The Discovery Programme

Centre for Irish Archaeological Research

The 'Rubble of the North'

-a solution for modelling the irregular architecture of Ireland's historic monuments

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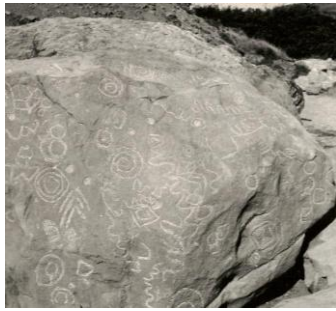
ISPRS Technical Commission V Symposium 2014
Riva del Garda, 23-25 June, 2014

Today's Presentation

1. Digitisation overview
2. The Challenge
   – making data accessible
3. Our proposed Solution
4. Deliverables



Digitisation - Different Scales

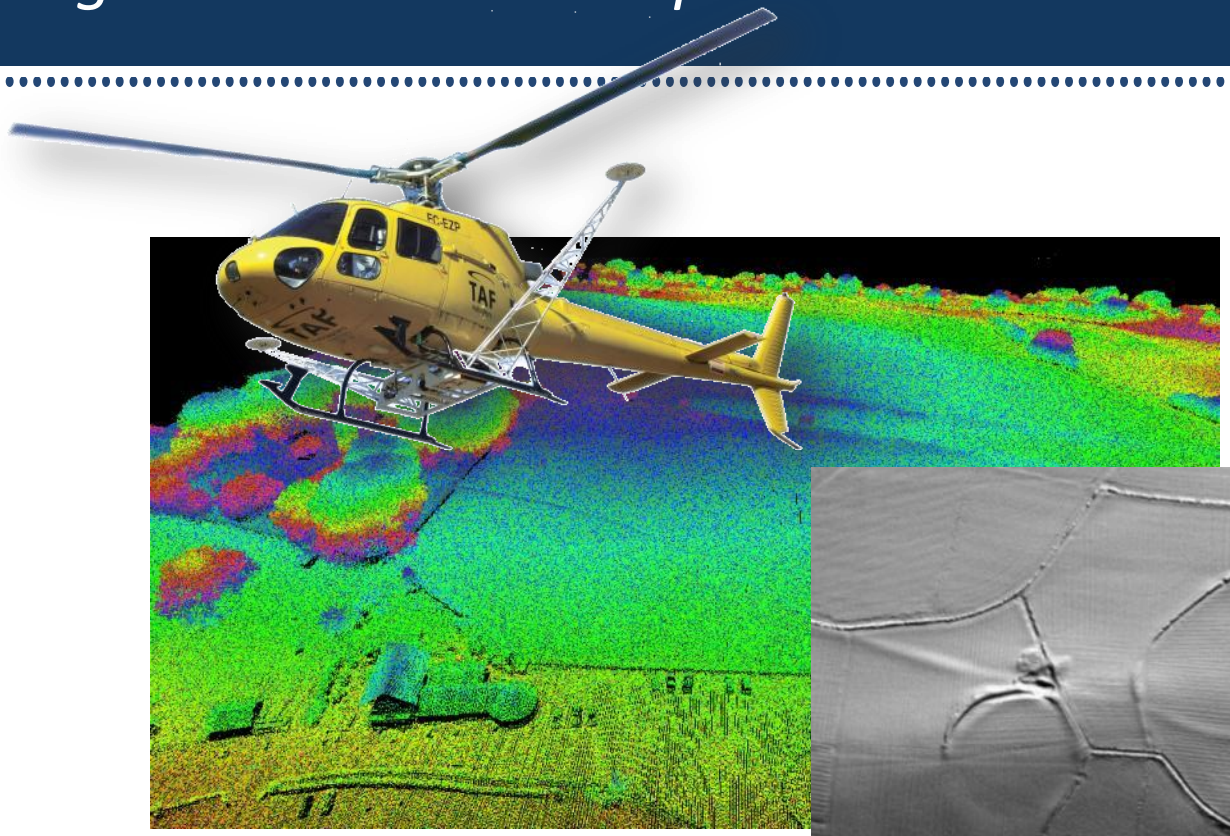
Landscapes

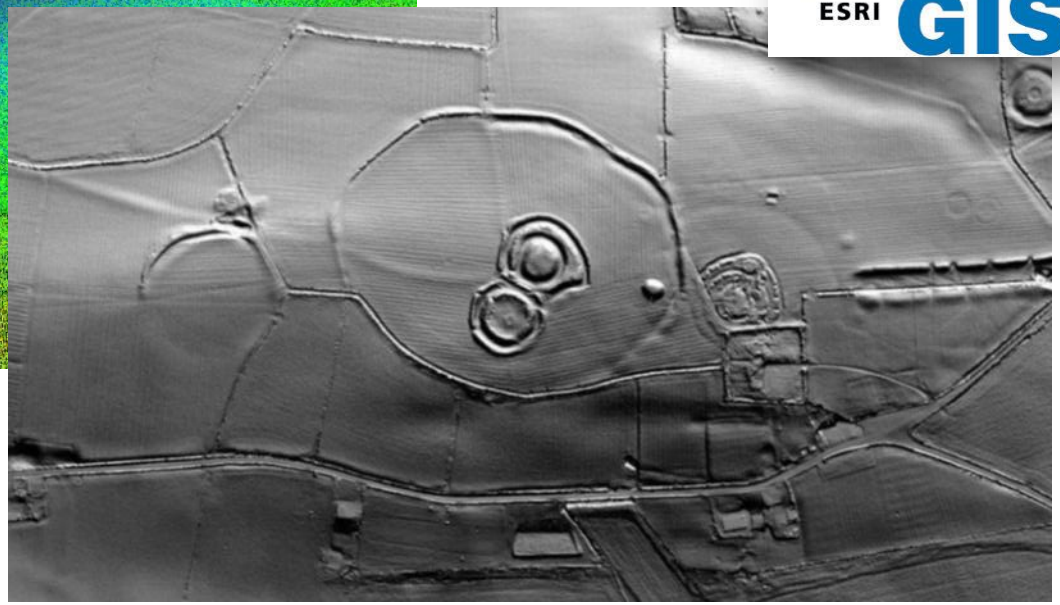
Buildings

Monuments

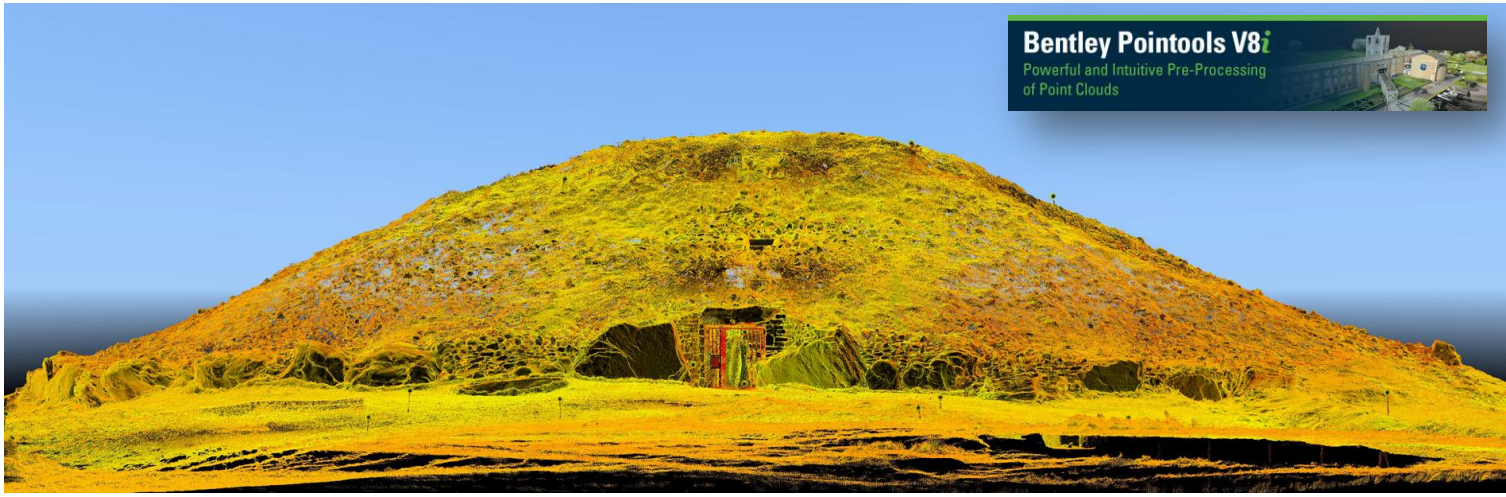
Artefacts

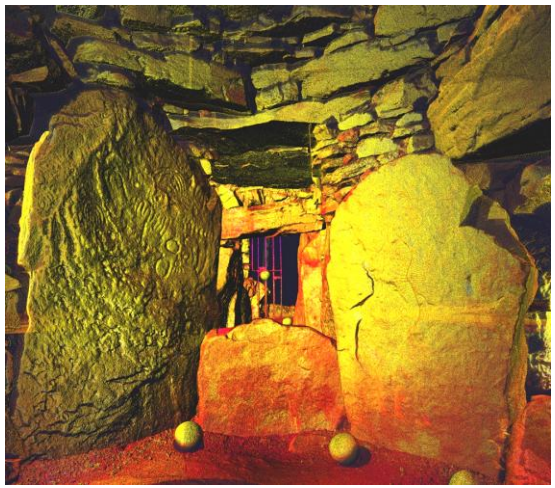
Digitisation – Landscape: Airborne Laser Scanning

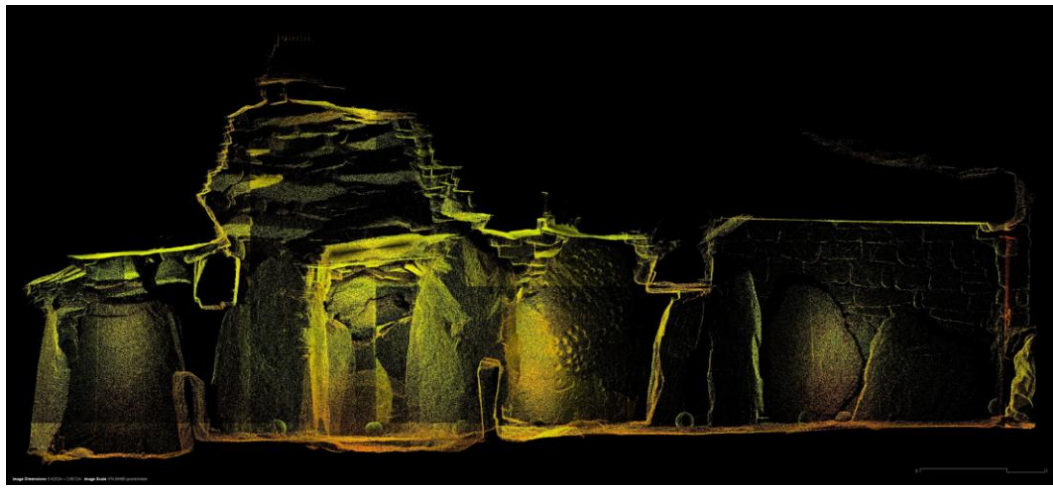




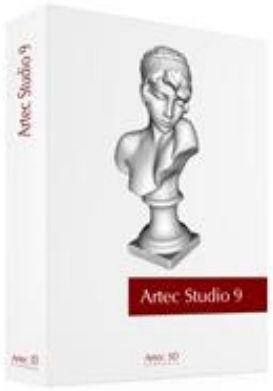
Digitisation – Buildings: Terrestrial Laser Scanning







