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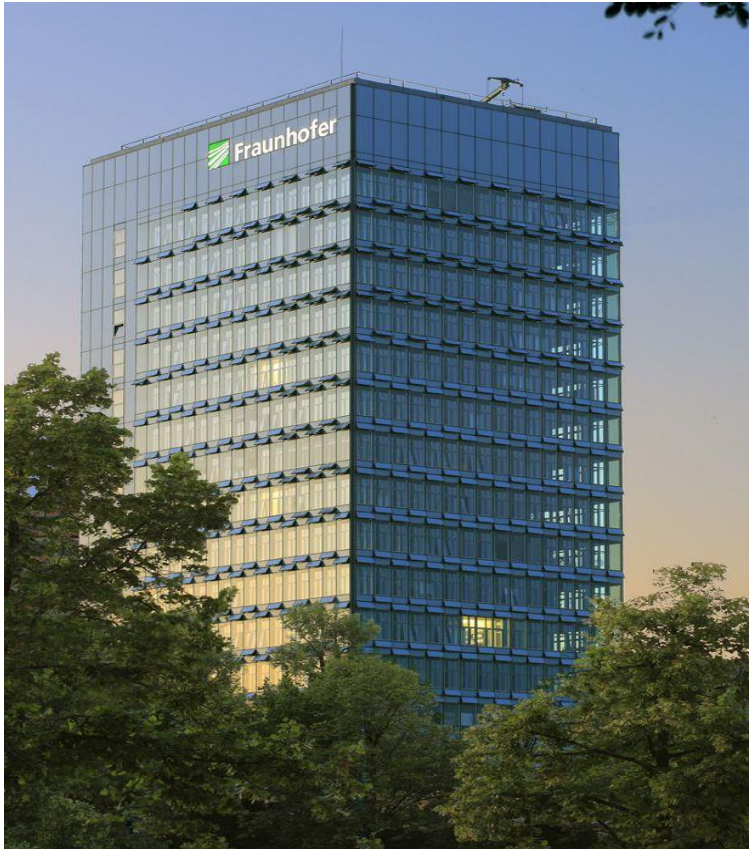
The Fraunhofer-Gesellschaft does applied research of direct utility to private and public enterprises and of wide benefit to society.

Our Customers:

- Industry
- Service sector
- Public administration



Fraunhofer

- More than 80 research institutions, including 60 Fraunhofer institutes
- More than 22,000 employees, the majority educated in the natural sciences or engineering
- An annual research volume of €1.8 billion,
  of which €1.5 billion is generated through contract research.
  - More than 70 percent of this research revenue derives from contracts with industry and from publicly financed research projects.
  - Almost 30 percent is contributed by the German federal government and the *Länder* governments in the form of institutional financing.
- International collaboration through representative offices in Europe, the US, Asia and the Middle East

