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Introduction

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3 What is your organisation?

Organisation:

AHRC/EPSRC Science and Heritage Programme and the National Heritage Science Forum

4 KEY QUESTION: What balance should we strike between meeting capital requirements at the individual research project and institution level, relative to the need for large-scale investments at national and international levels? (1000 words maximum)

Answer to question 1:

As this submission is a joint response between the AHRC/EPSRC Science and Heritage Programme representing 140 individual researchers and the National Heritage Science Forum representing 16 member institutions, it is considered appropriate for individual institutions responding to this Consultation to address this question.

5 How can we maximise collaboration, equipment sharing, and access to industry to ensure we make the most of this investment? (1000 words maximum)

Answer to question 2:

Between 2007-2014 the AHRC/EPSRC Science and Heritage Programme (SHP), a time-limited strategic interdisciplinary research programme, has enabled an active interdisciplinary research community that applies science, engineering and technology to increase knowledge and understanding of cultural heritage to be created. With a total budget of £8.1 million, 48 projects were funded through 5 competitions, satisfying 16% of demand and leading to an 80% direct increase in research activity. Fifty new industry partners (business, industry and SMEs) were involved in new research with 135 resources produced for industry comparable to the 184 resources produced for academia and 166 for the public. The SHP leveraged an additional 4% of direct funding with around 15% additional in-kind support from industry partners. In parallel, and collaboratively with the SHP, the National Heritage Science Forum, the UK's leading voice for heritage science representing 16 leading HEIs, IROs and other agencies engaged in heritage science, is actively facilitating collaboration among the heritage science research community within HEIs and non-HEIs by operating a Kit-Catalogue, an online database that lists scientific and analytical equipment used in heritage science research that institutions are prepared to make available to other users. Maximising collaboration, equipment sharing and access to industry are core values of both the SHP and NHSF and the research community we represent, hence this joint response to this Consultation. We consider investment in heritage science capital infrastructure on the lines outlined in 1.13 Heritage Science is the crucial next step that the sector requires to reach maturity as without a connected community and shared resources, growth will be stymied. We believe that infrastructure investments should build on the progress that has been achieved over the last 7 years. Five research hot spots have emerged across the UK as a result of SHP strategic funding. These hot spots in Scotland and Northern Ireland, North of England, Central England, London and the South East, and Wales and the South West are viewed as the possible foundation on which 5 regional clusters of excellence engaging HEIs, IROs and industry can be built. SHP researchers and NHSF members have a demonstrable commitment to developing distributed and shared mobile science facilities. The most recent is the bid (currently under consideration) to EPSRC by the Centre for Doctoral Training (CDT) in Science and Engineering for Arts Heritage and Archaeology (SEAHA) for a mobile heritage science laboratory with public engagement capability. The UK is the acknowledged global pace setter for heritage science. There is no comparable vision anywhere that links infrastructure to both the 'users' and 'doers' of heritage science.

6 What factors should we consider when determining the research capital requirement of the higher education estate? (1000 words maximum)

Answer to question 3:

As this submission is a joint response between the AHRC/EPSRC Science and Heritage Programme representing 140 individual researchers and the National Heritage Science Forum representing 16 member institutions, it is considered appropriate for individual institutions responding to this Consultation to address this question.

7 Should - subject to state aids and other considerations - science and research capital be extended to Research and Technology Organisations and Independent Research Organisations when there are wider benefits for doing so? (1000 words maximum)

Answer to question 4:

The SHP and NHSF are of the view that science and research capital should be extended to Independent Research Organisations (IROs) which in the heritage science sector include museums, galleries, libraries, archives and heritage organisations. However the same obligations to carry out excellent research, to publish in peer-reviewed publications and be subject to the same level of assessment of research excellence should apply to all institutions in receipt of capital infrastructure investment. Heritage science is characterised by a collaborative culture enabled by SHP funding, with 'users' and 'doers' of research rarely working

separately. However there is room for increasing collaboration. HEIs work collaboratively each other, with IROs and with industry. IROs work collaboratively with HEIs and with each other. However it is not common for IROs to work collaboratively with industry. Access to science and research capital by IROs could serve to encourage IROs to develop stronger heritage science partnerships with industry. The most prominent industry sectors working with heritage science presently are sensors and instrumentation, conservation, creative industries and the tourism industry. There are partnership opportunities with other business sectors including construction and property development; insurance, forensics and security, and education and training. Just as the SHP has demonstrated how investment can boost collaboration among HEIs and industry with 50 new industry partners engaging with heritage science, so too can extending science and research capital to IROs help to boost collaboration with industry. The vision of a distributed national network of five clusters of excellence would also be enabled by HEIs and IROs being treated with parity but also with the high expectation that strong partnerships between HEIs and non-HEIs are maintained and developed. The NHSF is demonstrating how this can work through its operation of a Kit-Catalogue in which its 16 member organisations of which 6 are IROs, 3 are HEIs and 7 other heritage institutions have made equipment sharing a priority in order to strengthen skills and knowledge in the application of scientific techniques to understanding and protecting cultural heritage. Furthermore, industry partners are more likely to be attracted to clusters of knowledge, skills and equipment which will enhance the UK's competitiveness in heritage science.

