# Emerging Trends: Cultural Heritage 3D Modelling

Preserving Computer Aided Design
Institute of Mechanical Engineers,
London 26th July 2013

Stuart Jeffrey

The Digital Design Studio (DDS)

- Specialist part of Glasgow School of Art

- Founded in 1997

- Centre of excellence for digital design

- *State-of-the-art* facilities for visualisation, sound and interactive technologies

- Focussed on research, teaching and commercialisation of digital visualisation technologies

- 33 taught postgraduate students (4 PhD)

- Located in the heart Scotland's Digital Media Quarter in Glasgow

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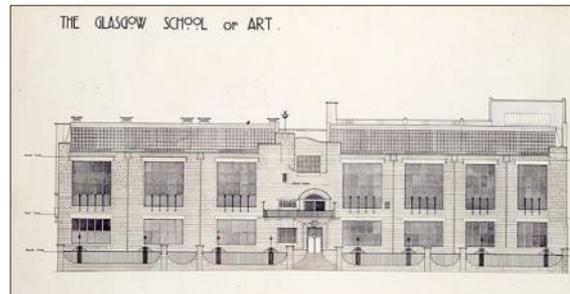
The Digital Design Studio (DDS)

- Mixture of commercial and academic projects

- Heritage

- Architecture

- Medical

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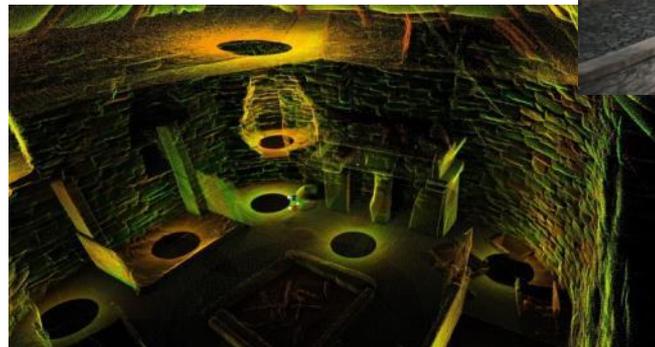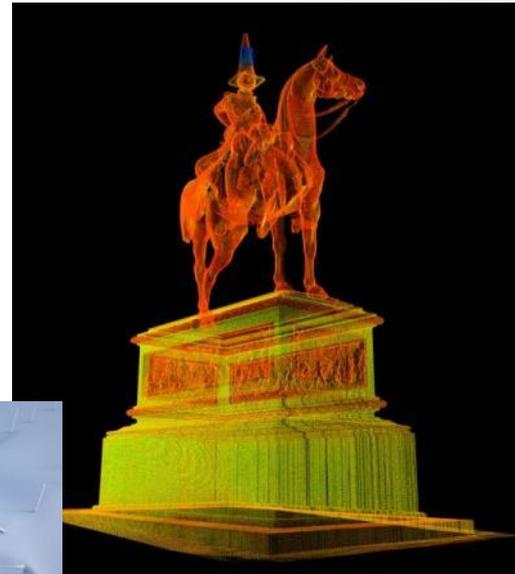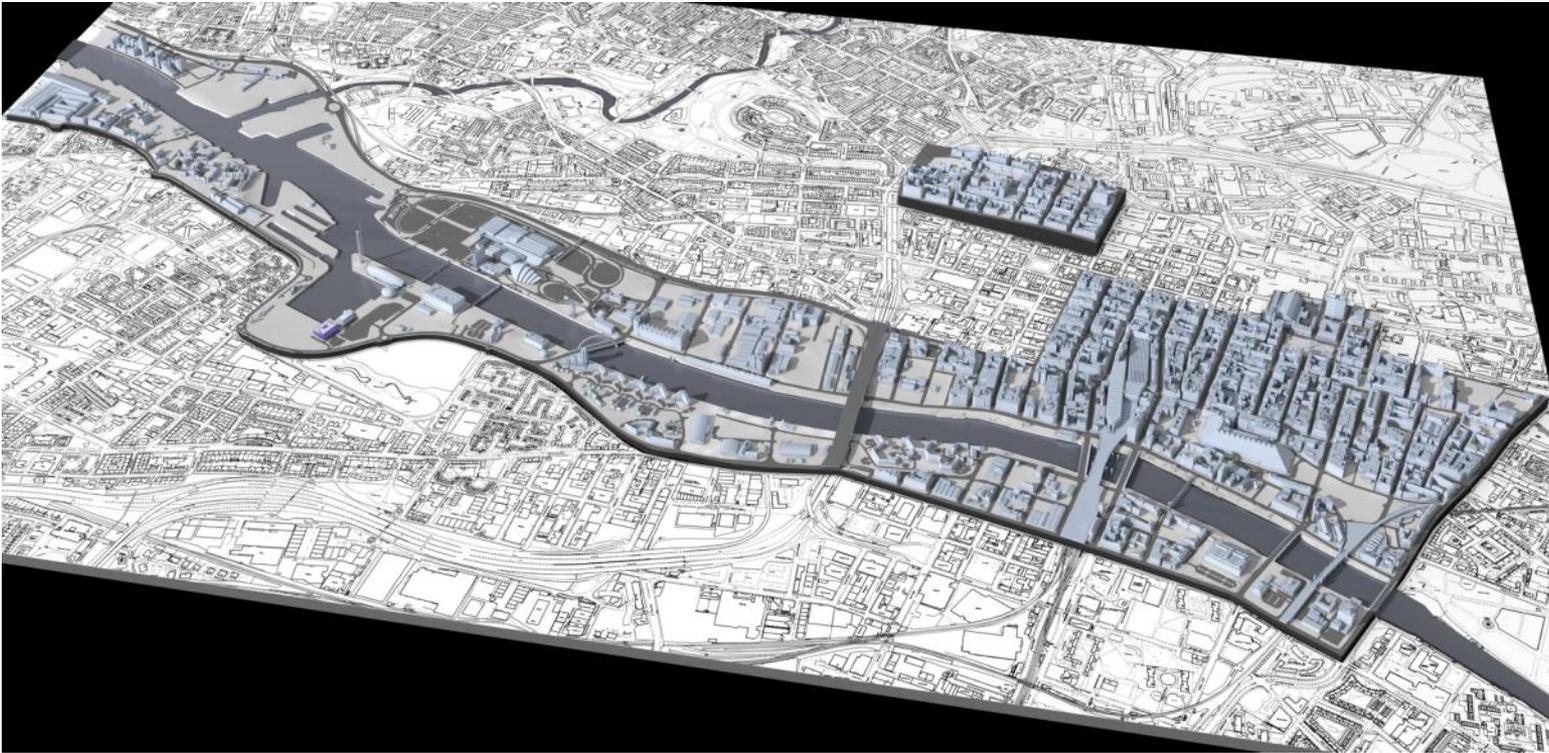
Glasgow City Model

Glasgow City Council

- Largest project of its type in Europe
- Aims to create a model of the entire city of Glasgow for planning control and other purposes
- Uses a mixture of ground and air based LIDAR scanning

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Mount Rushmore

CDDV – Cyark – National Parks Authority

archive

1. A place in which public records or other important historic documents are kept. Now only in *pl.*

1645 HOWELL *Lett.* VI. 5 Lubeck, wher the Archifs of their ancient Records is still. 1667 E. CHAMBERLAYNE *St. Gt. Brit.* I. III. x. (1743) 217 The Tower of London is likewise..the Great Archive where are conserved all the ancient records. 1777 SIR W. JONES *Poems & Ess.* Pref. 13 Preserved in the archives of the Royal Society. 1775 R. LOWTH *Let. Warburton* 43 Laid up in the same Archive. 1866 FELTON *Anc. & Mod. Greece* II. xi. 209 That authenticated copies..should be deposited in the public archives.

archive, *v.*

trans. To place or store in an archive; in *Computing*, to transfer to a store containing infrequently used files, or to a lower level in the hierarchy of memories, esp. from disc to tape.

