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Structure from Motion

Different approaches and practical application

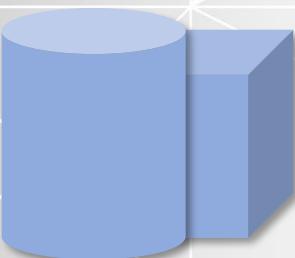
A volunteer?





Different 3D Modelling techniques

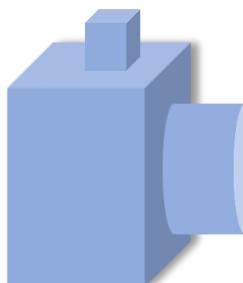
Subdivision
and geometric
primitives



Mesh sculpting



Scanning /
Acquisition



Agisoft



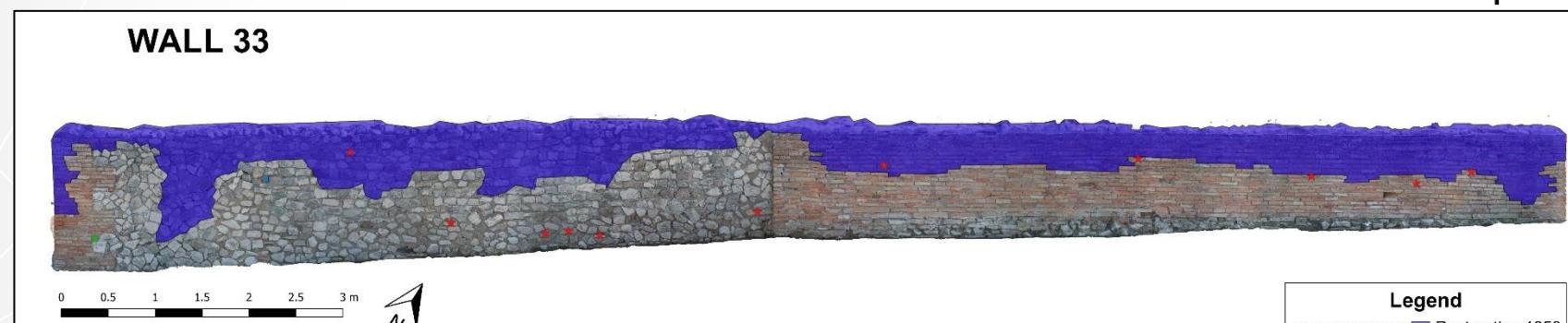
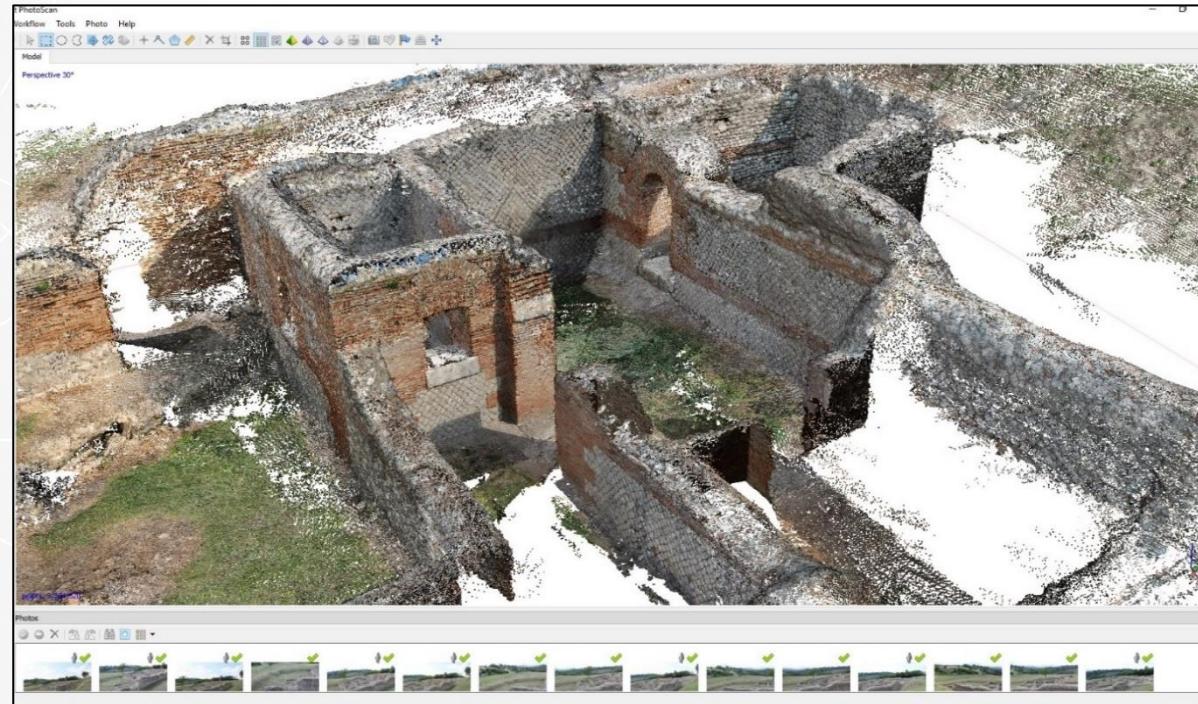
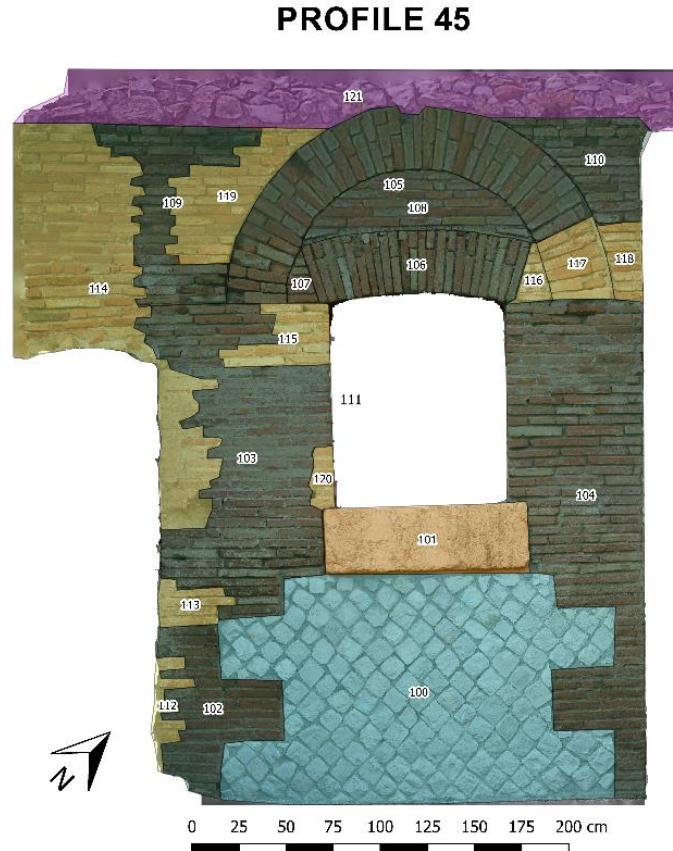
Why?

