

# Digital Heritage: Anticipating an Integrated Way Forward

**Edinburgh Group**  
**Workshop Report: November 2019**  
**The Engine Shed, Stirling**



# Digital Heritage: Anticipating an Integrated Way Forward Workshop Report

*Edited by Ingal Maxwell and Diana Avramica*

Thanks are due to Historic Environment Scotland for hosting the Edinburgh Group Workshop arranged in association with the Group's meeting at The Engine Shed, Stirling on 7 November 2019. Thanks and appreciation are due to all speakers who freely gave their time to prepare for and offer the workshop presentations for discussion. This report, on building upon the presentations, develops the issues raised by the speakers by offering additional information with on-line url links to the variously referenced support topics. Thanks are also due to Barry Bridgwood for his editorial support.

The event was enabled by COTAC on behalf of the Edinburgh Group.

## Council on Training in Architectural Conservation (COTAC)

COTAC originated in 1959 in response to the need for training resources for practitioners so they could properly specify and oversee work involved in repairing and conserving historic buildings and churches. Since its inception the Charity has persistently and influentially worked to lift standards, develop training qualifications and build networks across the UK's conservation, repair and maintenance (CRM) sector, estimated at over 40% of all construction industry activities. This has involved working partnership with national agencies, professional and standard setting bodies, educational establishments and training interests.

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## Edinburgh Group

The Edinburgh Group was originally formed in 1999 by Historic Scotland with the aim of brokering commonality in the approach and assessment techniques across the emerging range of professional building conservation accreditation schemes. The fundamental intention was, and remains, to ensure that commissioning clients of an accredited professional can be assured that the appointed individual has relevant competencies appropriate to the task and that they have been formally assessed on an equal basis by their professional body. In 2008 the Group passed from Historic Scotland to the Charity, COTAC, with a remit to continue to enable and facilitate it into the future. Meeting 6-monthly, updated Operational Terms of Reference were agreed to by Group Members in January 2016.

Cover: Forth Bridge World Heritage Site Scan © CDDV

COTAC, London: January 2020

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# 1: Voices of Culture and Open Method of Coordination reports on Skills, Training and Knowledge Transfer in Cultural Heritage Professions

## Developed Report Based on a Presentation by Nessa Roche

*Senior Architectural Advisor, Department of Culture, Heritage and the Gaeltacht*

*Current Chair, Open Method of Coordination*

The 2018 *European Year of Cultural Heritage* contained an objective “...to support the development of specialised skills and improve knowledge management and knowledge transfer in the cultural heritage sector, taking into account the implications of the digital shift...”. The transmission of knowledge and skills is impacted by the combined effect of Europe’s age pyramid, cuts to public budgets, the digital shift and the academisation of society. New skills and competences are needed to progress towards a more integrated and participatory management of cultural heritage and better use of the opportunities offered by new technologies.

The *Open Method of Coordination* (OMC) Group, from 22 EU countries including the UK, worked over two years and produced a comprehensive report containing a series of recommendations on the four development phases of potential heritage professionals: raising awareness, education and training, lifelong learning and knowledge transfer. The report has contributed to cultural heritage having recently been selected under the EU’s *Blueprint for Sectoral Cooperation on Skills* (2017). A call is to be issued in October 2019 backed by *Erasmus+* funding towards the development of a cultural heritage sector skills strategy.

## Key Documents

Behind the *Erasmus+* call of October 2019, two key EU documents provided the background to raised awareness of the need for funding and other initiatives:

- *The Voices of Culture (VoC): Brainstorming Report Towards an Integrated Approach to Cultural Heritage for Europe- Prospectus on Skills, Training and Knowledge Transfer for Traditional and Emerging Heritage Professions* (October 2017) (1)
- *Fostering cooperation in the European Union on skills, training and knowledge transfer in cultural heritage professions* (June 2019) (OMC Report) (2)

## The Voices of Culture (VoC) Executive Summary notes:

- *Heritage professionals require broad skillsets, in depth expertise and a strong foundation in ethics.*
- *The ‘traditional’ sectoral skills need to be updated and made more relevant to the new integrated approach.*

- *Those with professional expertise need their existing profiles defined in relation to necessary:*
  - *Education*
  - *Competences*
  - *Access*
  - *practical application of skills, and*
  - *responsibilities towards cultural heritage*
- *Education and training should be broader, go beyond the ‘traditional’ competences and skills involved in cultural heritage professions. The new subjects that need to receive increased attention are:*
  - *transversal skills (management, communication, fundraising, sustainability...)*
  - *ethics that should inform all practice*
  - *expertise for new forms of heritage such as digital heritage*
  - *transversal approach and multidisciplinary work.*
- *The two-way influence between principle and practice needs to be fostered, in academia, in vocational education and in cooperation with professionals in the field*
- *It is necessary to identify/map professions; demonstrate their position in the European Qualification Framework realistically; locate needs to improve capacity building and recognise professions where they are acting responsibly and, where they could beneficially develop.*
- *Ensure the core competencies are considered within the scope of recruitment, training and policy making. It will enable increased resilience and innovation for cultural heritage.*

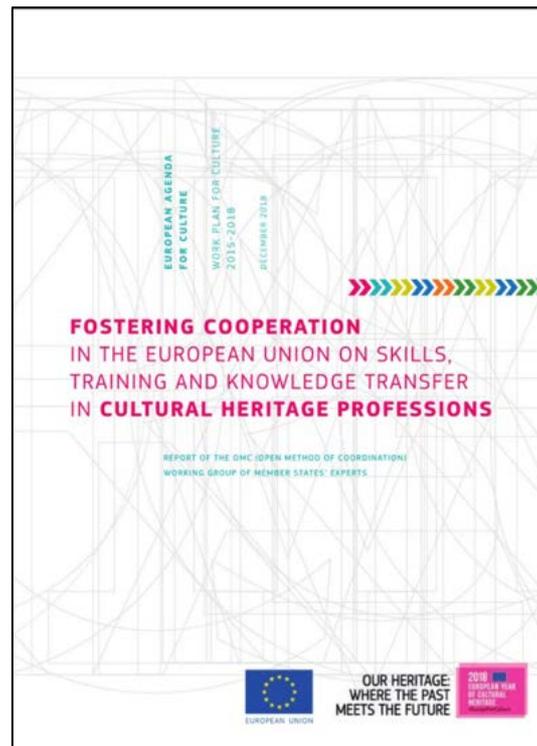
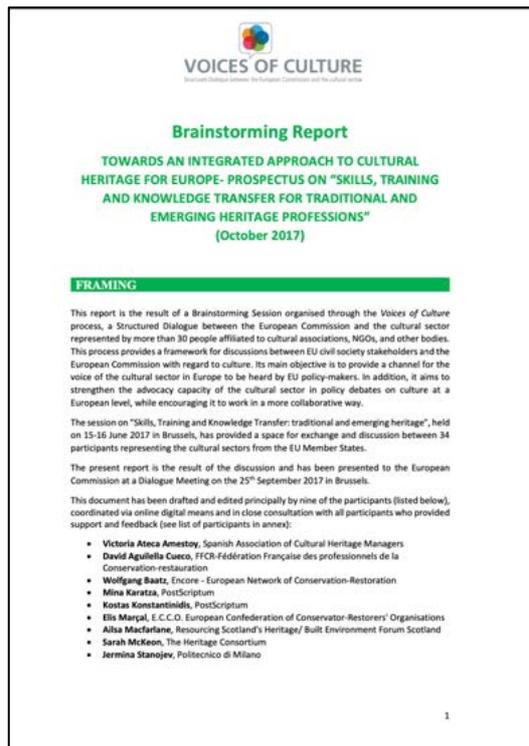
### **OMC Report: Fostering cooperation in the European Union on skills, training and knowledge transfer in cultural heritage professions**

Introducing the 208 page Study, the Publications Office of the European Union website states:

*For the first time, the Council of the European Union has invited a group of national experts to investigate skills, training and knowledge transfer in the heritage professions in Europe. The group was operational in 2017 and 2018 under the Work Plan for Culture 2015-2018, with the support of the European Commission. This report is intended to be a resource for the European Union (EU) to ensure the long-term sustainability of Europe’s cultural heritage. It aims to do this by contributing to the European Year of Cultural Heritage 2018 objective “...to support the development of specialised skills and improve knowledge management and knowledge transfer in the cultural heritage sector, taking into account the implications of the digital shift”. It will also contribute to the European Framework for Action on Cultural Heritage, launched by the European Commission with the aim of leaving a policy imprint beyond 2018*

## Combined Impact

These two reports were outputs of the *European Council Work Plan for Culture 2015-2018* (3) and the EYCH. They were also inputs to implementing the *European Framework for Action on Cultural Heritage (2018)* (4). The reports helped in the successful application for funding under the *Blueprint for Sectoral Cooperation on Skills* (5) with EU politicians and policymakers recognising and supporting the important role of cultural heritage professionals in building Europe's future



It is anticipated that both the VoC and OMC reports will achieve benefits through implementing the recommendations that will resolve several fundamental problems in identifying, measuring and valuing the work that cultural heritage professionals do. In addition measuring this work gives visibility to the sector to help make a case for resources for education, training and awareness-raising within all sectors which interact with cultural heritage.

Questioning if Cultural Heritage skills needs were being met by education, training and knowledge transfer, it was considered that the availability of expertise hinges on the accessibility of good quality education and training (both formal and non-formal), in addition to workforce mobility and working conditions. Many cultural heritage professions are not included in occupational statistics as their roles are not classified, nor their economic activity codified, meaning that relevant data cannot be collected. This creates a

significant problem as, without that data, skills-needs forecasts cannot be made; thus creating a potential 'Catch 22' situation. Educational frameworks respond to sector forecasts based on analysed data; therefore, if training and educational needs are not sufficiently articulated funding might not become available.

Both the OMC and VoC reports clarify the breadth of issues that need to be addressed, including the:

- Absence of statistics to calculate the number and character of Europe's cultural heritage professionals which might enable a forecast of the knowledge and skills required – short and medium term
- Lack of mapped occupational profiles and occupational standards for many roles
- Absence from the International Standard Classification of Occupations, European classification system (ESCO) and the Nomenclature of Economic Activities
- Absence from the Common Procurement Vocabulary
- Education and training providers lack clarity about learning outcomes and/or the likely demand for their programmes
- Education and training quality is difficult to assure without occupational profiles and standards as benchmarks
- Digital and other technological developments are changing skills requirements and putting craft skills at risk
- Education system prioritises academic achievement over craft skills
- Many recruitment or procurement authorities do not specify a requirement for competent cultural heritage professionals
- Skilled people are not attracted to start or remain motivated to stay within cultural heritage occupations where competences are not valued

Within the context of four previously identified EYCH themes of *Engagement, Sustainability, Protection* and *Innovation* the OMC recommendations align as follows:

**EYCH Engagement:** disseminate and communicate the value of Cultural Heritage

**OMC recommendation:** *stimulate multi-directional communication between cultural heritage, other sectors and new audiences to foster demand for, and supply of, CH skills, including by developing best volunteer management practice*

**EYCH Sustainability:** plan and manage structures to build capacity and mobility

**OMC recommendation:** *support knowledge-sharing and succession-planning tools; develop guidance on personnel recognition schemes, validation of prior learning and mobility [and] devise a lifelong learning toolkit; develop and use European cultural heritage standards*

**EYCH Protection:** research and map professions; generate strategic data

**OMC recommendation:** address skills gaps and shortages through mapping and classifying occupations and activities to build a strong evidence base and generate data for the sector, including on skills at risk, and develop plans to safeguard and augment skills at risk

**EYCH Innovation:** stimulate an integrated approach to education

**OMC recommendation:** improve links between education and training providers and the workplace; support skills research at EU level; develop an information exchange portal and encourage establishment of more centres of excellence

### **OMC Steps towards Sustainability in the Cultural Heritage Sector**

The OMC goal is to achieve a targeted education and training system that gives people the knowledge and skills they will need to start and stay working within the cultural heritage sector. To achieve this there is a requirement for:

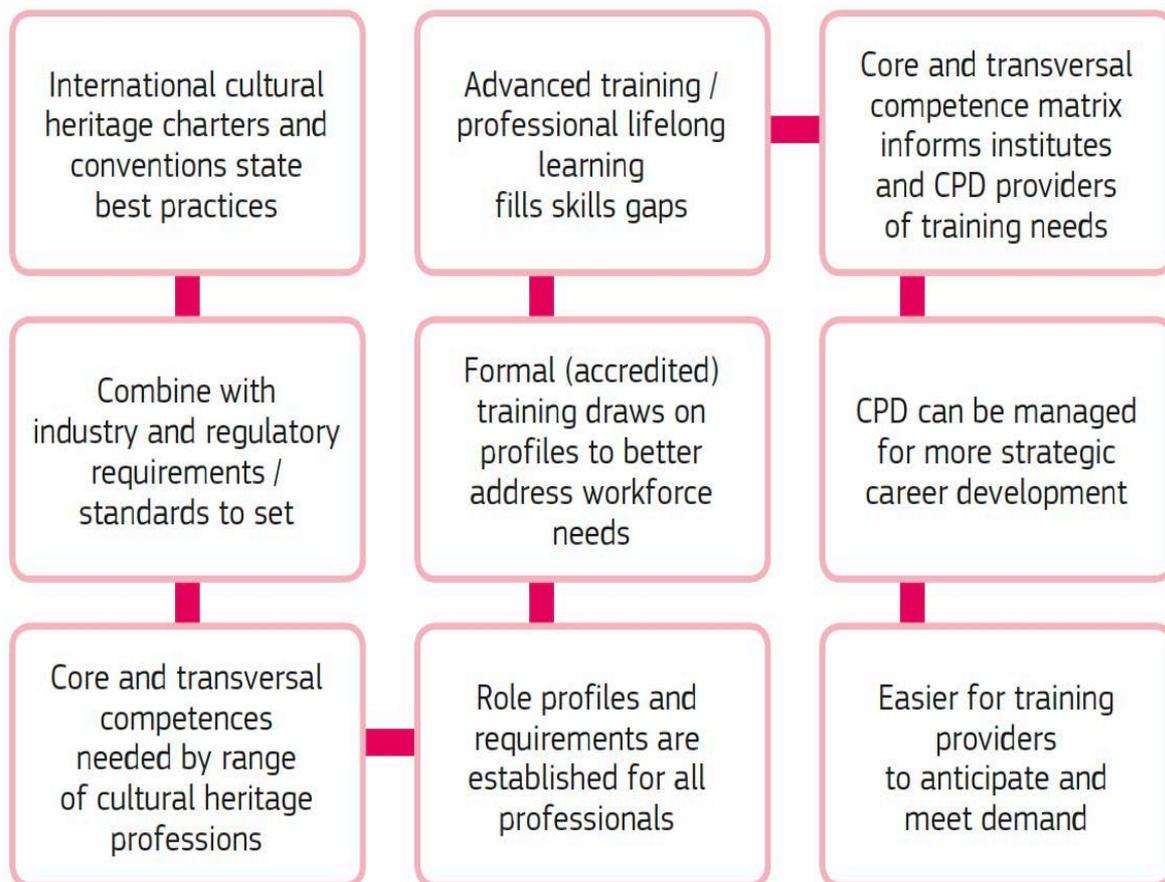
- *Knowledge of existing skills needs and accurate methods of forecasting future needs:*
  - *What size is the sector?*
  - *What work do people do now?*
  - *What core and transversal skills will be needed in future?*
- *Existing sustainable models showing how professionals learn, maintain and upgrade their skills as part of lifelong learning*

To know the answers there is a requirement for:

- *Descriptions of the roles of heritage professionals so they can be mapped and their activities classified and coded to enable data to be generated and statistics gathered from for those which are essential to characterise the CH sector*
- *Models of good training and practice - can we review, adapt and share*

Starting from established (and emerging) recognised conservation charters and conventions, a “*cultural heritage flow chart and virtuous learning circle*” flow-chart was devised (as below). This plotted a sequential and ideal progression through the various steps involved to satisfy the needs of providers to plan for and accommodate expected future demands. Whilst logically and succinctly set out, an additional incentive to achieve these intentions will require the provision of support funding as a key driver. In this regard, the release of the *Erasmus+* funding call (requiring the establishment of *cultural heritage sectoral skills alliances*) offers a strategic approach where participating partners must develop a comprehensive and considered methodology encompassing all activities:

- *To support the sector in addressing most pressing challenges*
- *To support to achieve medium and long-term goals (incl. where relevant: growth, innovation, competitiveness and employment)*



Flowchart for Strategic Lifelong Learning: Report of the Open Method Of Coordination Working Group of Experts: Page 96 extract

### **Erasmus+ Application**

A detailed *Erasmus+ Programme Guide* was launched on 5 November 2019 (6). The Call Application sets out the required activities of a Sector Skills Alliance:

- *Interpret research evidence when implementing Education and Training, and designing qualification standards*
- *Where appropriate base the proposed work on existing skills studies commissioned by the EU (see EU Skills Panorama (7) )*
- *Translate into innovative, learning outcome-orientated vocational curricula (applying ECVET (8) ) including work-based learning, underpinned by QA mechanisms in line with EQAVET (9)*
- *Demonstrate measures to be taken for the formal recognition or certification of the new VET curriculum and how this will be pursued after EU funding has ended*
- *Carry out the proposed activities in a way that maximises the impact on one or several related professions in the sector*
- *Must also conform to Lot 1 activity requirements on design and delivery of VET*

## Key Features of Sector Skills Alliances

Sector skills alliances are required to be innovative in vocational education and training and to create an impact beyond the project's lifetime and that of the partner organisations. They also need to produce measurable impacts with transferable and accessible solutions.

Regarding subject matter criteria, there are three mandatory areas:

- Safeguarding and preservation
- Crafts and traditional knowledge
- Dissemination and communication

Optional areas include:

- Knowledge (identification, study and recording)
- Planning/management (strategic; site and project, mediation, procurement and policymaking, etc.)

There is also a need for compatibility and an integrated approach using existing evidence including:

- European Framework for Action
- Declaration of cooperation on advancing digitisation of Cultural Heritage
- European quality principles
- Voices of Culture report 2017
- Open Method of Coordination report 2019
- Competences for access to CR profession

The award criteria that will assess the relevance of the project should consider:

- Links to EU policy and objectives
- Education representation
- Sector representation
- Proposals integrate digital technologies
- Green and blue skills (circular and greener economy)
- Purpose: is relevant to objectives
- Consistency: clearly defined, sound needs-analysis and, be realistic
- Innovation in methods, techniques, results, solutions
- Generates European (transnational) added value

A Summary of the anticipated activities to be incorporated in the bids include those to:

- Develop a sectoral skills strategy – first key deliverable, identifying concrete actions and indicating activities, milestones and well-defined outputs
- Detail how major trends are likely to affect jobs and skills needs
- Underpin and illustrate activities with concrete examples of policies

- Develop a common methodology for assessing current situation and anticipate future needs and monitor progress
- Identify occupational profiles that need to be revised or created alongside corresponding skills needs and levels, drawing on ESCO and existing competence frameworks. This may include development of a sectoral competence framework
- Identify, describe and indicate priorities for the review or establishment of new qualifications on the basis of relevant occupational profiles
- Foster development of VET solutions and business/education/research partnerships
- Devise solutions for mobility, capitalising on existing EU tools
- Develop actions to promote the sector to all entrants – youth; gender balance, vocational and academic
- Design long-term action plan for progressive rollout of project deliverables after completion
  - Governance structures; scalability; financial sustainability; visibility; dissemination of work;
- Indicate how EU and national/regional funding might support initiatives
- Deliver material as open and freely available data



Engagement of Youth to experience traditional skills © Engine Shed

## Erasmus+ Eligibility

Organisations from public, private and NGO areas are already coordinating on the potential to form a consortium to respond to the call. This remains open until 26 February 2020.

All 28 Member States of the European Union can take part fully in all the 'Actions' along with the Non-EU Programme Countries of the Republic of North Macedonia, Iceland, Liechtenstein, Norway, Turkey and Serbia.

