

Written evidence submitted by the National Heritage Science Forum (BSI0072)

This written evidence is submitted by the National Heritage Science Forum (NHSF). Heritage science is the application of science and technology to cultural heritage to improve management decisions, enhance understanding and increase public engagement. Heritage science research and innovation is carried out in research institutions, heritage institutions, universities and by businesses. The Forum is a registered charity that brings together 18 organisations from these sectors to share knowledge, increase efficiencies through collaboration, and maximise public benefit.

Summary

- The heritage industry makes a significant contribution to the UK economy and society, and acts as a force-multiplier for other industries including the construction, tourism and medical industries.
- Heritage science research not only protects heritage science assets and develops new means to engage more fully with them, but it is also used by industry and is applied far more widely than the heritage sector.
- Heritage science research has benefitted from Horizon 2020 and predecessor EU research and innovation framework programmes and the National Heritage Science Forum is concerned that this niche sector risks suffering a disproportionate reduction in funding as a result of exclusion from EU funding programmes and a UK focus on 'grand challenge' areas that are targeted at significantly larger sectors.
- There is an opportunity to transform the relationship between heritage science research and industrial innovation which requires investment, particularly in infrastructure. UK heritage science infrastructure is currently benefiting from EU investment in the UK national hub of the European Research Infrastructure for Heritage Science and this is an opportunity for the UK to build on post-Brexit.

Heritage as a force-multiplier and the role of heritage science and innovation

Heritage is a multi-million pound industry. In England alone it contributes £11.9 billion of GVA and employs 278,000 people (Historic England, *Heritage and the Economy*, 2017). It can act as a crucible for science and digital innovation that can be applied to other industries. For example,

Heritage science	Contribution to wider markets and applications	Example
Infrastructure and agricultural industries: Remote sensing techniques	Heritage science contributes to over 100 applications (underpinning other industries or adding to their productivity): Assessing condition of rural roads; Complete view of real estate; Conserving lakes & rivers; Detecting land cover & use; Determining soil moisture content from space; Early detection, investigation & management of archaeological sites; 3D mapping of volumes & extraction of mineral deposits; Finding missing bodies; Increasing precision farming; Locating construction & building alterations; Mapping soil types for agriculture planning; Quantifying earthquake damage; Uncovering habitat suitability & protected area fragmentation.	Remote sensing: <i>'Different communities at the Royal Agricultural College in Cirencester are using data from DART for a variety of activities, including mapping and examining carbon sequestration in field boundaries'</i> . Beck, A & Neylon C (2012) A Vision for Open Archaeology, World Heritage, Vol 44, Issue 4.
Construction Industry: Measuring & modelling	Heritage BIM; Drone applications, Hyperspectral imaging from space/air/local; Laser scanning Recent development of reality capture	Hyperspectral imaging: <i>"This exciting work started only in October 2015 & yet has already borne significant images & results in both academic & potentially commercial environments. We have worked closely with Hend to develop new algorithms for image & colour analysis & the solid ground work that she has developed and proven at UCL is</i>

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	<p>technologies, together with the development of algorithms to effectively process the acquired data, offers the promise of transformation in current building surveying methods through development of original algorithms for automatic segmentation of individual masonry units</p> <p>Point cloud data from laser scanning before & after building fires can play a crucial role in engineering stability assessments of damaged exterior walls and informing dismantling and rebuilding works</p>	<p><i>now being converted to high efficiency directly coded algorithms at GILDEN Photonics".</i> Dr John R Gilchrist, MD, Gilden Photonics Ltd http://www.silva-sandbox.ucl.ac.uk/heritage-science-impact/Industry_sectors/Industry_Case_Study_Gilden_Photonics_Ltd</p> <p>Historic Environment Scotland, the Institute for Sustainable Building Design & Heriot-Watt University project, 'Automatic Segmentation of 3D Point Clouds of Rubble Masonry Walls and its Application to Building Surveying Repair and Maintenance' published in the 'Evaluation of Historic Masonry Substrates: Towards Greater Objectivity and Efficiency', Heritage Building Information Modelling, Routledge, 2017. ISBN 9781138645684</p> <p>Reconstruction of the iconic Charles Rennie Mackintosh Glasgow School of Art building following fire in 2014 underpinned by heritage science & digital expertise from Historic Environment Scotland/GSA. GSA team requested heritage science support, eg with portable X-Ray Fluorescence & paint analysis to analyse material compositions (building components & artifacts) & interior surface coatings (historic paints & plasters) to assess damage & establish compositions to inform accurate specifications for reconstruction & replacement. http://www.constructionmanagermagazine.com/news/3d-laser-scan-helps-reconstruct-glasgow-school-art/ https://www.architectsjournal.co.uk/news/in-pictures-3d-scans-reveal-extent-of-mack-work/10004169.article</p>
<p>Medical and Biomolecular industries: Forensics, ancient DNA, proteomics</p>	<p>"Ancient DNA has grown from a scientific curiosity into a powerful research tool in fields as diverse as molecular evolution, archaeology, palaeontology, conservation genetics and forensic identification." Royal Society 2014</p>	<p>"aDNA research has revolutionized a multitude of scientific disciplines. Representing the most direct route to address a large number of questions in evolution, medicine, anthropology, and history, aDNA became an indispensable tool in population genetics, paleo-epidemiology, and related fields." https://academic.oup.com/dnaresearch/article/23/4/295/2469973 <i>Toward high-resolution population</i></p>

