underpin subsequent field-testing of heritage iron objects, and the development of sensors and management guidelines.

The resulting corrosion control model and its monitoring methods will be tested in-situ using Brunel's iconic and multiple conservation award winning ship SS Great Britain. Monitoring the controlled environment at selected points on the ship will identify corrosion rates and these may then be linked to preservation costs and the carbon footprint of environmental control. A cost-benefit analysis can then be extrapolated to offer options for acceptable corrosion rates and object longevity. A similar test will be run in the metal stores at the Mary Rose Trust but on smaller objects held in different conditions.

The outcomes will be of direct practical use to the wide range of organisations that store and conserve large and small iron objects. The project will deliver a holistic management system for the first time. This will enable the development of clear guidelines on the preservation of chloride contaminated iron, based on predictions of lifespan from accurate corrosion rate data. The transparent decision making process will allow managers to link corrosion control to preservation outcomes and use of resources.