Historic England

Technological Opportunities and Developments

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ARPAS-UK The UK Drone Association
THE SURVEY ASSOCIATION
THE COMMERCIAL UAV SHOW

COTAC Edinburgh Group Workshop – Stirling: 7th November 2019

1

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What do I do?

- I run a team of five surveyors based in York that specialise in applying geospatial survey techniques to heritage
  - Jon Bedford
    Senior Geospatial Survey Analyst
  - David Andrews
    Geospatial Survey Analyst
  - Gary Young
    Geospatial Survey Analyst on 16 month fixed term contract
  - Elizabeth Stephens
    Geospatial Survey Technician Apprentice on 2 year apprenticeship with Historic England – our first heritage apprentice – with industry assistance from The Survey Association (TSA)

2

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Geospatial Apprenticeships a great opportunity for the heritage survey sector

- The Survey Association, known generally as TSA, is the trade body for commercial survey companies in the UK
- TSA has funded the development work on the Geospatial Survey Technician Apprenticeship (Level 3) and Geospatial Mapping and Science Degree Apprenticeship (Level 6)

www.instituteforapprenticeships.org/apprenticeship-standards/geospatial-survey-technician/

www.instituteforapprenticeships.org/apprenticeship-standards/geospatial-mapping-and-science-specialist-degree/

THE SURVEY ASSOCIATION

THE SURVEY SCHOOL

3

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What does the Geospatial Survey Team do?

We advise on and undertake surveys for:

- Historic England Research Projects — *Survey for research*
- Heritage at Risk (HAR) — *Survey for heritage at risk*
- Heritage Action Zones (HAZ) – unlock the economic potential of a historic area — *Survey for heritage action zones*

4

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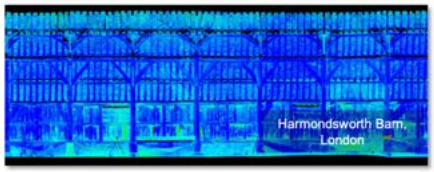
What does the Geospatial Survey Team do?

Survey for English Heritage

We advise on and undertake surveys for

- Historic England research projects
- Heritage at Risk (HAR)
- Heritage Action Zones (HAZ)
- English Heritage projects
  - English Heritage (EH) are an independent charity that looks after the National Heritage Collection of more than 400 historic properties
  - Includes objects, buildings & sites
  - Survey requests managed through a Shared Service Agreement between the Conservation & Research Departments of HE & EH



ENGLISH HERITAGE

www.english-heritage.org.uk

5

Historic England

What does the Geospatial Survey Team do?

Collaborative research on survey

We advise on and undertake surveys for

- Historic England research projects
- Heritage at Risk (HAR)
- Heritage Action Zones (HAZ)
- English Heritage projects
- We undertake collaborative research with academic partners

https://historicengland.org.uk/research/agenda

UCL Institute for Sustainable Heritage
UCL

SEAHA
EPSRC CENTRE FOR DOCTORAL TRAINING IN SCIENCE AND ENGINEERING IN ARTS HERITAGE AND ARCHAEOLOGY

University of Reading

University of Brighton

Civil Engineering and Geosciences
Newcastle University

6

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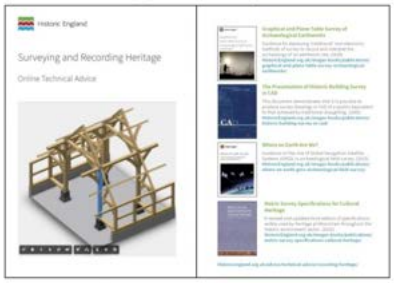
What does the Geospatial Survey Team do?

Technical guidance publication

We produce technical guidance publications related to geospatial survey techniques and analysis

https://historicengland.org.uk/advice/technical-advice/recording-heritage/



7

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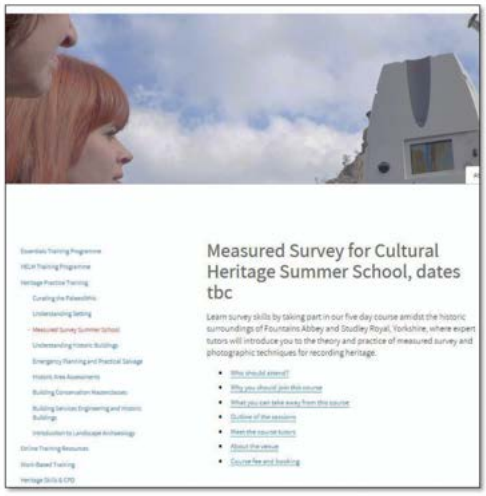
What does the Geospatial Survey Team do?