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		<i>genomics using archaeological samples 2016</i>
Advanced physics: Materials science	The characteristics of archaeologically recovered metals have played a hugely important role in shielding advanced detection instruments	<p>“newly smelted lead contains a radioactive lead isotope, Pb-210, which is generated in the decay of U-238. While the uranium and other radioactive elements are largely removed during the smelting process, the Pb-210 remains, producing a low-level radioactive decay ... that restricts the ability of the most sensitive nuclear and particle physics experiments to function”. “Roman lead [from an excavation] has a radioactive level roughly 100,000 times lower than is found in new lead</p> <p>https://newatlas.com/relics-physics-archaeology-roman-lead/30032/</p>
Tourism: Virtual digital access to and strategic management of heritage sites	<p>Virtual digital access to heritage sites using mobile app platforms with interactive augmented reality and 3D virtual reconstructions, improving understanding and access for users on-site and also for those who may want to visit ‘virtually’.</p> <p>Coastal monitoring of vulnerable heritage sites using laser scanning has been providing online web maps & resource to help communities & others assess risk to coastal infrastructure</p>	<p>Recently produced remote visitor access apps for Rosslyn Chapel, Maes Howe Chambered Tomb in Orkney, and Antonine Wall all available through Google Play and Apple stores. The Antonine Wall app allows visitors to explore the landscape using personal mobile devices, including GPS navigation with alert for nearby points of interest and 360° viewing of virtual reconstructions and objects.</p> <p>www.alapp.eu</p> <p>Coastal monitoring has been used to support the Scottish Government funded strategic National Coastal Change Assessment</p> <p>http://www.dynamiccoast.com/</p> <p>Ongoing 3D monitoring scans of key heritage sites have been used for comparison with historical records with direct application of heritage science techniques and expertise. Many of the heritage sites are of economic importance in their own right eg Skara Brea, Orkney World Heritage Site is under threat from climate change related sea level rise.</p>

In the last decade, heritage scientists have been developing links with industry. This is exemplified in:

- the grass root collaboration of 50 industries in 48 research projects funded by the AHRC/EPSRC Science and Heritage Programme (2007-2014)

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- the intellectual involvement and financial contribution of 19 industries to 35 PhD projects funded by the EPSRC Centre for Doctoral Training in Science and Engineering in Arts, Heritage and Archaeology (2014-2020).
- The funding by EPSRC of the UK's first Mobile Heritage Science Laboratory is proving to be as popular among schoolchildren as it is among industrialists. However, one vehicle is not enough to service the entire country.

Investment in heritage science research

EU funding has been of great importance to heritage science research. Of the €57 million of funding for cultural heritage research under the FP7 Environment programme, UK institutions benefited from €3,857,657 (source: CORDIS: Community Research & Development Information Service). The UK participated in 16 out of the 25 projects in the FP7 programme.

In the period 2014-2020, cultural heritage is eligible for significant EU funding including for conservation, digitisation, infrastructure research and skills from a number of programmes including: European Structural and Investment Funds, Horizon 2020, Creative Europe, Erasmus +, and Europe for Citizens.