Public engagement

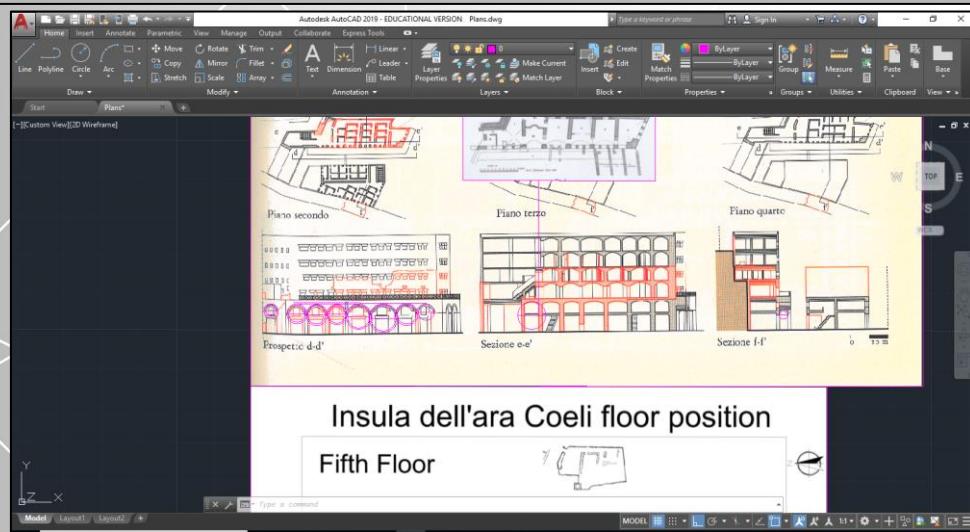
Enabling examination of fragile artifacts

Creating simulations for measurement

Tracking restorations, documenting standing remains and dating buildings in Aeclanum

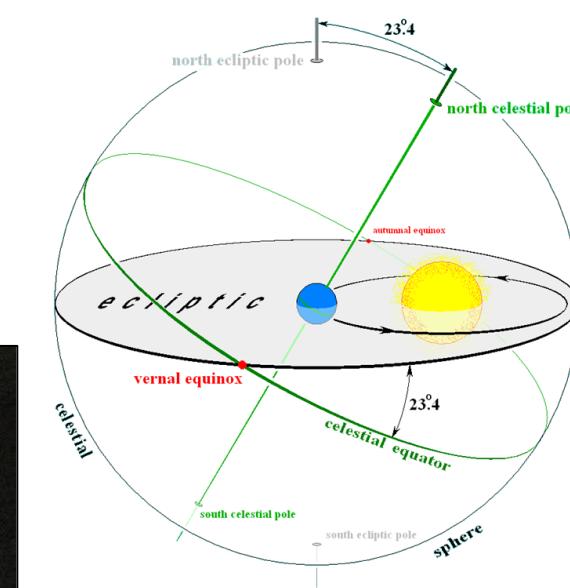


The Insula dell'Ara Coeli



- Ongoing project of the University of Southampton (Laserscanner and Gpr analysis)
- Using 3D model for analysing the levels of natural light in highly dense populated areas

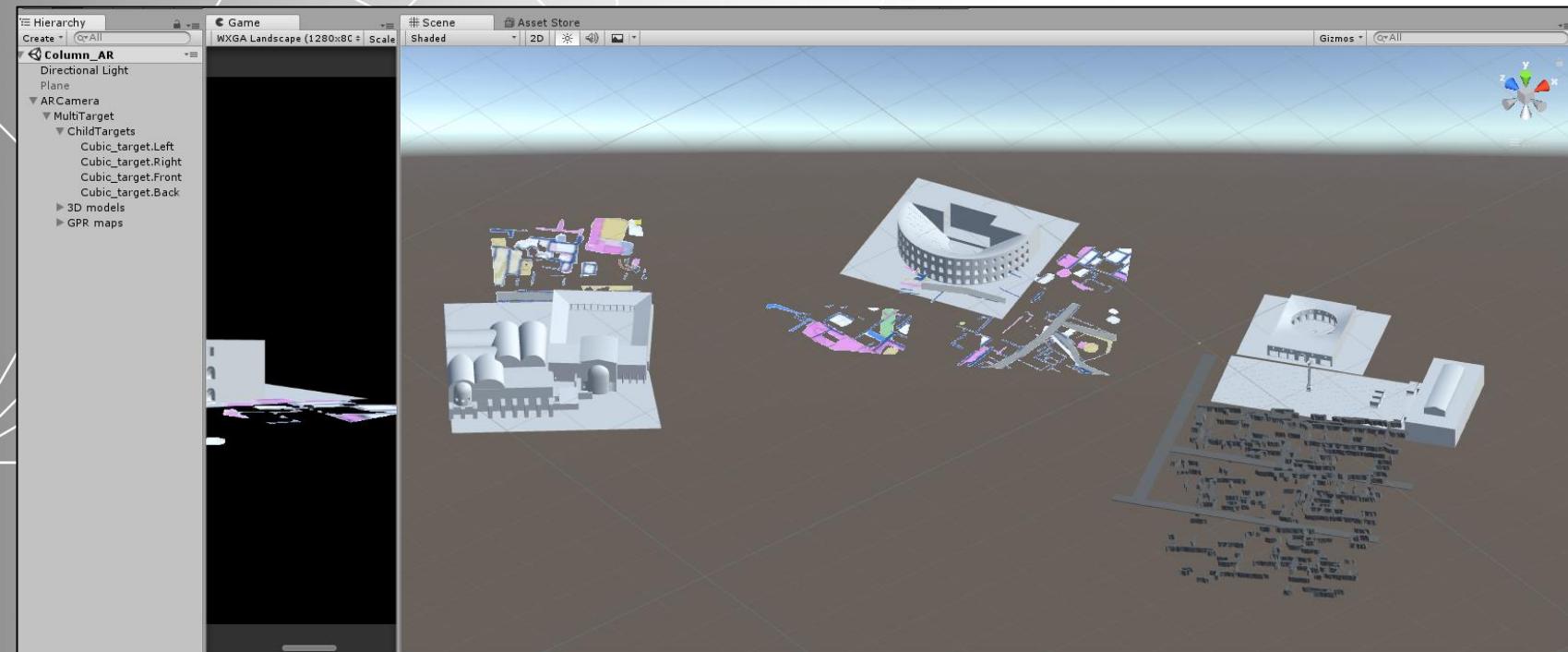
Studying natural light levels with 3D reconstructions



Title	<i>Medianum 9 at the ground floor of the Apartment 15 of the Case a Giardino (glazed windows)</i>
From	N
Time	14:30
Day	21/06
Sun Inclination	56.1°
Median Luminance	25/255
Histogram	A histogram showing the distribution of image luminance values. The x-axis is labeled "Luminance value (Low light => High light)" and ranges from 0 to 120. The y-axis is labeled "Image percentage" and ranges from 0 to 5. The histogram bars are blue, showing a primary peak at approximately 25, which is highlighted by a red vertical line. The distribution is roughly symmetric and centered around 25.