1934 in WEBSTER. 1950 *Times* 3 Mar. 5/7 The Government's clandestine censors are not content merely to open letters, copy the contents, and then reforward them; they either archive or destroy the letter. 1979 *Nature* 29 Nov. 538/3 Before being archived, data will also be examined by an Advisory Committee. 1982 *Amer. Speech* LVII. 163 All..files will be archived at the University of Wisconsin after the project is complete. 1985 *Computerworld Focus* 19 June 22/4 Finished plans would be transmitted to a DNC host computer where they would be archived and managed.

back-up

d. *trans. Computing.* To provide back-up for; to make a duplicate copy of (a file, program, etc.), esp. to safeguard against loss or corruption of the original.

1967 *AFIPS Conf. Proc.* XXX. 776/1 A parallel DDC computer system..not only provides computer backup but 'backs up' the time-shared analog and digital input/output equipment. 1974 *Computing Rev.* June 204/2 The objective of this paper is to determine the optimum frequency for backing up a data base. 1983 *Austral. Microcomputer Mag.* Sept. 70/3 The tape drive can also be used to backup the IBM XT's hard disk.

This causes some real confusion…….
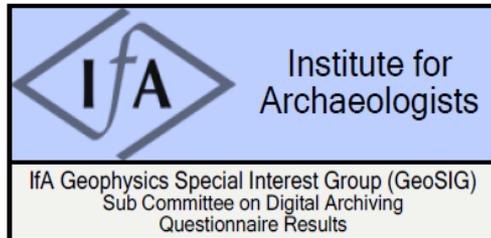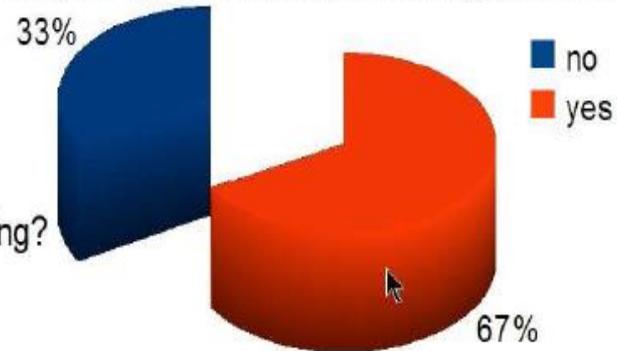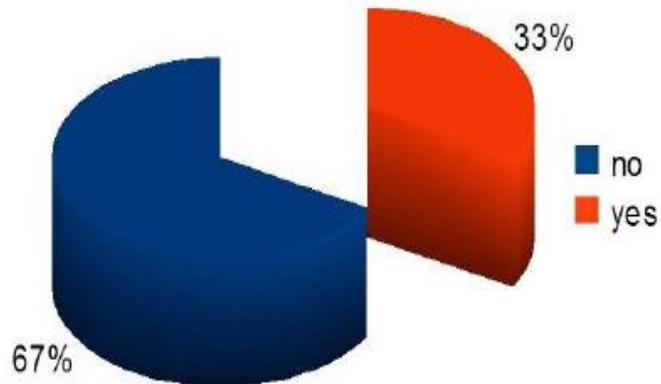
The Open Archival Information System (OAIS)
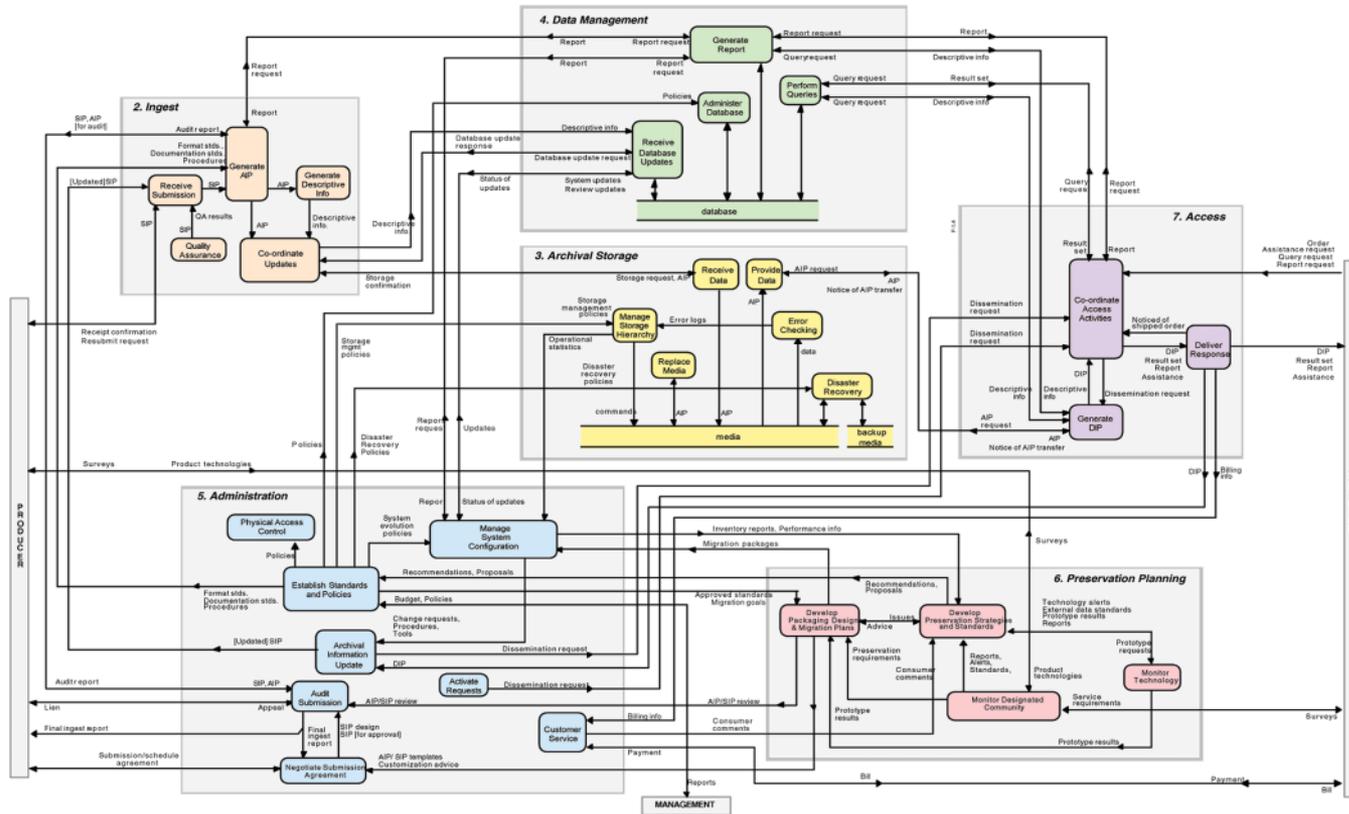
Figure F-1: Composite of Functional Entities

DPC Briefing, London

Note: potential 'data bloat'

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The size of digital archives - archaeological bodies