Teaching and training in survey

We advise on and undertake surveys for

- Historic England research projects
- Heritage at Risk (HAR)
- Heritage Action Zones (HAZ)
- English Heritage projects
- We undertake collaborative research with academic partners
- We produce technical guidance publications related to geospatial survey techniques and analysis
- We undertake teaching and training on geospatial survey techniques and applications



https://historicengland.org.uk/services-skills/training-skills/heritage-practice-residential/measured-survey-summer-school

8

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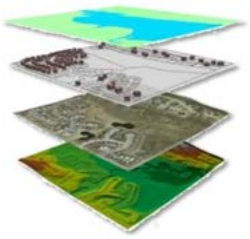
What Geospatial Survey technologies are currently used by heritage?

Geospatial Data

*"the availability of information relevant to **location**"*



Geospatial Survey

*"The **technologies** used to extract geospatial information from remotely sensed imagery and other raster data types"*

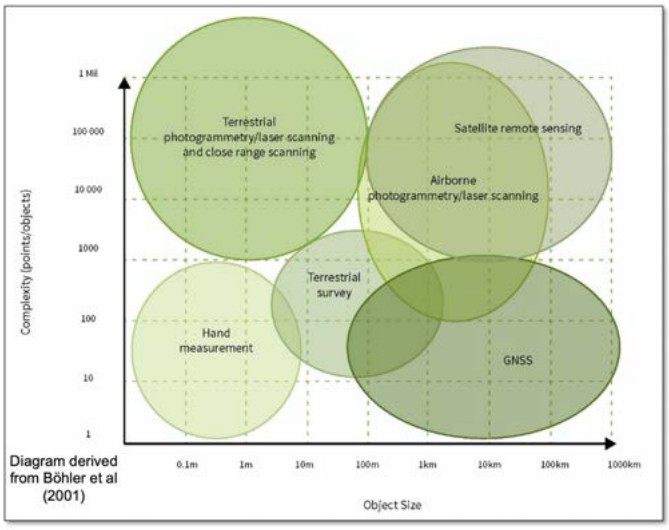


Diagram derived from Böhler et al (2001)

9

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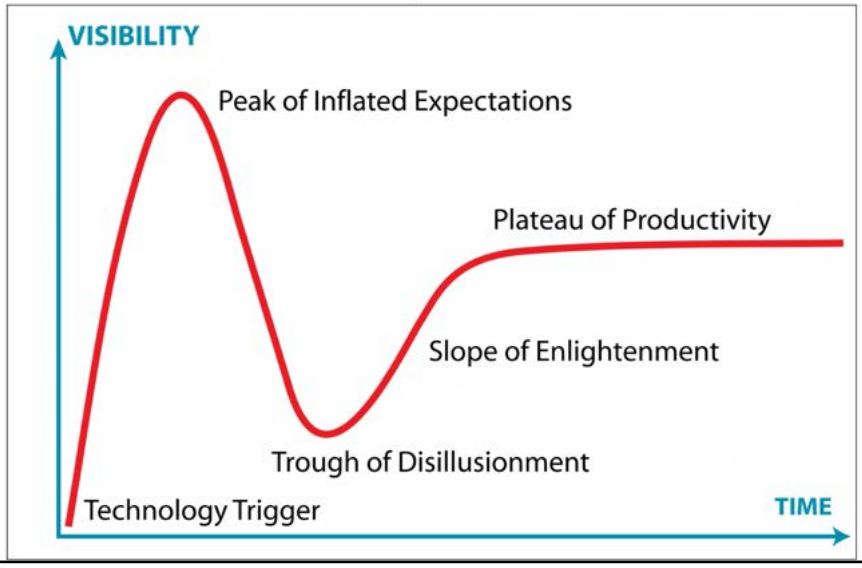
Gartner Hype Cycle for Emerging Technologies