Digitisation – Monuments: Structured light scanner

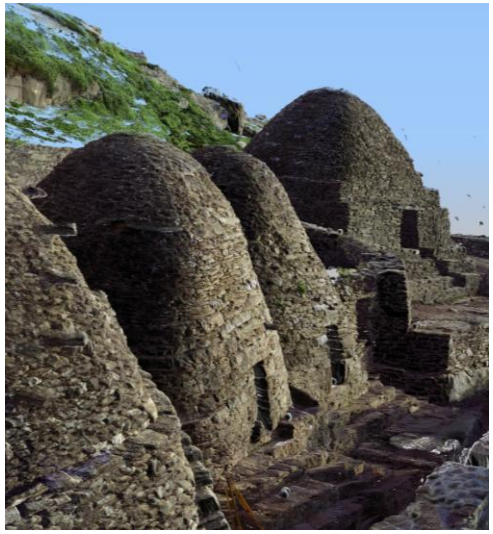


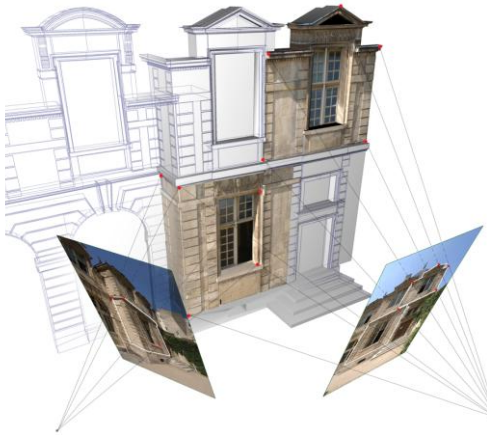
geomagic
the magic of making it simple™

isprs
information from imagery

The challenge: accessing the information

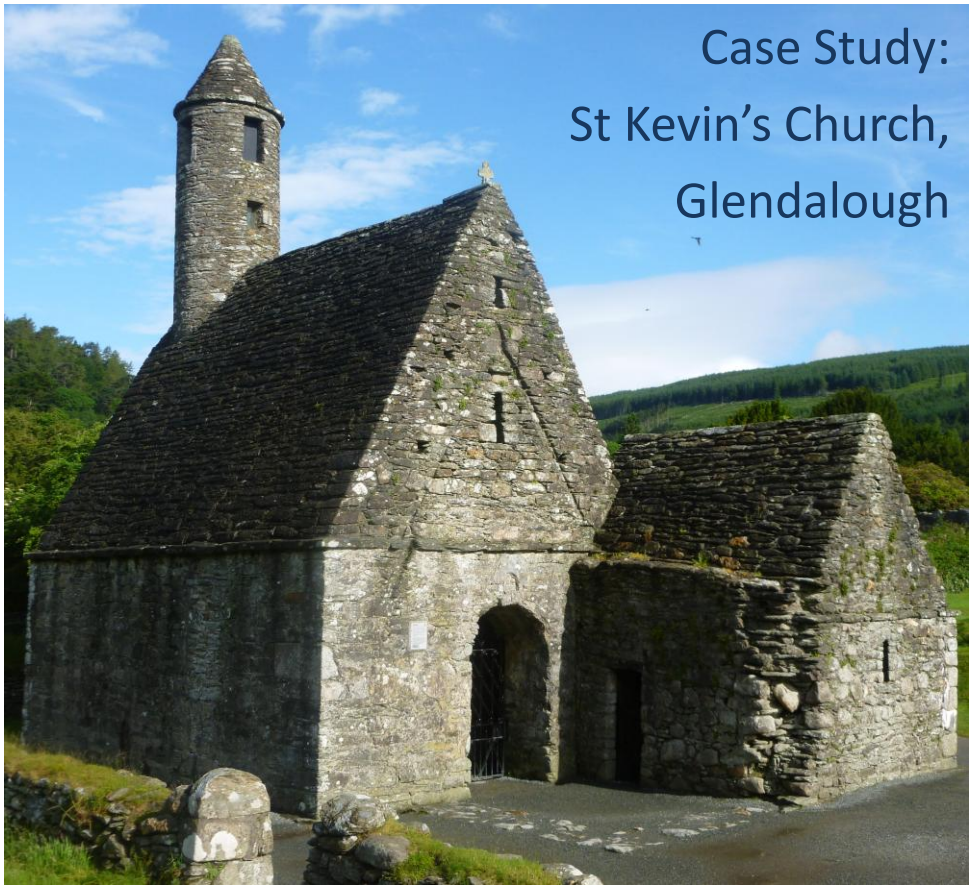
- Digitisation results in massive data volumes!
- Scientific data sets of value in their own right, but need to be adapted to be made accessible
- Raw data is often points not surfaces – difficult for inexperienced user to interpret.
- Interaction requires access to proprietary software, often at significant cost
- In many cases highly irregular shape and structure, procedural modelling not a satisfactory approach.
- More sophisticated approach required .....





Today's presentation

1. Digitisation overview
2. The Challenge – making data accessible
3. Our proposed Solution
   - Processing the pointcloud
   - Creating a mesh
   - Texture application
   - Final model
4. Deliverables



Case Study:
St Kevin's Church,
Glendalough

Processing the pointcloud

Case Study: St Kevin's Church, Glendalough

Faro Focus laser scan survey: 212,000,000 pts

Original Faro Data: 1.48 GB

Pointools: 1.77 GB

XYZ export file: **7.5 GB**

Note:
212 million points = 400 million+ polygons
Estimated OBJ file: 30 GB

Poor texture quality from Faro scan data

Processing the pointcloud

Case Study: St Kevin's Church, Glendalough

Pointcloud is decimated to 1cm resolution:

8,600,000 pts (4%)

XYZ export file: **330MB**

Note:
Decimation to 1cm was selected after experimentation

Appears to retain all relevant detail while being a more manageable file size.