1999 – Strategies for Digital Data:

http://ads.ahds.ac.uk/project/strategies
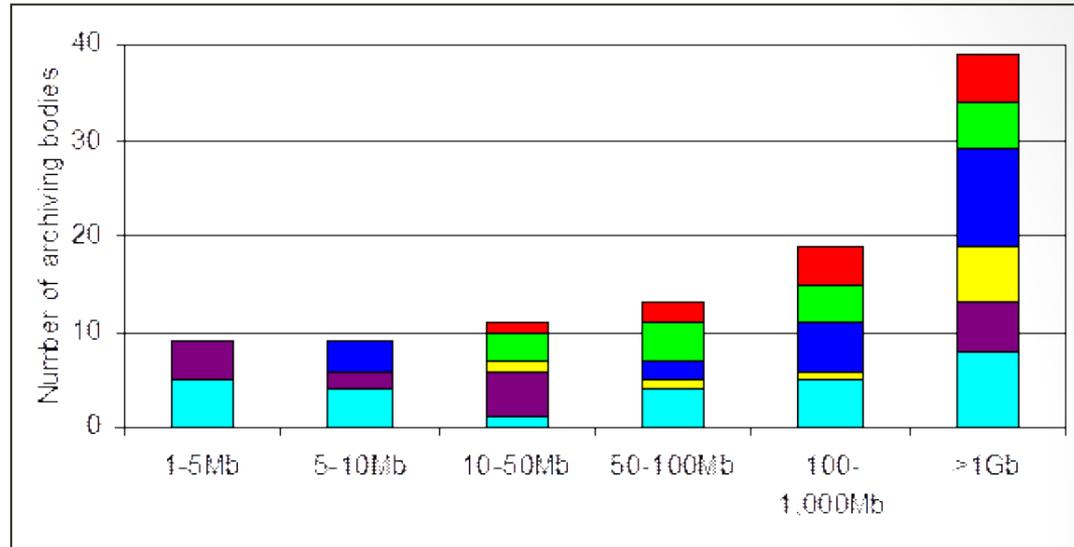
Average project size (estimated)
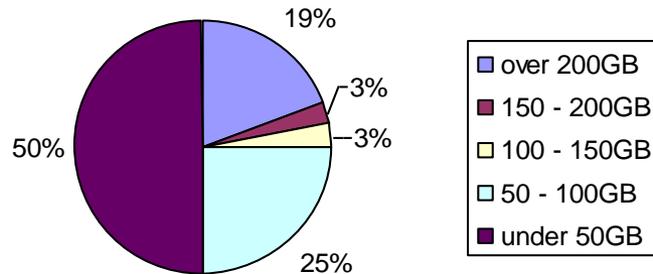
2005 EH/ADS Big Data Project:

http://archaeologydataservice.ac.uk/research/bigData

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Sydney Opera House

CCDV Scottish 10 Project - work in progress from the registration/processing (260Gb raw data)

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Does size matter?

1000 – ○ ◀— **1981 – Apple 5mb drive, \$3500.**

100 – ○ ◀— **1983 – Iomega, Bernoulii box, \$2000 plus \$89 per 10mb.**

10 –

1 – **1995 - Seagate's 1Gb drive, \$849**

0.1 – ○

\$700 per Mb

0.01 –

2007 Hitachi Deskstar 7K100 1Tb drive, \$349

0.001 –

0.0001 – **0.002C per Mb** ○

0.00001 –

1981 1985 1990 1995 2000 2005 2010

Projected

After www.guarddawg.net

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HPC

Utility Computing

Tier 1-4 Data centres

google

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Cost of preservation = A + I + D + R

A = Management and Administration, I = Ingest Costs, D = Dissemination Costs, R = Refreshment Costs

Retention period	Cost for refreshment
5 years	R + E
10 years	R – DR + E - DE
15 years	R – 2DR + E - 2DE
20 years	R – 3DR + E – 3DE
25 years	R – 4DR + E – 4DE

R = refreshment cost (labour)
DR = decreasing cost of refreshment
E = cost of storage (hardware)
DE = decreasing cost of storage

Retention period	Cost for refreshment	Cumulative total (example in pence)
5 years	9 + 4 = 13	13
10 years	9 - 3 + 4 – 1 = 9	22
15 years	9 – 6 + 4 – 2 = 5	27
20 years	9 – 9 + 4 – 3 = 1	28
ongoing		28.1