With the continuing uncertainty of BREXIT, Footnote 10 on page 22 indicates that:

*FOR BRITISH APPLICANTS: Please be aware that eligibility criteria must be complied with for the entire duration of the grant. If the United Kingdom withdraws from the European Union during the grant period without concluding an agreement with the European Union ensuring in particular that British applicants continue to be eligible, you will cease to receive EU funding (while continuing, where possible, to participate) or be required to leave the project on the basis of the relevant provisions of the grant agreement on termination.*

### On-line References:

- (1) <http://www.voicesofculture.eu/wp-content/uploads/2018/06/VoC-Skills-and-training-Final-report-with-Appendix1.pdf>
- (2) <https://op.europa.eu/en/publication-detail/-/publication/e38e8bb3-867b-11e9-9f05-01aa75ed71a1/language-en>
- (3) <https://data.consilium.europa.eu/doc/document/ST-16094-2014-INIT/en/pdf>
- (4) [https://ec.europa.eu/culture/content/european-framework-action-cultural-heritage\\_en](https://ec.europa.eu/culture/content/european-framework-action-cultural-heritage_en)
- (5) <https://ec.europa.eu/social/main.jsp?catId=1415&langId=en>
- (6) [https://ec.europa.eu/programmes/erasmus-plus/sites/erasmusplus2/files/erasmus-plus-programme-guide-2020\\_en.pdf](https://ec.europa.eu/programmes/erasmus-plus/sites/erasmusplus2/files/erasmus-plus-programme-guide-2020_en.pdf)
- (7) <https://skillspanorama.cedefop.europa.eu/en>
- (8) <https://www.cedefop.europa.eu/en/events-and-projects/projects/european-credit-system-vocational-education-and-training-ecvet>
- (9) <https://www.eqavet.eu>

## 2: Technological Opportunities and Developments

### Developed Report Based on a Presentation by Paul Bryan

*Geospatial Survey Manage, Building Conservation & Geospatial Survey Team  
Technical Conservation, Policy & Evidence Group, Historic England*

Recording of heritage has long been an important aspect of the conservation and restoration of historic buildings, monuments and sites. Often seen as the initial platform upon which required tasks, processes and programmes are developed. The ever-accelerating use of digital technologies has seen a dramatic change in both the way primary data is gathered *'in the field'* and how it is later used *'in the office'* by all the end-users engaged in the project.

Emerging and developing technological change (as seen by the annual Gartner Hype Cycle for emerging technologies) invariably bring challenges that must be overcome before a new approach is accepted, adopted and the benefits exploited. Within the world of heritage survey 3D scanning and drones have both been through this cycle and matured sufficiently to become accepted tools within heritage applications. So far Building Information Modelling (BIM) has not appeared on the cycle in its true form; although its digital twin has, appearing in 2017, thereby offering an indication of where BIM is heading. If this proved to be the case, what opportunities and developments might that bring to those involved in heritage conservation?

### The EH Geospatial Survey Team, Historic England

English Heritage (EH) cares for over 400 historic buildings, monuments and sites. Set up as a registered charity in 2015, the English Heritage Trust is responsible for conserving and maintaining some of the most nationally and internationally significant historic buildings, monuments and landscapes in England. Based in York, Historic England has a Geospatial Team of five surveyors who specialise in applying geospatial survey techniques to the heritage. They also advise on and undertake surveys across a broad range of issues, including:

- Historic England Research and Conservation Projects
- Heritage at Risk locations (HAR)
- Heritage Action Zones (HAZ)
- English Heritage National Heritage Collection Projects
- Collaborative research with academic partners

Survey requests are managed through a Shared Service Agreement between the Conservation and Research Departments of Historic England and English Heritage and, undertake teaching and training on geospatial survey techniques and applications. The team

has also produced technical guidance publications that are available on-line as free pdf downloads or, as printed copies, for purchase (1). Topics include:

- Metric Survey Specifications for Cultural Heritage
- 3D Laser Scanning
- Photogrammetric Applications for Cultural Heritage
- Using airborne LIDAR in archaeological survey
- The Presentation of Historic Building Survey in CAD
- BIM for Heritage: Developing a Historic Building Information Model
- BIM for Heritage: Developing the Asset Information Model
- Traversing the Past: landscape survey
- Where on Earth are We: GPS in archaeological field survey
- Graphical and Plane Table Survey of Archaeological Earthworks

### **The Survey Association**

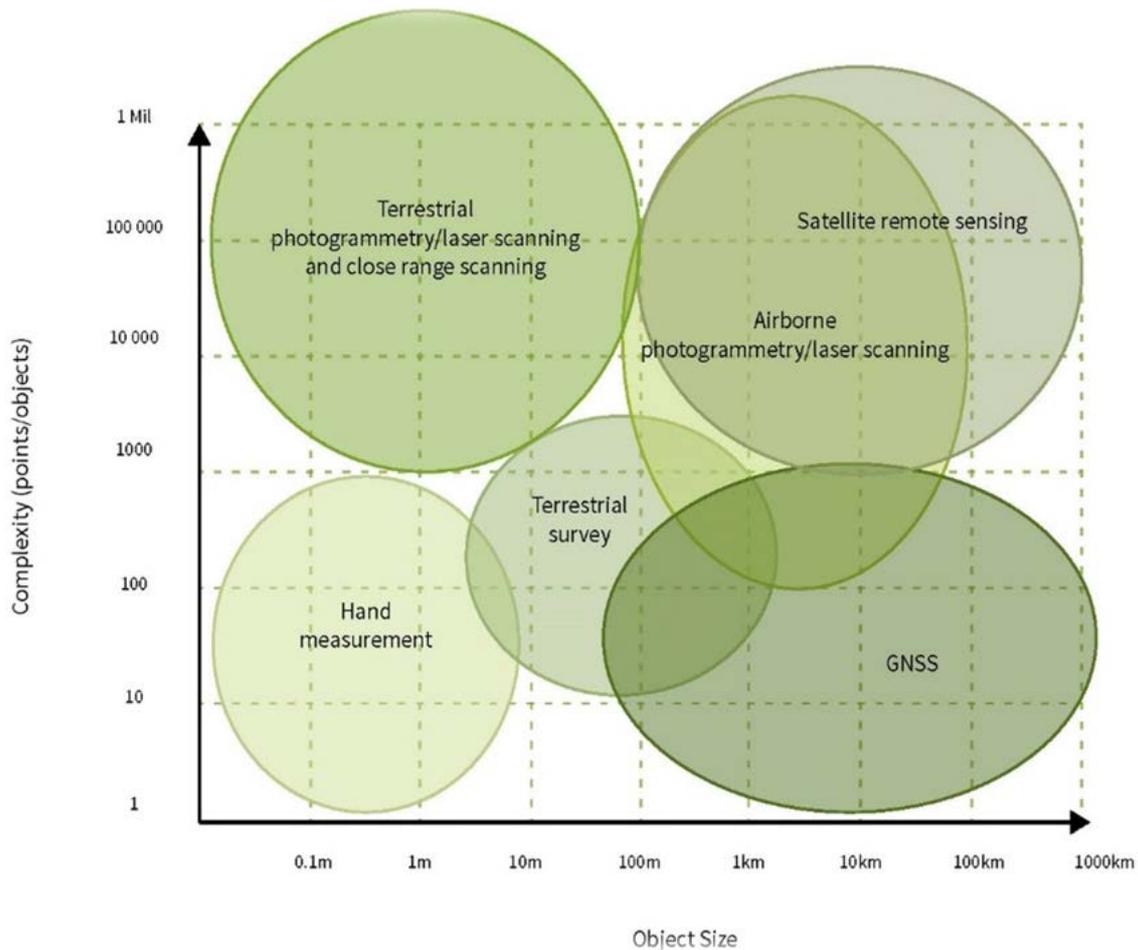
The Survey Association, known generally as TSA (2), is the trade body for commercial survey companies in the UK. Its role is to promote best practice amongst members, provide a forum for discussion, debate and continuing professional development and, for a wider audience such as engineers and architects, providing guidance on new methods and techniques and a list of suitably qualified and experienced companies. In training terms TSA has funded development work on the Geospatial Survey Technician Apprenticeship (Level 3) (3) and Geospatial Mapping and Science Degree Apprenticeship (Level 6) (4).

TSA has produced some 30 *Client Guides*, *Guidance Notes* and *Briefing Notes* on various areas of surveying (5). These are available on-line to download as pdf files. *Client Guides* are primarily aimed at other professionals such as engineers, architects, planners and, clients in general. They are not intended to go 'in depth' into practical issues but act as a basic guide on a particular topic and, in particular, on procedures and regulations which may govern how a particular aspect of the survey is carried out. *Guidance Notes* are generally aimed at survey companies and clients who require detailed information on a subject. Where procedures are recommended for specific professional tasks, these are intended to embody 'best practice', i.e. procedures which, in the opinion of TSA, meet a high standard of professional competence. *Briefing notes* are intended to provide information and explanations to members on specific topics relevant to the profession. They are not intended to recommend or advise on professional procedures. All published content is based on information available at the time of issue.

### **Geospatial Definitions**

In this detailed area of activity it is helpful to understand and recognise two related definitions:

- Geospatial Data is “the availability of information relevant to location”
- Geospatial Survey involves “The technologies used to extract geospatial information from remotely sensed imagery and other raster data types”



Diagram, derived from Böhrer et al (2001), illustrates the range and relevance of the various survey techniques and application as defined by object complexity (points captured) and object size

### Investing in Emerging Technologies and their Capabilities

For many practitioners, the decision when to invest in new technology is fraught with concerns, not least of which is the financial implication of how such an investment might be balanced against perceived operational gain. When evaluating such imponderables the annually released *Gartner Hype Cycle for Emerging Technologies* can be of assistance in highlighting advances that may have a significant impact on business, society and people over the next five to 10 years (6).

Amongst others, the *Emerging Technologies* cycles offer graphic representations of acceptance in a pattern that ranges between initiation and acceptance. This profile illustrates a typical progression through five stages, being:

### **1. Innovation (Technology) Trigger**

- The launch of new initiatives which might raise anticipation of value alongside a perception of improved abilities and benefits.

### **2. Peak of Inflated Expectations**

- Caught up in the excitement of intentions and having joined the "*bandwagon*"; limitations begin to be balanced against anticipated results. Thus questioning whether or not to continue with the initiative.

### **3. Trough of Disillusionment**

- When disappointment emerges against perceived expectations, a question of "*why did we bother*" arises.

### **4. Slope of Enlightenment**

- A gentler trend to acceptance occurs as a result of understanding the potential through experience.

### **5. Plateau of Productivity**

- By benefiting from realistically experienced and proven values, greater positive outcomes and acceptance occurs through use.

With reference to the Gartner Hype Cycle, the following brief comments on recently emerging technologies might be offered to assist practitioners in their consideration of which surveying technologies might suit their needs.

## **Terrestrial 3D Laser Scanners**

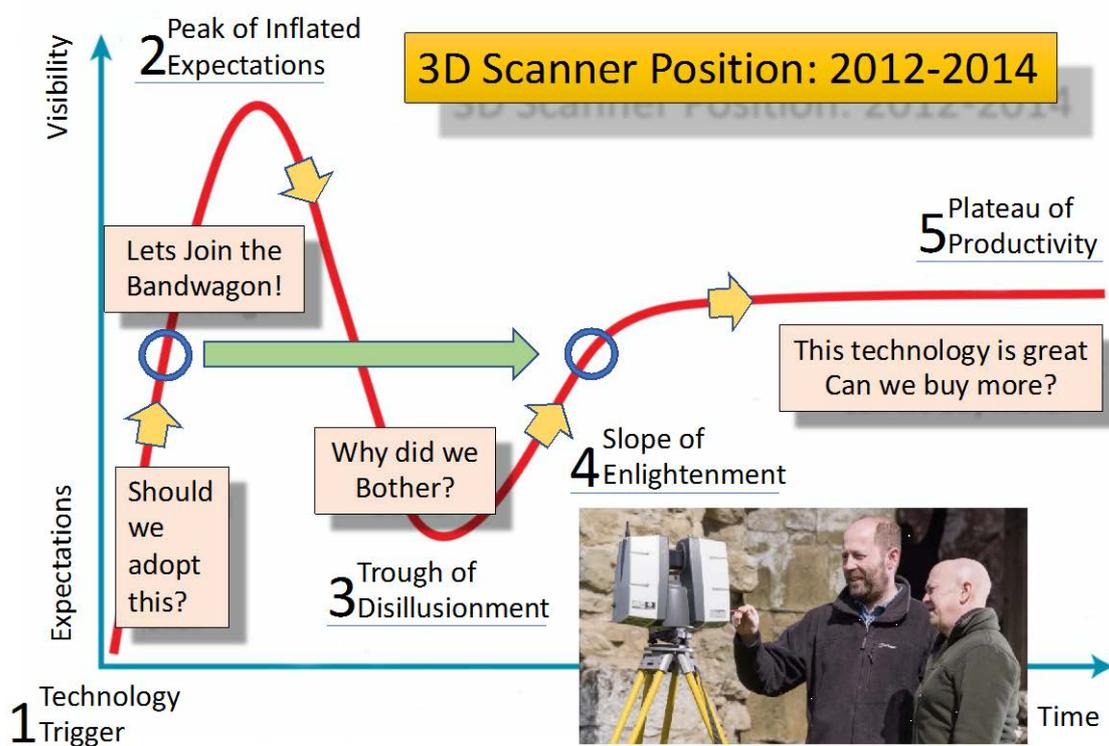
Terrestrial 3D laser scanners work by emitting a laser beam and recording either the time or phase change in the reflected signal to determine an accurate distance to whatever surface the beam bounces off. Combined with the '*emission angle*' this information allows for a 3D point cloud to be generated. Their range can typically extend from 0.5 m to 300 m producing a point accuracy typically of 1 mm – 10 mm. Most scanners can now record colour information along with the scan point data and are relevant for recording heritage buildings and structures. But, with a purchase price of more than £30,000, it is an expensive option/solution.

## **Mobile 3D Laser Scanners**

Mobile 3D Laser Scanners combine a rotating laser scanner and Inertial Measurement Unit (IMU) that uses a *Simultaneous Localisation and Mapping (SLAM)* algorithm allowing rapid mobile mapping of complex spaces. Their range can typically extend from 0.5 m to 30 m with a relative point accuracy < 40 mm. with a Data capture rate of 40,000 pts/sec, an on-board digital camera also captures colour. They offer the possibility for rapid recording of heritage spaces but not their architectural detail. Costing more than £25,000, they are an expensive solution.

In summary, 3D Laser Scanning has a number of advantages. Being applicable for use on all 2D and 3D surfaces and, very fast, it records over 1,000,000 points measured per second with a high resolution of millimetre point spacing. Mobile scanning solutions allow data capture ‘on the move’ and it is now possible to integrate the point data with imagery from on-board sensors: it is RGB (an additive colour model in which red, green, and blue light are combined to reproduce a broad array of colours), 360° and thermally sensitive.

But, it also has some disadvantages as scanning generates very large data files that are often difficult to view without high-end and costly computers. The scanners too are expensive to buy, costing between £25K and £90K. Sophisticated post-processing software is needed to generate useable output and line drawings still require manual digitisation.



Over a period of two years, and confirming their greater widespread adoption by practitioners, the *Gartner Hype Cycle for Emerging Technologies* illustrated that the adoption of 3D Scanners moved from a position halfway towards the “*Peak of Inflated Expectations*” in 2012 to advance well up the “*Slope of Enlightenment*” by 2014.

Laser scanners have since advanced and are well used to offer effective productivity. There remains, however, some cautionary operational concerns regarding associated fitness for purpose and obtained results; their adoption has to be balanced against the additional need to have associated additional IT hardware and software to fully utilise the results.

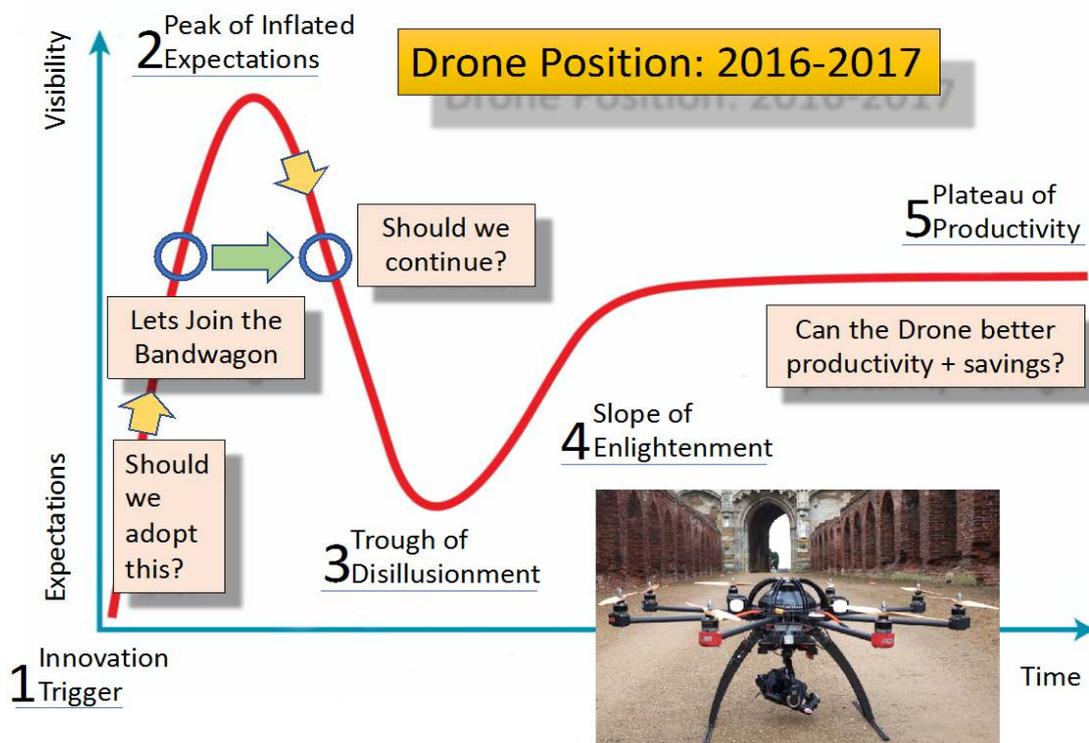
## Remotely Piloted Aircraft Systems (RPAS)

The term 'drone' is commonly used by the public and media when referring to Remotely Piloted Aircraft Systems (RPAS) [also known as ROVs and UVSs]. Used appropriately, drones provide unique vantage points for low-level aerial photography and are useful for mapping, inspection, monitoring, presentation and research.

Small rotary wing vehicles can carry a range of sensors and have the ability to hover and operate in confined spaces. Fixed wing vehicles offers good stability and can fly over long distances, surveying large areas, typically carrying compact digital camera.

There are some disadvantages to their use that need to be considered, including the important aspect of public safety. There is a requirement always to keep the drone within sight (whilst being flown) in order to avoid collision with other objects. Additionally, regulations limit upper operational ceiling to <400 feet (120 m) to reduce the risk of conflict with manned aircraft and battery life can impose a limit to operating time in the air.

Whilst, initially, public/hobbyist flying was increasingly difficult to control, commercial use now requires permission from the UK Civil Aviation Authority (CAA).



During 2016-2017 the *Gartner Hype Cycle for Emerging Technologies* illustrated that the adoption of drones waned from their year-previous position having slipped back towards

the ‘*disillusionment*’ stage. In part this may have been due to increasing concerns raised by the Civil Aviation Authority who set mandatory operational requirements in November 2019 (7). These require operators to have two formal registrations in place before flying a drone or model aircraft; where the operational weight [max take-off weight] is between 250 g and 20 kg. In addition drone pilots must pass a theory test to obtain a flyer ID; also, responsible operators must register and obtain an operator ID.

Notwithstanding the CAA formalities and their advice offered by *The Drone and Model Aircraft Code For flying drones and model aircraft of 20 kg or less outdoors in the UK*, (8) it is clear that appropriate and authorised use of drones can be beneficial in terms of surveying productivity, time and cost.

The acquisition of safely obtained, comprehensive and relevant data can be significant when compared to previous time-consuming access scaffolding used with manual survey methods. Consequently, since 2017, the use of drones by surveying and mapping professionals has become more commonplace; especially on projects in high-risk or hard-to-reach situations. Autonomous drones enable automated capture of acquired imagery suitable for mapping. They additionally provide the potential for automated analysis of structures including cracks, damp, erosion, weathering and decay. Remote inspection drones enable visual inspection of inaccessible areas to provide mapping of heritage spaces; additionally, this whilst ensuring increased operator safety.