From excavation to augmented reality



Presenting all this
invisible knowledge?

- **3D overlay** of camera feed.
 - Unity 2018.1 for development.
 - Vuforia 7.2.20 for AR features.
- Multi-image target



Neolithic House, Skara Brae, Orkney

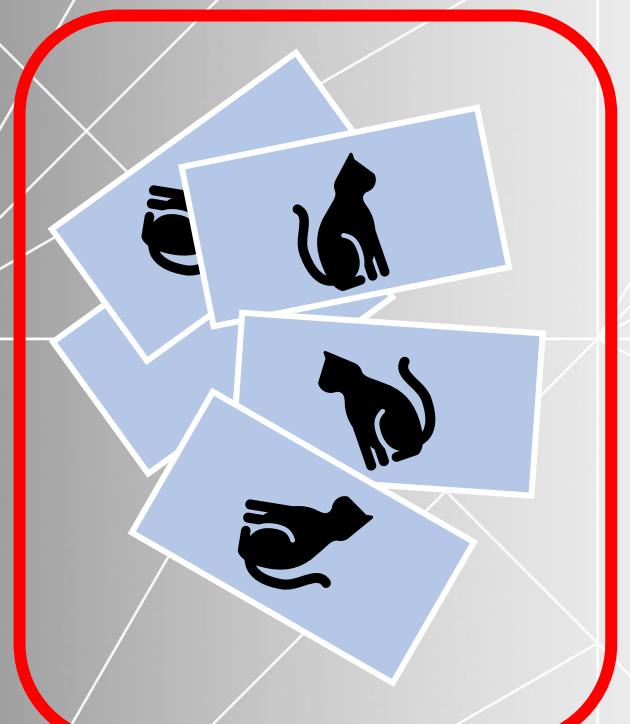
Dr Hugo Anderson-Whymark
<https://skfb.ly/lYv>



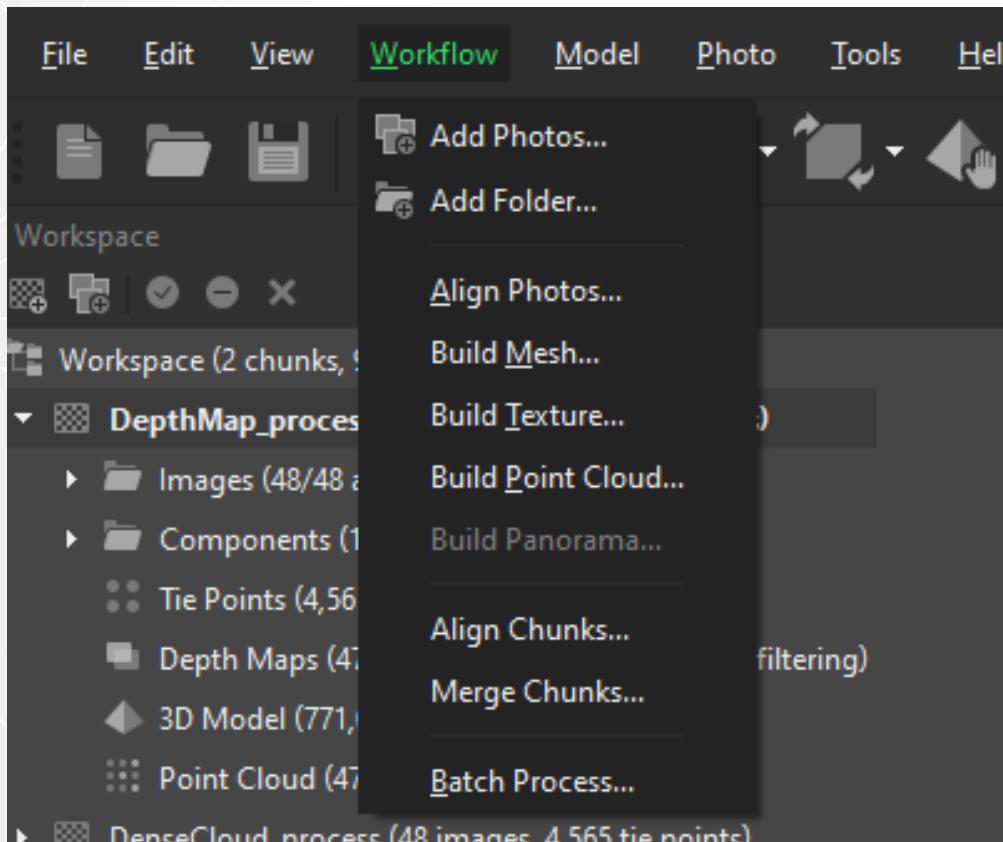
Pictish Cross Slab, East Mainland, Orkney