The Fraunhofer-Gesellschaft in Germany

- 60 Institutes
- more than 20,000 employees

… and the world

Fraunhofer
IGD

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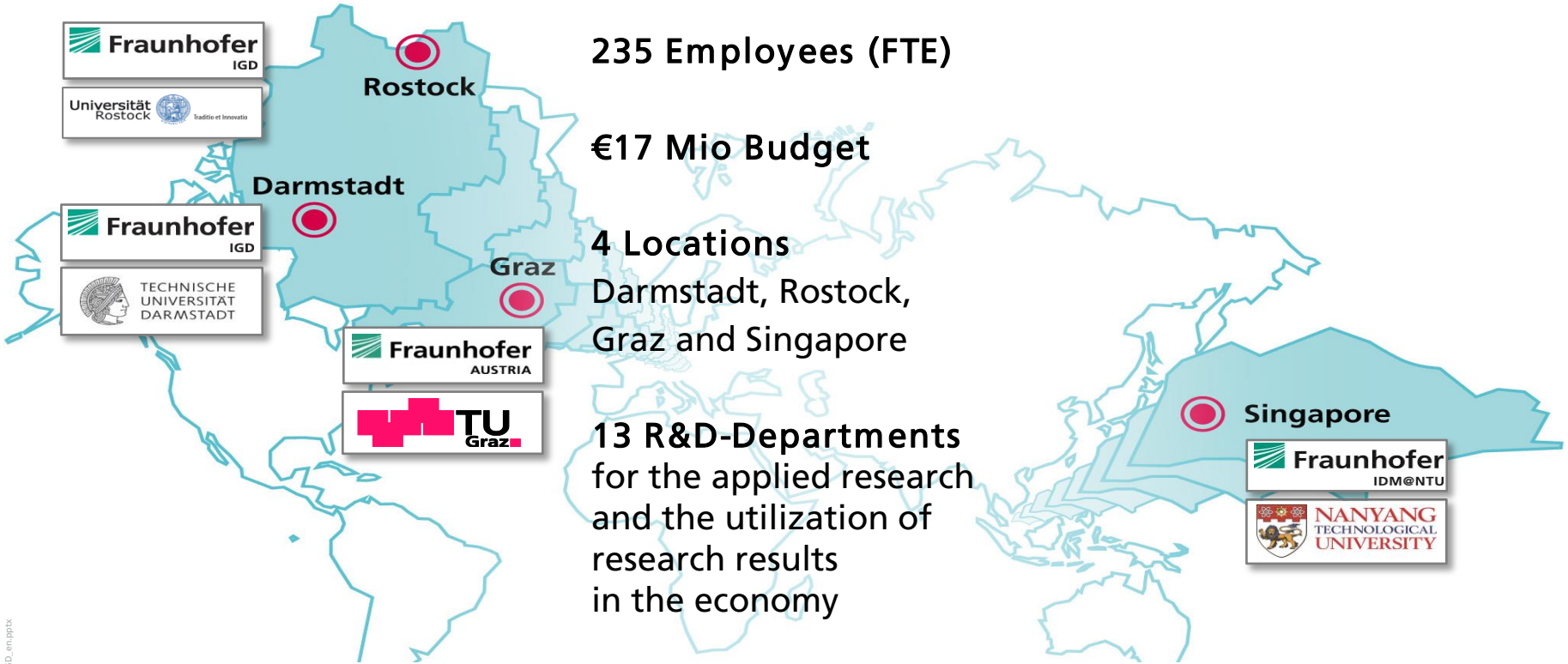
Fraunhofer IGD (as of 2012)



235 Employees (FTE)

€17 Mio Budget

4 Locations
Darmstadt, Rostock,
Graz and Singapore

13 R&D-Departments
for the applied research
and the utilization of
research results
in the economy

The world's leading institute for applied research in Visual Computing

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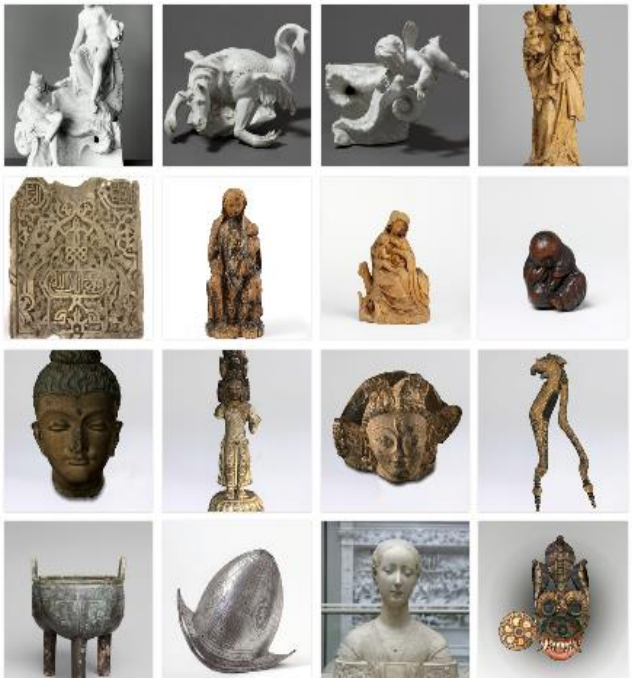

ON THE VERGE OF 3D MASS DIGITIZATION IN THE CULTURAL HERITAGE DOMAIN

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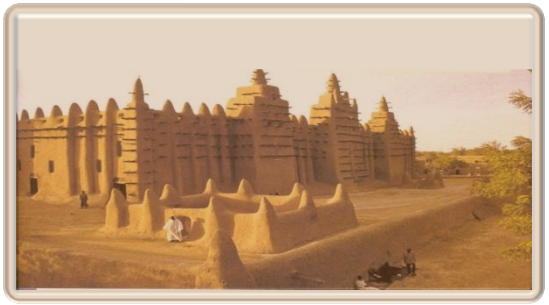
Why Digitization?