### **Photogrammetry Structure-from-Motion (SfM)**

Produced in October 2017, as one of Historic England Technical Advice documents on how to survey historic places, the highly informative *Photogrammetric Applications for Cultural Heritage Guidance for Good Practice* (9) covers the practical application of photogrammetry with particular reference to “*structure from motion*” techniques.

Until recently, acquiring and processing photogrammetric images, required a considerable investment in hardware and software, but is now available at a fraction of previous costs, leading to greatly increased use in cultural heritage recording. It is characterised by its versatility and is as applicable to recording landscapes as it is to museum objects.

*Reality Capture is “the direct integration of data derived from both photogrammetry and 3D laser scanning” (Historic England 2018)*

*Structure from Motion* is a low cost technique and is making use of photogrammetry fashionable again. The advantages of adopting it might be listed as:

- Being applicable on all 2D and 3D surfaces
- Multi-image photography offers an excellent archival record

- Not having to rely on calibrated metric cameras, modern approaches can use ‘*off-the-shelf*’ cameras
- Being able to generate high-resolution 3D ‘*point clouds*’

However, a number of disadvantages might also be noted including:

- The approach requires multi-overlap imagery – ideally 80% forward and 60% side
- Correlation needs visible texture to exist within the imagery
- Accurate data relies on good imagery and control
- Blackbox software may simplify photogrammetric processing but,
- Beware of the adage “*Rubbish in = Rubbish out!*”

### **Building Information Modelling (BIM)**

Surprisingly, of all the initiatives noted on the 2017 *Gartner Hype Cycle for Emerging Technologies*; Building Information Modelling (BIM) does not appear despite its growing use and increasing adoption in the new-build construction world. A number of views exist on what BIM is and what it can do. Included are:

- “*A collaborative process for the production and management of structured electronic information and illustrating, in digital terms, all the elements that compose a building*” (Historic England, 2017)
- “*BIM gets people and information working together effectively and efficiently through defined processes and technology*” (RICS, 2017)
- “*BIM or Building Information Modelling is a process for creating and managing information on a construction project across the project lifecycle*” (National Building Specification, 2016)

The current approach to documentation of heritage projects is that it is typically dispersed, inaccessible and unstructured, leading to ineffective collaboration, duplication of work and poor management. Understanding new-build BIM developments is relevant for heritage applications because they can facilitate collaborative production and, the delivery and management of building information across a building’s lifecycle. Bearing in mind best practice in conservation is based on informed decision making and judgement the BIM approach also offers benefits for record keeping and an integrated project database.

### **Developing an Historic Building Information Model**

Acknowledging primary work in 2012 (and by COTAC’s *BIM4Conservation Group* (BIM4C) and on-line reports dating from 2014 – 2016) in July 2017 the English Heritage publication *Developing a Historic Building Information Model* (Historic BIM) (10) offers guidance for owners, end-users and professionals in the fields of heritage and construction. It considers

the issues surrounding the production and use of BIM for historic buildings and provides information for managing a building's entire life cycle.

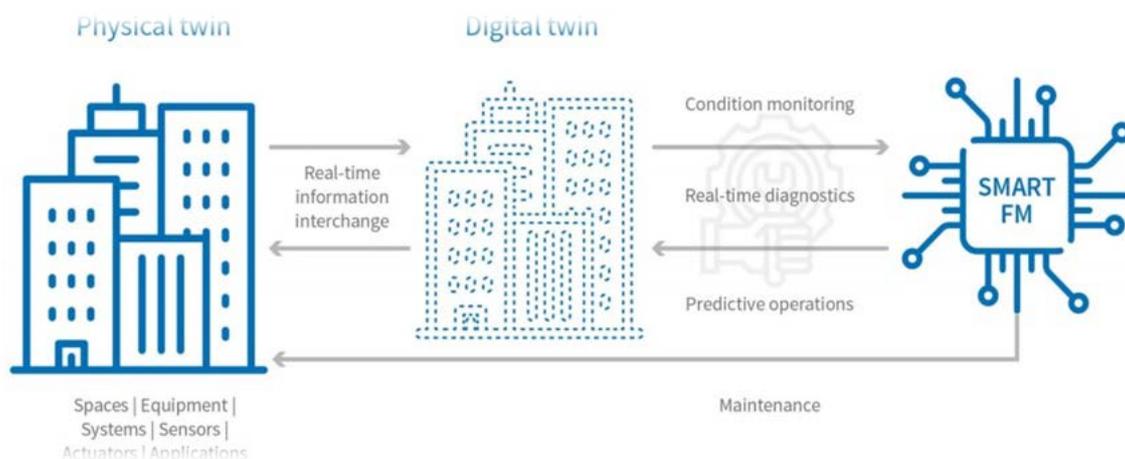
### **BIM for Heritage Developing an Asset Information Model**

This new Historic England guidance was released in November 2019 and focuses on heritage asset management with regard to conservation repair and maintenance (11). It suggests the first task when adopting a BIM information management approach is to develop an *Asset Information Model (AIM)* and offers related Templates for *Organisational Information Requirements (OIR)*, *Asset Information Requirements (AIR)* and *Exchange Information Requirements (EIR)*. In doing so, it notes:

*Asset management refers to systematic procedures and processes that help monitor and maintain things of value, including tangible assets, such as buildings, and intangible assets, such as intellectual property – data and information. “It involves the balancing of costs, opportunities and risks against the desired performance of assets to achieve an organisation’s objectives” (The Institute of Asset Management). The discipline of asset management and an integrated approach to the management of information allows organisations to apply analytical approaches towards the management of assets.*

### **Digital Twin**

In 2018 the Gartner Hype Cycle for Emerging Technologies started to identify the emergence of the *Digital Twin* – a virtual replica of a physical product, process or system. The digital twin bridges the gap between the physical and digital worlds by incorporating operational technologies such as the *Internet of Things (IoT)*. It also provides a platform to test scenarios and hypotheses to provide a better understanding of the performance of the asset. The *Open Data Institute* asserts that its functionality can better support the design, operation and maintenance of our built environment by making it safer and more efficient.

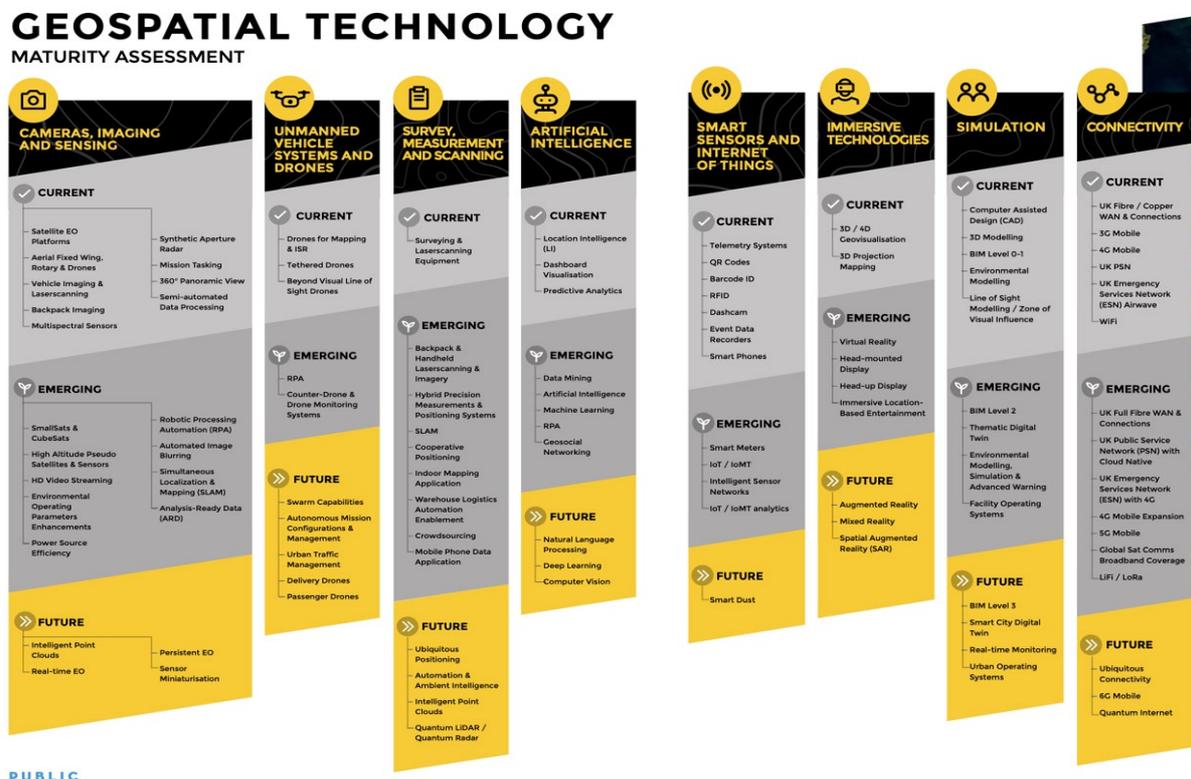


Digital Twin Image courtesy of Pressac Communications

As well as promoting the value of digital twins for individual assets, the *Open Data Institute* also offers a vision for a *National Digital Twin* (NDT): this being a federation of connected digital twins across all sectors at a national scale, with the Key to digital twinning being its openness across data, culture, standards and collaborative models to build trust, reduce cost and create additional value (12).

## Geospatial Technological Opportunities and Developments: What next?

The UK's Geospatial technology sector is recognised as the second most developed in the world, being second only to the US. Funded by the *Geospatial Commission* (13) (created in April 2018) a new report entitled *Future Technologies Review* (14) was published in August 2019.



The Report highlights how use of geospatial data by innovative technology, including *Artificial Intelligence*, is helping to grow the UK economy. It also considers current, emerging and future considerations; a *Maturity Assessment* of Geospatial Technology considered the topics of:

- Cameras, Imaging and Sensing
- Unmanned Vehicle Systems and Drones
- Survey, Measurement and Scanning
- Artificial Intelligence
- Smart Sensors and Internet of Things
- Immersive Technologies
- Simulation
- Connectivity

## Backpack Imaging

There seems little doubt that many of the considered topics will continue to impact on the needs of the built heritage. For example, with regard to *Static and Backpack Imaging* the report notes:

*The emergence of backpack-mounted imaging systems and static camera options has been brought about by the requirement to image and texture 3D city models, provide imagery context for indoor spaces and support for floor plan mapping. GoogleTrekker is an example backpack system used by surveyors for the capture of immersive imagery for Streetview.*



Backpack imaging in progress Machu Picchu. On-line image sourced via <https://www.theguardian.com/travel/2015/dec/03/machu-picchu-google-street-view-peru#img-3>

Pedestrianised Backpack Imaging enables capture of data ‘on the move’ by integrating location, imaging and scanning in one package offering the potential for complete coverage of historic building interiors in addition to detailing large external sites and locations. The 22 kg Google Trekker comprises 15 high-resolution cameras and takes a GPS tagged photo every 2½ seconds that are matched into panorama views. An increasing number of Trekker-scanned international heritage sites are becoming available on-line, including Petra, Angkor Wat, Venice, the Great Pyramids and Machu Picchu (15) the recording of which took seven days.

Having mapped more than 7,000,000 miles of roads in 65 countries the *Google Street View Camera Loan Program* (16) can help others create and share 360° experiences via Google Maps. The programme is open to professional photographers, travellers, and organizations such as tourism boards, non-profit bodies, government agencies, universities and research groups. It is also open to those seeking to promote areas of cultural, historical or touristic significance and those who intend to photograph business interiors. Under the program, Google might offer loan of a Street View Trekker backpack or a Street View app-compatible 360° camera depending on availability and what may best match the needs of using groups.

### **Simultaneous Location and Mapping**

Simultaneous Location and Mapping (SLAM), enables a user or an autonomous device to create a dynamic map and to navigate complex environments while using an image generated in real-time. SLAM enables the remote creation of GIS data in situations where the environment might be too dangerous or inaccessible for humans to map. Autonomous devices are using the technology to recognise features and become a fundamental component of modern mobile mapping systems, offering the potential for faster mapping and analysis of historic buildings and structures.

### **Machine learning and AI**

Artificial Intelligence (AI) is anticipated to be one of the primary areas of growth in the UK geospatial sector over the coming years. It will fundamentally change how day-to-day business operations might be supported in analysis by providing enhanced intelligence opportunities for entities across a multitude of sectors.

Machine Learning involves building statistical models based on sample data to make predictions or decisions without being explicitly programmed to perform the task. This has been leveraged effectively by geospatial companies to allow systems to derive insights and make decisions from '*Structured and Unstructured*' datasets with minimal human intervention. Potential use exists within different environments and for BIM and Digital Twin applications.

### **Augmented Reality (AR)**

Using wearable mobile devices, AR can remotely transport individuals into different geographic locations to create, view and evaluate/interpret contextual-awareness. Whilst currently in development by the military AR has the potential for live viewing of interpretive modelling of heritage sites and structures. This to verifying survey derived modelling and for viewing below ground services, geophysics and archaeological mapping and where

professionals might, quickly and easily, offer their expertise from remote locations anywhere in the world.

### **Skills Needs and Training**

From the heritage perspective the questions raised by the Geospatial Commission also has relevance:

- How can the profile of geospatial skills, careers and their value to the economy be raised?
- How can short and long term skills gaps, embed technology and learn from international exemplars and be identified?

### **On-line References:**

- (1) <https://historicensland.org.uk/research/approaches/research-methods/terrestrial-remote-sensing/specialist-survey-techniques/>
- (2) <https://www.tsa-uk.org.uk>
- (3) [www.instituteforapprenticeships.org/apprenticeship-standards/geospatial-survey-technician/](http://www.instituteforapprenticeships.org/apprenticeship-standards/geospatial-survey-technician/)
- (4) [www.instituteforapprenticeships.org/apprenticeship-standards/geospatial-mapping-and-science-specialist-degree/](http://www.instituteforapprenticeships.org/apprenticeship-standards/geospatial-mapping-and-science-specialist-degree/)
- (5) <https://www.tsa-uk.org.uk/downloads/>
- (6) <https://www.gartner.com/en/documents/3887767>
- (7) <https://register-drones.caa.co.uk>
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- (9) <https://historicensland.org.uk/images-books/publications/photoqrammetric-applications-for-cultural-heritage/>
- (10) <https://historicensland.org.uk/images-books/publications/bim-for-heritage/>
- (11) <https://historicensland.org.uk/images-books/publications/bim-for-heritage-aim/heaq271-bim-developing-asset-info-model/>
- (12) <https://theodi.org/article/digital-twins-user-research/>
- (13) <https://www.gov.uk/government/publications/future-technologies-review>
- (14) [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/827507/Final\\_Version\\_-\\_Future\\_Technologies\\_Review.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/827507/Final_Version_-_Future_Technologies_Review.pdf)
- (15) <https://www.theguardian.com/travel/2015/dec/03/machu-picchu-google-street-view-peru>
- (16) <https://www.google.com/streetview/loan/>

### **3: Skills Training in Scotland: Tradition and Innovation**

#### **Developed Report Based on a Presentation by Colin Tennant**

*Head of Technical Education and Training Conservation Directorate, Historic Environment Scotland*

The presentation: outlines the work that Historic Environment Scotland (HES) is doing in partnership with others to trial and promote, skills development initiatives; to more forcefully articulate related ideas about innovation and education and, to consider how to achieve their application and use across a broader sector. The underlying theme is that knowledge, skills and materials underpin the stewardship of Scotland's heritage. Across the built environment sector the need is for others to realise that it has become essential to 'compete' for young people's attention - to get them participating and contributing to the economy - and for them to get engaged with a better understanding of the 'world of work' before they enter the workforce.

#### **Background**

The national *Education Scotland* programme "*Developing the Young Workforce*" (DYW) (1) aims to enlighten young people about the 'world of work' and what it is going to be like when they get there. The programme is centred round the principle of restoring "*Parity of Esteem Between Vocational and Academic Training*". Over the last few decades there has been a considerable political push directing individuals to enter an academic route in terms of their education but, there is now a recognised need to rebalance that approach and to comprehend the value of vocational training and hands-on learning. This re-awakening is beneficial as it will help to engage those individuals who are not fully enthused by an academic approach.

But, it is quite difficult to achieve a significant change in an approach that has been in the mindset of many for some 20 - 30 years. To address this concern, in part, during March 2019, *Historic Environment Scotland* launched the '*Historic Environment Skills Investment Plan and Action Plan Skills Investment Plan*' (2) in conjunction with *Skills Development Scotland* (SDS) (3). First of its type, the Plan is not just about traditional and craft skills, or even about built environment related skills, it is about inclusive skills required across the whole historic sector - including museums, galleries, landscape, and tourism – all of which are incorporated.

#### **Key findings of the Skills Investment Plan**

Within the Plan a number of Skills Drivers have been identified, including:

- Significant increase in tourism (heritage tourism) and, thereby, public interest

- Policy agenda for improving and widening access to heritage assets
- Enhancing the overall visitor experience, including technological and digital transformation
- Climate change affecting the condition of heritage buildings
- Increased commercial focus for heritage organisations requiring a diversification of skills

Indicating that success will require re-focussing on a number of areas including identified Skills Challenges involving:

- Raising awareness, appreciation and development of traditional craft skills
- Maintaining the specialist technical skills that underpin the historic environment sector
- Continual promotion of professional skillsets
- Vocational training and learning
- New (and changes to) technical skills and practices arising from the ongoing development of new technologies, approaches, products and materials
- Wider underpinning/ supporting skills needed by, but not unique to, the historic environment sector.

Within the Plans, future demand will inevitably span across traditional craft sectors such as stonemasonry, joinery and plastering, together with skills for resilience and growth and to include:

- ICT and digital
- Leadership and management
- Business and enterprise
- Customer service skills
- Marketing and communication
- Advocacy
- Creativity and co-production

But, it is also considered that the Historic Environment Sector needs to confront its considerable fundamental challenges to:

- Address the perceived image of being '*old-fashioned*' among young people, and face stiff competition from other sectors
- Demystify the historic environment sector for young people as many feel that it is '*not for them*'. Action is required to help make this sector a career of choice and, raise awareness of the range of opportunities available
- Widen the talent pool and address gender inequality

- Develop more vocational skills learning into courses to support the readiness of new entrants (technical/professional and broader skillsets required) and help manage the expectations of those coming into the sector at entry level
- Widen entry-level routes and pathways into the sector and educate industry as to the most appropriate routes for the roles
- Address the decline in education and training provision of specialist skills
- Upskill and develop the existing workforce to meet employer demands
- Engage with the whole sector (including hard to reach micro/small businesses) to support workforce development
- Identify qualifications/accredited training for volunteers to ensure consistency in the workforce and recognised career progression
- Ensure that the operation and growth of the historic environment is not constrained by a lack of suitable and appropriate talent
- Improve awareness and understanding of employment opportunities
- Ensure that all supporting sectors have a good understanding and awareness of the historic environment
- Promote equality and diversity in the sector
- Act as a catalyst for increased delivery within related actions in construction, creative industries and tourism Skills Investment Plans
- Establish a regime that recognises “*parity of esteem*” across both academic and vocational qualifications and without the need for ‘academic badges’

The Plan recognises the need to stop wasting opportunities and educate people about what the world of work needs through widening sector entry level routes and pathways. In addition, in re-educating industry, there is a need to encourage and recognise that there are other available training routes into most professions and, a requirement to address the decline in specialist skills. Historically, vocational qualifications have been perceived as a ‘*lesser relation*’ when evaluating ability! The Plan also identifies qualifications crediting training for volunteers - hitherto not something seen as a priority – but it is an issue that keeps re-emerging. Volunteers should be given the opportunity to transform themselves into the world of work by getting proper credit training whilst volunteering so they can move forward more effectively. This plan element is to make sure we are not constrained by a lack of suitable talent. In summary, a number of key Priority Areas emerge:

1. Engaging the sector in skills and innovation:
  - a. Improve awareness and understanding of skills challenges and solutions
  - b. Widening employer engagement in skills
  - c. Promoting innovation
  - d. Integrating professional and craft training regimes so that each is aware of both
2. Attracting future talent and improving access:

- a. Promote the sector as an attractive place to work
  - b. Promote pathways into the sector for all
  - c. Developing apprenticeships and enhancing further and higher education provision
  - d. Develop volunteer networks for young people and offer work placements
  - e. Removing the social stigma between professional and craft
3. Workforce development:
- a. Expand traditional skills and specialist provision
  - b. Develop and enhance CPD provision and availability nationally
  - c. Increasing skills and qualifications of volunteers

Alignment across construction, creative industries and tourism sectors is achieved by sharing resources and expertise in workforce development; the need is to demonstrate to young people that the sector is innovative, digital savvy and aware of new technologies and techniques and less socially divisive. Improving on what is done by carrying that out in a more efficient manner becomes a key aspect in attracting new blood into the sector. Expanding traditional skills and specialist provision over the past 10 to 15 years had the aim of trying to keep courses going whilst ensuring their quality was up to standard. Now, especially with budgetary constraints, there is a struggle generated by craft, professional and technical skills training becoming too expensive to deliver. This creates a need to articulate why it is vital to fund things appropriately and, to make sure we have a broader range of related CPD opportunities that are delivered nationally and not just concentrated on specific locations – a National Plan!.