Dr Hugo Anderson-Whymark
<https://skfb.ly/lYv>





Starting simply

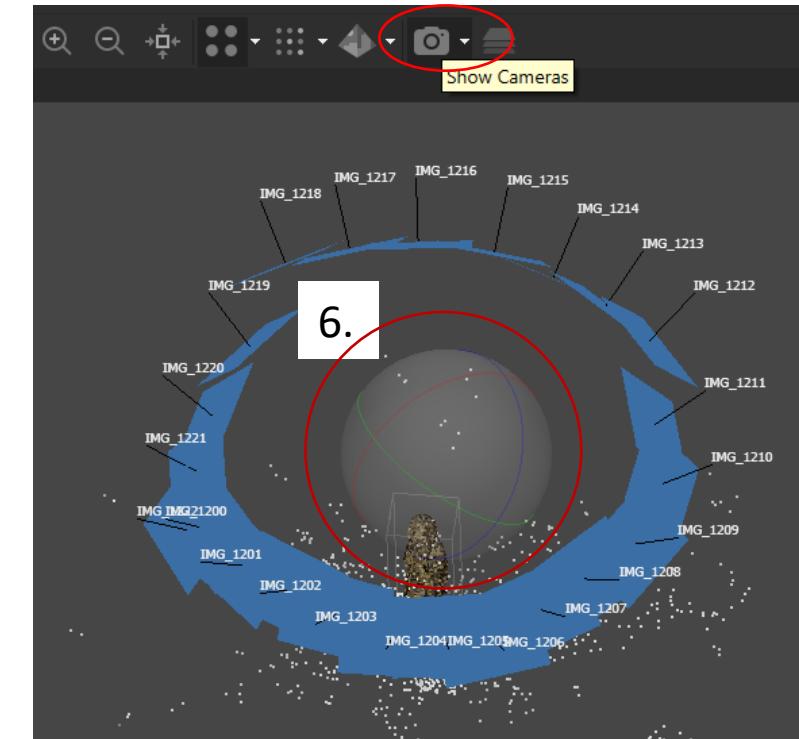
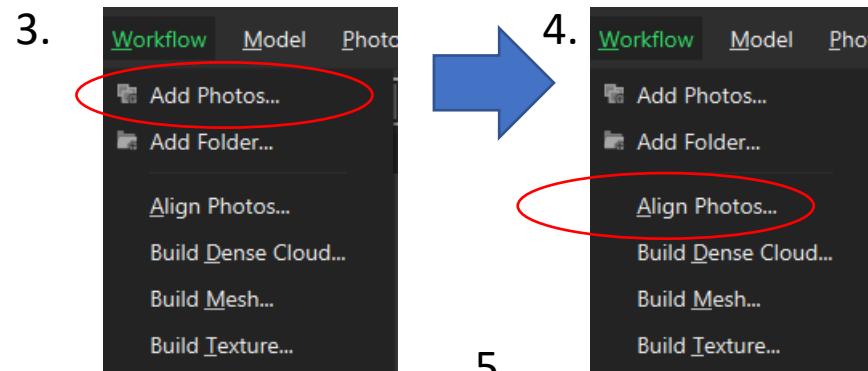


Sample Data

https://github.com/CambridgeDH/DH-RSE-Summer-School-2023/blob/main/Day4/optimised_reduced_overlap.zip

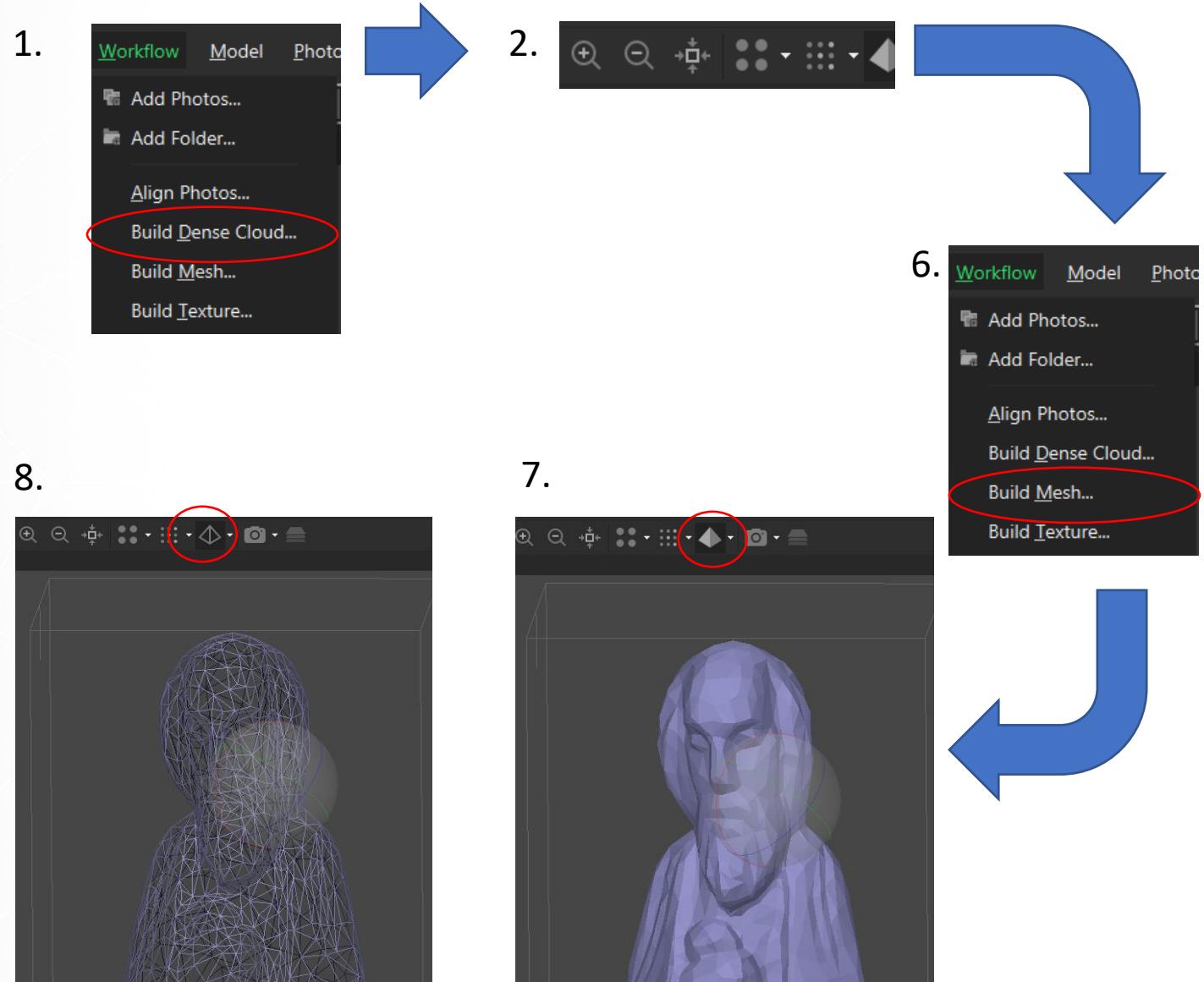
Photogrammetry workflow using default settings

1. Unzip bird_bath.zip file – it contains 23 images
2. Open Agisoft Metashape
3. Import the photos
4. Align the photos
5. Inspect the camera positions
6. Rotate the scene using the ball