The UK is a leader in the field of cultural heritage research. It has contributed significantly to the policy initiatives associated with the development of the research programmes to support cultural heritage. In the Horizon 2020 'Expert Group on Cultural Heritage' the UK had two members out of a group of ten.

Heritage science research is at risk of a disproportionate reduction in funding and influence as a result of exclusion from EU funding programmes and a UK focus on 'grand challenge' areas that are targeted at larger sectors. The Forum is concerned that efforts to maintain relationships and build new collaborative partnerships will focus on the larger sectors with few mechanisms for collaboration to support smaller scale sectors. The Forum asks the Committee to consider the scalability of mechanisms to support future collaboration and partnership working by niche sectors such as heritage science.

Post-Brexit opportunities

There is an opportunity to transform the relationship between heritage research (which locates and identifies specimens and test environments) and industrial innovation (which profits from and extends the resulting applications) by building on a current EU infrastructure initiative.

Current challenges:

- One challenge facing the heritage industry is bringing research products and services to market.
- Another challenge is to get scientific capability (expertise and instruments) which the UK excels in producing, to all the places in the UK where heritage is present in abundance, unique but often fragile and vulnerable, in some way similar to the communities themselves such as in Cromer, Great Yarmouth, Grimsby and Lowestoft.
- A third challenge is to develop local skills to enable communities to care for their heritage while making heritage a beacon for economic regeneration.

To achieve the ambition of transforming the relationship between heritage research and industrial innovation, for wider public benefit, the UK needs to address its distributed heritage science infrastructure - from major international research infrastructures such as the Diamond Light Source and ISIS, to mobile and digital infrastructures - ensuring these are co-ordinated, and standards of data management are set, in order to deliver best value to the local economy and society.

Part of this ambition is being realised with the launch of the UK hub of the European Research Infrastructure for Heritage Science (E-RIHS). With the support of the UK Government, heritage science was included in the roadmap of the European Strategy Forum for Research Infrastructures which is enabling the organisational structure of E-RIHS.uk to be developed by 2020.

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“The European Strategy Forum on Research Infrastructures (ESFRI) was established in 2002 to support a coherent and strategic approach to multilateral research initiatives by setting out a European Roadmap for research infrastructures for the coming 10 to 20 years. Currently, only EU Member States and countries associated to Horizon 2020 are members of ESFRI.”

Source: paragraph 34 of the paper ‘Collaboration on Science and Innovation: a partnership paper’

E-RIHS will go some way to improving access to research geographically across the UK and it is supported by the development of mobile, accessible and non-invasive instrumentation by the heritage industry in the UK, which is accelerating. The sector is hungry to develop far wider, cross-sector and cross-disciplinary links to catalyse new applications which can go to market. The market is not just heritage, but sensors and instrumentation, creative industries and construction. The sector is already working through the National Heritage Science Forum (NHSF) to update the National Heritage Science Strategy to provide strategic coherence to activities that strengthen work across academia, industry and civil society. This will concentrate and add value to the efforts of the sector.

Beyond the initial 3 years of European funding for E-RIHS.eu which will last till 2020, there is the need for Government to sustain E-RIHS.uk in the long term and to support the development of locally based mobile heritage science laboratories (MHSL) linked to existing fixed heritage science laboratories in universities and independent research organisations. MHSLs would act as platforms for research and science, training and engagement among heritage scientists, industry and local communities.

Beyond 2020, it is critical that heritage science infrastructure is supported by the Government. It underpins continued mobility of researchers from universities and IROs that enable these distributed facilities to be networked for the benefit of the cultural, social and economic life of the UK

The value of this infrastructure will be multiplied if the UK’s Public Sector Research Establishments (PSREs) cooperate more closely – through interlocking research strategies and agendas. This process had started with some welcome round-table meetings (hosted by the Department for Business, Innovation and Skills (now BEIS) in 2014. We urge the Department to resume this process to unlock synergies and economies of scale.

NHSF adds its voice to that of other parts of the scientific community to urge government to advocate strongly for UK participation in EU collaborative research programmes and mobility of researchers. This advocacy should not just be on the behalf of the UK’s universities but also its major cultural organisations (many of which have IRO status) and the independent organisations and businesses that have much to contribute to the highly interdisciplinary field of heritage science research.

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