### **HES Built Heritage Investment Plan**

Alongside the SDS *Skills Investment Plan*, HES has been creating a *Built Heritage Investment Plan*. Its approach offers ideas for stimulating demand and demonstrating the value of conservation, repair and maintenance, adding to the longer-term economic value by proactively tackling issues rather than putting off the work. The problem and its solution, however, lies in having the right skills, at all levels, for the right job. The *Scottish Traditional Building Forum (4)* and its Regional members support and coordinate such activities across Scotland offering many good examples of professionals, contractors, training providers and public bodies coming together to demonstrate their skill sets. Essentially repairs, maintenance and the energy efficiency retrofit of traditional (pre-1919) buildings using the right skills and materials can be long-lasting and offer good value. But the benefits of such an approach need to be made mandatory through changes to procurement policy, along with enforced compliance procedures to make a real impact.



Stirling Traditional Building Health Check Scheme © Engine Shed

In Stirling, a Heritage Health Check Scheme (5) has been on trial for a number of years. An option appraisal showed that the cultural benefits and positive changes could also be grown in the neighbouring authorities of Falkirk and Fife, as this would also encourage more demand for skilled professionals and to advance those who had trained.

With the need to have the right skills for the right job (in order to properly maintain and retain what is already built) there is a commensurate need to ramp up accreditation, certification and proof of competency as part of the recruitment process. It is important to use these as drivers to move from the *'need for skills people'* to a *'demand for skills people'* thereby enabling clients more easily to identify those with appropriate skills, training, knowledge and abilities to do the right types of work. Consequently, a question generated by the Traditional Buildings Scheme is: *"where can I source advice from competent and appropriately skilled people?"* Across the domestic market, that is quite a difficult question to answer and there is a need to make available a set of, *'easy-to-follow'* guidance notes for conservation project commissioning clients about best practice!

### The Engine Shed Initiatives

The Engine Shed (6) has given HES a great opportunity to proceed with much of the necessary work by providing a venue to demonstrate what can be done and how to do it.



The Engine Shed, with Stirling Castle Great Hall in the background © Ingval Maxwell

It also enables the sector to come together and work collaboratively to address some of the issues. It was always part of the HES concept that it should focus on young people to try to get them interested in what is done within the sector, understand why it is done, how it can be done and, to explore the available technologies to work effectively.

The HES approach is pursued in accordance with the national *Scottish Credit and Qualifications Framework (7)*. The SCQF educational framework spans from Level 1 Primary School Pupils to Level 12 PhD level. What HES is trying to do at the Engine Shed is to build “*blocks of activity*” covering areas within the framework by devising training packages such as:

- Education and Outreach: Levels 1 - 3 + Nursery
- Estate maintenance, lab based heritage management: Levels 4 + 5
- Qualifications in Estate Management: Level 6
- HVQ Craft Fellowship Programme: Levels 7 + 8
- Conservation Trainee Programme: Levels 10 + 11
- Advanced Technical Diploma: Level 11
- A PhD programme: Level 12

**THE SCOTTISH CREDIT AND QUALIFICATIONS FRAMEWORK**

This Framework diagram has been produced to show the mainstream Scottish qualifications already credit rated by SQA and HEIs. However, there are a diverse number of learning programmes on the Framework, which, due to the limitations of this format, cannot be represented here. For more information, please visit the SCQF website at [www.scqf.org.uk](http://www.scqf.org.uk) to view the interactive version of the Framework or search the Database.

SCQF Levels	SQA Qualifications		Qualifications of Higher Education Institutions	Apprenticeships & SVQs
12			PhD Programme	Professional Apprenticeship
11			Advanced Technical Diploma	Cons Trainee Programme
10			Honours Degree, Graduate Diploma, Graduate Certificate	
9			Bachelors / Ordinary Degree, Graduate Diploma, Graduate Certificate	Graduate Apprenticeship Technical Apprenticeship SVQ
8		Higher National Diploma	Diploma Of Higher Education	Craft Fellowship Programme
7	Advanced Higher, Awards, Scottish Baccalaureate	Advanced Craft	Certificate Of Higher Education	
6	Higher, Awards, Skills for Work Higher			Estate Management
5	National 5, Awards, Skills for Work National 5			Estate Maintenance
4	National 4, Awards, Skills for Work National 4	National Certificate	National Progression Award	
3	Education & Outreach			
2	Education & Outreach			
1	Education & Outreach			

SCQF 12 Levels with current (2019) overlaid HES Engine Shed educational and training initiatives

The intention is to open up a set of prior learning packages to different groups of people to help in being able to achieve recognised qualifications and, subsequently, get accredited.

Recognising that it is important to move people through the system within the skills, conservation construction crafts and technician groups; HES are currently tendering for the development of packages to underpin heritage skills vocational qualifications. Here, HES needs to step up its game and there are a whole range of graduates and modern traditional apprenticeships on the vocational side that needs greater consideration. There is also a need to increase use of conservation accreditation and to influence the content and delivery of undergraduate courses.

Also recognising the need: the *Scottish Funding Council (8)* wants to see universities produce people who are ready for work, challenging why there is investment in four years of training and education when individuals, subsequently, require a further postgraduate or internship qualification to become employable. The contention is that they should be sufficiently prepared by existing undergraduate programmes, via subsequent accredited qualifications achieved and through work-based learning. There is a big opportunity to ensure that CPD is also mapped against '12 Levels' so individuals can then use that to create building blocks of progression throughout their career.

### Achieving Level 1 and Beyond

So, by starting at the bottom below the framework Level 1, HES is using the Engine Shed as a test bed for developing training packages that concentrate upon science, social studies, technologies, mathematics and expressive arts. The approach actually starts with Nursery School participants: it is important to start by influencing the youngest possible age group as early as possible [as espouse by ICOMOS CIF *Capacity Building*]. So, a team are developing a whole range of workshop packages and Activity Plans. Some of these are based on familiar stories such as 'Three Little Pigs' and 'Jack and the Beanstalk' to explore who might be experts in construction and those who are not. By presenting familiar concepts to the young this can readily and easily introduce them to building materials and skills.



Engine Shed Early Years Workshops: Nursery – P1, Ages 3-5 Years Activity Plans: Familiar age-appropriate stories to find out and explore buildings, materials and skills

HES is also exploring material properties, bridge building, structural issues, robotics and VR programming to get an historic environment awareness into the minds of young people from Primary School upwards. Some of the issues are quite complex concepts so the approach is about making the aspects accessible, fun, and enable participants to remember what was experienced. An example talked about is the permeability of traditional building materials, explored through the medium of a “*chocolate digestive biscuit*”. The biscuit side is pretty permeable, the chocolate side isn’t!

In the 9 to 11 age group the approach can take them on a learning journey through *Activity Boxes* that have been developed along with workshops to introduce them to ways in which they might better understand their historic environment. Examples include “*Mini Bricks*” with worksheets on bonding patterns and the history of brick making; or the popular approach to “*Stone carving using blocks of soap*”. Each activity comes with a risk assessment method statement so, once trialled and shown to be effective, other sectors can start to use the same approach at similar events.

With the “*Master Builders*” programme a series of activities have been arranged over a number of weekends where youngsters can experience different craft areas. The “*Wee Builders*” programme had over 50 parents attending with their young children - all having a good time - whilst the parents picked up the free ‘*INFORM*’ leaflets on how to repair their homes - thereby influencing the wider family in the process.

Encouraged by such positive results, the Activity Boxes are being promoted to other partners across Scotland, such as Heritage Trusts, to help them to promote activities and, thereby, increase overall influence.



Local High School, Stirling: Building Craft and Technician Training Project © Engine Shed

Another pilot project, undertaken in conjunction with a local high school, was aimed at addressing complaints made to the SDS by the construction industry. These complaints tackled the issue of candidates coming from schools and colleges not really knowing what they were expected to do on a construction site. What emerged was a project-based learning approach within school environments. This initiative was supported by a passionate

head teacher who wanted to ensure that all pupils had an opportunity to do something worthwhile in transferring from school and education into employment.

Part of the project brief was that pupils had to use traditional materials to create something within the school grounds that would be useful to the school - in consequence, getting real life experiences that would help them move into apprenticeships, professional studies and, at the same time, positively developing their personal pride, engagement, confidence and self-esteem befitting the pending world of work. The initiative was treated in the same way as any construction project. Adopting the RIBA Plan of Work as the basis for its development and realisation - participants were able to assess themselves throughout the process to determine whether they needed to adjust or revise time scales, skills, costs, etc. The collective approach demonstrated the relevance of 'maths' and how that subject might impact on skills required in the world of work. The approach has since been adopted by three other schools supported by local construction industries. The students were noted as remarkably IT savvy: with good knowledge of CAD, Sketchpad and other applications. As a result, HES are developing a qualification that will be piloted with SDS and partner *Forth Valley College* (9). The aim is to deliver a mixed experience of different craft elements (roof tiling, stone masonry, brickwork, joinery etc) in addition to getting technical experience (quality surveying, structure, design) within an integrated approach.

To conclude, the underlying Engine Shed approach is to promote the idea that the sector generates a need to secure a better balance between vocational and academic training. Experience has shown that there has never been an event where it has not been possible to engage young people. Once the relevance, potential and opportunity has been pragmatically demonstrated all ages of participants became interested and involved.

#### **On-line References:**

- (1) <https://education.gov.scot/education-scotland/scottish-education-system/policy-for-scottish-education/policy-drivers/developing-the-young-workforce-dyw>
- (2) <https://www.skillsdevelopmentscotland.co.uk/media/45467/historic-environment-sip.pdf>
- (3) <https://www.skillsdevelopmentscotland.co.uk>
- (4) <http://stbf.org.uk>
- (5) <http://www.stirlingcityheritagetrust.org/traditional-buildings-health-check/>
- (6) <https://www.engineshed.scot>
- (7) <https://scaf.org.uk>
- (8) <http://www.sfc.ac.uk>
- (9) <https://www.forthvalley.ac.uk/courses/construction/advanced-professional-diploma-in-technical-building-conservation>

## **4: GO FORTH! Digital Heritage Learning Resources**

### **Developed Report Based on a Presentation by Dr Lyn Wilson**

*Digital Documentation Manager, Historic Environment Scotland*

Go Forth! is a major new educational resource available to all Scottish schools. It utilises the output of recently completed 3D digital documentation of the three Forth Bridges to support teaching of STEM subjects defined within the 'Curriculum for Excellence'. This initiative has its origins in the *Scottish Ten Digital Documentation Project* which involved the recording of UNESCO World Heritage Sites in five different countries using cutting-edge 3D laser scanning technologies.

In 2013, the Scottish Ten experience allowed the team to assess if it would be possible to record the Forth Bridge to help support its nomination for inclusion on UNESCO's World Heritage List. Having demonstrated that a 3D survey was possible, the recording of all three Forth Bridges commenced in 2015 with funding from the Scottish Government.

With digital models for all three Bridges complete, work commenced on developing learning resources designed to inspire school pupils. The aim being to generate interest in the Bridges themselves and to stimulate an enhanced take-up in associated science and technology subjects. Working with the assistance of technical teaching expertise from Dundee City Council, a suite of digital learning resources were developed: these were launched in late 2018 and are now freely available to all educators through the 'Glow Scotland' network.

### **Digital Documentation and Digital Innovation at Historic Environment Scotland (HES)**

*Historic Environment Scotland (HES)* uses a range of digital technologies to document its heritage in 3D. By applying innovative digital techniques and documentation data this approach is being used to assist in conservation, site management, learning, interpretation and accessibility of its sites to the benefit of the historic environment.

HES participates in related applied scientific research about the heritage sector in collaboration with local, national and international partners. The practice involves participating in training programmes, community engagement and outreach, whilst also providing advice and guidance across the heritage sector. With an emphasis on skills and capacity building, support is offered to encourage development of the next generation of digital heritage experts. Since 2012 this has included offering annual paid trainee positions in *Digital Documentation and Digital Innovation* based at the Engine Shed.

## **The Scottish Ten Project**

*The Scottish Ten (1)* project ran from 2009 to 2013. During that time, along with five international locations the (then) five World Heritage Sites in Scotland were digitally scanned and documented. The full set of ten are:

- Antonine Wall, Scotland
- Easter Qing Tombs, China
- Heart of Neolithic Orkney, Scotland
- Mount Rushmore National Memorial, USA
- Nagasaki Industrial Heritage, Japan
- New Lanark, Scotland
- Old and New Town of Edinburgh, Scotland,
- Rani ki Vav Step Well, India
- St Kilda, Scotland
- Sydney Opera House, Australia

In 2010 as part of the process, HES and the *School of Simulation and Visualisation* in the *Glasgow School of Art* formed a unique partnership to create the *Centre for Digital Documentation and Visualisation (CDDV)*. As a contributing partner, the *HES Digital Documentation Team (2)* and its *Technical Education and Outreach* and *Conservation Science* Teams are based at the Engine Shed.

## **The Scottish Ten Digital Assets**

Created by the *Scottish Ten* project, the resulting digital assets are central to the HES virtual learning environments. Included in the Engine Shed learning experience, interactive 3D models are used to showcase conservation practice and discover distant heritage sites. This also creates a focus exploring and interpreting the range and depth of academic and commercial collaboration in digital documentation and, in developing application of cutting edge technologies for use across the heritage sector. The Engine Shed's *Advanced Professional Diploma in Technical Building Conservation* also includes a Digital Documentation module helping students put into practice lessons learned by the *Scottish Ten* project.

## **The Forth Bridge nomination for World Heritage Site Status**

In 2013, building on the experience gained through the *Scottish Ten*, the CDDV piloted a digital feasibility study in support of the Forth Bridge UNESCO World Heritage nomination. Every World Heritage Site has to be managed, conserved and promoted, with regular reporting back to UNESCO, the potential of using the piloted digital documentation was positively recognised in variety of ways, including:

For Conservation:

- *Providing an accurate 3D survey of the existing as-built structures for conservation and management.*
- *Providing baseline survey data for potential future condition monitoring of the bridge.*
- *Generating data which could be used for a finite element analysis of small components on the bridge.*

For Management:

- *Providing weight to the Management Plan in support of the UNESCO World Heritage nomination.*

For Health and Safety:

- *Generating data which can be developed into virtual health and safety and for familiarisation site induction tools for bridge contractors and emergency services.*

For Learning and Interpretation:

- *Providing digital content for interpretation, with the potential for input into Network Rail Visitor Centres, remote/online access.*
- *Providing digital content for education e.g. Curriculum for Excellence lesson plans.*
- *Promotion as an engineering ambassador for the profession, with potential to inspire younger generations.*

For Political Policies:

- *Supporting the strategic outcomes identified in the National Performance Framework, not least those relating to education and young people, heritage, business and national identity.*

For Tourism:

- *Applications in advertising campaigns for Scotland (notably the cruise-ship and rail travel markets).*

For Media:

- *Possible commercial use in the entertainment industry (e.g. gaming, cinema).*

In 2015, the Forth Bridge was inscribed under Criterion (i) and (iv) on the UNESCO World Heritage List (3). Its citation reads:

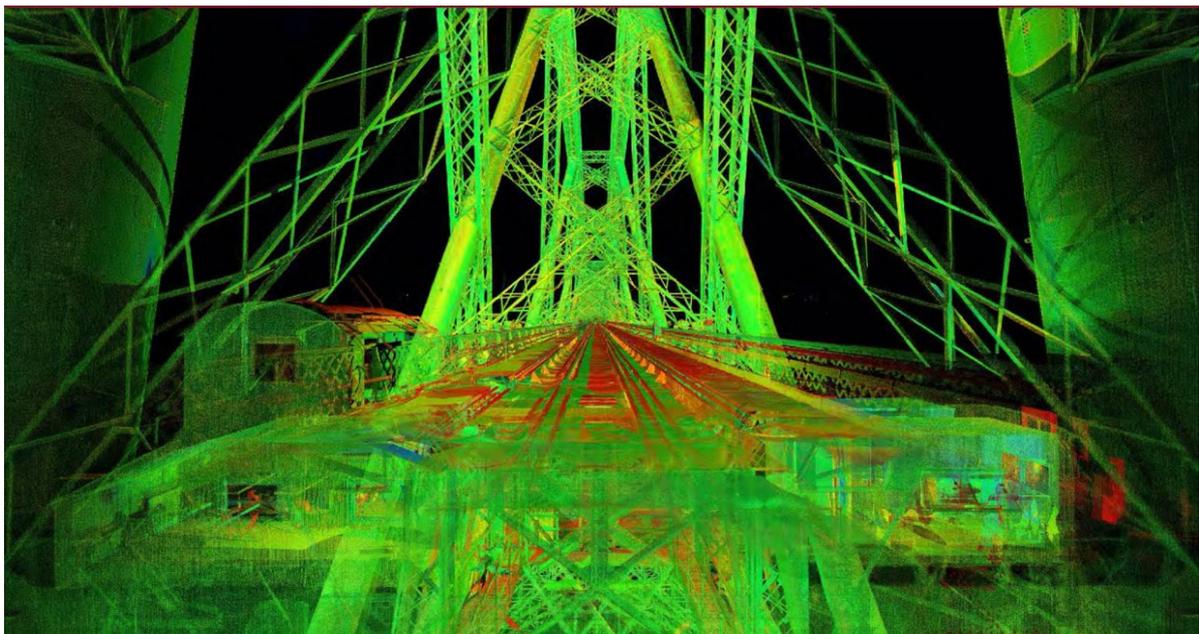
*This railway bridge, crossing the Forth estuary in Scotland, had the world's longest spans (541 m) when it opened in 1890. It remains one of the greatest cantilever trussed bridges and continues to carry passengers and freight. Its distinctive industrial aesthetic is the result of a forthright and unadorned display of its structural components. Innovative in style, materials and scale, the Forth Bridge marks an important milestone in bridge design and construction during the period when railways came to dominate long-distance land travel.*



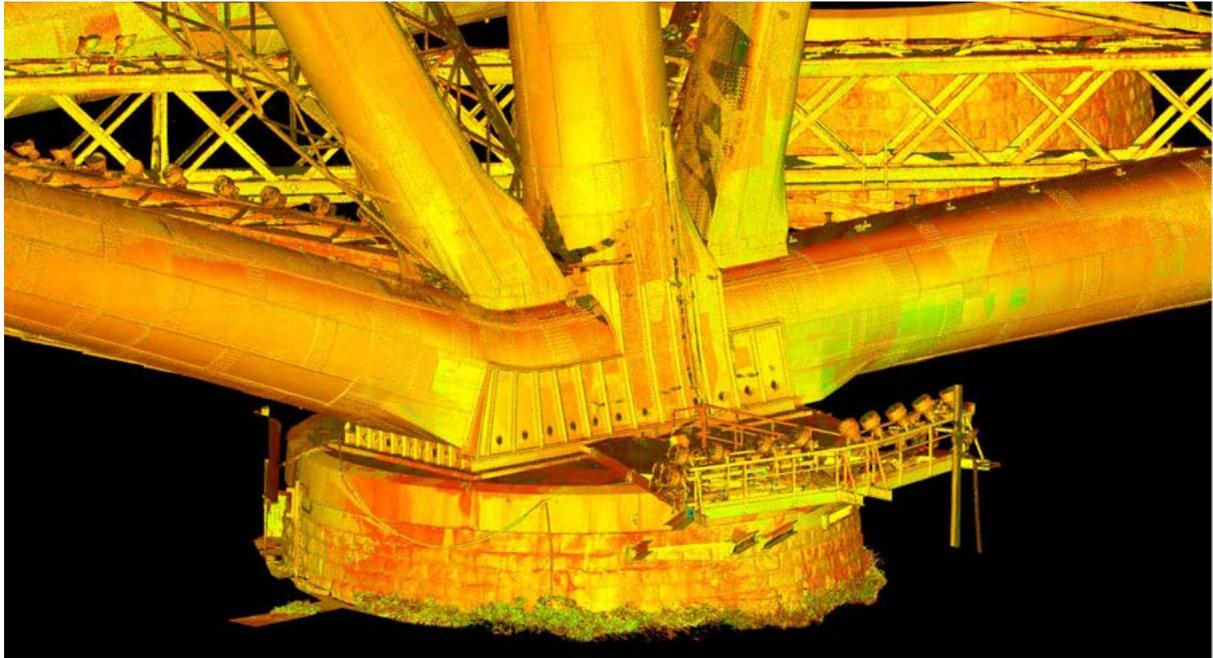
Forth Bridge World Heritage Site

Expanding on the Forth Bridge pilot study, work continued to include scans of the 1960's Forth Road Bridge and the (then under-construction) Queensferry Crossing. The £300,000 project was one of the most challenging and complex 3D digital documentation projects undertaken anywhere in the world.