Uniform point spacing

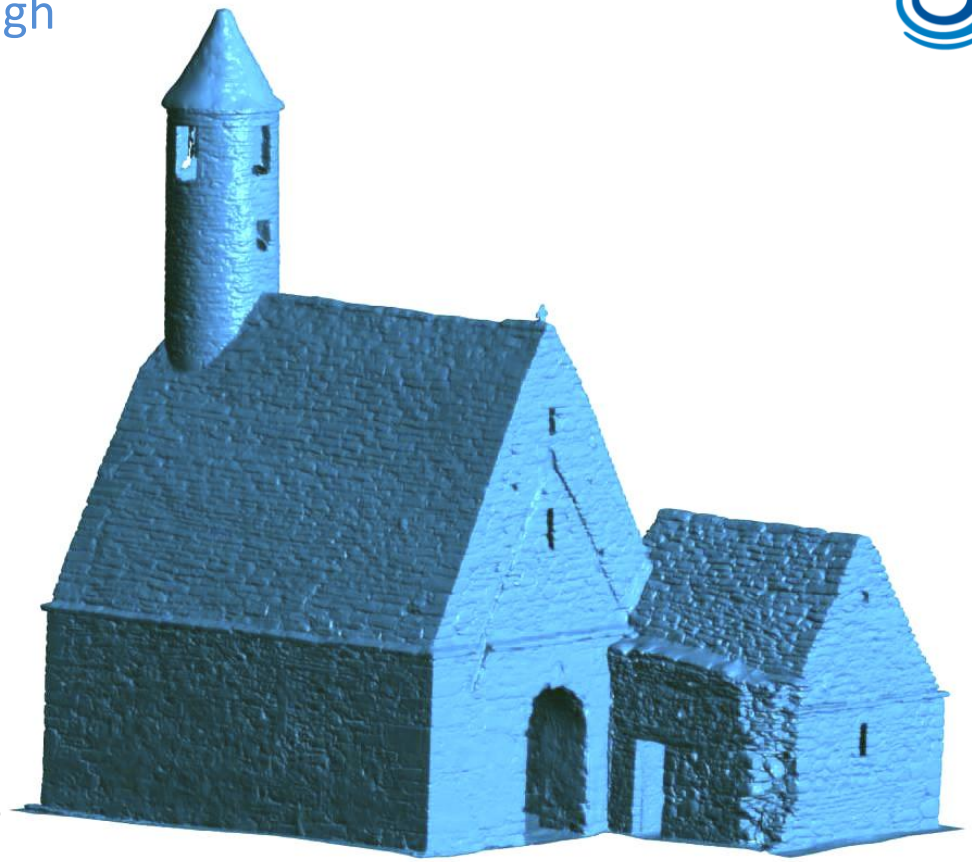
Creating the mesh

Case Study: St Kevin's Church, Glendalough

Meshed and 'cleaned up ' in Geomagic

Cleaned up by removing:
- Outliers
- Non-Manifold Edges
- Self-Intersections
- Small Tunnels
- Small Holes
- Highly Creased Edges
- Spikes
- Small Components

OBJ export: **17,600,000** polygons
1.34 GB
Hi-resolution mesh



Note:
OBJ file type is industry standard and one of the most cross platform extensions.

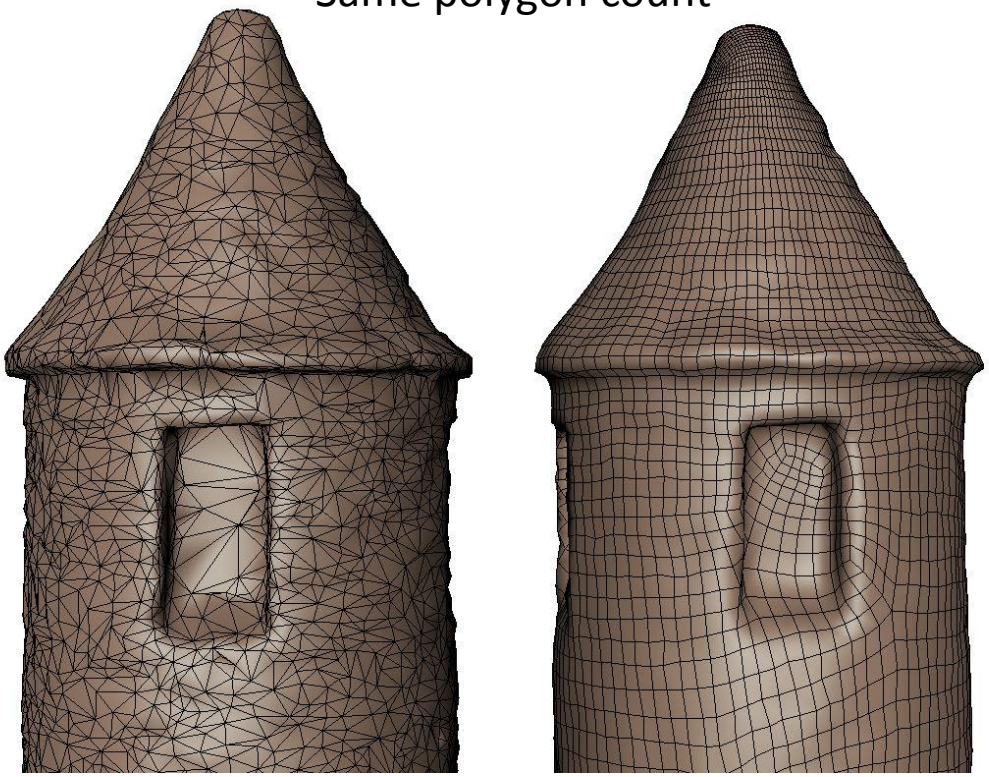
Retopology

Mesh is sent to Mudbox for **Retopology**

Retopology

The topology, or edge flow, is not ideal on the original mesh. This is certainly te case in scan data. It is usually very dense and very “messy”, with no order. This is not efficient for texturing, shading or animation and can cause issues with game engines, such as Unity. The purpose of retopologising is to create a clean mesh with desired edge flow that matches the form of the original mesh where the detail can be transferred from the original mesh.

Same polygon count



Decimated mesh

Retopologised mesh

Optimising the mesh

OBJ imported into Autodesk Mudbox for **Retopologising**

Imported mesh (high resolution)

17,600,000 polygons

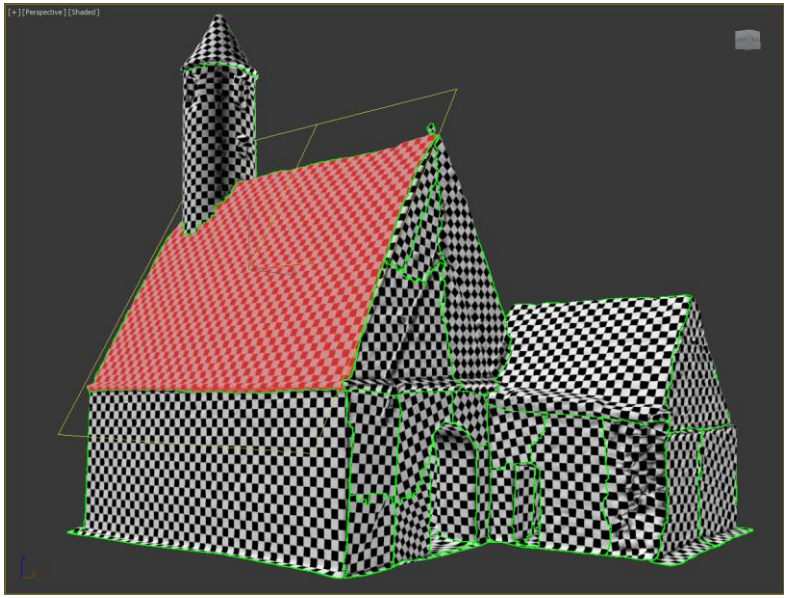
Retopologised mesh (low resolution)