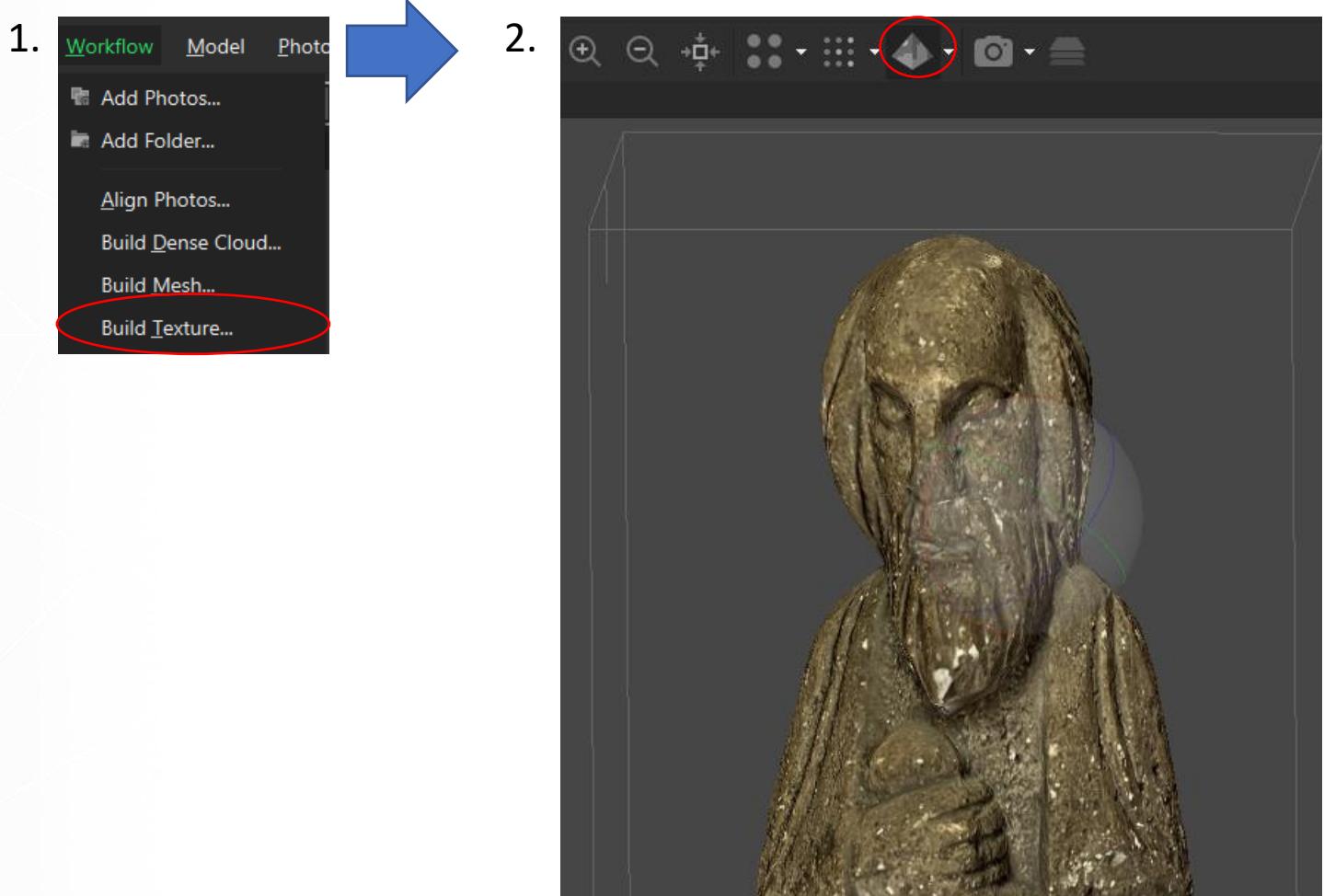


Photogrammetry workflow using default settings continued

1. Build Dense Cloud using 'Low' setting
2. Turn on the Dense Cloud display
3. Turn off the camera display 
4. Zoom into the point cloud using mouse wheel
5. Notice the cuboid Region – this is the 3D space that will be 'processed'
6. Build Mesh using 'Dense Cloud' and a 'Low' face count
7. View Mesh
8. Change mesh view to Wireframe



Photogrammetry workflow using default settings continued



What makes a suitable subject?

Considerations for Photogrammetry

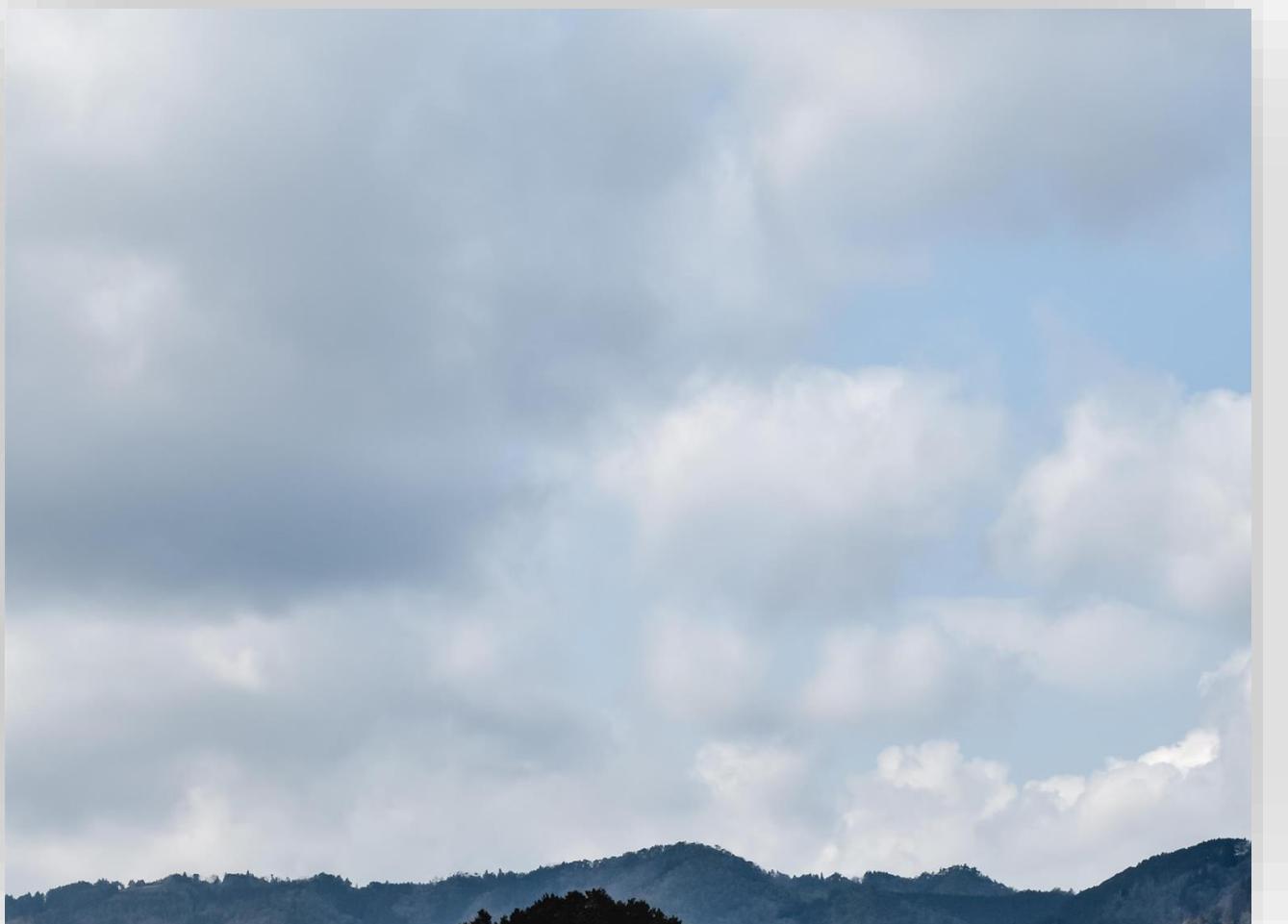
Ideal Subject requirements

- Non-reflective surfaces
- Surface textures visible
- Subject must remain in the same position throughout capture
- Access to the subject from multiple angles
- Capture a reference measurement