It amassed a point cloud of many billions of dimensionally accurate points on the bridge structures. Combined from almost 1,500 separate laser scans for each bridge, this created a digital 3D model that provided raw data from which the *Go Forth!* educational resources were developed.



Forth Bridge World Heritage Site Scan © CDDV



Forth Bridge World Heritage Site Scan © CDDV

### The Go-Forth! Project

In 2014, with funding from the Scottish Government, detailed recording of all three Forth Bridges commenced. With the laser scanning complete a further £425,000 grant from *Transport Scotland* in 2017 enabled work to start on developing related learning games, design and coding resources, a location-based app, virtual headset tours and video fly-throughs. The approach incorporated detailed original images of the Forth Bridge when it was under construction. Recorded by photographer engineer, Evelyn Carey, the original glass plate negatives are held in the National Records of Scotland as part of the British Rail collection. Available on YouTube (4) is a 5-minute video compilation by CDDV of the intricate scanning aspects of the project.



Forth Bridge under construction © National Records of Scotland

The adopted approach aimed to encourage a new generation to take an interest in the bridges themselves and to stimulate an enhanced take-up of associated science and technology subjects. The packages are currently available to all Scottish schools through *Education Scotland's Glow network (6)* and can be downloaded as pdfs from the Forth Bridge website (7). Launched in October 2018 the *Go Forth!* set of five teaching packages comprise:

- *Go Forth and Discover*
- *Go Forth and Design*
- *Go Forth and Create*
- *Go Forth, See and Hear*
- *Go Forth and Explore*



### **Go Forth and Discover:**

Is a digital game and lesson package offering a series of 10 challenges to build an understanding within the social studies curriculum from Level 1 onwards; 3d models and animations are used in the real-time game engines (8)

### **Go Forth and Design:**

Is an *Autodesk Tinkercad\** 3D resource and lesson package offering building engineering knowledge, computer aided design and problem solving skills on and offline. 3D models are used in CAD environments (9)

### **Go Forth and Create:**

Is a *Scratch\*\** coding resource and lesson package offering building computer science knowledge, engineering and problem solving skills collaboratively or individually, 3D models are used in coding programming (10)

### **Go Forth, See and Hear:**

Offer a 360 degree, virtual reality, tour of the Forth Rail and Road Bridges (11)

### Go Forth and Explore:

This will be a location-based app to be made available free of charge through iOS, Google and Play app stores.

During preparation and to ensure educational relevance an intensive testing phase was undertaken with young learners. Their feedback was listened to and changes made.

*\* Schools can use Tinkercad in compliance with online privacy and security regulations including COPPA and GDPR. School districts may also enter into Tinkercad's Student Data Privacy Agreement, which affirms Autodesk's commitment to protect student information consistent with these regulations. Students under 13 can create a Tinkercad account with approval from a parent/guardian or use Tinkercad in a Tinkercad classroom created by their teacher (12)*

*\*\* Scratch is a free application, developed by the MIT Media Lab, which allows users to create and share their own interactive stories, animations and games. It is easier to use than traditional programming languages as it consists of graphical blocks which snap together (13)*



Discovering the Digital Forth Bridge © Engine Shed

### Go Forth Related Benefits

*Go Forth!* provides safe virtual access to an operational railway bridge and is just one way in which the resources can be used to share this World Heritage Site with the rest of the world. The *Transport Scotland* website (14), commending the educational initiative, notes:

*The embedding of the Forth Bridges into teaching resources helps to demonstrate to pupils the wonders of modern digital technologies and to the extraordinary civil engineering from three different centuries we see sitting across the Forth.*

The website also acknowledges that, in the future, the digital survey data for the three bridges may also be used to support monitoring and maintenance programmes in addition to developing interpretation resources and virtual access available online and at proposed visitor centres. The data will also be able to support and enhance other applications such as site inductions, health and safety exercises, engineering calculations and potential historic reconstructions.

#### **On-line References:**

- (1) <https://www.engineshed.scot/about-us/the-scottish-ten/>
- (2) <https://www.engineshed.scot/about-us/teams/digital-documentation-team/>
- (3) <https://whc.unesco.org/en/list/1485/>
- (4) <https://www.youtube.com/watch?v=TY3VVMaJCN4&feature=youtu.be>
- (5) <https://www.gov.scot/policies/science-and-research/stem-education-training/>
- (6) <https://glowconnect.org.uk>
- (7) <https://www.theforthbridges.org/visit/go-forth-digital-learning-resources/>
- (8) <https://www.theforthbridges.org/forth-bridge/go-forth-and-discover-digital-game/>
- (9) <https://www.theforthbridges.org/media/33036/go-forth-and-design-cddv-learning-pack-compressed.pdf>
- (10) <https://www.theforthbridges.org/media/33038/go-forth-and-create-cddv-learning-pack.pdf>
- (11) <https://www.youtube.com/watch?v=u4F45RoqhR4&feature=youtu.be>
- (12) <https://www.tinkercad.com/teach>
- (13) <http://scratch.ie/resources>
- (14) <https://www.transport.gov.scot/news/go-forth-learn-and-be-inspired/>

## 5: Digital Heritage: Anticipating an Integrated Way Forward

### Developed Report Based on a Presentation by Ingval Maxwell OBE

*Chair COTAC and Edinburgh Group*

An increasing number of recent international reports and studies are recognising that developments in digital heritage are occurring at an ever-increasing pace; concluding that the sector needs to be better prepared to adopt emerging technologies for the benefit of cultural heritage. There are many definitions of what ‘*cultural heritage*’ entails. The variable use of the term ‘*cultural heritage*’ is discussed by Prof. Jokilhto in his working group papers to ICCROM in 1990 and to ICOMOS CIF in 2005 (1).

A more succinct definition of cultural heritage by UNESCO (2) (*in considering the Illicit Trafficking of Cultural Property*) encompasses several categories including:

*Tangible cultural heritage:*

- *movable cultural heritage (paintings, sculptures, coins, manuscripts)*
- *immovable cultural heritage (monuments, archaeological sites, and so on)*
- *underwater cultural heritage (shipwrecks, underwater ruins and cities)*

*Intangible cultural heritage:*

- *oral traditions, performing arts, rituals*

*Natural heritage:*

- *natural sites with cultural aspects such as cultural landscapes, physical, biological or geological formations*

Many of the funded studies and initiatives often omit detailed reference to the physical needs of the existing built historic environment; what is emerging in digital heritage work has a bearing on it, albeit as a secondary consideration.

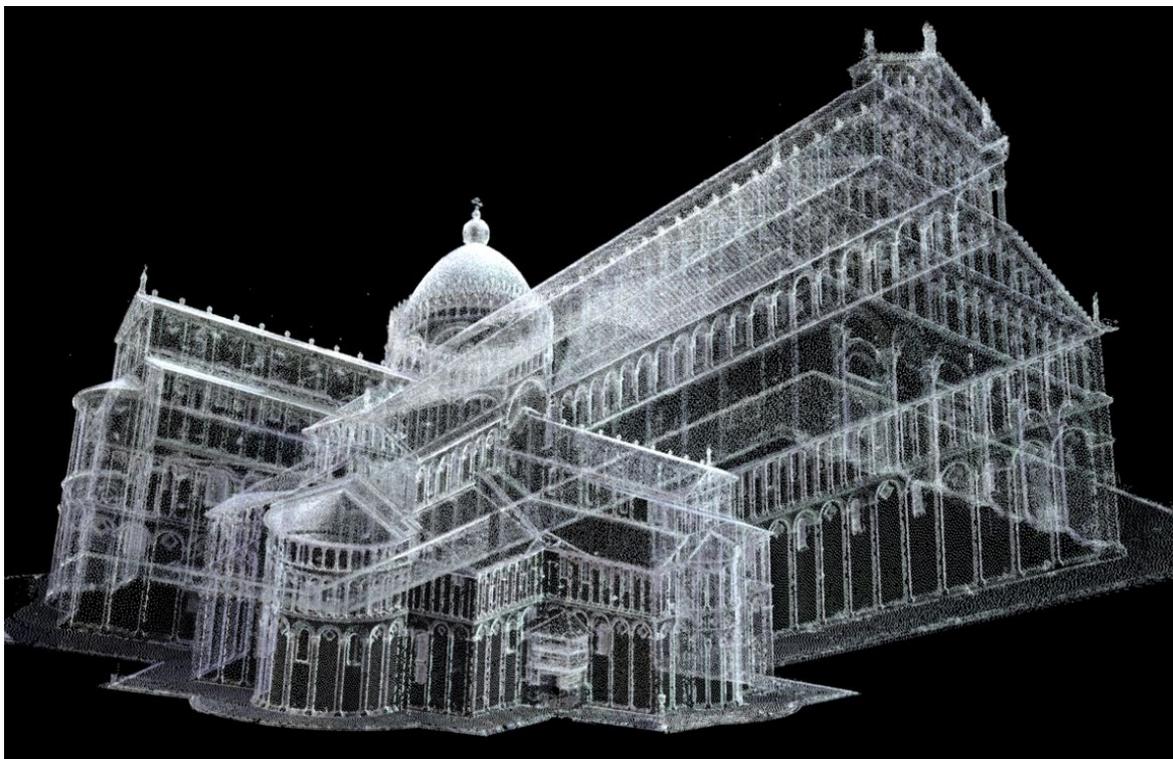
### Europeana

The European Commission through the Europeana Foundation is developing a Digital Service Infrastructure platform with digitised material from libraries, archives and museums, providing access to some 30 million cultural objects. Sourced from over 2,500 organisations *Europeana* (3) has enabled their resources to be more internet-friendly and widely accessible to provide data, technology, tools and services to Europe’s cultural heritage sector and its creative industries.

### INCEPTION - Inclusive Cultural Heritage in Europe through 3D semantic modelling

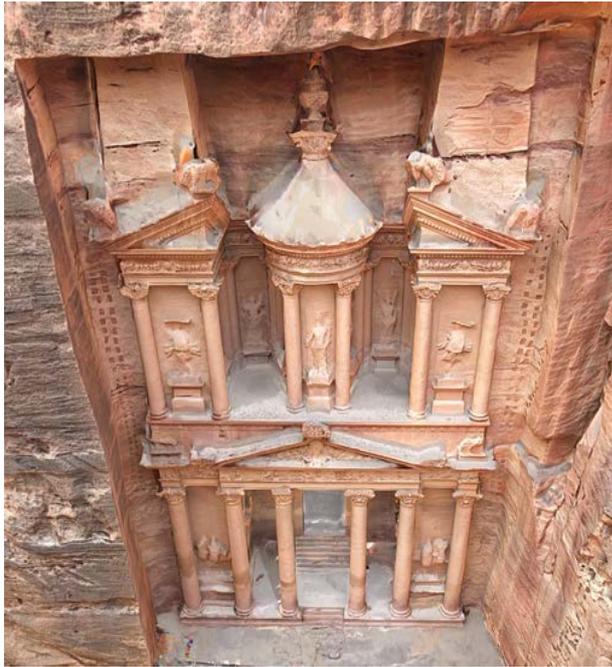
Co-ordinated by the University of Ferrara, Italy, and funded under the EU’s Horizon 2020 programme, the *INCEPTION* project rationale (4) indicates that:

*INCEPTION solves the shortcomings of state-of-the-art 3D reconstruction by significantly enhancing the functionalities, capabilities and cost-effectiveness of instruments and deployment procedures for 3D laser survey, data acquisition and processing. It solves the accuracy and efficiency of 3D capturing by integrating Geospatial Information, Global and Indoor Positioning Systems (GIS, GPS, IPS) both through hardware interfaces as well as software algorithms. INCEPTION methods and tools will result in 3D models that are easily accessible for all user groups and interoperable for use by different hardware and software. It develops an open-standard Semantic Web platform for Building Information Models for Cultural Heritage (HBIM) to be implemented in user-friendly Augmented Reality (VR and AR) operable on mobile devices.*

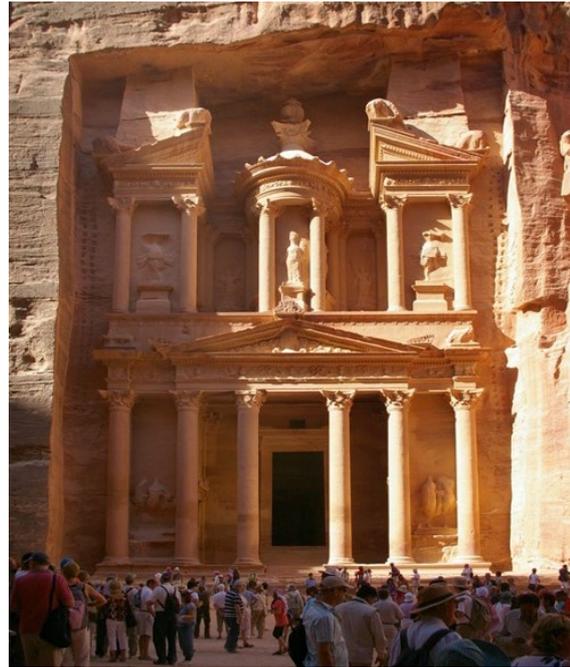


Pisa Cathedral Point cloud 3D model © INCEPTION

The scanned results of 10 *INCEPTION Project* 3D models, including Pisa Cathedral, are available to view on the '*Sketchfab*' website (5). However impressive these models are to view the see-through point clouds require considerable additional work to fully inform on the pragmatic needs of on-site conservation decision-making. But, a site such as *Sketchfab* offers (for sale) numerous 3D objects that are eminently suitable for 3D printing and gaming technology whilst, at the same time, providing exceptional virtual access. Exemplified by the colour-rendered 3D fly-through model of Petra (6) it is possible to appreciate the monument at every level in unprecedented detail – a facility that is denied to the ground-level tourist.



The Treasury, Petra: 3D beneficial vantage point viewing © Sketchfab



The Treasury, Petra: Limited access tourism © Ingval Maxwell

Such detailed 3D material, if offered with added photo-realism, could have potential, significant and real-life benefits for meticulous off-site interpretation of erosion, defect analysis and project planning requirements.

**Digital solutions in the field of cultural heritage: a Policy Brief from the Policy Learning Platform on Environment and resource efficiency.** August 2018. Interreg Europe (7)

The report Summary indicates:

*The objective of this policy brief is to describe the different opportunities created through digital technologies for the preservation and promotion of cultural heritage. The document provides a brief overview of the EU policy documents addressing digitisation of cultural heritage and presents inspiring good practices stemming from the Interreg Europe projects. Digital solutions are also applied in the field of natural heritage, but the focus of this policy brief is on cultural heritage.*

The report (page 6) further indicates:

*Digitisation requires not only technical knowledge, but also organisational capacity and understanding of how it could be beneficial to the organisations, regions and sectors. Limited knowledge understanding of the benefits that digitisation brings leads to low penetration of digital approaches. Consequently, the development and implementation of digitisation strategies for cultural heritage is considered a challenge for many regions across Europe.*

*At the same time, continuous disappearance of traditional skills and crafts which are part of the intangible cultural heritage is a key problem in heritage sector[s]. Besides, in many regions across Europe there are no specific regional policies on digitisation of intangible cultural heritage or there are only sporadic activities initiated by cultural centres, municipalities, etc.*

Although recognising the loss of traditional skills and crafts, the report omits to focus on how the emerging technologies can be beneficially integrated with vocational craft training and educational requirements within the actual building conservation workplaces. Instead, the perceived needs of intangible aspects and that of art, tourism, creative industries and civic regeneration, and the management, maintenance and preservation of digital cultural content predominate.

## **INNOCASTLE**

Running from June 2018 to November 2020, the *EU Interreg Europe* project exemplifies this discrepancy (8). The project seeks to demonstrate the importance of partnerships in the sustainable revitalisation and future-proofing of heritage sites. This to alert policy makers of the need for effective funding enabling heritage sites to become self-sufficient; this by highlighting shared European identity, noting:

*Mostly located in rural and remote areas, historic castles, manors and estates (HCME) have the potential to stimulate rural and regional development and innovation. However, this requires a shift of paradigm in governance and support. By developing new policy instruments to unlock these assets, HCME could act as drivers for job creation, better education, improving life quality and reducing social inequalities.*

### **Cultural Heritage Digitisation, online accessibility and digital preservation.**

The *Consolidated Progress Report on the implementation of Commission Recommendations (2011/711/EU) 2015 – 2017* (9), with reference to the recent (May 2018) fire in Notre-Dame Cathedral, stresses the need to preserve, record and protect European cultural heritage, the emphasis placed on digital recording runs to the detriment of support for Craft skills training in order to physically preserve and protect it. The report's Foreword only pays lip-service to this need as it indicates:

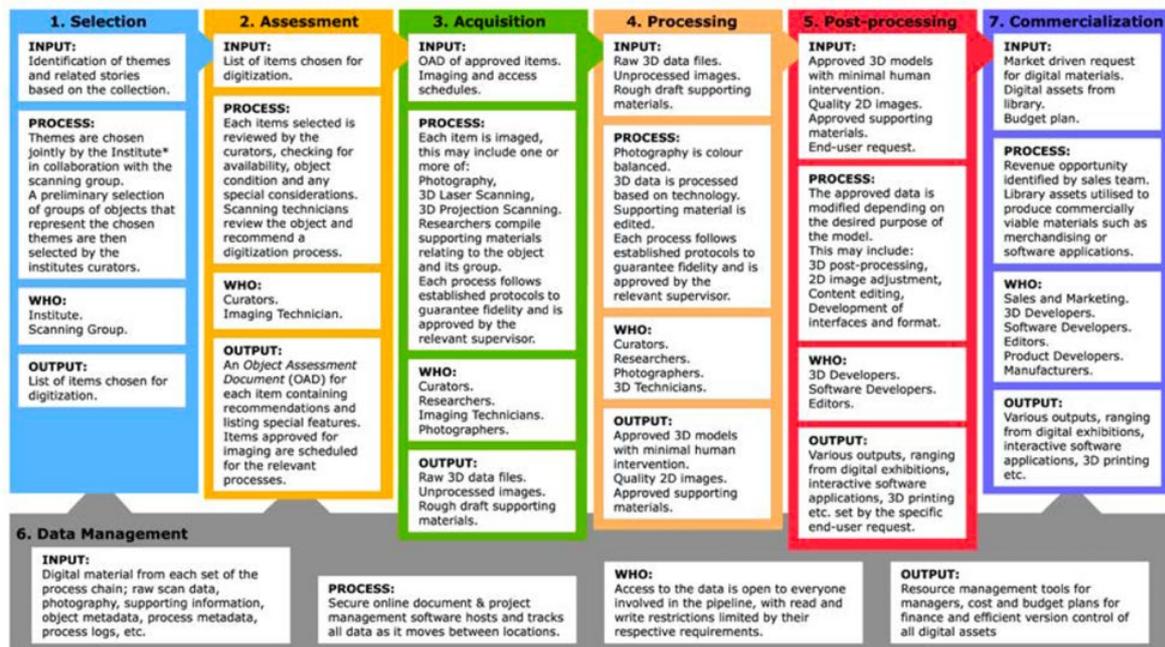
*Europe's galleries, libraries, archives, museums and audio visual archives have vast and rich collections that represent Europe's cultural diversity but also our shared history and values. In addition to the treasures guarded inside our cultural heritage institutions, Europe has many historical buildings, archaeological sites and monuments. Furthermore, Europe's intangible cultural heritage, such as cultural festivals, and craft making techniques are world renowned.*

*This Consolidated Progress Report shows the progress made by Member States with some important themes emerging such as use of 3D technology for digitisation of cultural heritage artefacts, monuments and sites, as well as initiatives to enhance cross-border cooperation and digital capacity in the cultural heritage sector.*

### 3D-ICONS

The 3D-ICONS pilot project exploits and uses existing tools and methodologies to create digitized material that contribute to 3D content for *Europeana*. Published in 2014 the project's 115 page *3D ICONS Guidelines and Case Studies* illustrated document describes the technical and logistical processes involved (10). Supported by 28 case studies, it provides a baseline for further consideration in five sections covering:

1. 3D Data Capture Techniques
2. Post Processing of 3D Content
3. 3D Publishing Methodology
4. Metadata
5. Licensing and IPR Considerations



3D ICONS Guidelines and Case Studies: Summary Considerations

With regard to IPR and 3D creative processes the 3D-ICON Guidelines warn (page 45) that the activities involved result in the generation of Intellectual Property Rights (IPR) conflict at all stages and the development of a suitable IPR model becomes relevant. This spans from the earlier phases (dominated by controlled access rights) to the later stages where substantial effort is required in modelling captured 3D data to produce relevant 3D heritage content.