2003 Earthquake – Bam, Iran, renown mud brick architecture

2004 Fire - Herzogin Anna Amalia Library Weimar

2009 Collapse – Cologne city archive 30 shelf-Km destroyed



2012 War - UNESCO World Heritage Timbuktu, Mali

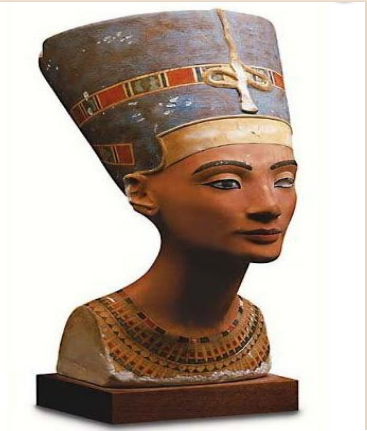
What happened so far ..

- **Digitization**: Transfer of real documents or artifacts into a digital representation
- **Two-dimensional cultural heritage objects**:
  - Huge campaigns on national, European and international Level to digitize antique scriptures, writings and paintings, e.g. German Digital Library, Europeana and Google Library Project, Microsoft Book Digitization Project.
  - Emerging world-wide multi-million Euro market of device manufacturers and service providers within the last 10 years.

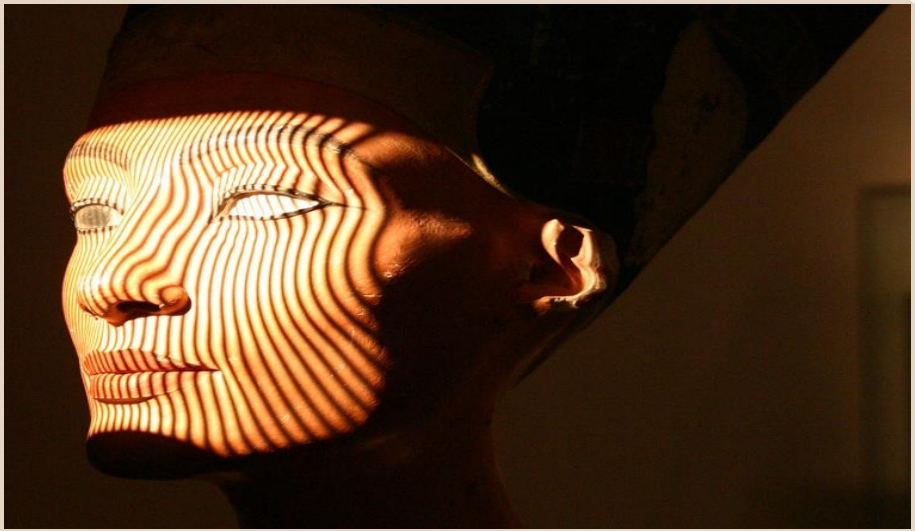
Collection of antiquities
SMB
Inv.Nr. AvP VII 50

.. and in 3D ?!

- **Three-dimensional cultural heritage**:
  - Only prestige objects so far (1999 Stanford, Michelangelo, Davistatue; 2002, Luebke, Monticello; 2005, Guidi, „Plastico di Roma antica“; 2009, Skyarc, Kasumi Tombs Uganda, UNESCO world heritage; 2008, 2011, Trigonart GmbH, Nofretete, Berlin)