200,000 polygons (1.13%)

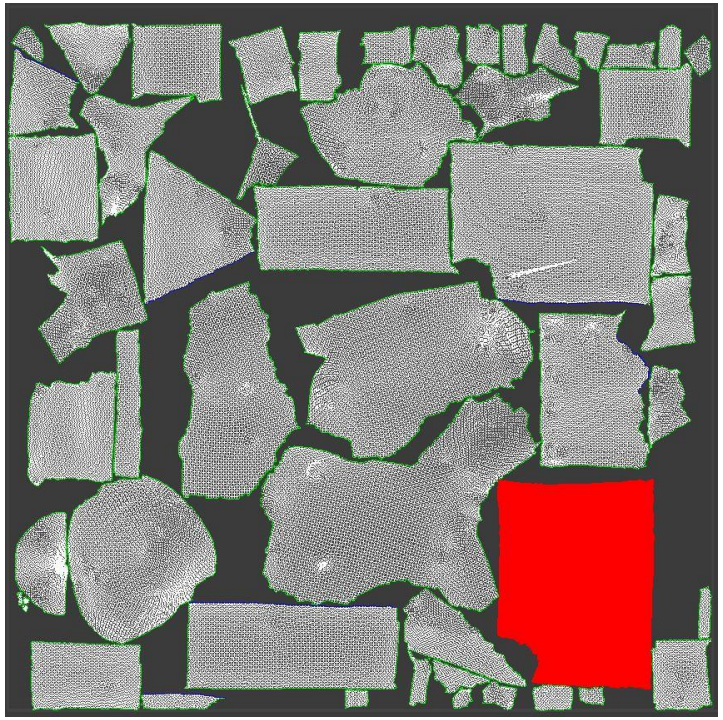
UV unwrapping

Retopologised mesh is **“UV unwrapped”** in 3DS Max

UV mapping is the 3D modelling process of making a 2D image representation of a 3D model. This process projects a texture map onto a 3D object. “U” and “V” denote the axis.



Checkerboard pattern added to examine texture stretching



Unwrella 3rd party plug-in that automatically unwraps the mesh in a few clicks. Supports multi tile UV’s

Extracting normal map

Case Study: St Kevin's Church, Glendalough

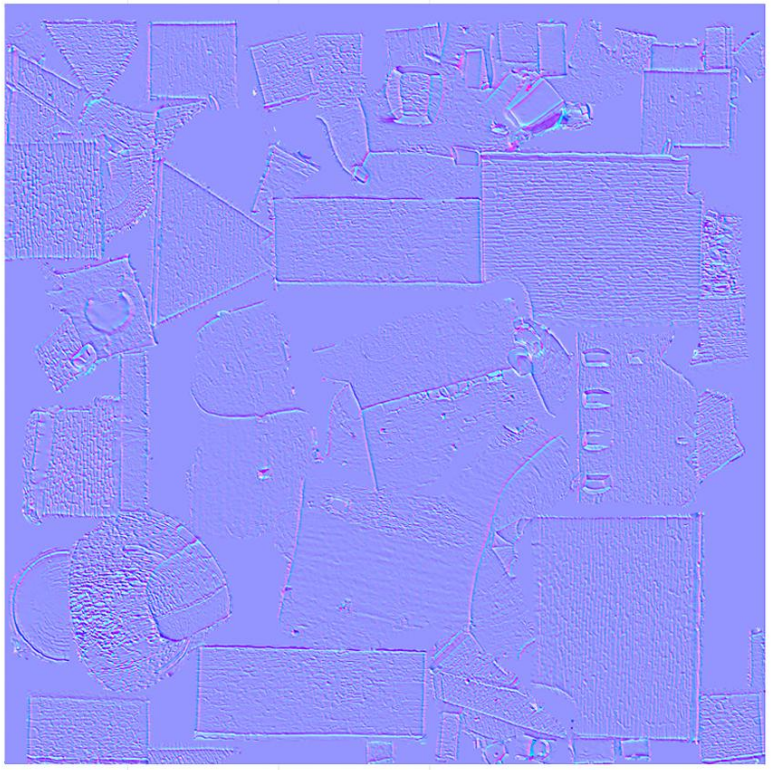
Normal Map extracted from hi-res mesh in Autodesk Mudbox

The detail from the high resolution mesh is extracted and applied to the low resolution mesh that now has it's UV coordinates. Note the detail is retained except the silhouette.

Normal maps

Normal Maps

A Normal Map is usually used to fake high-res geometry detail when it's mapped onto a low-res mesh. When a normal map is applied to a low-poly mesh, the texture pixels control the direction each of the pixels on the low-poly mesh will be facing in 3D space, creating the illusion of more surface detail or better curvature. However, the **silhouette of the model doesn't change**.