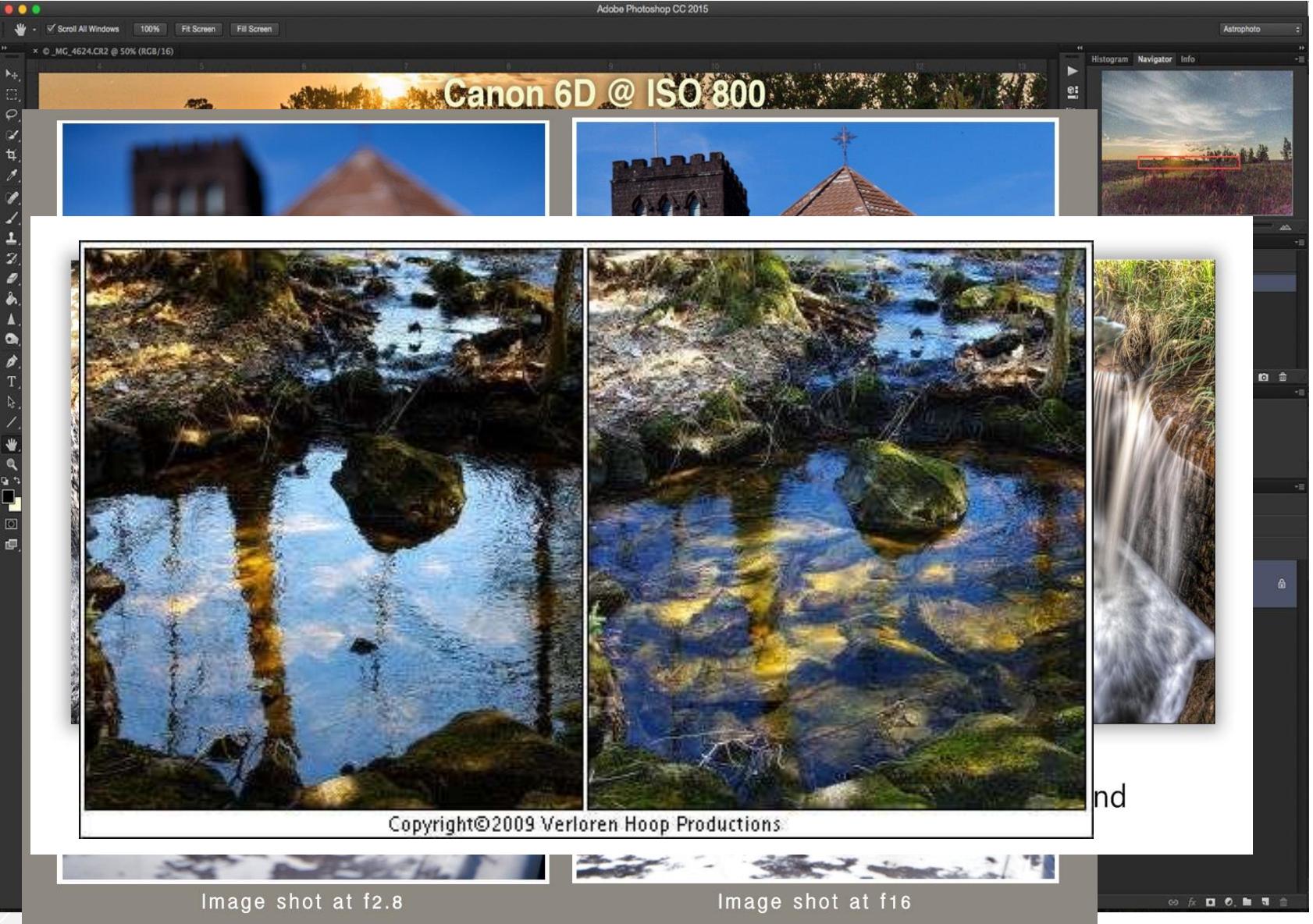
Ideal photographs

- Soft diffuse light (not bright sunny day)
- Avoid casting shadows on the subject
- Subject must remain in the same position throughout capture



Ideal photographs

- Fixed focal length for all photos
- Low noise (ISO settings)
- Large Depth of Field (Aperture settings with a higher f number e.g. 8 to 11)
- Tripod and remote control
- Polarising filter can reduce glare and reflections