Staatliche Museen zu Berlin
Preußischer Kulturbesitz



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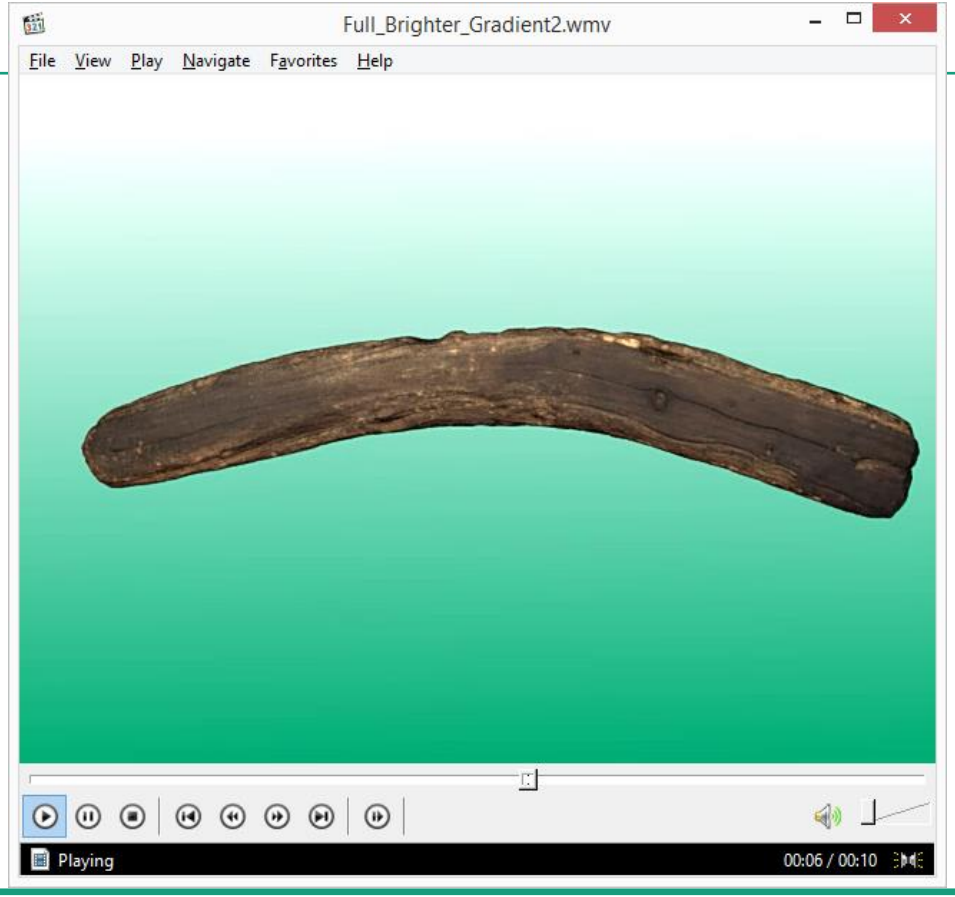
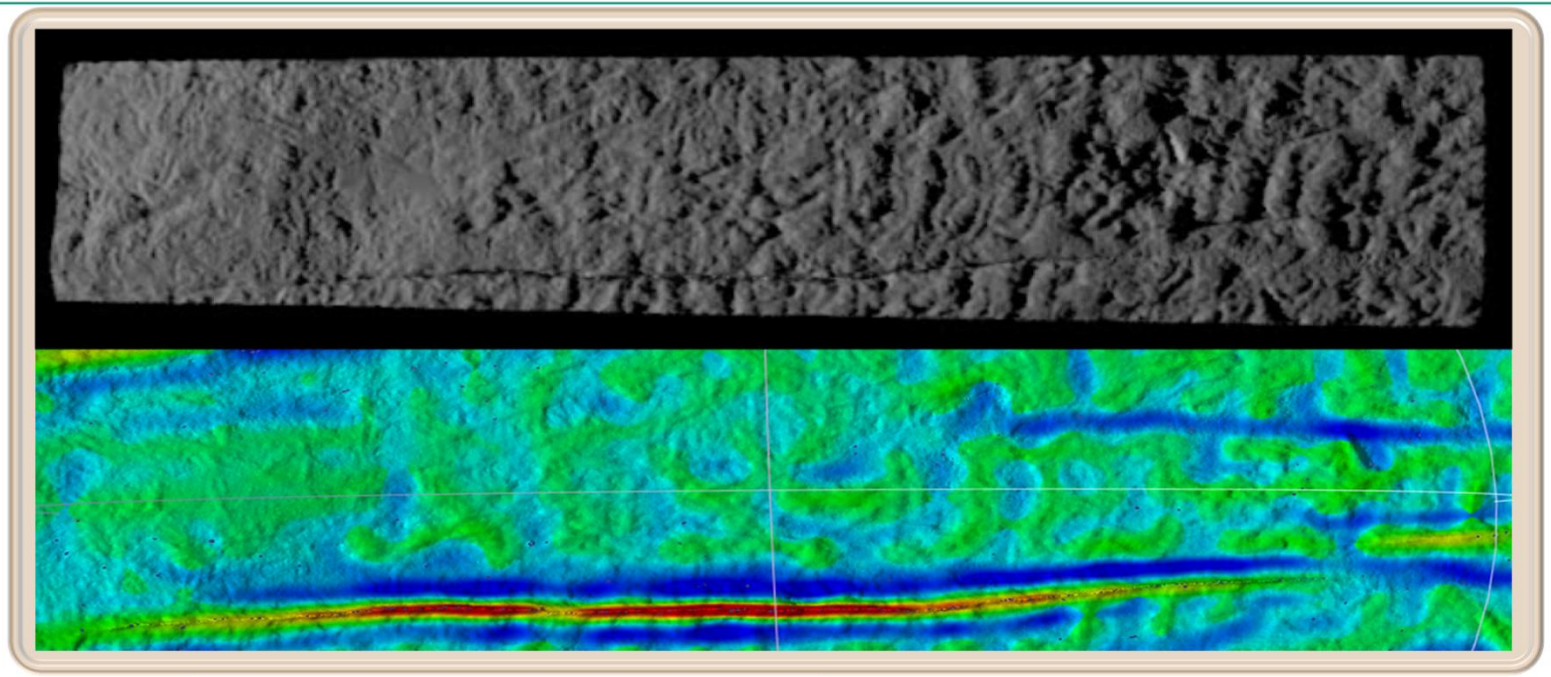
To date: Manual 3D Digitization of Artifacts