8 KEY QUESTION: What should be the UK's priorities for large scale capital investments in the national interest, including where appropriate collaborating in international projects? (1000 words maximum)

Answer to question 2:

Since 2007, the UK has led its international competitors in investment in heritage science research which has drawn worldwide recognition for its breadth and quality. In contrast, there has been no national strategic investment in capital infrastructure for heritage science to date and the only international capital investment, the European Union's heritage science infrastructure investment in Charisma and its successor Iperion has only benefitted a handful of national museums in the South-East representing one segment of cultural heritage that is museum collections. Heritage science capital infrastructure must also address the needs of historic buildings and contents, ruins, archaeology (surface, buried and marine), cultural landscapes, standing monuments, parks, gardens and cemeteries as well as museum collections.

The vision for heritage science capital infrastructure investment that the SHP and the NHSF propose here is strongly based on the narrative for a capital project in heritage science outlined under 1.13 in the Consultation document and is highly evidence based. The one output that is common to all heritage science research whether it is applied to the moveable (collections) or immoveable (buildings, archaeology, landscapes) heritage is the generation of data. There needs to be an imperative for data reuse after its first use by the primary generators and heritage science could act as an exemplar through investment in capital infrastructure. It is inefficient and a potential net loss to the economy not to use this data to its full. Our proposal therefore has as its ultimate goal the effective use of data for the intellectual and commercial advancement of the UK.

Capital infrastructure investment would build on the achievements of the 90 HEIs and the 86 heritage institutions supported by the SHP to create 5 regional heritage science clusters of excellence. Investment would aim at upgrading existing fixed facilities within the clusters and filling important gaps in advanced instrumentation which prioritise shared use in order to minimise downtime of equipment. Efforts at developing interdisciplinary collaboration among institutions within a cluster would be rewarded as would be integrating public engagement activities. In order to create a national network among the five regional clusters centred on Scotland and Northern Ireland; North of England; Central England; Wales and the South West and London and the South East, the investment would include four fully instrumented specialised mobile units equipped with non-destructive/non-invasive analytical equipment (organic, inorganic, structural/environmental and imaging) supported by the upgraded fixed facilities that could reach the four corners of the UK so that no cultural heritage of value to local and regional communities will be without heritage science support should they need it. The NHSF could act as a guarantor of public interest in heritage science in three ways. It could co-ordinate the activities across the clusters to help realise the national network, it could enable the management and mining of research data and it could co-ordinate the mobile units' programmes in order to ensure that the legacy of any visit is a community of citizen heritage scientists better equipped to care for its cultural heritage through its encounter with high quality science.

The estimated cost to deliver this vision for integrated equipment, services and data management is £40M. Broadly £25M is required to set up the 5 clusters for 5 years; additional instrumentation including the mobile units would cost £10M and co-ordination including maintenance is estimated at £5M. An advisory board made up of key stakeholders will be tasked to chart the future of this distributed, networked facility with their main focus of ensuring that this government investment will be used to leverage support from heritage, business, charitable and philanthropic sources using experience gained from academic-industry interactions in the CDT SEAHA. Furthermore, this investment could be complemented by capital investment funding from HEIs and IROs participating in the clusters of excellence. As a challenging area of applied science, with the appropriate level of investment in capital infrastructure, heritage science could be a vehicle for the delivery of two out of the eight Great Technologies in the Government's Industry Strategy, namely 'Big Data and Energy Efficient Computing' and 'Advanced Materials and Nanotechnology.' And because of the emphasis of this vision on public engagement, further investment could be drawn from the proposed 'Inspiring Science' Capital Investment Fund and Connecting Research and Communities (Annex A7) which the SHP and NHSF fully support.