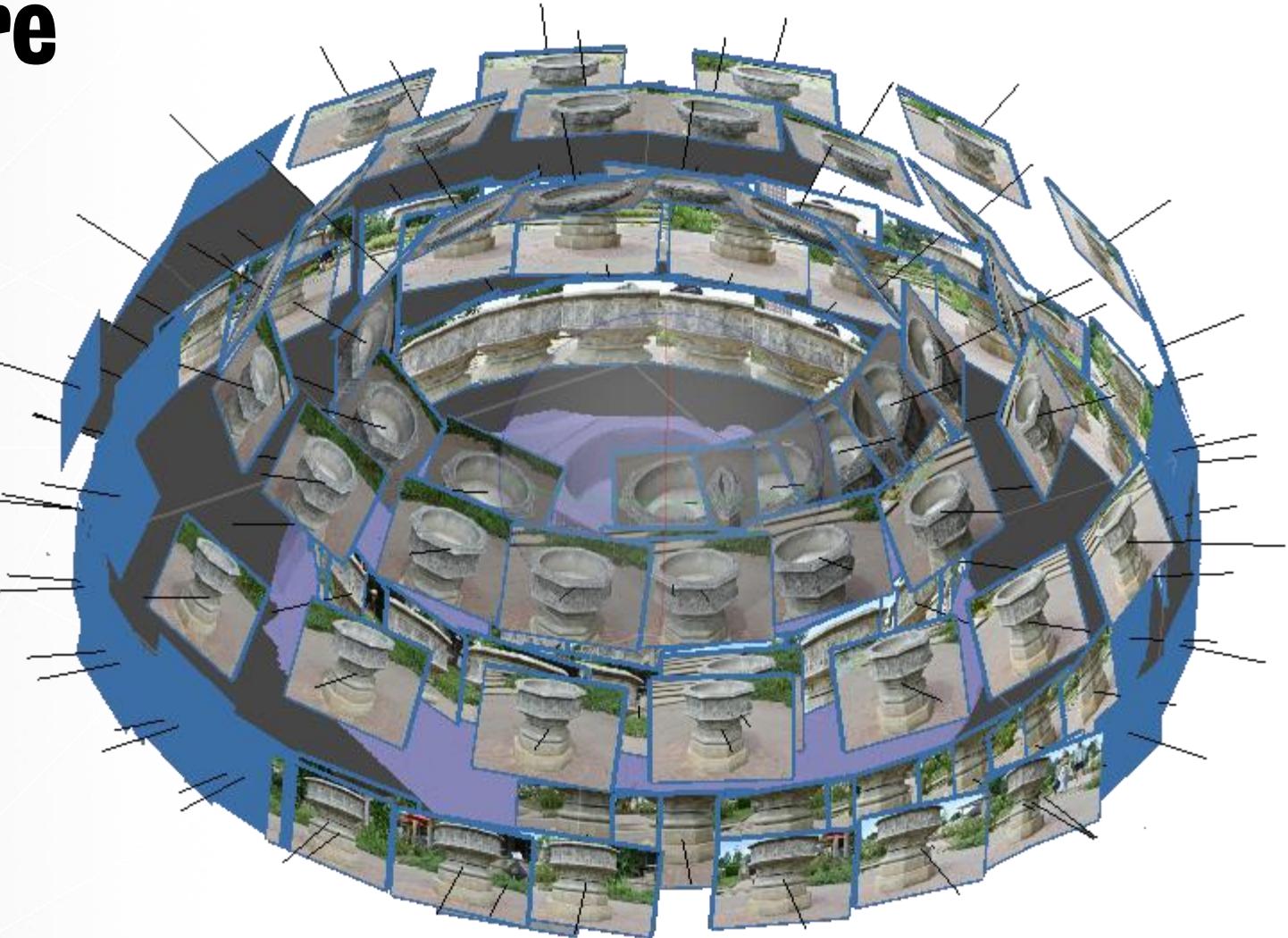


Camera Tips

- | Set the ISO fixed as low as it will go (i.e. not Automatically adjusted) to 100 or 200
- | Use a tripod to keep the camera still
- | Use a time delay remote control for even more stability and turn off Vibration Reduction
- | Use a Cross Polarizing Filter to reduce specular light
- | Set aperture to $> f8$ to maximise the depth of field
- | Keep focal length fixed, or use a Prime lens
- | Aim for 70% overlap in your images

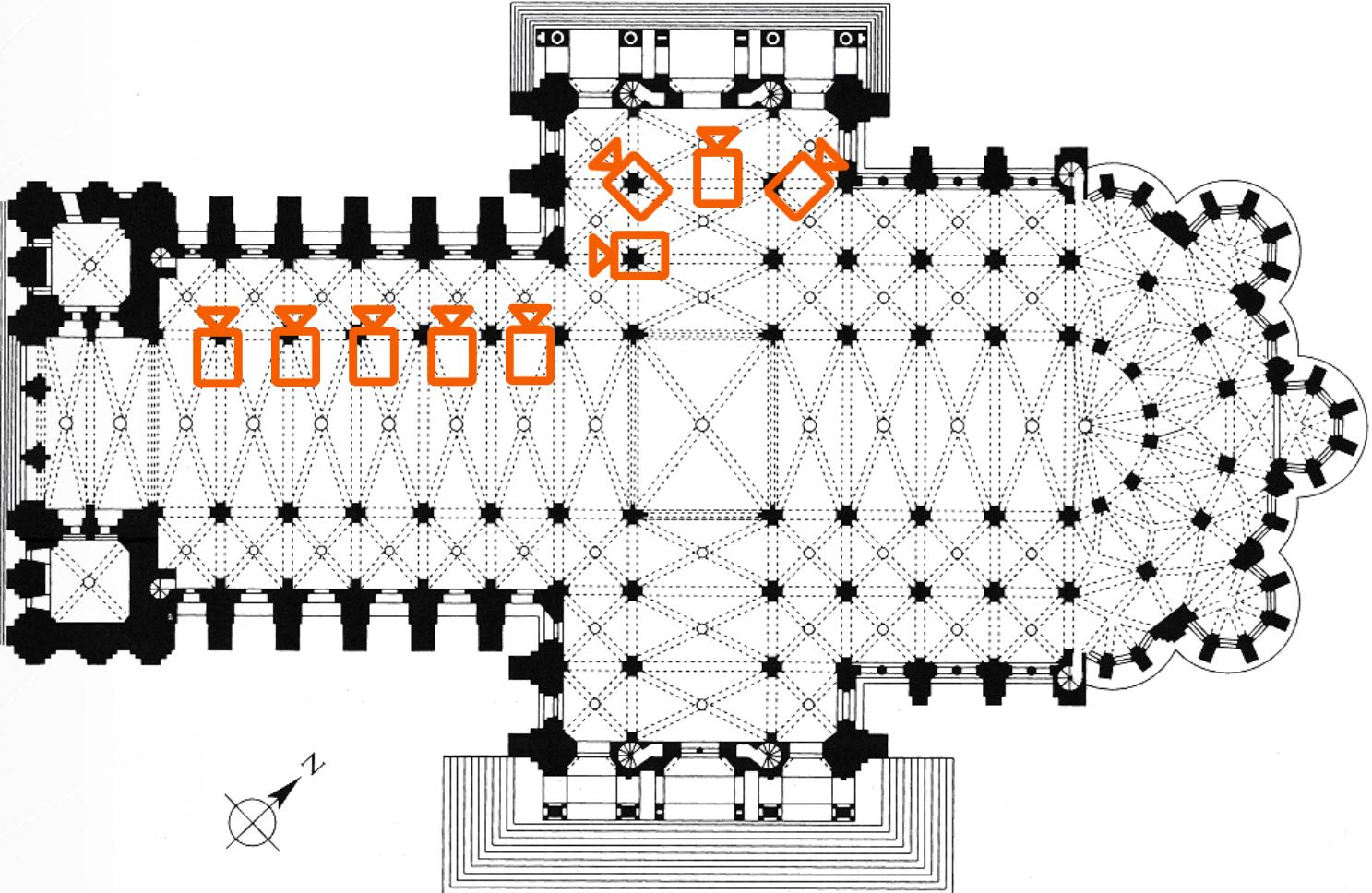
Two Strategies for Capture

Objects



Two Strategies for Capture

Interior spaces



Rule breaking example

Download and unzip BirdBath_by_video.zip

The images in this set were extracted from a video using a program called ffmpeg using this command:

```
ffmpeg -i IMG_1169.MP4 -r 1/0.5 bb_pp_%03d.jpg
```

Explanation:

-i (input)

-r (rate, in this example 1 frame for every 0.5 seconds of video)

%03d - a syntax which increments the image file name.