Technology development indicator



10

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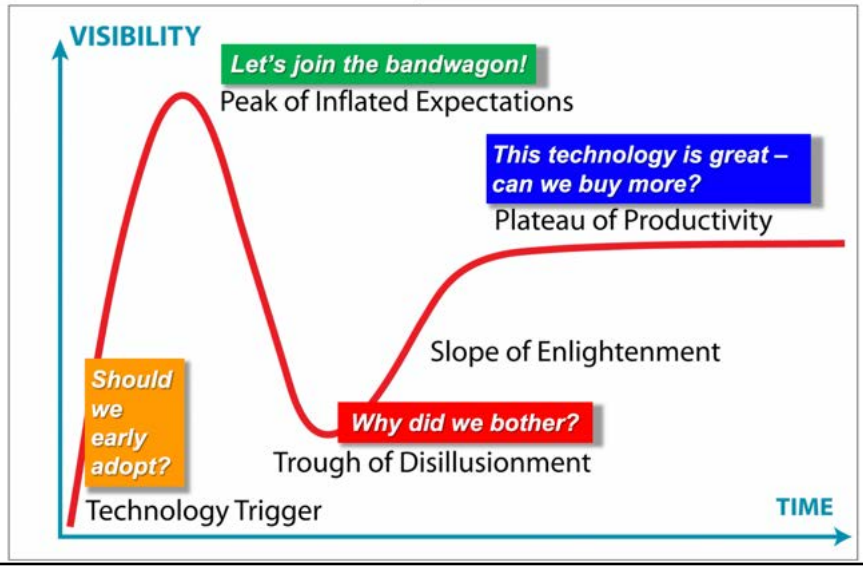
Gartner Hype Cycle for Emerging Technologies

When should we invest?



11

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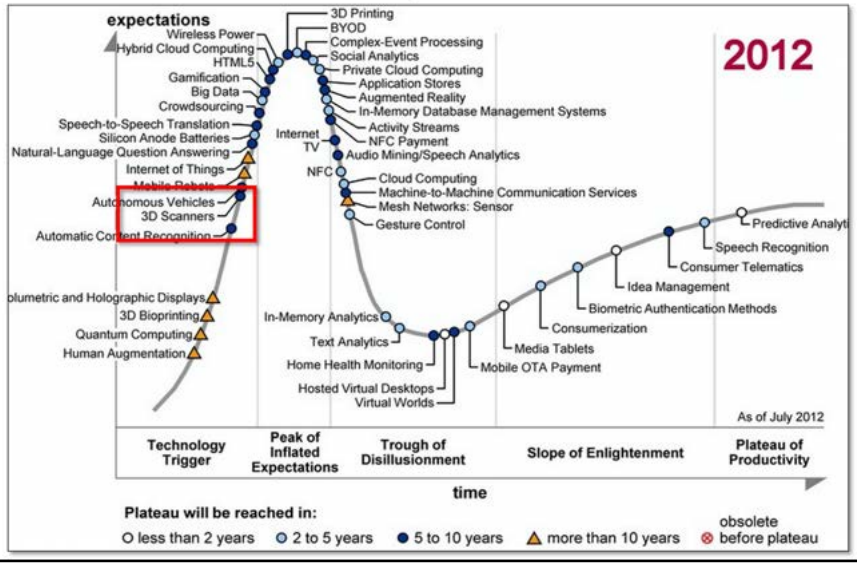
Gartner Hype Cycle for Emerging Technologies

2012 – 3D Scanners Position



12

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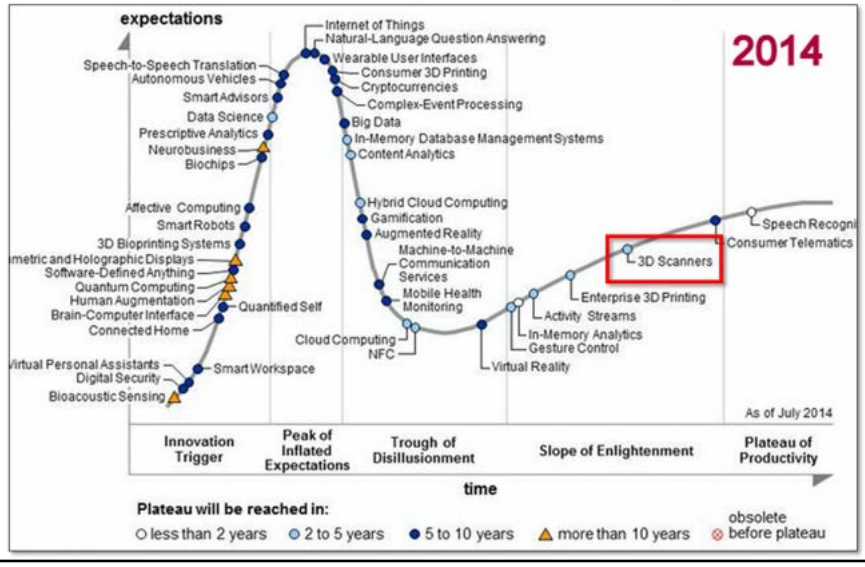
Gartner Hype Cycle for Emerging Technologies

2014 – 3D Scanners Acceptance Position 2-years later



13

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3D laser scanning

Laser scanning is an active, fast and automatic acquisition technique using laser light for measuring, without any contact, and in a dense regular pattern, 3D coordinates of points on surfaces

Grussenmeyer 2016

14

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3D laser scanning
Terrestrial

- Works by emitting a laser beam and recording either the time or phase change in the reflected signal to determine distance to the surface
- Combining with the emission angle allows 3D point cloud to be generated
- Range typically from 0.5m – 300m
- Point accuracy typically 1mm – 10mm
- Most scanners now record colour information with scan point data
- Great for recording heritage buildings and structures but at more than £30,000 it's an expensive solution!