It is important to recognise that whilst content providers may control access, the later stages incur the highest costs and greatest IPR risk. The publication also offers a summary *Illustration of the Object Activity Chain identifying the range of people and organisations involved in creating 3D content for culture*. However, although this work has been devised primarily for museum objects/collections, the framework has relevance in its application for buildings. This when reinterpreted from that perspective where outputs might be re-engineered/re-defined for project management and HBIM purposes.

The proposed IPR scheme integrates all activities of the 3D modelling process from initial data capture to delivery of 3D heritage content online where several key players and organisations are noted:

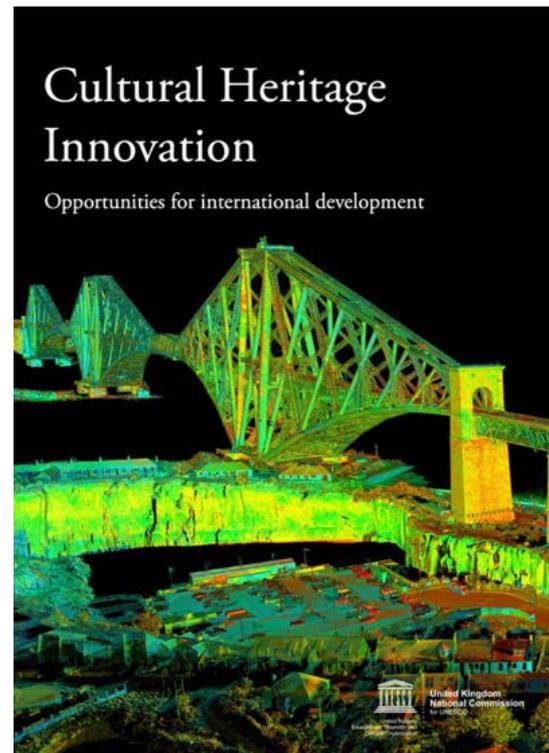
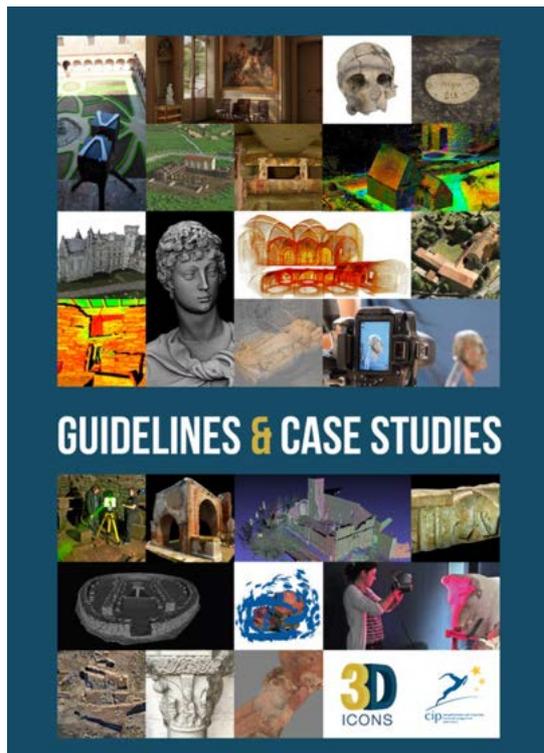
- *Monument/artefact Manager – organisation who are the custodians or owners of the heritage object, e.g. museum*
- *Imaging Partner – company or institution which carries out the primary 3D data capture of the heritage object*
- *3D Development Partner - company or institution which executes the 3D data modelling of the heritage object for delivery online*
- *Distribution Partner – organisation which hosts 3D content for public use*
- *Commercialisation Partner – company which wishes to establish a potential revenue path for 3D data*

A related portal enables users to search all the content that the 3D ICONS partners made available to *Europeana* (11)

**Cultural Heritage Innovation Opportunities for international development.** UK National Commission for UNESCO (12)

This July 2019 report, with a front cover image of the digitally documented Forth Bridge, provides an overview of 37 projects demonstrating novel techniques and innovative models that could be used to help promote sustainable development in Official Development Assistance (ODA) countries. From a UK perspective, the Executive Summary states:

*The work being undertaken by UK universities and heritage institutions is broad-ranging, diverse and impressive, illustrating the UK's eminence in heritage science and research and its people-centred approach. Some projects are rooted in physical on-site conservation, some on the detailed scientific study of artefacts, some on managing and democratising data, others on communicating and sharing an improved understanding of aspects of the past. Many have visitor experience related outcomes that would contribute to the 10% of global GDP (and 1 in 10 jobs) created by tourism and travel.*



Whilst this acknowledges on-site conservation needs, across Scotland 3D laser scanning ‘...is being used at an unprecedented level.’, amongst the recommendations to strengthen the interconnections between research, policy and practice, the following needs are identified:

*(R 7) In drawing up funding criteria, funding bodies should communicate the value of interdisciplinary research and delivery.*

*(R 9) Education providers should recognise and promote the need for emergency and post-disaster heritage training.*

*(R 13) Project sponsors should ensure that maximum value is obtained from individual projects by sharing policies and training with other countries.*

*(R 14) All funding bodies should require long term digital storage and data management as a condition of a grant.*

*(R 15) All funding bodies should require adequate provision for translation and dissemination where appropriate as a condition of grant.*

Particular reference (on pages 31- 32) is made to Historic Environment Scotland (HES) working with partners in Germany and Austria to produce mobile applications for the Frontiers of the Roman Empire UNESCO World Heritage Site and to where:

*HES is also developing Go Forth: 3D Forth Bridges Learning Resource to support STEM subjects, history and Scottish Studies and enhance problem solving, investigation of evidence and digital literacy. The aim is to create animations, digital educational games, CAD and coding resources, virtual reality tours and an augmented reality app and learning resource packs which will be freely accessible to school children across Scotland.*

## **Advancing the digitisation of cultural heritage**

In April 2019, 26 European countries signed a *Declaration of cooperation on advancing digitisation of cultural heritage* (13). The signatories agreed to work closely together to use state-of-the-art digital technologies to address risks that Europe's rich cultural heritage is facing; thus enhancing its use and visibility, improving citizen engagement and supporting overflows into other sectors. The declaration has three mainstays of action:

- A pan-European initiative for 3D digitisation of cultural heritage artefacts, monuments and sites;
- Re-use of digitised cultural resources to foster citizen engagement, innovative use and overflows into other sectors;
- Enhancing cross-sector and cross-border cooperation and capacity building in the sector of digitised cultural heritage.

Here, perhaps, the 2008 ICOMOS Charter for the Interpretation and Presentation of Cultural Heritage Sites Quebec definition (14) has great relevance:

*Cultural Heritage Site refers to a place, locality, natural landscape, settlement area, architectural complex, archaeological site, or standing structure that is recognized and often legally protected as a place of historical and cultural significance.*

## **Digital Day 2019**

Held on 9<sup>th</sup> April 2019, Digital Day was a unique event intended to enable the EU and interested Member States to pool efforts and resources focused on accelerating digital developments in key areas that might provide tangible benefits for our societies and economies.

A *Declaration of cooperation on advancing digitisation of cultural heritage* was advanced and signed by 22 countries (15) and states that:

*In the spirit of the Rome Declaration, and the momentum created by the European Year of Cultural Heritage 2018, the signatories of this Declaration agree to step up efforts and pursue progress, together, under three main pillars:*

- *A pan-European initiative for 3D digitisation of cultural heritage artefacts, monuments and sites*

- *Re-use of digitised cultural resources to foster citizen engagement, innovative use and spill-overs in other sectors*
- *Enhancing cross-sector, cross-border cooperation and capacity building in the sector of digitised cultural heritage*

Within which there is an intention of:

*Supporting the capacity of heritage professionals to manage the digital shift by acquiring and developing digital skills and knowledge.*

### **The Value and Challenges of the Construction Conservation Sector to Embrace Digitisation**

The UK construction industry contributes nearly £90 billion to the national economy (accounting for 6.7%) and hires as many as 2.9 million workers equating roughly to 10% of its workforce. Yet despite its clear importance to the UK (and indeed to the global economy where it contributes \$8.5 trillion a year) the industry has, still, to undergo any significant digitisation (16).

The recent digitisation index from the *McKinsey Global Institute* ranks the industry as the least digitised industry of all (by comparison, it sits only above agriculture and hunting). The index also recognises (June 2019) that the United Kingdom is one of Europe's AI leaders but still needs to build on strengths and tackle weaknesses (17).

The McKinsey Briefing Note *Artificial intelligence in the United Kingdom: Prospects and challenges* of June 2019 (page 6), indicates that:

*Another strength in the United Kingdom is that it has more science, technology, engineering, and maths (STEM) graduates than any other country in Europe—more than 60 percent more than either Germany or France, according to UNESCO data. Nevertheless, like most countries, the United Kingdom faces a shortage of people with advanced technological skills as demand for those skills is expected to increase significantly.*

The Briefing Note concludes (page 9):

*It is also important to encourage and ensure R&D projects in collaboration with academic institutions, and to challenge academia and tech companies alike to apply cutting-edge techniques in a live business environment. Such programmes can provide access to the latest academic research as it is filed and to lab experimentation that can be evaluated rapidly and then adopted.*



**Technology**  
**Wasps show the way for printed houses in Italy**

27 October 2019 | By Andrew Piring



**Technology**  
**Bricklaying robot to produce demo homes**

29 October 2019



Q-Bot works beneath suspended timber floors



**Technology**  
**Japanese droid can screw in drywall panels**

3 October 2018 | By BIM+ staff

CIOB BIM+ Various on-line Robotic article illustrations sourced October 2019

Whilst the UK construction Industry is making significant new-build advances in BIM and exploring automation, little is being done to recognise and incorporate the needs of the built heritage sector – with the exception perhaps of what is happening at HES Engine Shed. Here a reinterpretation of the conclusion of the above Briefing Note is in the process of being realised. However, more needs to be addressed and done. How then might the emerging new professions become better informed, be better integrated, sit alongside and support the heritage sector?

Estimates for future IT needs suggest a requirement for 12,500 people/year, however, only some 5,000 are currently emerging. This suggests a latent and considerable digital skills shortage generating a potential for fierce competition within the IT sector and which might affect the built heritage sector in its ability to train, educate and keep pace with those needs?

Inevitably this is a complex area with many new descriptor terms, initiatives and aspects emerging that generate a challenge for those wanting to fully understand what the opportunities and challenges might be. The published programme for the *Third International Congress and Expo Digital Heritage 2018 new realities: authenticity and automation in the digital age*: The Congress, held 26<sup>th</sup> – 30<sup>th</sup> October 2018 in San Francisco,

USA (18) offers an insight on that complexity as revealed by the published list of event themes:

<p><b>Reality Capture track</b> Digital Documentation &amp; Input</p>	<p><b>Visualization and Interaction track</b> Digital Presentation &amp; Output</p>
<ul style="list-style-type: none"> <li>• Photogrammetry, image-based modeling, SFM</li> <li>• 2D scanning &amp; document digitization</li> <li>• 3D scanning (laser, structured light, mocap, etc)</li> <li>• mobile and indoor scanning and sensing</li> <li>• remote monitoring technologies</li> <li>• GPR &amp; magnetometry</li> <li>• Remote sensing and aerial lidar</li> <li>• GNSS (GPS, GLONASS, Galileo)</li> <li>• Low-cost &amp; gaming 3D input</li> <li>• Gigapixel, ultra-high res &amp; HDR photography</li> <li>• Terahertz, Infrared, UV &amp; X-ray imaging</li> <li>• Advanced sensors research</li> </ul>	<ul style="list-style-type: none"> <li>• Immersive and Active/Passive stereodisplays</li> <li>• Real + virtual worlds (mixed/augmented reality)</li> <li>• Virtualization of senses (touch, taste, smell, sound)</li> <li>• Haptic &amp; Multimodal interaction</li> <li>• Distributed VR</li> <li>• Local/remote rendering</li> <li>• Innovative interaction systems</li> <li>• Storytelling and design of heritage communications</li> <li>• Usability, effectiveness and interface design</li> <li>• Visual simulation of materials</li> <li>• Emerging visualization technologies</li> <li>• Rapid prototyping, 3d printing &amp; reproduction</li> </ul>
<p><b>Analysis and Interpretation track</b> Digital Content Management &amp; Analysis</p>	<p><b>Policy and standards track</b> Digital Heritage Policy &amp; Societal Issues</p>
<ul style="list-style-type: none"> <li>• Historic Document Analysis</li> <li>• Remote Sensing Analysis (incl aerial image proc.)</li> <li>• Finite element, structural and other analyses</li> <li>• 3D modeling (CAD-based and reality-based)</li> <li>• Building Information Modeling (BIM)</li> <li>• Virtual Reconstruction Issues</li> <li>• Realism and Interpretation in CH</li> <li>• 3D, multimedia and GIS repositories, platforms, &amp; info systems</li> <li>• Digital Curation</li> <li>• Virtual GIS and Mapping tools</li> <li>• Emerging technologies</li> </ul>	<ul style="list-style-type: none"> <li>• Metadata Handling &amp; Management</li> <li>• Digital Rights</li> <li>• Heritage Commons</li> <li>• Cultural Analytics</li> <li>• Heritage at Risk</li> <li>• Heritage Consortia</li> <li>• E-libraries</li> <li>• Digital Humanities</li> <li>• Born digital content issues</li> </ul>
<p><b>Preservation track</b> Digital Preservation &amp; Standards</p>	<p><b>Theory, methodologies &amp; applications of Digital Heritage track</b> Digital Heritage Solutions &amp; Best Practices</p>
<ul style="list-style-type: none"> <li>• Metadata, standards, ontologies in Heritage</li> <li>• Requirements and policies</li> <li>• Trusted digital repositories / OAIS</li> <li>• Institutional Repositories, digital libraries</li> <li>• Semantic Web and processing in CH</li> <li>• Long term storage and persistence</li> <li>• authentication, accreditation and DRM</li> <li>• Data formats and compression for preservation</li> <li>• Watermarking, orphan works, copyrights &amp; IPR</li> </ul>	<p>Integrated solutions and best practices in:</p> <ul style="list-style-type: none"> <li>• Virtual documentation</li> <li>• Virtual conservation &amp; restoration</li> <li>• Virtual archaeology</li> <li>• Virtual museums &amp; exhibitions</li> <li>• Serious Games for heritage</li> <li>• Collaborative environments</li> <li>• Internet technologies and social media</li> <li>• 3D sensing</li> </ul>

Third International Congress and Expo Digital Heritage 2018: Published Congress themes and sub-topics, October 2018

How then might heritage sector clients both value and gain from the tangible and intangible benefits of such, potentially, complex issues, specifically regarding possible benefits from a clarification of:

- Gathering/validating/certifying/storing/archiving digital data

- Using/updating/interpreting digital data
- Setting private needs against commercial pressures

### **International BIM Standards are Emerging**

The UK's decision to move BIM Level 2 to an international standard goes back to the 2011 *Report for the Government Construction Client Group – BIM Strategy Paper*. Whilst the report encouraged a greater adoption of BIM it also recognised that it would become disruptive and 'game-changing' to traditional ways of working. The BIM process within the UK crosses borders so a UK consensus emerged that such 'globalisation' would inevitably trigger the need for new international norms and standards – the result being the creation of BS EN ISO 19650 (19).

- BS EN ISO 19650 Part 1 outlines the concepts and principles and, provides recommendations on how to manage building information
- BS EN ISO 19650 Part 2 supplies information management requirements in the delivery phase of assets. It covers processes involved in the procurement, design, construction and/or commissioning of assets as well as those involved in delivering asset management activities, including operations and maintenance.

With maintenance being identified there is a clear implication that Part 2 should be appropriate for use in caring for the existing built heritage. It may also be relevant to consider this within the context of BS 7913 (2013) which provides information on the conservation principles and guidance of historic buildings and sites: This being particularly relevant when setting conservation policy, management strategy and procedures.

### **Future Challenges**

Under the heading '2019 Landmarks – The 'firsts' that spell change, an on-line article (20) by *Stephen Cousins* in CIOB's BIM+ release of 17 December 2019 flags up a number of recent initiatives that will continue to impact on the construction industry by noting:

*The pace of technological change is dizzying but 2019 still saw landmark moments in the development and deployment of BIM, drones, 3D printing, AI, offsite modular, low carbon assessment tools and more.*

Whilst such prospects pay scant regard to the practical and physical conservation needs of the historic built heritage, there is an emerging, entirely new and challenging language of tasks and descriptions that individuals might adopt. Amongst other job titles, the Algorithm Engineer, Machine Learning Expert, Data Scientist, Analytical Insight Consultant and IT Project Manager are emerging professional disciplines. The question is how these new

specialities and their evolving technologies and knowledge base might be integrated within the existing heritage sector and its professionals, technologists and vocational skills cohorts?

Here, there are some fundamental heritage-based questions that do not yet have clear answers for its practitioners, particularly regarding the challenge of small practices trying to achieve a more effective integration:

- What happens when technological and digital skills change or develop in order to absorb/adopt the next emerging IT initiatives?
- What happens when heritage practitioners try to cope with the need to accommodate/purchase/train in IT hardware and software when changes occur rapidly in that sector in order to, commercially, keep pace with ever increasingly sophisticated developments?

More basically, is the heritage sector sufficiently alert to what material developments (including BIM) are happening in the new build world, let alone its own sector and, what part might the previously adopted set of conservation charters and conventions play in integrating with that process?



Europe's first industrial 3D concrete printing factory in Eindhoven Holland was set up in January 2019 in collaboration with Eindhoven University of Technology. BIM+ on-line image sourced on 17 December 2019 at:

[http://www.bimplus.co.uk/client\\_media/imagecontent/xBAM\\_3D\\_print\\_facytory.jpg.pagespeed.ic.arLcXmUd5y.jpg](http://www.bimplus.co.uk/client_media/imagecontent/xBAM_3D_print_facytory.jpg.pagespeed.ic.arLcXmUd5y.jpg)

In considering what the future interdisciplinary mix of heritage professionals might look like a number of other questions might be posed-:

- Will such an approach require new innovative conservation charters, conventions and legislation that might require re-drafting to include a digital shift emphasis?
- How will data scientists/technologists/innovators and others be professionally integrated alongside those with an understanding/analysis/rationalisation of heritage construction decay mechanisms and effects?
- How will the key conservation and digital processes that require access to knowledge, skills and materials be integrated?
- What additional support training and supply needs will need to be developed to make the new approach work?
- How will GDPR, AI, IPR and ©/IPR matters be addressed and resolved alongside future proofing heritage archive requirements?



Whilst alluding in appearance to a medieval fortification, the Chinese 1.5 m high, 432 m long flood defence wall connecting the Beijing–Hangzhou Grand Canal with Shanghai’s Huangpu River claims to be the largest 3D printed structure to date. BIM+ on-line image sourced on 8 December 2019 at

[https://res.cloudinary.com/dtdz9wriq/image/upload/f\\_auto,q\\_auto/bim//client\\_media/images/win.jpg](https://res.cloudinary.com/dtdz9wriq/image/upload/f_auto,q_auto/bim//client_media/images/win.jpg)

Clearly more detailed consideration will be required to understand and develop strategies on how the digital shift might impact the conservation sector (and vice versa). This will need to be progressed in a spirit of mutual collaboration and understanding if the conservation sector is not to be left in the dark.