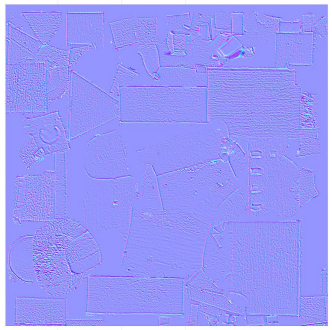


Normal map extracted from hi-res mesh

Texture ready mesh

1 2 3

+



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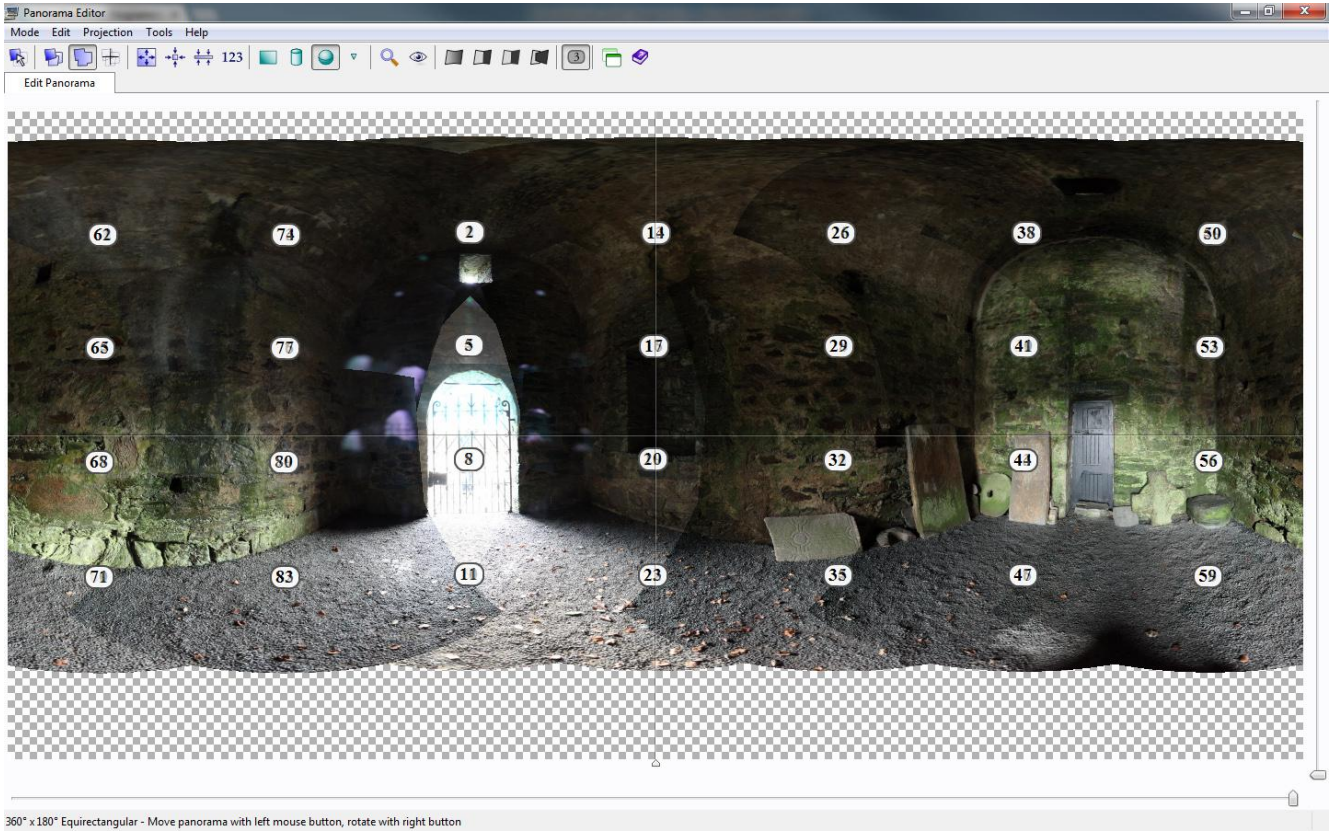
1. Low-resolution mesh with a clean topology and UV coordinates for applying maps.
2. Normal map simulating detail from hi-resolution mesh
3. Texture ready mesh

Texture creation - panoramic image capture

- Canon 5D Mk 2
- Gigapan Epic Pro
- PtGui Software



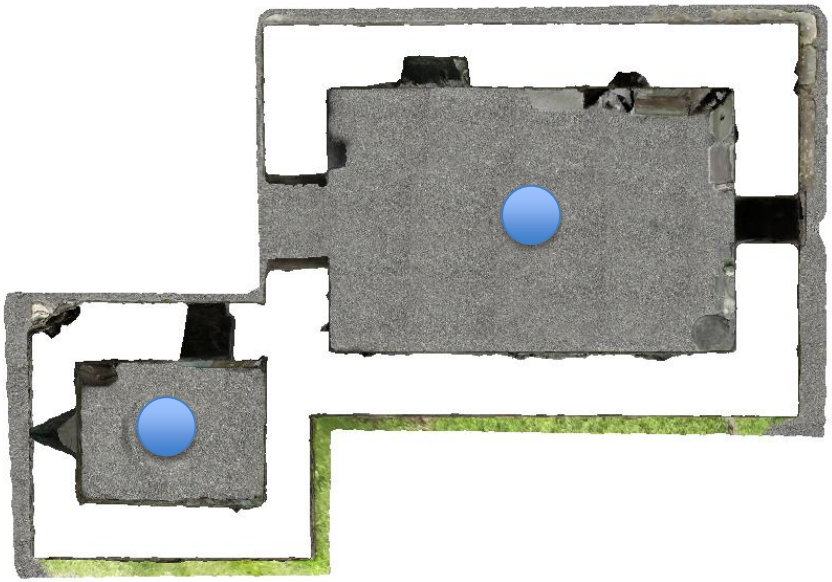
Internal chamber was very dark with bright light coming through so HDR images were captured at 3 exposures. 84 images in total

Texture creation - Mapping

7 Panoramic set up positions

5 External
2 Internal

Objective is to get good coverage of the building with an adequate overlap



Texture creation - stitching

Equirectangular Projections

FOV of 360 ° x 180°

Texture creation - Mapping

In **Mari** the **Sphere Map Projector** function used and unwanted data is masked out
Panoramas are projected from the same locations within the scene

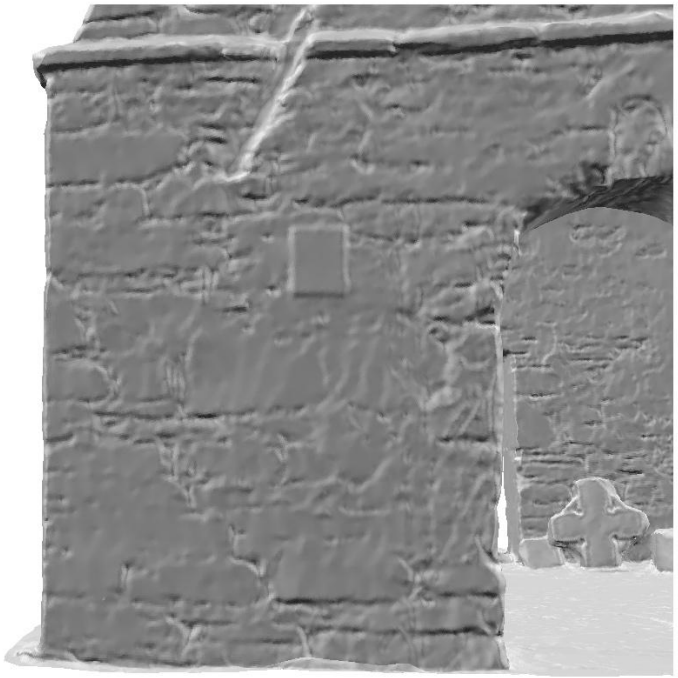
2. Texture projected on the side of the building is skewed due to the angle of the surface to the camera