Post-fire recording
Leica P40 laser scanner
Barnsley, South Yorkshire, UK

Monitoring Roman mosaic floor
Faro S150 laser scanner
Brading Roman Villa
Isle of Wight, UK

15

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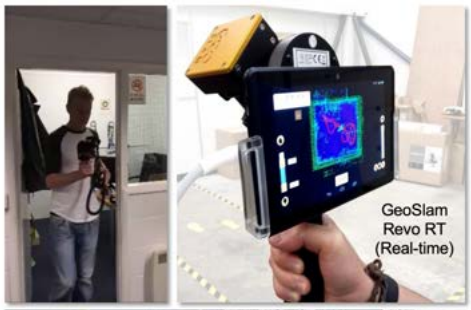
3D laser scanning
Mobile

- Combines rotating laser scanner & Inertial Measurement Unit (IMU)
- Uses *Simultaneous Localisation And Mapping* (SLAM) algorithm for rapid mobile mapping of complex spaces:
  - Range typically from 0.5m – 30m
  - Relative point accuracy < 40mm
  - Data capture rate 40,000 pts/sec
  - Captures colour with on-board camera
- Excellent for the rapid recording of heritage spaces but not the architectural detail…and at more than £25,000 another expensive solution!



GeoSlam
Revo RT
(Real-time)

Recording listed building
GeoSlam Revo RT
Windlestone Hall, Co Durham, UK

16

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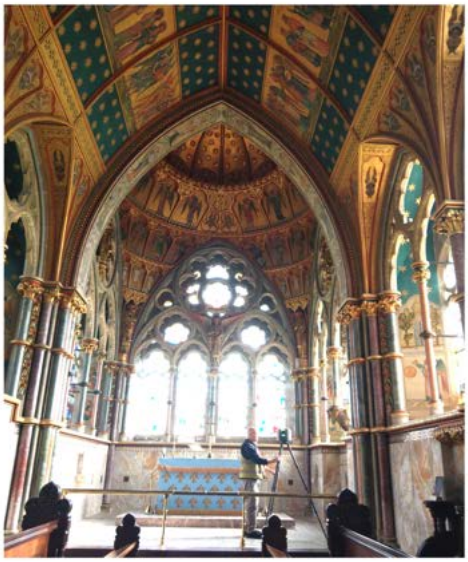
3D laser scanning

Advantages

- Applicable on all 2D and 3D surfaces
- Very fast – over 1,000,000 pts per second
- High resolution – millimetre point spacing
- Mobile scanning solutions allow data capture 'on the move'
- Now integrating point data with imagery from on-board sensors - RGB, 360° & thermal

St Mary's Church, Studley Royal, Z+F 5016, Courtesy of Z+F UK



17

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3D laser scanning

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- Very fast – over 1,000,000 pts per second
- High resolution – millimetre point spacing
- Mobile scanning solutions allow data capture 'on the move'
- Now integrating point data with imagery from on-board sensors - RGB, 360° & thermal

Disadvantages

- Generates very large data files often difficult to view without high-end computers
- Scanners expensive between £25K - £90K
- Sophisticated post-processing software needed to generate useable output
- Line drawings still require manual digitisation

St Mary's Church, Kempley, Leica P40 © Historic England

18

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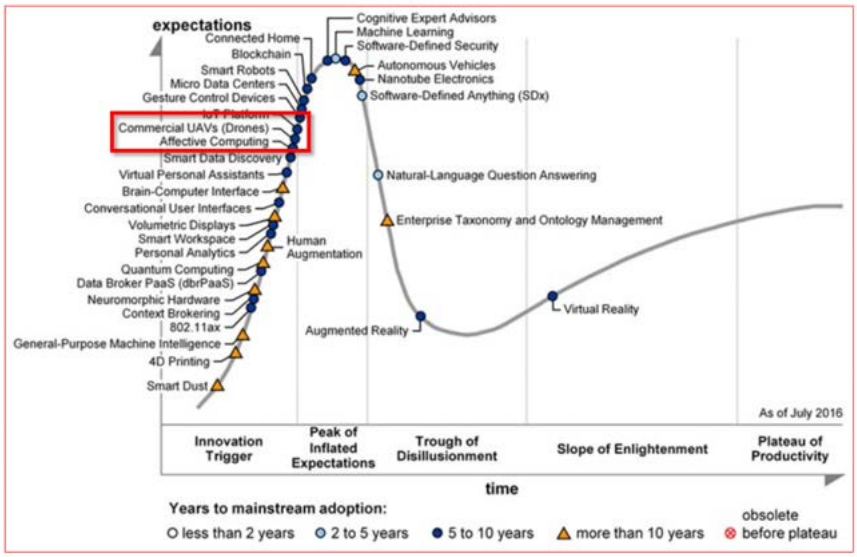
Gartner Hype Cycle for Emerging Technologies