Source: ADS Charging Policy
**http://archaeologydataservice.ac.uk/advice/refreshmentCharges**

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Complexity Vs Volume

**= 260Gb**

260Gb=

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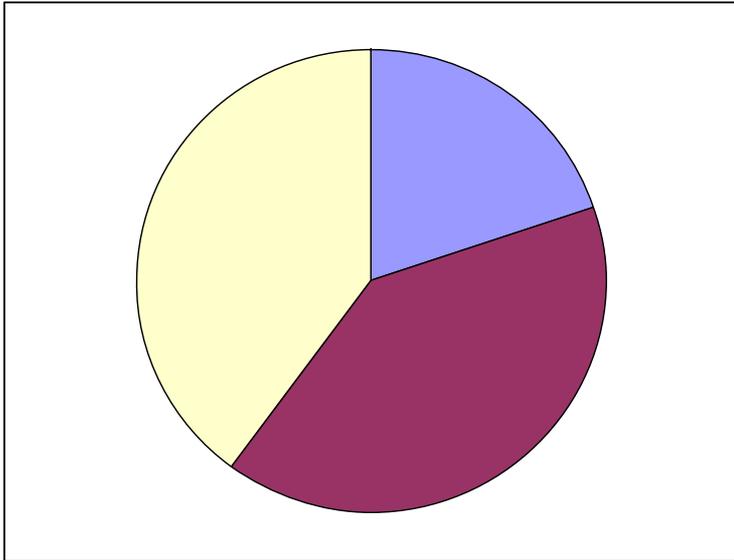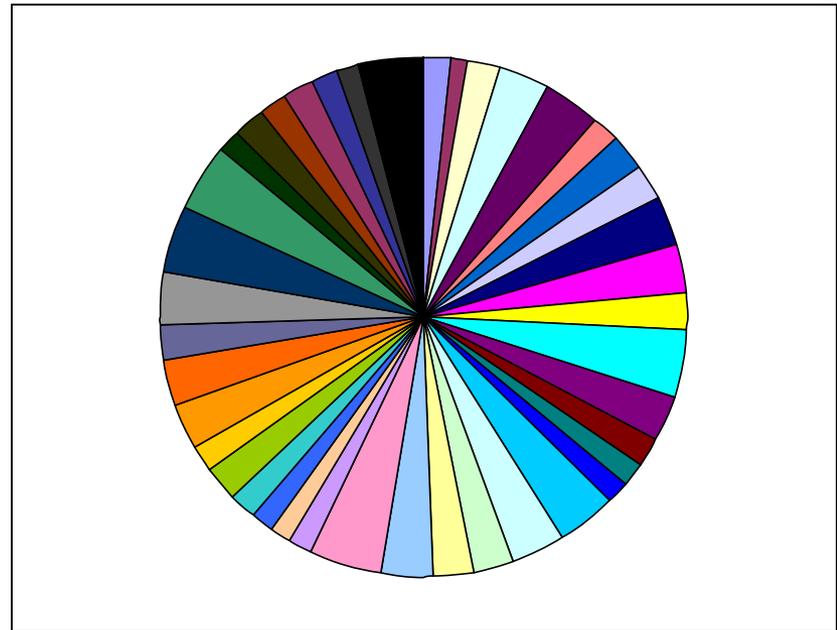
Cloud Security Alliance – July 2013

Survey Question 1: (For non-US residents only) Does the Snowden Incident make your company more or less likely to use US-based cloud providers?

CSA received 207 responses from self-identified non-US residents.

- 56% less likely to use US-based cloud providers
- 31% no impact on usage of US-based cloud providers
- 10% cancelled a project to use US-based cloud providers
- 3% more likely to use US-based cloud providers

(For non-US residents only) Does the Snowden Incident make your company more or less likely to use US-based cloud providers?