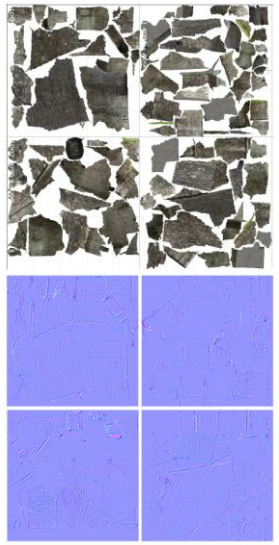
3. These areas are then masked out and textured from another projection

1. Location of Sphere Map Projector in scene

Texture creation - Mapping

-A high quality texture is applied to the whole mesh
-Areas that the panoramas missed are textured from individual images
-To increase the quality of the texture multiple UV tiles can be created.
- Instead of a single texture map up to 100 maps can be applied to a single mesh

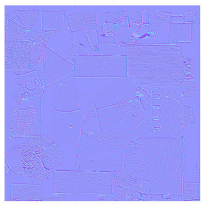




4 UV tiles:
Diffuse and
Normal Map

Texture creation – Final Model

Final model with normal and diffuse (texture) map

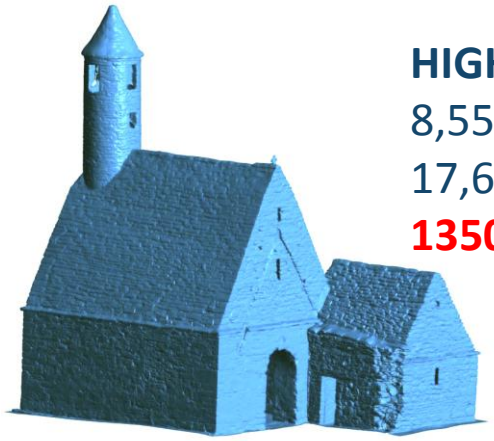


Final model

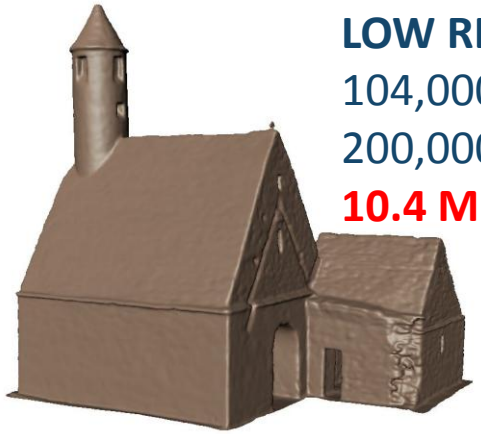
Final model

Workflow summary

ORIGINAL SCAN DATA
212,000,000 Points
400,000,000+ Polygons
7500 MB pointcloud



HIGH RES MESH
8,550,000 Points
17,600,000 Polygons
1350 MB obj



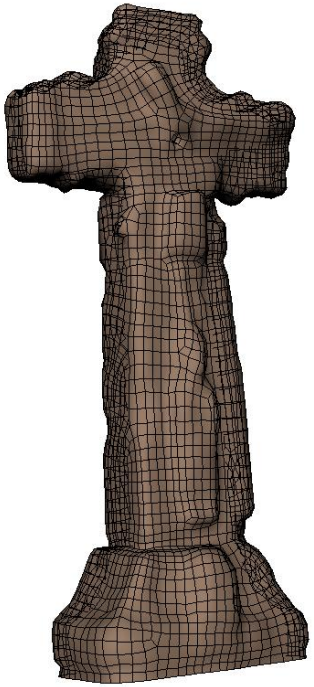
LOW RES MESH
104,000 Points
200,000 Polygons
10.4 MB obj

TEXTURED MODEL
10.4 MB
+ Diffuse 3.5 MB
+ Normal 2.5 MB
= 17 MB total (.22%)

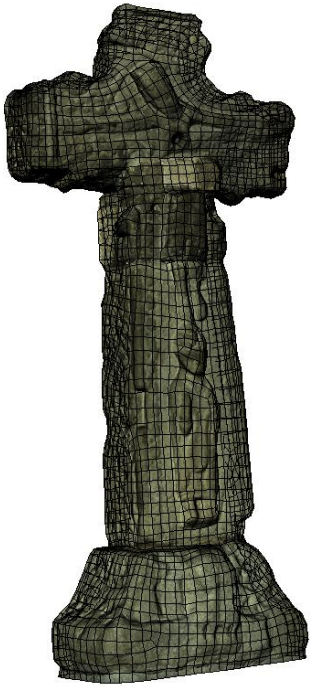
Workflow - monuments

Case Study: Market Cross, Glendalough

Original Scan Data
7.35m polys / **2130 MB**



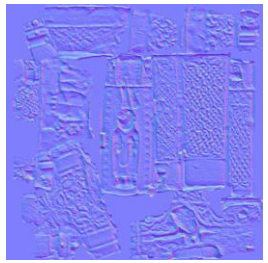
Retopologised Mesh
7700 polys / **558 KB**