- Example: Digitization of a Rongorongo Tablet, Easter Islands
  - Polymetric 3D Scanner PT-M (4 Mpixel Cameras, 35mm Lenses) – High-Resolution of 15µm
  - 300 Scans, 36 hours for global registration alone on a 32 core machine with 256GB RAM
  - 18h total scan time - manual re-positioning of scanner = 85% time expenditure

Rongorongo Tablet
Berlin Museum of Ethnology


Full_Brighter_Gradient2.wmv
File View Play Navigate Favorites Help
Playing
00:06 / 00:10

Light-surface interaction: High-res. scans and filters allow char recognition

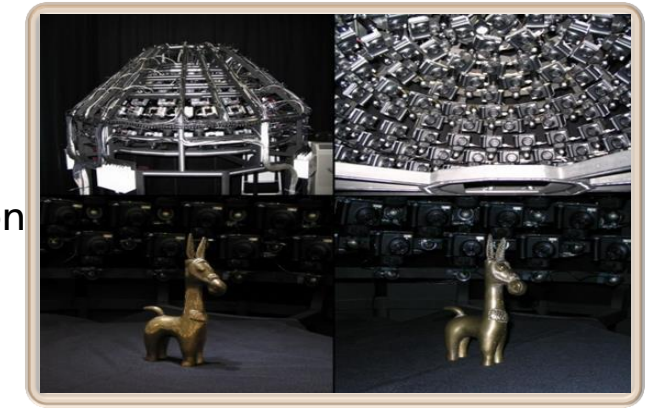


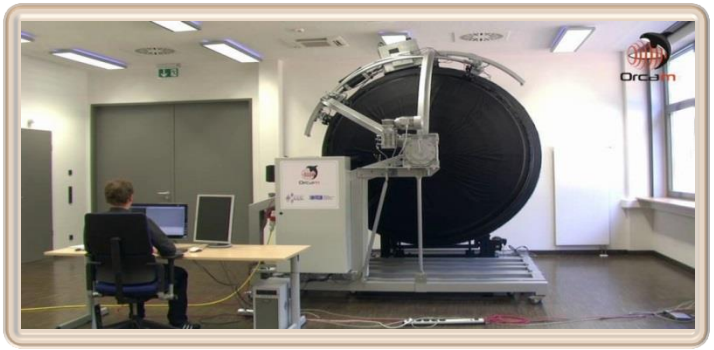
Time expenditure today - V&A study: geometry and texture