Legend:
- More
- Less
- No impact
- Have already cancelled a project in response to the news
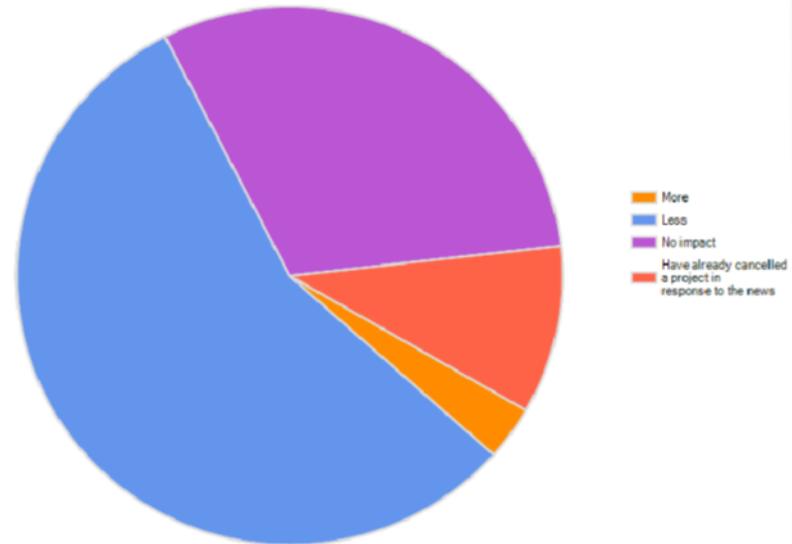
downloads.cloudsecurityalliance.org/initiatives/surveys/nsa_prism/CSA-govt-access-survey-July-2013.pdf

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http://guides.archaeologydataservice.ac.uk/

3.2.2 Scan Level Metadata

| Element	Description
Scan Filename	The name of the scan. A suggested filename for original raw scans for archiving is in this format: *ProjectName_scan1.txt*.
Scan Transformation Matrix	The name of the transformation matrix used in Global Registration. Suggested file name: *ProjectName_scan1_mtrx.txt*
Matrix Applied to Scan?	Y/N Has the matrix been applied to the archived scan?
Name of monument/object	Name of monument or object being scanned
Survey Date	Date of scan
Data Resolution	Fixed resolution or data resolution at specific range.
Number of Points in Scan	Total number of points in the scan file
Additional Scan Notes	Additional notes
Scanner Technology	TOF/Phase/Triangulation
First or Last Return (TOF scans only)	Indicated whether first, last, or both returns were specified
Camera Exposure Settings (If RGB acquired)(TOF and Phase scans)	Exposure settings set on scanner
Frequency Settings (Phase scans only)	Frequency settings set on scanner
Noise Settings (Phase scans only)	Noise settings set on scanner
Lense or FOV Details (Triangulation scans only)	Indicate which lense or FOV was used during scan

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Workflow diagram showing three main sections:

Process Flow (left):

Acquire Scans (ASCII and Native):
- Acquire Raw Scans → Acquire Targets/Control Points

Register Point Clouds (ASCII):
- Register Scans to common coordinate system
- Georeference Scans
- Pre-Meshing Edits (Subset of original PC)

Create Polygonal Model (OBJ):
- Create Polygonal Mesh
- Edit and Hole Fill Polygonal Mesh
- Additional Mesh Optimizations/Decimation

Create Other Products:
- Create 2D CAD Drawings (TXT, DXF)
- Create 3D CAD Models (DXF, DWG)
- Create Video/Animation (AVI)
- Create Digital Elevation Model (DEM) (DXF, DWG)

Metadata (center):
- Project Level Metadata
- Scan Level Metadata (per scan)
- Registration Metadata
  - Global registration error
  - Total number of scans used in registration
  - Total number of points
  - Dataset Georeferenced (Y/N)
    If Yes, include TXT file of control points
- PreMeshing Metadata
- Mesh Creation/Editing Metadata
- 3D CAD Model Parameters
- Cross Section, Plan or Elevation CAD Drawing Parameters
- DEM Parameters
- Video Parameters