Texture/Normal/AO Mapped
7700 polys / 558 KB
3 MB Total

Note: For Artec scanner the scan texture can be transferred to new mesh

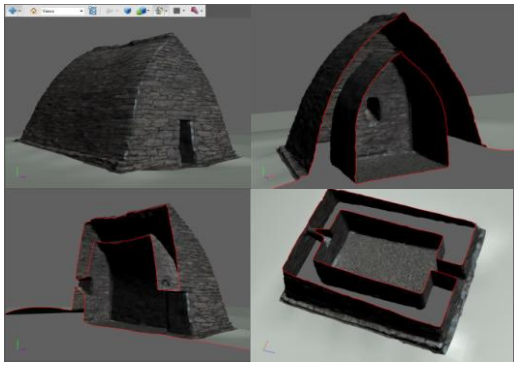
Diffuse Texture



Normal Map

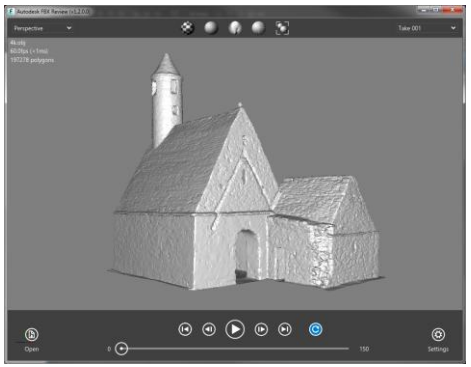
Ambient Occlusion

Potential Deliverables



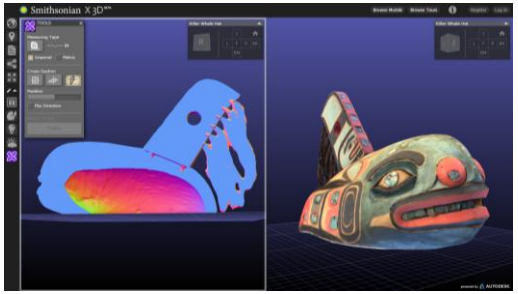
3D PDF

- Some browsers don't support
- Some pdf viewers don't open
- Can require download
- Doesn't support Normal Maps
- Can be RAM heavy



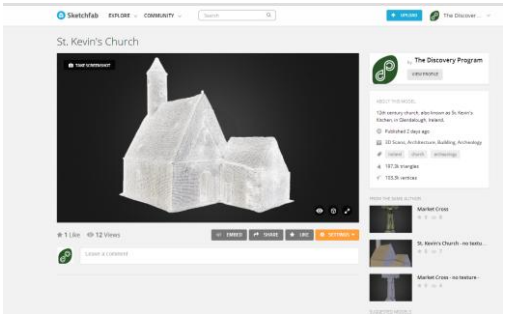
Autodesk FBX Review

- Free mesh inspection software
- Requires download and installation
- Works on Apple products
- Works 'offline'



Autodesk X 3D

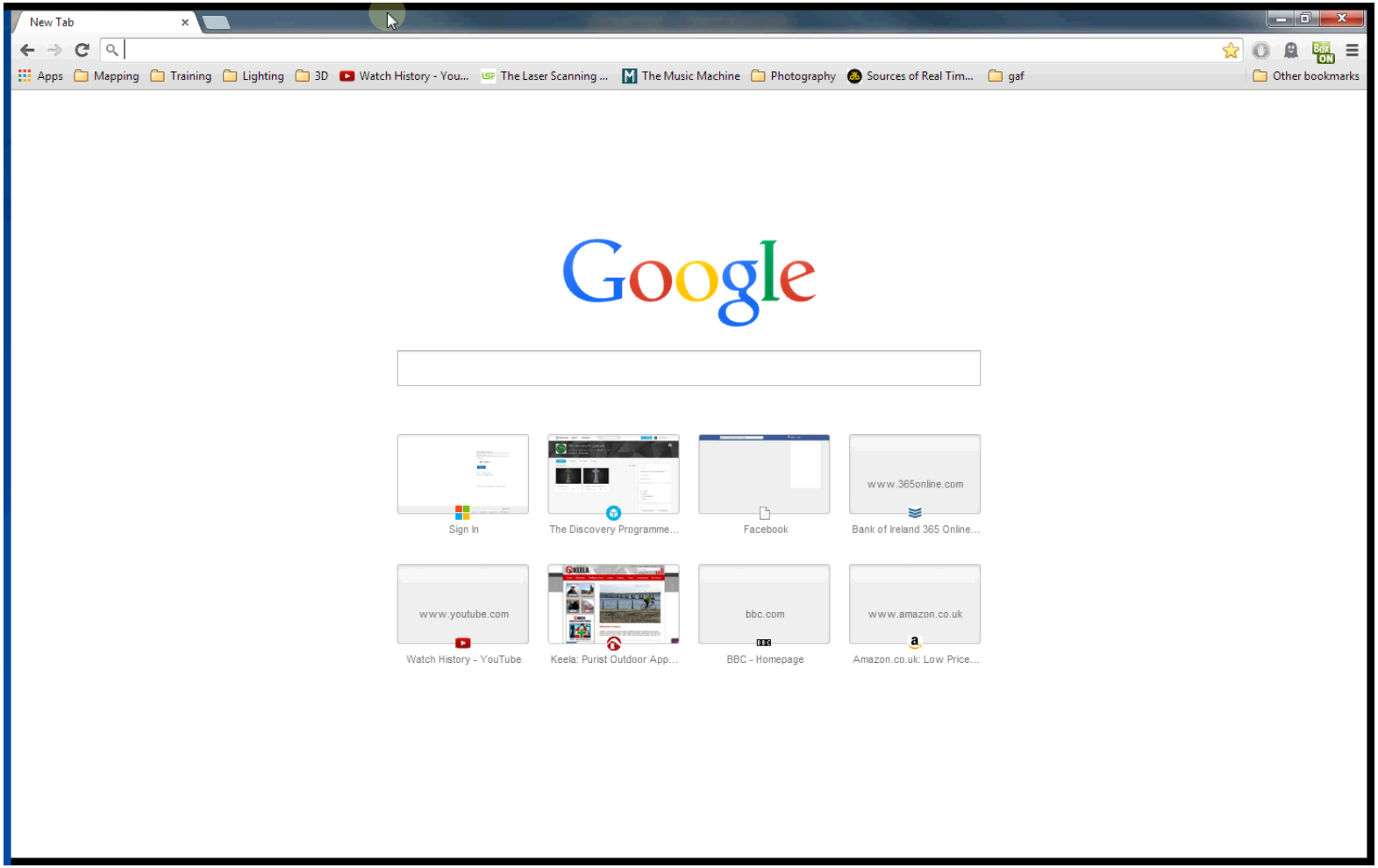
- Online in-browser viewer
- Variety of functions: Measure/Cross-section/Move light source/Turn off texture
- Not available until 2015



Sketchfab

- Online in-browser viewer
- Less functions than X 3D (currently)
- Ready available
- Tablet and Mobile support (fixed rotation)

Deliverables - demo



information from imagery

The Discovery Programme

Centre for Irish Archaeological Research

Questions?
Thank You

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3D ICONS is funded by the European Commission's ICT Policy Support Programme.