(Study: Victoria & Albert Museum)

First attempts at speeding up the process

- DOME:
  - University of Bonn, Prof. R. Klein
  - 176 Cameras and light sources
  - Geometry, texture and material property acquisition
- ORCAM:
  - DFKI, Prof. D. Stricker
  - Geometry, texture and material property acquisition
- Drawback:
  - Occlusions cannot be scanned
  - Processing time per artefact takes hours
  - Post-processing takes hours
  - Manual artefact placement and removal





What's missing ? (e.g. Berlin Museums)

- ~ 6 million artifacts
- 120.000 New entries per year

- Effort appraisal …
- 3D digitization of only the new entries …
  - 120.000 / 365 days / 24 h / 60 minutes =
  - 0,22 objects/min = 4,38 min/object !!!

- *Not feasible! Missing automated, scalable and economic digitization procedures!*

Staatliche Museen zu Berlin
Preußischer Kulturbesitz

- CH artifacts from all over the world
- Up to 6000 AD
- More than 175 years of museum history

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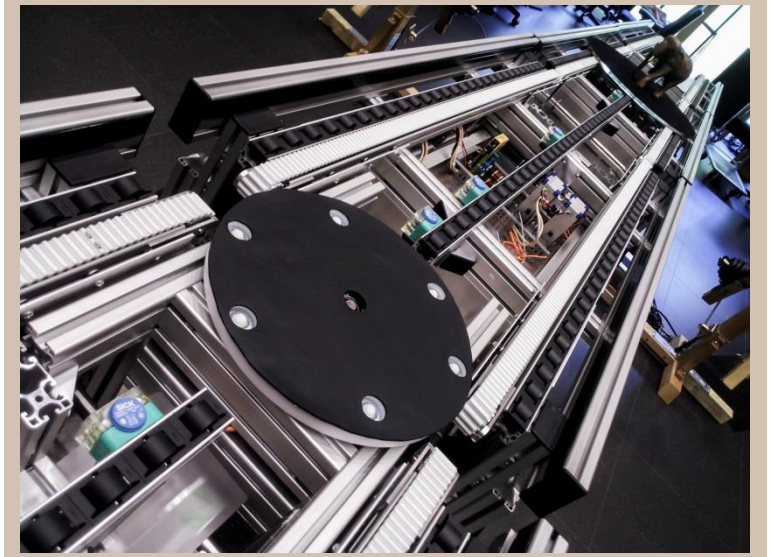
Challenges for 3D mass digitization in Cultural Heritage

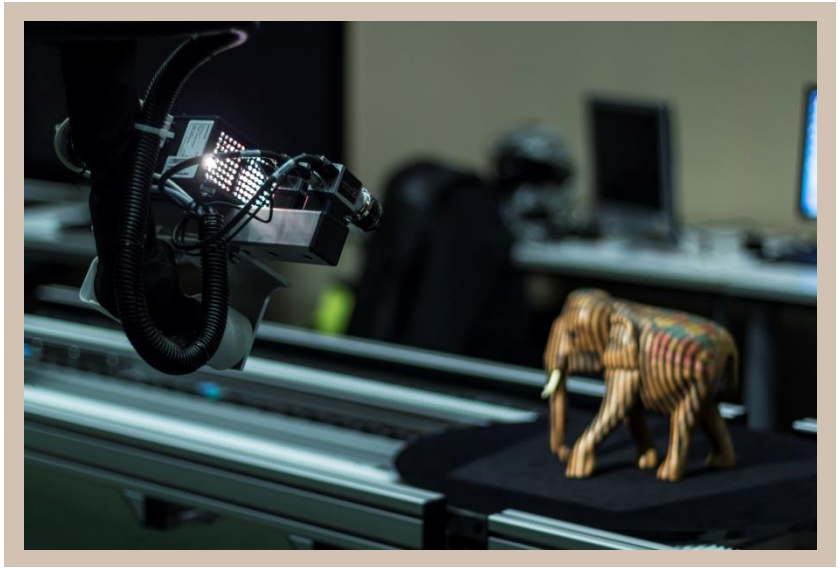
- Improved / Simplified methods for:
  - Geometry, texture, material property acquisition
- Reduction of cost / high throughput:
  - Automation and Industrialization
- Improved workflows:
  - Single-pass, multi-stage, parallel lines
- Fast post-processes:
  - Parallel computation
  - Multi-core, multi-GPU computation
  - out-of-core computation