2016 – Drones Position



19

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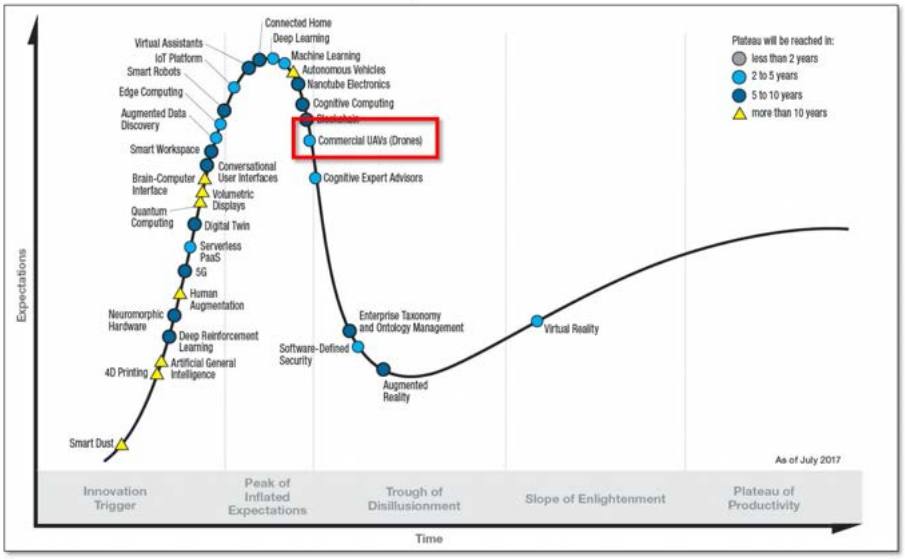
Gartner Hype Cycle for Emerging Technologies

2017 – Drones Position



20

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Drones

'Drones' :
the term
commonly used by
the public and
media when
referring to:

Remotely Piloted
Aircraft Systems
(RPAS)

21

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Drones

Photography of heritage sites
Landscape mapping + building inspection

- Provide unique vantage point for low-level aerial photography

- Useful for landscape mapping and building inspection

22

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Drones
Rotary + Fixed Wing

Appleby, Cumbria flown by Kestrel Cam © Historic England

Rievaulx Abbey, North Yorkshire
Intelligent Mapping Solutions
© Historic England

23

Historic England

Drones
In-house flying by Historic England

- Provide unique vantage point for low-level aerial photography
- Useful for mapping, inspection, monitoring, presentation and research
- Rotary wing – carry a range of sensors, ability to hover and operate in confined spaces
- Fixed wing - shape gives good stability, can glide over long distances and survey larger areas
- We now fly four drones in-house - used for condition inspection and mapping using photogrammetry

24

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Photogrammetry

The art, science and technology of determining size, shape and identification of objects by analysing terrestrial or aerial imagery

Boardman 2016

25

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Photogrammetry
Structure-from-Motion (SfM)

Advantages

- Applicable on all 2D and 3D surfaces
- Multi-image photography excellent archival record
- Modern approaches use 'off-the-shelf' cameras
- Does not rely on calibrated metric cameras
- Can generate high-resolution 3D 'point clouds'
- Structure from Motion (SfM) is low cost and making photogrammetry fashionable again

Disadvantages

- Requires multi-overlap imagery – ideally 80% forward & 60% side
- Correlation needs visible texture within imagery
- Accurate data relies on good imagery & control
- Black-box software may simplify photogrammetric processing but beware

Rubbish in = Rubbish out!