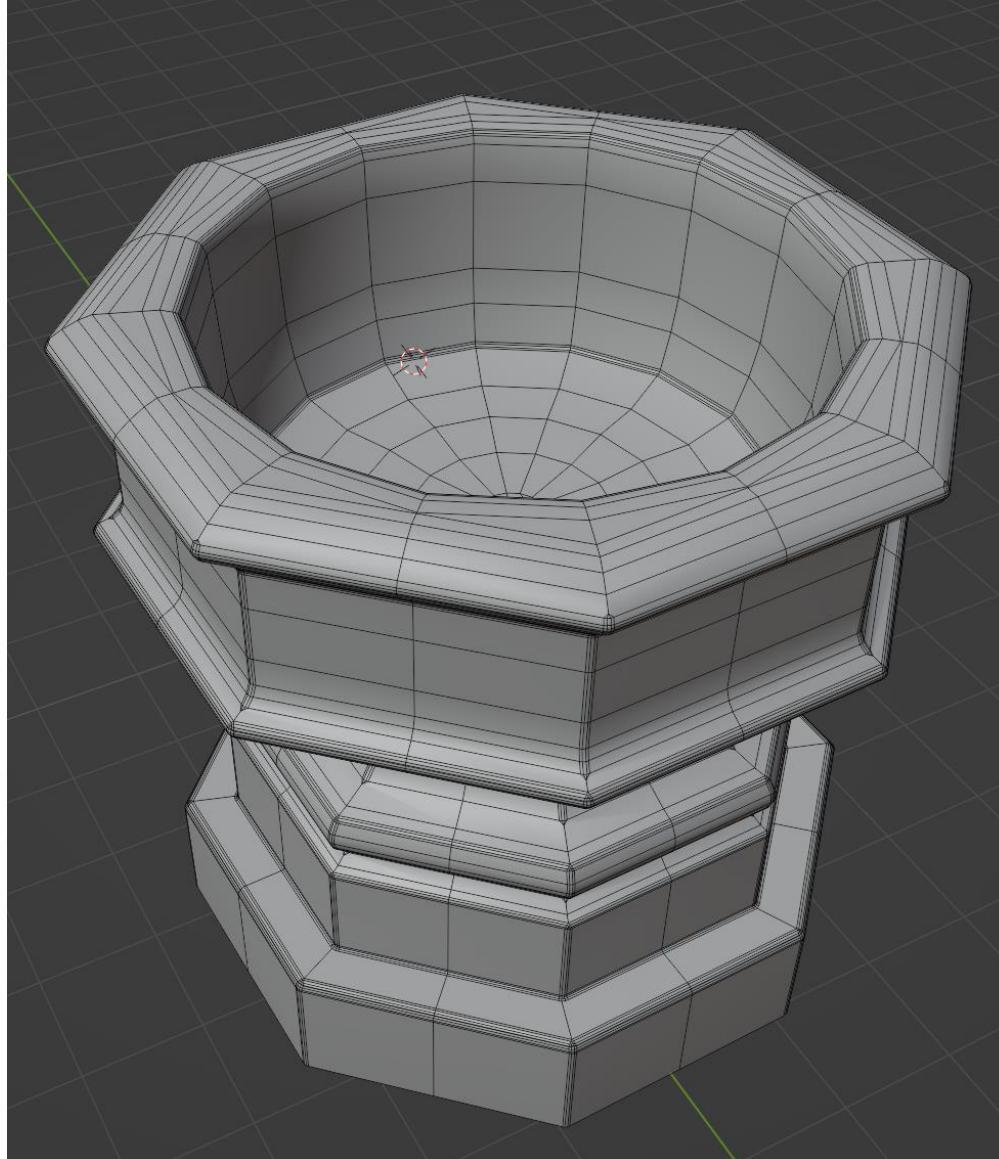
e.g. bb_pp_001.jpg, bb_pp_002.jpg, bb_pp_003.jpg etc.



Models created through Photogrammetry are very dense – there is often much more geometric information than need to represent the form of the object.

Using 3D modelling software we can reuse some of the data captured through photogrammetry to make a simpler model for visualisations

The Blender file in the folder BirdBathBlender contains a completed example which I'll demonstrate ...



Masking

- A turntable can be used for small objects rather than moving the camera
- Masking can be done per image, using the Photo tool
- Masking can be done by model – do a quick and dirty model to isolate

Selecting and deleting

- Areas of mesh and point cloud can be selected and deleted before or after mesh creation
- Space Bar will toggle you between current and previous tool
- Orthographic perspective can be helpful for deleting precisely (Num Pad 5)
- Freehand deletion is good for “shaving” off edges

Viewport Navigation

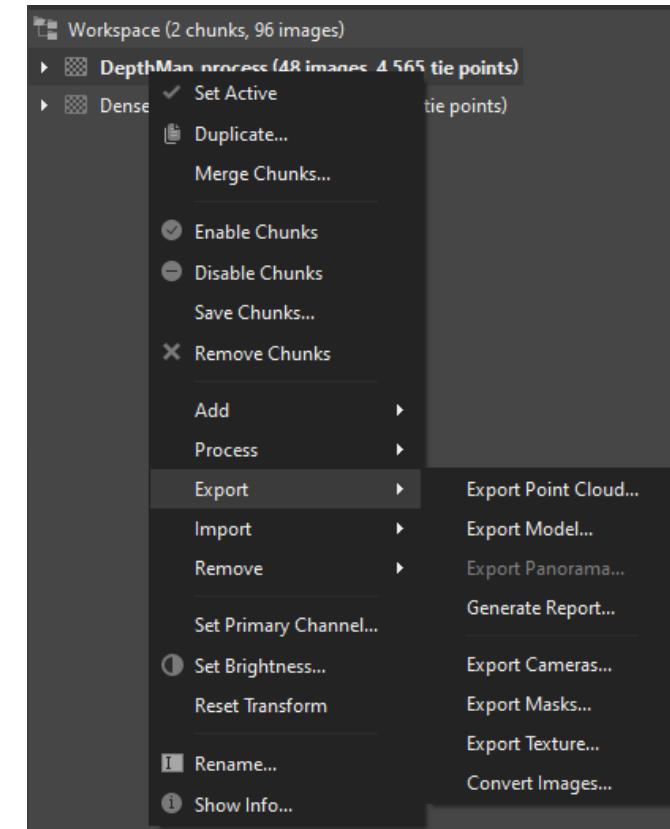
- Num Pad 5 toggles into Orthographic/Perspective view
- Use the 'ball' to rotate your scene intuitively

Export Options

Directly to SketchFab

Local export to OBJ, FBX etc.

Camera Normal and Depth map export



Archiving and Reproducibility

- Always store the RAW files of any archive destined model rather than JPEGs
- Use the Export > Generate Report option to create a PDF of your process
- Include a clear scale item in your scan