www.cultlab3d.de

Challenges for 3D mass digitization in Cultural Heritage

- Comprehensive:
  - All sizes
  - All materials
- Comparable quality standards for 3D digitization:
  - Environmental parameter control:
    - Lighting
    - Temperature
    - Humidity
  - Definition of minimum equipment capabilities



www.cultlab3d.de


Windows Media Player
CultLab3D-BMBF-V2
Cultlab3D


Cultlab3D

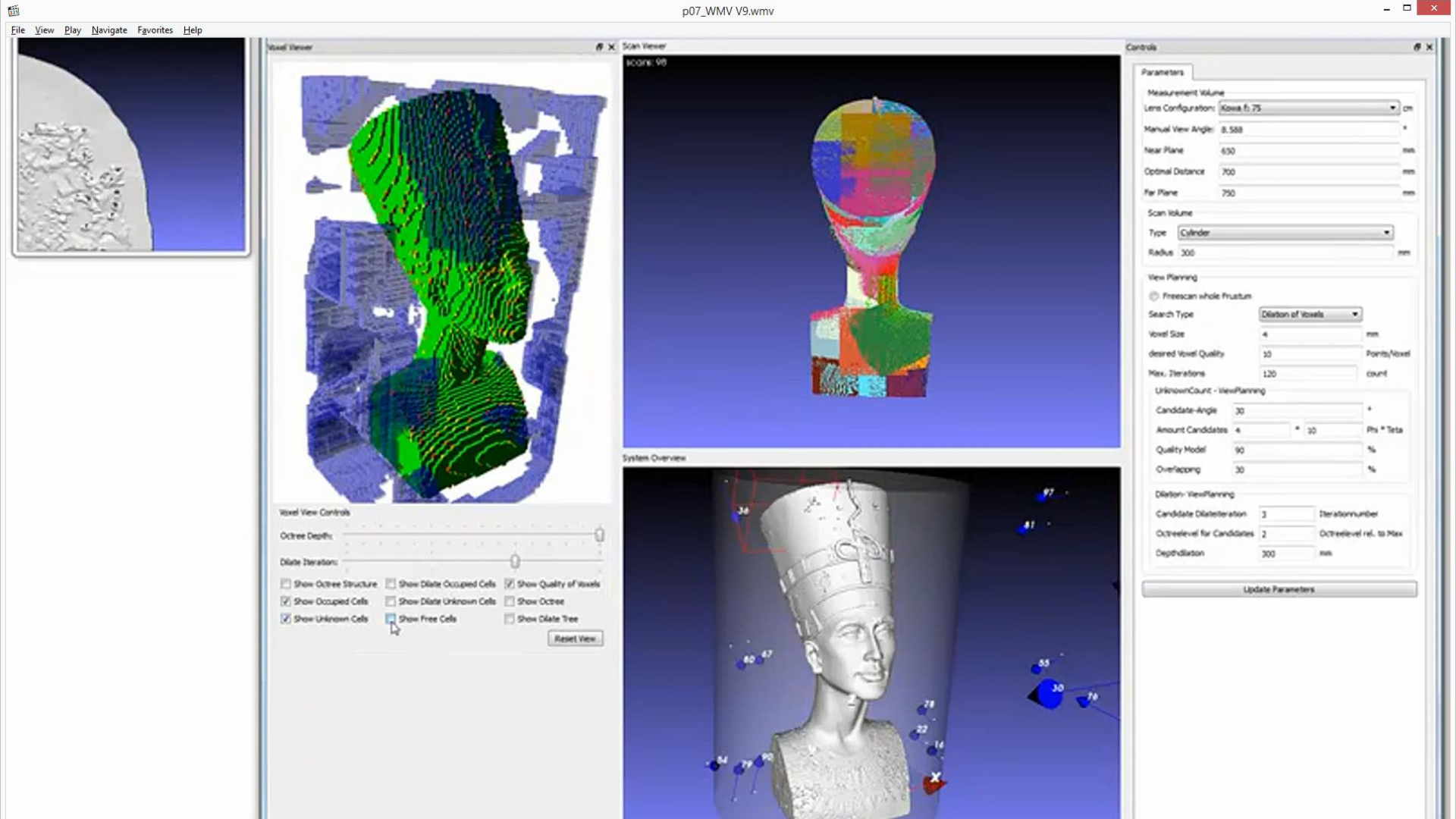
Further Samples and todos until Sep2015

Further samples

- Naturkundemuseum Berlin => meshlab results

Todos until Sep 2015

- Realtime Geometry at CultArc3D from Photogrammetry
- Next Best View Planning for CultArm3D => video


p07_WMV V9.wmv
File View Play Navigate Favorites Help
Voxel Viewer
Scan Viewer
scans: 95
Controls
Parameters