9 What should the criteria for prioritising projects look like? (1000 words maximum)

Answer to question 6:

The proposed criteria for prioritisation in Annex B2 are appropriate for prioritising a capital project on heritage science which is the focus of the SHP and NHSF response to this Consultation. In terms of the Affordability criterion, the 90 HEIs and 86 non-HEIs involved in SHP-funded projects are well positioned to contribute to the creation of 5 clusters of excellence with clear opportunities to share operational and project costs associated with use of a distributed facility. In terms of the Excellence criterion, 296 applications totalling £106,331,804 were submitted for SHP funding from which 16% or 48 projects were selected by independent peer-review, a process by which they were identified as excellent. Upwards of 200 researchers were engaged by the SHP funded projects and based at institutions that have become centres of specialised excellence in heritage science. With the right investment in capital infrastructure, these could participate in the development of regional collaborative clusters around heritage science thus creating an internationally competitive critical mass. In terms of the Impact criterion, SHP projects have collaborated with 50 new industries producing 135 new resources for industry with impacts that range beyond heritage science. For example, the 'Optical Coherence Tomography (OCT) for Art Conservation' project has produced two state of the art OCT systems (800nm and 2000nm) which when used in conjunction remove the need for invasive sampling of objects. This has led to the development of optical components and photon detectors at two commercial UK companies. Beyond heritage science there are several potential industrial applications of these detectors including: pollution monitoring; in paint formulation; testing photovoltaic cells and in multi-layered 3D shaping technology. In terms of the Skills criterion, the EPSRC CDT in Science and Engineering in Arts Heritage and Archaeology (SEAHA) will over the next 8 years deliver 60 heritage scientists with the knowledge and transferrable skills

attractive to industries such as Dyson and Philips Lighting that are early investors in SEAHA. These heritage scientists, added to those already supported by SHP funding, will force change in the job market as the mix of highly skilled jobs in the public, private and independent sectors is enlivened. In terms of the Efficiency & Leverage criterion, the track record of researchers that the SHP and NHSF represent, in attracting leveraged funds and in kind support from collaboration is outstanding. For example, SHP-funded projects have together leveraged over £950,000 in additional funding. In the six months since the announcement of the CDT awards, SEAHA has raised £0.5M in hard cash and £6.9M in in kind support from heritage and industry partners. With the right level of investment in capital infrastructure for heritage science, there is optimism on the part of the SHP and NHSF that if the proposed criteria for prioritisation are confirmed, then they could be met by the sector.

10 Are there new potential high priority projects which are not identified in this document? (1000 word maximum)

Answer to question 7:

As this submission is a joint response between the AHRC/EPSRC Science and Heritage Programme representing 140 individual researchers and the National Heritage Science Forum representing 16 member institutions, it is considered appropriate for individual institutions responding to this Consultation to address this question.

11 Should we maintain a proportion of unallocated capital funding to respond to emerging priorities in the second half of this decade? (1000 word maximum)

Answer to question 8:

As this submission is a joint response between the AHRC/EPSRC Science and Heritage Programme representing 140 individual researchers and the National Heritage Science Forum representing 16 member institutions, it is considered appropriate for individual institutions responding to this Consultation to address this question.

12 Are the major international projects identified in the consultation the right priorities for this scale of investment at the international level? Are there other opportunities for UK involvement in major global collaborations? (1000 words maximum)

Answer to question 9:

Considering that heritage science research operates at an international level, there has been only one significant infrastructure project that has operated at a European level: the EU Charisma project and its successor Iperion. However only the South East of England, and London in particular, have benefitted from the services of its mobile analytical facility. For the rest of the UK especially for cultural heritage that is either fixed, too large, too fragile or impossible to move such as buildings and archaeology unless destructively sampled, there has been no opportunity for cultural heritage more widely to benefit from heritage science capital infrastructure. The value of the vision for networked clusters of excellence across the UK linked by mobile facilities that the SHP and NHSF propose is that no cultural heritage manager from the Outer Hebrides to the Isle of Wight would be more than a few hours away from facilities or expertise. Other national investments in heritage science facilities that come close to competing with what the UK has to offer today are in USA: the Getty Conservation Institute; the Chicago Institute of Art/Northwestern University; Harvard University (which benefits from a combination of National Science Foundation, Mellon Trust and mostly private funding) and a newly established facility at Yale University which brought together existing Mellon funded facilities onto one campus; in France: Soleil (which compares to what is available to heritage science in the UK from the Diamond Light Source and ISIS) and C2RMF (which is funded nationally); in Italy with the National Research Council (CNR) and regional funding, particularly in Tuscany; in Germany, the Fraunhofer has growing interest in heritage science research and in the Netherlands, the NWO has invested in the study of pigments related to the art of the 17th century. Bilateral collaboration between UK researchers and all of these countries already takes place on a project-by-project basis. However despite the fact that heritage science research is an international trans-boundary endeavour, there have been no opportunities to develop international capital infrastructure projects which would set heritage science on the road to gathering and mining the big data that is currently unhelpfully dispersed among different countries. We have recognised the intellectual and commercial advantages that this strategic approach would offer. It is in the UK's interest to develop its own infrastructure capability in heritage science and then as the world leaders in this field as publicly acknowledged by the Smithsonian Institution, we can lead the development of an international coordinated network of heritage science facilities from a position of strength.