Archival (right):
- Data Sets Required for Archival
- Data Sets Strongly Advised for Archival
- Raw Scans → Metadata for Raw Scans
- Transformation Matrices (TXT)
- Registered Data Set → Metadata for Registration
- Interim DataSet → Metadata for interim level dataset
- Transformation Matrices (TXT)
- Final Product → Complete Metadata for Final Product

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Preservation Intervention Points

VENUS: Virtual ExploratioN of Underwater Sites
http://archaeologydataservice.ac.uk/attach/venus/VENUS_Preservation_Handbook.pdf

ADS G2GP File Formats Example

Raster

The formats described in the table below are recommended for the long-term preservation of digital raster images:

Preservation Format	Requirements
.tif / .tiff	TIFF 6.0 remains widely accepted as a preservation format for digital raster images and includes support for EXIF metadata.
.dng	As an open extension of the TIFF/EP standard with support for EXIF, IPTC and XMP metadata, the Adobe DNG format is rapidly becoming accepted as a standards for storing raw image data (primarily from digital photography).

Vector

The formats described in the table below are recommended for the long-term preservation of digital vector graphics:

Format	Properties/Technologies	Description	Recommendations
.txt, .csv	A simple, text only file used to store textual information in a database table using the ASCII standard code	Text files can store data in a database table by delimiting individual pieces of information within a row (or record) with a comma, semi-colon, or space.	See Section 3.1 of the Laser Scanning guide for more information on this format.
.obj	OBJ is an open format storing 3D objects and is accepted by nearly all CAD/3D modeling software	OBJ files can be used to store a wide range of 3D objects. OBJ can store files with high polygon counts and polygon textures.	See Section 3.1 of the Laser Scanning guide for more information on this format.
.x3d	X3D was developed for the storing of complex 3D objects and is an ISO standard (ISO/IEC 19775-1.2:2008)	X3D is an open format used in a number of open source 3D modeling software packages. Polygonal models stored in X3D can retain textures, normals, and a number of other features used for renderings.	This format is an alternative for and similar to the OBJ format.
.dxf	An Autodesk AutoCAD file format. Can be opened or created by a large number of other software systems	Good for interoperability between CAD and a large number of other software systems, namely GIS software.	See Section 3.3 of the CAD guide for more information on this format.

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The London Charter

For the use of 3-Dimensional Visualisation in the Research and Communication of Cultural Heritage.

Principle 1- Implementation

The principles of the London Charter are valid wherever computer-based visualisation is applied to the research or dissemination of cultural heritage.

Principle 2 - Aims and Methods

A computer-based visualisation method should normally be used only when it is the most appropriate available method for that purpose.

Principle 3 - Research Sources

In order to ensure the intellectual integrity of computer-based visualisation methods and outcomes, relevant research sources should be identified and evaluated in a structured and documented way.

Principle 4 - Documentation

Sufficient information should be documented and disseminated to allow computer-based visualisation methods and outcomes to be understood and evaluated in relation to the contexts and purposes for which they are deployed.

Principle 5 - Sustainability

Strategies should be planned and implemented to ensure the long-term sustainability of cultural heritage-related computer-based visualisation outcomes and documentation, in order to avoid loss of this growing part of human intellectual, social, economic and cultural heritage.

Principle 6 - Access

The creation and dissemination of computer-based visualisation should be planned in such a way as to ensure that maximum possible benefits are achieved for the study, understanding, interpretation, preservation and management of cultural heritage.

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http://www.londoncharter.org/

CH Sector trends

• Selection and Retention – preservation planning from project initiation

• Technical metadata, workflow metadata, resource discovery metadata and Paradata – cooperation between archives.

• Workflow convergence – BIM, Scan to BIM, LD from BIM

• Mass storage, hardware and software costs do not necessarily impact on preservation costs – good workflows impact on preservation costs.

• Project Co-design and production

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