26

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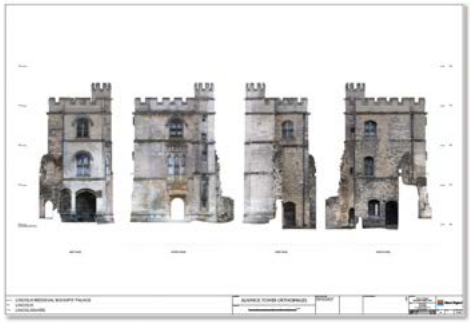
Reality Capture

The direct integration of data derived from both photogrammetry and 3D laser scanning *(Historic England 2018)*



27

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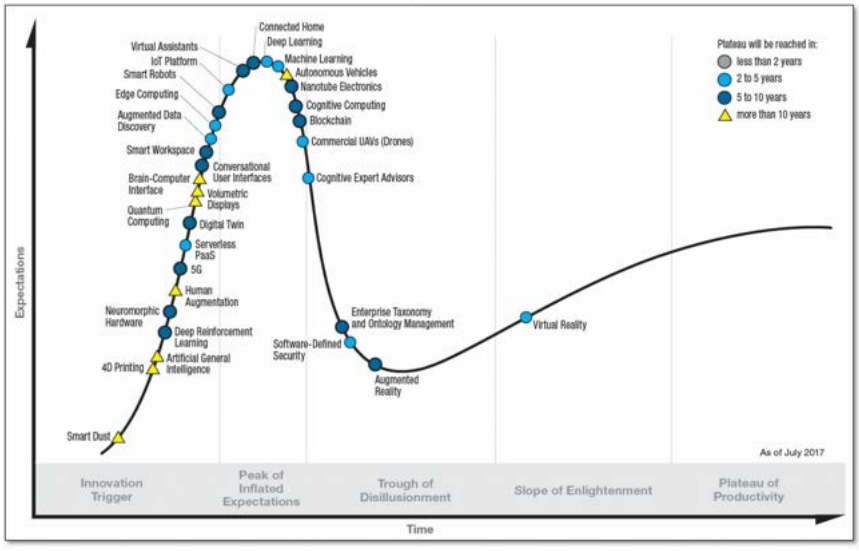
Gartner Hype Cycle for Emerging Technologies

2017 - Building Information Modelling (BIM) doesn't appear



28

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Building Information Modelling
What is BIM?

- 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)

29

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Building Information Modelling
Why is BIM important to heritage?

- Allows collaborative production, delivery and management of building information across a building's lifecycle
- Provides information management, record keeping and integrated databases for a heritage project
- Heritage project documentation typically dispersed, in-accessible and unstructured = ineffective collaboration, duplication of work and poor management
- Conservation best practice is based on informed decision making and judgement!!

30

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BIM for Heritage
Developing a Historic Building Information Model

- Published in July 2017 this publication on Building Information Modelling for heritage (Historic BIM) 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
- Since release the publication has had over 3,036 downloads – the second most downloaded piece of guidance in our suite

https://historicengland.org.uk/images-books/publications/bim-for-heritage/

31

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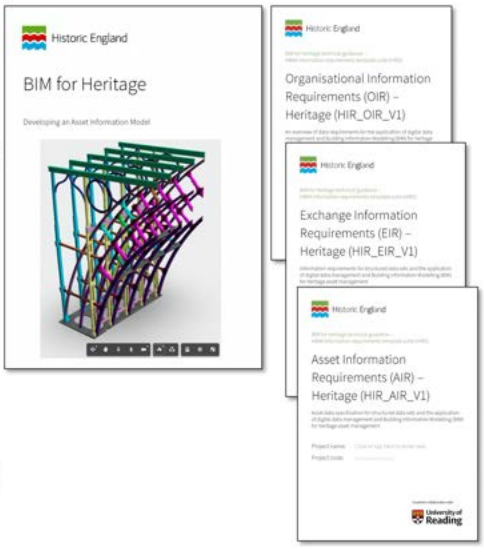
BIM for Heritage
Developing an Asset Information Model

- This new guidance, due out in November 2019, focuses on heritage asset management, in particular conservation repair and maintenance
- It suggests the first task when adopting a BIM information management approach is to develop an Asset Information Model (AIM)
- Includes Information Requirement Templates for OIR, EIR and AIR
- Authored by Joanna Hull BSc MSc MAPM, PhD research student at Reading University studying:
  "*Heritage BIM: New ways of digital data management for the historic built environment*"