## On-line References:

- (1) [http://cif.icomos.org/pdf\\_docs/Documents%20on%20line/Heritage%20definitions.pdf](http://cif.icomos.org/pdf_docs/Documents%20on%20line/Heritage%20definitions.pdf)
- (2) <http://www.unesco.org/new/en/culture/themes/illicit-trafficking-of-cultural-property/unesco-database-of-national-cultural-heritage-laws/frequently-asked-questions/definition-of-the-cultural-heritage/>
- (3) <https://www.europeana.eu/portal/en>
- (4) <https://www.inception-project.eu/en>
- (5) [https://sketchfab.com/inception\\_eu](https://sketchfab.com/inception_eu)
- (6) <https://sketchfab.com/3d-models/al-khazneh-the-treasury-petra-39ef0f6c82224860ad49039d2534046d>
- (7) [https://www.interregeurope.eu/fileadmin/user\\_upload/plp\\_uploads/policy\\_briefs/2018-08-06\\_Policy\\_brief\\_on\\_digital\\_technologies.pdf](https://www.interregeurope.eu/fileadmin/user_upload/plp_uploads/policy_briefs/2018-08-06_Policy_brief_on_digital_technologies.pdf)
- (8) <https://www.interregeurope.eu/innocastle/>
- (9) <https://ec.europa.eu/digital-single-market/en/news/european-commission-report-cultural-heritage-digitisation-online-accessibility-and-digital>
- (10) <https://zenodo.org/record/1311797#.Xff--S10dUN>
- (11) <http://3dicons.ceti.gr/>
- (12) <https://www.unesco.org.uk/wp-content/uploads/2019/07/Cultural-Heritage-Innovation-2.pdf>
- (13) <https://ec.europa.eu/digital-single-market/en/news/eu-member-states-sign-cooperate-digitising-cultural-heritage>
- (14) [https://www.icomos.org/charters/interpretation\\_e.pdf](https://www.icomos.org/charters/interpretation_e.pdf)
- (15) <https://ec.europa.eu/digital-single-market/en/news/eu-member-states-sign-cooperate-digitising-cultural-heritage>
- (16) <http://www.bimplus.co.uk/analysis/will-2020-will-finally-be-tipping-point-digitisation/>
- (17) <https://www.mckinsey.com/~media/McKinsey/Featured%20Insights/Artificial%20Intelligence/Artificial%20intelligence%20in%20the%20United%20Kingdom%20Prospects%20and%20challenges/Artificial-intelligence-in-the-United-Kingdom-VF2.ashx>
- (18) <http://www.digitalheritage2018.org>
- (19) <https://bimportal.scottishfuturetrust.org.uk/page/new-international-bim-standards>
- (20) <http://www.bimplus.co.uk/news/2019-landmarks-firsts-spell-change/>

## 6: Expanded Presentation-based Round Table Discussion

Following the presentations a discussion session raised a number of relevant points about where digital technological developments were heading and which were already having an influence on heritage matters. Without fully addressing the suggested discussion topics in combination the examples quoted offered an insight and awareness of emerging potential IT benefits and AI gains. In addition they revealed a number of challenges that will need to be addressed in the future. It became clear, however, that these could be addressed by reference to the ICOMOS Education and Training Guidelines (E+TG) (1).

In preparing this report a wide range of issues and topics emerged. These were frequently associated with initiatives and intentions that had also been aired in the media and/or on related websites. Where possible and to help clarify matters that emerged, reference has since been made to the relevant websites to expand upon the content of the topics discussed. For information, associated URL's (correct to November 2019) have been identified with the intention of providing direct access to expanded details: This should readers wish to source or research additional information.

### Charters and Conventions: ICOMOS Education and Training Guidelines - 1993

Acknowledging, through COTAC, the 1992 formative drafting work in creation of the Guidelines by Sir Bernard Feilden (in this the centenary year of his birth) the continued importance and significance of the Guidelines remain a recognised force. Pre-dating the digital era it was conceded that, although they don't specify particular skills that are related to digital opportunities and needs, they have an inherent flexibility upon which numerous initiatives could be hung. Their state Aim, in Paragraph 1, being:

*...to promote the establishment of standards and guidelines for education and training in the conservation of monuments, groups of buildings ("ensembles") and sites defined as cultural heritage by the World Heritage Convention of 1972. They include historic buildings, historic areas and towns, archaeological sites, and the contents therein, as well as historic and cultural landscapes. Their conservation is now, and will continue to be a matter of urgency.*

Consequently, given a willingness to do so, the Guidelines can be adopted and extended into the digital range of skill sets, knowledge and operational activities to create and incorporate relevant expertise, support and documentation. The E+TG's flexibility are its greatest strength and their adoption in the Digital sector could occur through prioritising and considering which Paragraph actions might be combined with emerging related training and educational initiatives.

It might be noted that the significant 14 ICOMOS E+TG, 'one-liners' listed a) to n) in Paragraph 5 are only a part of the overall document. Whilst the introductory text of

Paragraph 5 offers some commonality to connect across disciplines, it specifically intimates that *'Conservation works should only be entrusted to persons competent in these specialist activities'*... whilst the Guidelines' Preamble accepts that: *'...many different professions need to collaborate within the common discipline of conservation'*. The subsequent Paragraph 6 view that: *'There is a need to impart knowledge of conservation attitudes and approaches to all those who may have a direct or indirect impact on cultural property'* defines the challenge, virtually all new disciplines and their associated technologies and techniques might readily be integrated.

As such, the complete Guideline intentions offer an holistic overview and understanding of what the needs are of all those involved in the recording, care and archiving of the historic built environment.



Modern technology at work [DSC01680.JPG] © Ingval Maxwell

Building upon the baseline of the full Guideline text, emerging new professions, technologies and initiatives could well benefit from a start to integrate the two approaches. Perhaps, by thinking about the challenges and where the various digital and IT issues fit within the set of 14 *'one-liners'*, a foundation to do so could be created.

## The challenges of digitisation due to its capability

Recognising how extraordinarily easy it is to create digital versions of what exists for a wider general viewing on monitors and/or laptops: ICOMOS T+EG Paragraph 17 notes that conservation depends on having documentation adequate to understanding an historic asset. One philosophically challenging example that was raised was the case of the RMS Titanic wreck, lying some 3,800 metres below the surface of the Atlantic. Protected since April 2012 under the *2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage (2)*, it is a poignant cultural, historical and archaeological site more than 100 years old; it is generally out of reach; few get to see and experience it; and its relentless decay can't be managed. The question being: why should it have protected status bestowed on it? The *UNESCO Underwater Cultural Heritage* website explains:

*For the Titanic wreck its protection means that all [41] State Parties to the 2001 Convention will prohibit the pillaging, commercial exploitation, sale and dispersion of the wreck and its artifacts. They will take all measures in their power to protect the site, and to ensure that proper respect is given to the human remains still to be found on it... According to the ...Convention all ancient wreck sites should be treated with respect and be regarded as maritime memorials to the people who perished when the ships sank. They should be researched instead of serving profit interests.*

To that end in the Summer of 2021 and offering part resolution of Paragraph 17 and the rest of the E+TG, the *Titanic Survey Expedition* plans to digitally create a detailed 3D model of the shipwreck and portions of the debris field using the latest multi-beam sonar, laser scanning and photogrammetric technology. In scanning and recording the remains, the planned approach supports (and is in accordance with) the *UNESCO Underwater Heritage Convention (3)* guideline; this whilst: paying respect, facilitating research and monitoring. By adopting new digital technologies the project hopes to bestow upon the wreck site an understanding that many people might value and appreciate.

## Variations in Scanning Technology

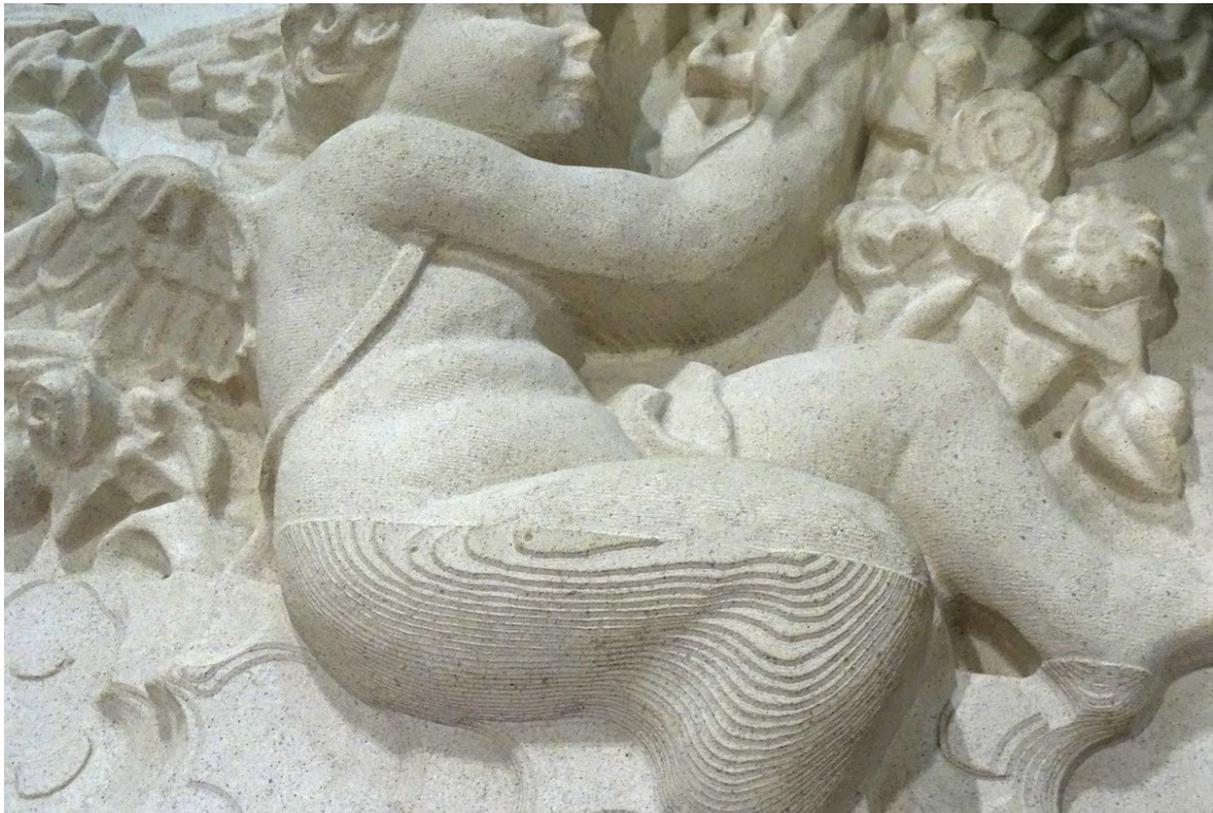
It was reported that many consultancies, including architects, still continue to produce and use 2D drawings for their historic buildings work. It was suggested that this was likely to remain the norm until greater ventures into 3D environment occur, thus facilitating easier and common manipulation of datasets at an economic rate. This challenge builds upon E+TG Paragraph 7 which indicates that the *practice of conservation is interdisciplinary* and those *who have already received their normal qualification will need further training in order to become conservationists*.

The use of more economic technology - such as the adoption of basic 360° digital panoramic cameras set on tripods to gain reasonable quality site and locational imagery - is emerging.

With basic equipment costing around £100, its use made economic sense for practices. The alternative might cost in the region of £30,000 to purchase a high-end scanner and associated IT equipment in order to process and use the imagery. Digital camera technology is considered cheap and of good-enough quality for many projects. There is also an underlying need for increased collaborative working in the exchange of data files. With the availability of digital 3D files there is the potential for simpler and cheaper methods to exchange data. What small practices often do not have is the comparative technology to enable all consultancies digitally to 'talk' to each other. It was considered that that ideal may still be a few years away - exciting though this possibility is!

### **Linking digital technologies and vocational skill developments**

A strong message was presented by what was happening through the Engine Shed's established links with school children. Hearing what was happening in the local primary schools and, in nursery classes too, it was accepted that emerging generations will be more technically savvy. Inevitably, this will create pressures on the workplace to be able to respond more effectively to those job-seekers who have IT skills, understanding and awareness. Such pressure will demand and dictate change.



Display example of computerised milling and hand finishing DSC08554a.jpg © Ingvai Maxwell

Over recent years the approach adopted by the Engine Shed teams is to marry proven digital material with trained craft skills. Through a trial skills exchange involving the digital

team, apprentice stonemasons and partnership work, comparisons were made between the time and work involved in hand-carving a moulded stone; setting this against the adoption of digital scanning, 3D printing and computer-aided milling techniques.

Initially the accuracy of milling machine cutting heads was found insufficient to replicate detail required by the 3D model, traditional skills being required to hand-finish the work. This included any under-cutting that the mill cannot (as yet) produce. In the interim, technology has evolved, the cost of milling equipment has been greatly reduced and accuracy much improved. As the operational benefits of a digital approach became obvious to the masons, a complete shift in acceptance and attitude occurred, resulting in much beneficial synergy emerging between the two teams.

The joint exercise also revealed a fundamental need to evaluate all emerging technologies and question what real benefits might be adopted and integrated. A key aspect to emerge was the need to build these positive experiences into everyday training of stonemasons. Building upon ICOMOS E+TG Paras 10 to 14, and with a look to the immediate future, a trainee mason might receive additional instruction in the use of digital photography from which, 3D print(s) could emerge to form their working template(s). With greater investment in courses and workplace equipment much more could be achieved through improved training regimes: This also had the potential to increase productive and output.

### **School involvement in economic recording techniques**

In respect of E+TG Para 3 regarding clarification of various factors underpinning cultural context, a Church of England project in conjunction with Historic England was reported on: The project aims to digitally record every cemetery and churchyard in England. Initially the project was to use a firm of surveyors operating with *'back-pack'* scanners. The methodology was changed to involve volunteer efforts of school children using tablet computers. As GIS co-ordination works out where the individuals are the children simply take a photograph of each of the gravestones. Results obtained can then be lodged immediately into the database.

A transcription of the inscription can often be retrieved from a photograph; however, some additional interpretative work is called for if the inscription is lost or partially lost through weathering. This approach is being carried out with a budget of c £400 per churchyard. Significant cost savings are being achieved and, with the recording of some 10,000 locations, this would have been impossible five years ago. With the blessing of head-teachers, several other pilot projects, involving school children, are being considered where use of *'simple'* digital technology can provide them with a greater understanding of their local history and society.

## Digital technology and reconstructions

Directly relating to the required range of abilities listed under E+TG Para 5, a technical and philosophical question was considered on whether or not the Bamiyan Buddhas could be rebuilt from the 2001 explosive destruction which produced a multitude of shattered pieces. Using digital methods to scan the pieces they were reinstated like a 3D jigsaw. Reflecting also on the 1993 destruction of Mostar Bridge and the Palmyra Arch in 2016, what might the philosophical justification be in undertaking similar, digitally facilitated, reconstructions?

It was noted that on the latter two cases, physical replacements have already emerged. At Mostar the UNESCO/Bosnian approach to rebuild the bridge was founded on the Athens, Venice and Narra Charters but was at a time when digital technologies were not available. The eventually adopted philosophy was, as André de Naeyer intimated in 1982 (4) :

*The study of projects born from reconstruction and the controversies they have raised shows that in the area of the conservation of monuments, like in politics, it is often necessary to look for a compromise between what is desirable, what is acceptable, and what is achievable.*



Mostar Bridge after reconstruction, August 2010 [IMG8442a.JPG ]© Ingal Maxwell

Resulting from a major collaboration between the *London Institute for Digital Archaeology*, *UNESCO* and the *Dubai Museum of the Future Foundation*, a reduced 2/5<sup>th</sup> scale physical 3D reconstruction of the Palmyra Arch was robotically sculpted in Egyptian marble at the

Carrera Quarry in Italy. It was then erected in Trafalgar Square, London for three days in 2016 before being displayed in Dubai and New York.

With a price tag of some \$143,000 to produce the reconstruction, the approach was controversial and raised numerous questions. Digital technology was used in its creation. The scaled-down 3D structure grew out of the Institute's *Million Image Database* (5) and relied on incorporating and manipulating a multitude of freely-offered photographs submitted by the wider community in support of the process.

Numerous new alternative digital options have emerged since the 1982 views of Prof. de Naeyer's were expressed. These new options will inevitably be added to the continuing intense political and philosophical debate when reaching relevant and appropriate future solutions. In the case of the Bamiyan Buddhas an insight into this potential dilemma is offered in a Guardian newspaper article in January 2015 (6) by Frederic Bobin.

### **UK's Adoption of the 1954 Hague Convention**

In November 2017, after prolonged international concern at the UK's delay in ratifying it, an official DCMS document provided information on the Government's implementation of certain aspects of the *1954 Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict*, its two *Protocols* of 1954 and 1999 and the *Cultural Property (Armed Conflicts) Act 2017* (7).

In direct consequence of the DCMS action (acknowledging the ICOMOS E+TG Para 9 intentions regarding training in disaster preparedness) the *Heritage Protection Network* hosted its first workshop at the University of Leicester on 11 January 2018. This marked the passage of the *1954 Convention* into UK Law and, in October 2018, the UK Army created its *Cultural Property Protection Unit*. This new unit aims to draw membership from those serving in the Army, Navy, RAF and Royal Marines. Any Civilians wishing to join will have to first enlist in the Army Reserves. Once operational, the 15-strong unit will be sent into war zones where art and archaeological sites are at risk.

It was reported that there was a recent interest by the Unit in wanting to know more about the use of drone technology for assessing war zone damage. But, the Unit's approach is more about trying to limit the damage that has been caused, rather than using drones to effect any direct reconstruction of sites damaged by conflict.

It was reported that the British Council indicated that it will continue its 4-year successful *Cultural Protection Fund* (8) with another round of funding extending into 2021. With anticipated greater considered use of digital technologies, the Fund will support efforts to protect cultural heritage at risk in twelve Middle Eastern and North African countries. By

building capacity to foster, safeguard and promote cultural heritage affected by conflict, grants will be available to applicants working with partners in Afghanistan, Egypt, Jordan, Lebanon, Libya, Iraq, Occupied Palestinian Territories, Sudan, Syria, Tunisia, Turkey and Yemen.

Whilst such wider initiatives are to be welcomed, on considering a philosophical issue (and being slightly provocative) a comment was made on the basis that if something was destroyed and there was a virtual record of it, is there a need to do anything else, other than archive that record and make it readily available?



3D Viewer display, London May 2017 [IMG\_1215.JPG] © Ingval Maxwell

It was discussed that, one day, there will be a different technology emerging that doesn't discriminate against what is being looking at; where its value can be examined and appreciated in its three dimensional reality space. Where might it be possible to inhabit that scan created space to allow a detailed examination of its physical condition and location. This could create a potential to engage heritage supporters in a completely new and far reaching manner. But, there is also the need to think about what happens if the data disappear, and what might be lost, so the record itself will then be worth protecting.

With regard to *'people driven'* related opportunities, it was considered that recent developments in environmental science such as crowd sourcing and participatory GIS (allowing people to gather and share their experiences of places) will continue to develop as individuals promote their own views and contribute them online. A pending Shetland Island project was discussed where recorded voice and dialect information will be included in an

interactive experience which users might explore as they interrogate a digital project location. Whilst the results can be collated by GIS links it can also be created as a multimedia experience with imagery that can be accessed via a 'click' to gain a personal experience of the site.

Participatory crowd sourcing was noted to have great potential value, like obtaining photographs from the public that might be placed as a 'community layer-qualitative user database' within a multi-layered, social, historic GIS environment. This might create capacity to capture and positively use indiscriminately held data made available to a wider audience.

Reference was also made to crowd sourcing technology to understand how urban spaces are being used and which are not specifically limited to heritage interests. Thinking about people and how spaces are actually used: what are the barriers for people better to engage with places and what might the priorities be for use of those places? There is a growing interest in the potential of obtaining and using crowd sourced data to supplement a set of more authoritative geographic data that is either currently, unavailable, outdated, historic or incomplete (9).

Referring to the publication *Voices of Culture and Open Method of Coordination reports on Skills, Training and Knowledge Transfer in Cultural Heritage Professions*, one of the illustrated examples indicated a patent shift towards finding ways to give access to digital material as an aspect of preservation. In a related manner, mention was made of the various categories in the *Digital Impact Awards (10)* (run by *Communicate Magazine* over the last decade) which sets an industry benchmark for digital stakeholder engagement. Noting that in the 2018 applications the Church of England scooped numerous top-level corporate awards, perhaps this scheme's intentions could offer a route from which the heritage sector might learn and explore?

With no irony intended, it was remarked that the Workshop was being held on *World Digital Preservation Day (11)* under the auspices of *International Council on Archives*. The WDPD was organised by the *Digital Preservation Coalition* with the theme of 'At Risk Digital Materials' and coincided with the Edinburgh Group Workshop topic where:

*... the digital preservation community will come together to celebrate their work - the collections they have preserved, the access they have maintained and the understanding they have fostered by preserving digital materials.*

*Pervasive, changing and ubiquitous, digital technologies are a defining feature of our age. Digital materials are a core commodity for industry, commerce and government. They are fundamental for research, the law and medicine. The creative industries, cultural heritage and the media depend on reliable access to digital materials while*

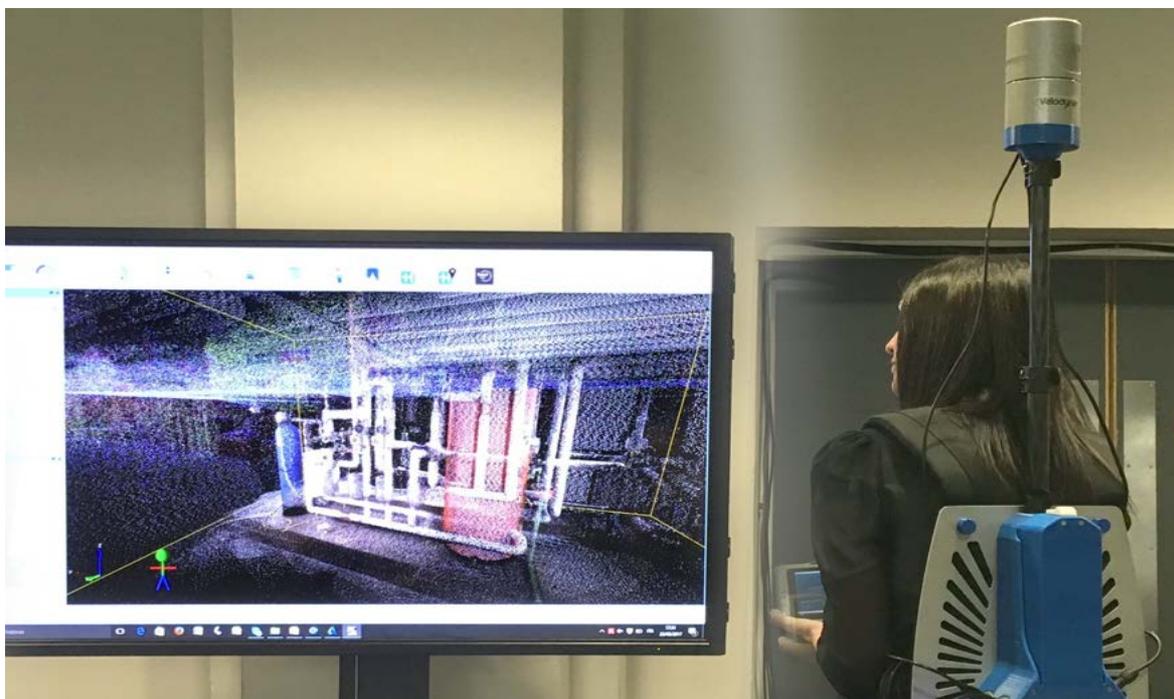
*families and friends extend and sustain their relationships through digital interactions. What better reasons to celebrate the opportunities created by digital preservation?!*

*The aim of World Digital Preservation Day is to create greater awareness of digital preservation that will translate into a wider understanding which permeates all aspects of society – business, policy making, personal good practice.*

## **Digital Twin**

A question was raised of the value of creating a non-static digital twin of a heritage asset; this being a digital representation of its physical being that facilitates understanding and modelling of performance through continuous updating from multiple sources. This would involve stepping beyond the limitations of a 3D digital scan of the asset; much additional information would, however, be required through extensive data gathering, IoT links and other insertions, all requiring regular/real time updating.

Considerable commitment and financial investment would be required in order to achieve emerging analytical ideals.



Display example of Backpack scanning technology [IMG\_1242b.jpg] © Ingval Maxwell

A further challenge in creating a Digital Twin of an existing elderly historic asset would be a requirement to provide detailed initial analysis and interpretation of what is, effectively, a collection of skilled craft inputs.

A modern building, on the other hand, is a collection and accumulation of products that can easily be incorporated and updated into the concept. A fuller explanation of the Digital Twin concept is available online (12).

## **Discussion Summary**

An integrated summary of the points emerging from the presentations and discussion session are aggregated below and fall into a number of sub-heads:

### **Underlying Philosophy and guidance**

A reaffirmed admiration for the continued relevance and use of all the ICOMOS Training and Education Guidelines text was offered, noting that it still has a great strength in the manner by which they were formulated. Whilst not focusing on philosophy, in Paras 2 and 3 they prescribe instead what conservation is and, as a result, they can accommodate various appropriately justified philosophies. As they stand the guidelines clearly remain valid as presented. They form a very flexible and relevant document that might continue to inform how the emerging implications of the digital era might be integrated within the heritage sector. In doing so they re-emphasise a need to reflect on just what modern digital '*tools*' can offer and where human interface still needs to emerge and coalesce.

The really exciting and impressive way in which the digital heritage could be incorporating is through an engagement with people in a multi-disciplinary way. Perhaps an answer to that lies in co-production and collaboration - which has always been the conservation approach. Emphasised in Para 4, the ICOMOS Guidelines are all about collaborative enterprise where the presentations and discussed projects reaffirmed the need for integrated working relationships. Reiterated by E+TG Para 6, collaboration is critical to effective working within and across heritage and digital environments.

### **Data handling**

The Workshop presentation on the Forth Bridges scanning project and related outcomes was considered extraordinarily insightful in the way it addressed and overcame, project and location embedded, multiple practical and technological challenges. As a perfect exemplar of E+TG Para 8 intentions, the relevance of emerging digital material aiding the management of the Forth Bridges' World Heritage Status became apparent. Additionally, how reinterpreted digital results and material might synergise related educational ideas and deliverables; thus revealing how comprehensively digital results might be utilised.

Given the amount of data that scanning technology can amass it was generally thought impossible to have an overview of everything that can be downloaded. Here, the need was

to keeping 'calm' in the face of such digital complexity where many aspects develop and move at speed; forcing the question of whether or not it creates a challenge for human ingenuity to integrate fully within a greater understanding of their cultural identity. There could just be too much data produced for it to be realistically handled. This has to be accepted and resolved by those creating it so that others might benefit more clearly from outcomes achieved. A preliminary need is to establish that the requested and produced data has clearly defined purposes. It was considered that potential demographic problems exist in the adoption and use of emerging complex digital technology by older generations where information overload could be counter-productive to its adoption. Accessing digital material was considered a potential 'mine field' but it was recognised that important data sets were probably going to 'get lost' if they were not digitally created, preserved and archived. This raised a question about how to overcome the challenges of digital preservation and make the information more relevant and accessible for all users.

Perversely, exciting as digital innovations are, it was considered that actions to preserve the data could pose as many difficulties and challenges as actual physical preservation work. Operationally and pragmatically, there may be a need to 'strip down' the vast scale of data sets by determining whether or not it is important to keep everything that might emerge from a digital survey. On the other hand such pre-consideration might better determine the scope and scale of what is required/necessary before the survey work starts.

### **Involvement of the young**

With all the available existing opportunities the potential that digital initiatives have for educational use, training and skills developments is considerable. These initiatives should not be taken for granted as virtual reality learning capability by viewing building sites and locations via headsets is incredible. The involvement of young people, at an early age, was considered essential along with the need to encourage and inspire them into taking up traditional craft and professional skills in their future lives. By adopting digital methodologies the next generation might be shown how the heritage and digital sectors can interact. In this regard the various HES Engine Shed initiatives fulfilled E+TG Para 15 intention of being a *comprehensively organised institute* for Scotland.

The experience of one HES pilot project, involving a local high school, encouraged children to investigate heritage and what they might do despite not being actively interested in it. The results illustrated a high degree of self-affirmation for those who participated that will last throughout their life. The process provided context to where they stood, their place in society and, where they were able, confidently, to position themselves when the heritage focused project concluded. Similarly, the adopted HES approach involving nursery education was considered astonishing given that the children moving from nursery pre-education

exposure into school learning will be digitally savvy and comfortable with what the digital world is generating.



HES Engine Shed Activity Boxes: Stone carving with soap and Use of 3D pens © HES Engine Shed

### **Skill developments and Value**

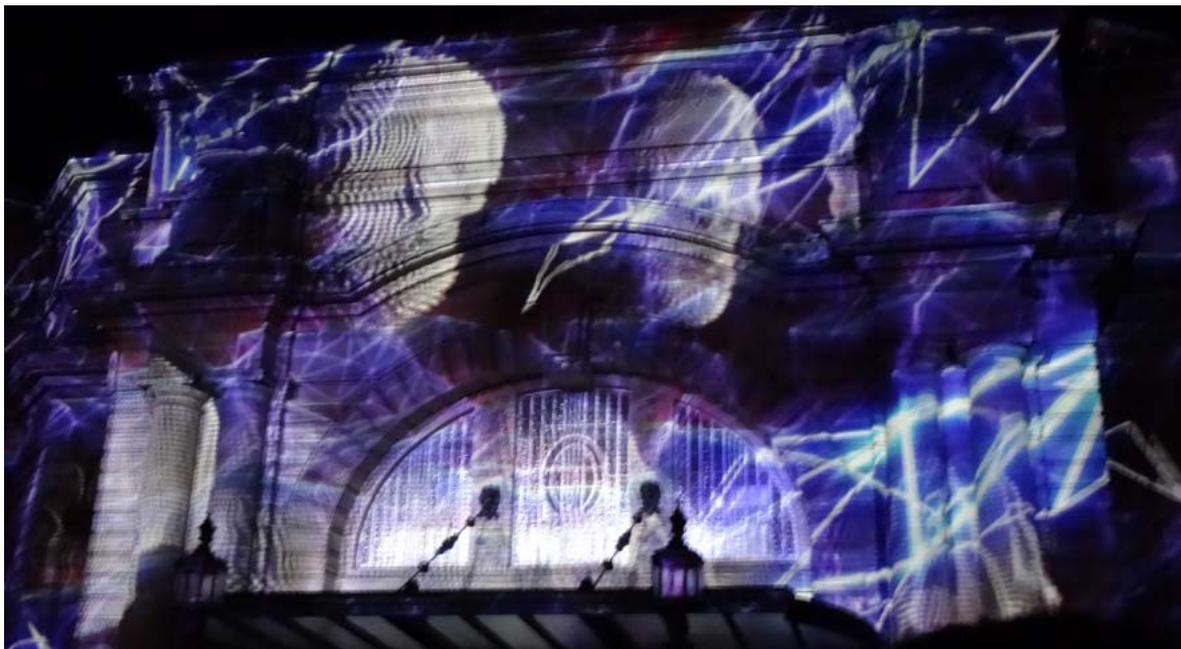
The pride of individual crafts men and women was recognised as vitally important. This self-esteem must be fully acknowledged as the relationship between digital developments and craft skills is explored and integrated. To a large degree technology serves the traditional, through mutual belonging and respect; including the way people interact with their environment. Technology cannot lead, nor should it lead, but should be used to serve the greater purpose allowing active participants to motivate themselves as they create and innovate. There is a need to work with tools – but, the tools are just tools: they help but cannot be the end in themselves (although, in the future, with advancing technologies, they might!). We can construct and re-construct anything society wants, but there is also a need to be careful about the message that is promoted by the sector in terms of adopted philosophy and technique. Everything has its place and whilst the technical and/or digital can serve their purpose, they ought not to lead on their own. A clearer way of effecting mutually beneficial integration needs to be established; this in addition to being a way of addressing E+TG Para 13 intentions.

Whilst the idea of human enterprise, and the *'romance'* associated with it can be seductive, an underlying mantra needs to recognise that individuals need to get paid at the end of the week! Part of the process involves creating meaningful jobs with a *'demand'* for skills, not a *'need'* for skills - essential and required though these skills might be. Whilst professional, technical and craft skills will contribute culturally, individuals need to make a living, be respected and be recognised as part of the norm of everyday life. This key aspect needs to be better articulated to both employers and job seekers. The first question a school kid asks is what they are going to get paid. Sometimes teachers are shocked on being told that a good stonemason can earn more than they do! [the parity of esteem issue] But, ability and

skills remunerations are relevant. An average (London based) annual salary of an IT consultant is currently £33.5 k rising to some £65 k, whereas an average for a stonemason's salary is in the region of £27 k rising to £38.5 k. Such variation may not be totally conducive to an effective integration of their respective abilities.

## Education

A key approach to the provision of effective education in heritage and associated digital matters needs to involve widening the participation and access of all involved. This might be achieved by capitalising on the mapping profiles of existing qualifications as suggested by E+TG Para 15. By re-tuning what already exists a *'re-inventing the wheel'* approach could be avoided. Such an integrated message targeted at politicians, should be based on a foundation of taking the private sector along with the argument - politicians don't listen to the public sector voice; they listen to people who are in the workplace *'doing it for a living'*. There is, therefore, a need to make sure that the private sector understands the issues. So, the promotion of new and current initiatives must illustrate that it is based on firm industry support: This calls for greater clarity of purpose all round.



Digital projection and underlying heritage. August 2015 [DSC0901.JPG] © Ingval Maxwell

Trying to articulate what future details of digital job descriptions is likely to be can be difficult to formulate. Those currently working in the field are liable to have a broad based set of skills - such as digital projection, game asset development or 3D modelling. This is unlikely to incorporate much heritage-based practical conservation awareness. This raises a question for the (immediate) future about how the digital community might blend with the heritage sector. This so that assimilated teaching (the taking on of trainees and reaching out

to different audiences) avoids becoming an operational challenge? The issues involved need to be considered in anticipation of and planned for now.

There is need for an immediate conversation to be held on the issue of demand, creating demand and how these issues might be addressed. This must involve identifying what skills will be required across the whole sector and how any gaps might be bridged by educating, training and up-scaling individuals at all levels. This must include preparing for university graduates coming into the workplace who have not undertaken any heritage related coursework. Whilst this is a currently recognised shortfall the current delivery system does not contribute sufficiently to the pool of specific and integrated skills across the sector.

By way of example: a recent urban-conservation course was explicit in its intentions to train Conservation Officers, however, the parent University closed it down because it did not fit with higher education demands in terms of research outputs. At an archaeological skills event in 2018, academic archaeologists revealed that they considered it was not their job to train archaeologists. They felt that their job was to educate people in archaeology. A view which resulted in the attending funding body representative emphasising an essential requirement should be to align with the interest of industry where people undertake practical tasks, not those within academic environments simply doing research!

The challenge would be to ensure that pragmatic, industry relevant, course requirements should become mandatory. It is critical that drivers for change to outmoded attitudes become recognised by the educational establishment across all heritage disciplines.

### **Client considerations**

The need for community engagement was recognised as essential in determining and achieving relevant changes. For home and building owners, and related organisations, it is essential that they can be offered appropriate skills for future commissioned projects. Clients must be aware of and fully understand that achieving their heritage responsibilities via the adoption of digital technologies is an essential tool for the advancement of activities: This as practitioners learn and benefit from related and digitally supported heritage projects.

It is becoming an essential requirement for all to think imaginatively and democratise the available technologies for those organisations funding heritage. In that process dissociated sources (such as the gaming industry) may be able to offer relevant influences and should not be discounted

## Conclusion

There was, perhaps, an overall necessity to appreciate that currently we are all responsible as ‘temporary custodians’ of heritage assets. In that process, we can be critical of decisions taken in the past but, equally, future decision-makers will have a right to be critical of what we have chosen to do in our time. As we continue increasingly to embrace the unparalleled digital capability that is now on offer, it is incumbent upon all currently involved to recognise that responsibility. It is our temporary responsibility to handle the emerging pressures and opportunities effectively. Having effective and full knowledge of new possibilities is part of that approach. As new techniques, developments and technologies are constantly offered, these will inevitably create challenges. Preparing to adopt or incorporate these is an essential prerequisite and that is what the Workshop presentations have offered as a brief insight. This insight has been enhanced by the many comments and views aired during the discussion session.

*“Let us always be aware of the uncertainty of private judgement, remembering that what to us may be without merit may well prove to posterity, who can view in perspective, of considerable value.”* Osbert Lancaster, 1976.

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## Contributor Biographies

### Diana Avramica

Diana Avramica is an accredited Romanian architect with diverse experience in architectural design, conservation research, informal education and public engagement. Interested in the relation between tradition and innovation, she is a co-founder of 'Re cult' cultural Association, based in Timișoara, Romania. As a practicing architect, she has been involved in a number of historic fabric regeneration and new development projects including building conservation. With a Master's Degree in Preservation of Built Heritage (Transylvania Trust, Ro) and an MSc in International Heritage Visualisation, (Glasgow School of Art, UK) she is currently conducting her PhD research project at the University of Strathclyde exploring the adoption of Extended Media and Immersive Technologies in Architectural Conservation Projects in support of enhancing collaboration, inclusion and participation.

### Nessa Roche

Nessa Roche is a Senior Architectural Advisor with the Department of Culture, Heritage and the Gaeltacht. She has a doctorate in architectural conservation from Heriot-Watt University, Edinburgh (1999) and has written, edited or project managed a number of guidance publications and reports issued by the Department of Culture, Heritage and the Gaeltacht and its predecessors. Nessa is currently chair of an EU Open Method of Coordination working group on cultural heritage skills and was the lead editor of its report *Fostering Cooperation in the European Union on Skills, Training and Knowledge Transfer in Cultural Heritage Professions*.

### Paul Bryan

Paul Bryan is the Geospatial Survey Manager within Historic England's Building Conservation and Geospatial Survey team. Based in York, Paul leads the Geospatial Survey team which carries out surveys of historic objects, buildings and landscapes using laser scanning, photogrammetry and drones. Paul has extensive knowledge of image-based survey methodologies and advises the sector on heritage applications of drones and Building Information Modelling (BIM). He co-authored the '*Metric Survey Specifications for Cultural Heritage*', which sets the standard for surveys across the heritage sector; '*3D Laser Scanning for Heritage*' and '*BIM for Heritage - Developing a Historic Building Information Model*'.

### Dr Lyn Wilson

Dr Lyn Wilson is Digital Documentation Manager at Historic Environment Scotland. She is responsible for all aspects of digital documentation, research and the application of 3D

technologies. Her team is delivering the Rae Project, to digitally document properties in the care of HES and their associated collections to help in conservation, management, learning and accessibility. Lyn is a heritage scientist with a BSc in Archaeology, MA and PhD in Archaeological Science. She is an expert member of CIPA and a Fellow of the Society of Antiquaries Scotland. Her research focuses on the intersection of heritage science and digital technologies in the historic environment.

### **Colin Tennant**

Trained as a geographer at Strathclyde University Colin Tennant is Head of Traditional Skills and Materials, Conservation Directorate, Historic Environment Scotland, based at the Engine Shed, Stirling

See *'How are Historic Environment Scotland Doing It?'* YouTube presentation by Colin Tennant, 9 March 2018 at:

<https://www.youtube.com/watch?v=-TwFnpOT97M>

### **Ingval Maxwell**

Ingval Maxwell retired from his 40-year professional career in 2008 after 15 years as Director of Historic Scotland's Technical Conservation, Research and Education Division. He is an Honorary Member of the ICOMOS International Scientific Committee on Stone and currently sits on the RIBA Conservation Group and RIBA Conservation Accreditation Steering Group; the Journal of Architectural Conservation Editorial Advisory Board, and the Stone Federation Awards Panel. He is Chairman of the RIBA's Conservation Assessors Moderating Panel and the Council on Training in Architectural Conservation. In December 2018, he was inaugurated as a Fellow of the Royal Institute of British Architects.