32

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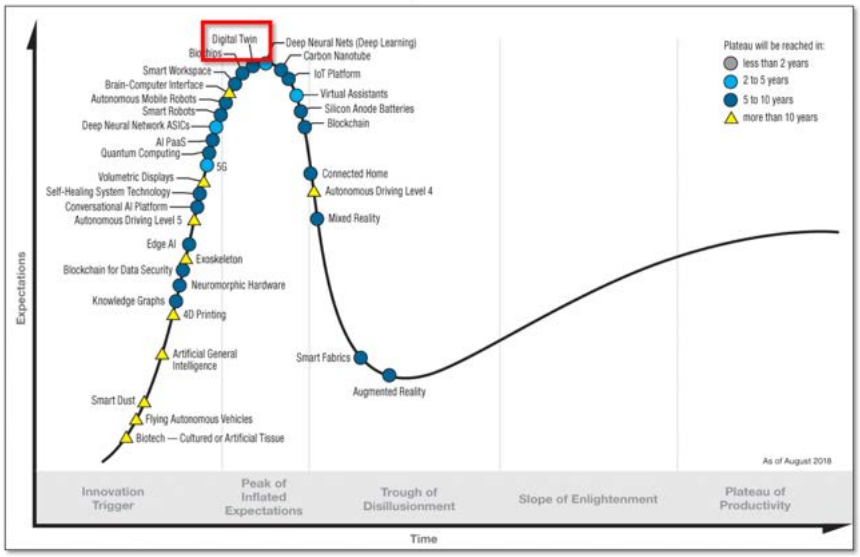
Gartner Hype Cycle for Emerging Technologies
2018 – Digital Twin



33

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BIM for Heritage
Digital Twin – what is it?

- A virtual replica of a physical product or a process or a system
- For infrastructure a digital twin bridges the physical and digital worlds gap by incorporating operational technologies such as the Internet of Things (IoT)
- Digital twins provide a platform to test scenarios and hypotheses and provide a better understanding of the performance of the asset (Bentley Systems, 2019)
- A National Digital Twin (NDT) is a federation of connected digital twins across all sectors and at a national scale (Open Data Institute, 2019)

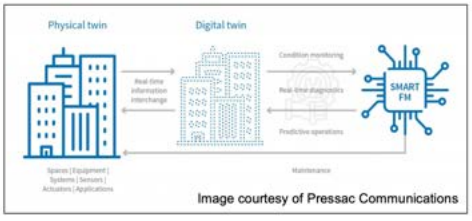

Image courtesy of Pressac Communications

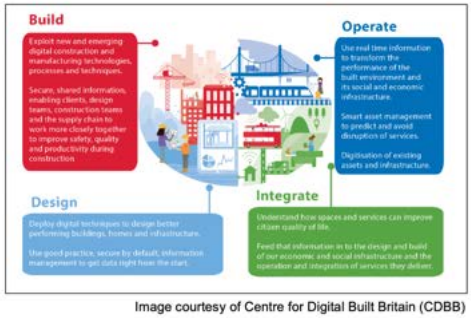

Image courtesy of Centre for Digital Built Britain (CDBB)

34

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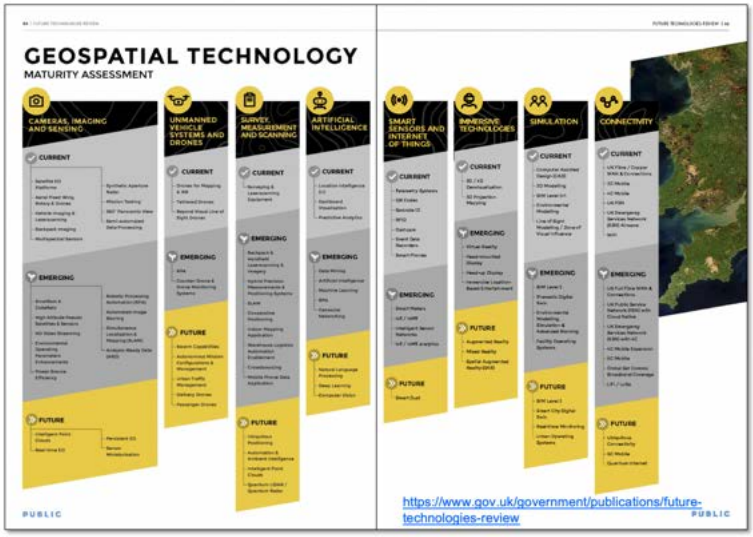
Geospatial Survey Future Technologies Review: Technological Opportunities and Developments What next?



This new report by the Geospatial Commission highlights how use of geospatial data by innovative tech is helping grow the UK economy

The UK's Geospatial technology sector is recognised as the second most developed in the world, only behind the US

35

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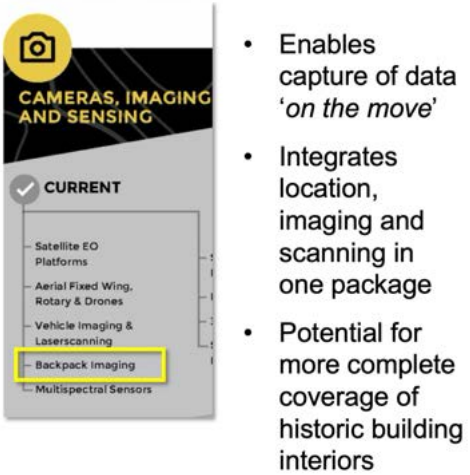
Some future developments Backpack Imaging



- Enables capture of data '*on the move*'
- Integrates location, imaging and scanning in one package
- Potential for more complete coverage of historic building interiors

36

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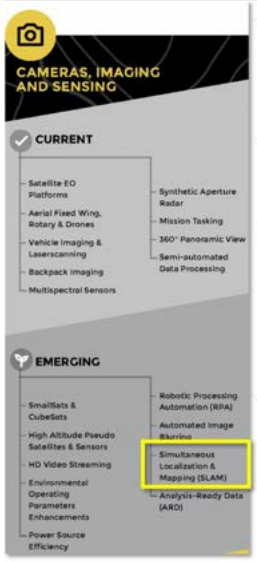
Some future developments Simultaneous Localisation & Mapping (SLAM)



- Enables mapping of internal spaces without GPS/GNSS
- Can use imaging and/or scan technologies
- Becoming a fundamental component of modern mobile mapping systems
- Potential for faster mapping and analysis of historic buildings and structures

www.blk2go.com/

37

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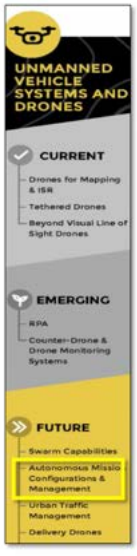
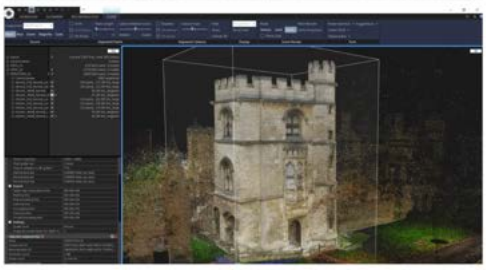
Some future developments Autonomous drones



- Enable automated capture of drone acquired imagery suitable for mapping
- Potential for automated analysis of structures – cracks, damp, erosion, weathering and decay



38

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Some future developments Remote inspection drones

UNMANNED VEHICLE SYSTEMS AND DRONES

CURRENT
- Drones for Mapping & ISR
- Tethered Drones
- Beyond Visual Line of Sight Drones

EMERGING
- RPA
- Counter-Drone & Drone Monitoring Systems

- Enable visual inspection of inaccessible spaces
- Enable remote mapping of heritage spaces
- Increase operator safety

39

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Some future developments Machine learning and AI

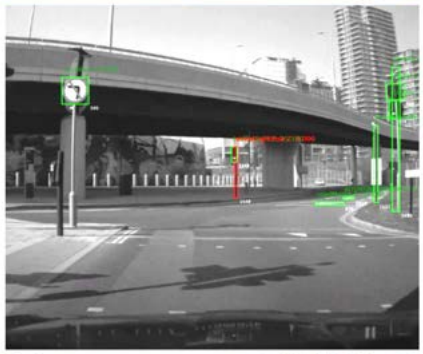
www.ordnancesurvey.co.uk/news/mobileye

ARTIFICIAL INTELLIGENCE

CURRENT
- Location Intelligence (LI)
- Dashboard Visualisation
- Predictive Analytics

EMERGING
- Data Mining
- Artificial Intelligence
- Machine Learning
- RPA

- Enable automated identification of asset infrastructure
- Potential for machine learning within different environments
- Potential for BIM and digital twin applications



40

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Some future developments Augmented Reality (AR)

- Enables viewing of design models upon view of reality
- Potential for live viewing of interpretive modelling of heritage sites and structures
- Potential for verification of survey derived modelling
- Potential for viewing below ground services, geophysics and archaeological mapping

https://sitevision.trimble.com/

41

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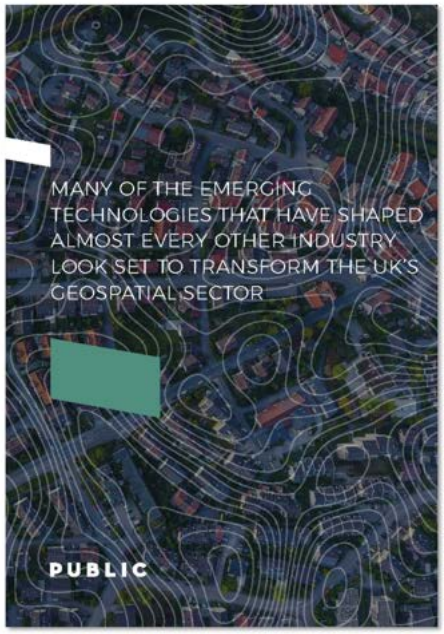

https://www.gov.uk/government/publications/future-technologies-review

42