Measurement Volume
Lens Configuration: Kowa fl. 25 cm
Manual View Angle: 8.588 °
Near Plane 650 mm
Optimal Distance 700 mm
Far Plane 750 mm
Scan Volume
Type Cylinder
Radius 300 mm
View Planning
Freescan whole Frustum
Search Type Dilation of Voxels
Voxel Size 4 mm
desired Voxel Quality 10 Points/Voxel
Max. Iterations 120 count
UnknownCount - ViewPlanning
Candidate-Angle 30 °
Amount Candidates 4 * 10 Phi * Teta
Quality Model 90 %
Overlapping 30 %
Dilation- ViewPlanning
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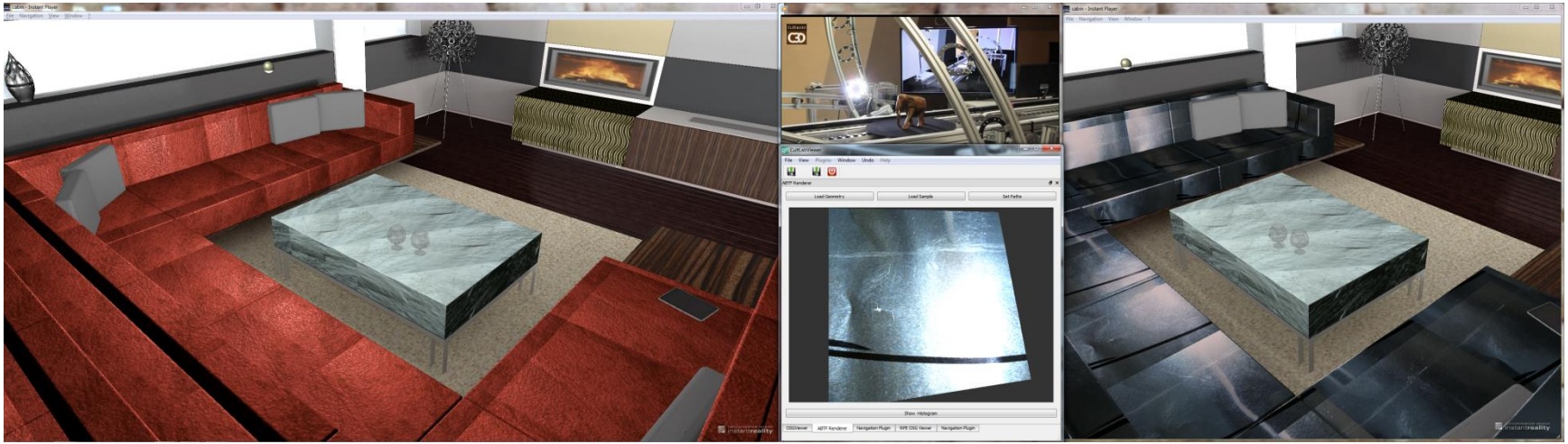
Octreelevel for Candidates 2 Octreelevel rel. to Max
Depthdilation 300 mm
Update Parameters
Voxel View Controls
Octree Depth:
Dilate Iteration:
Show Octree Structure
Show Occupied Cells
Show Unknown Cells
Show Dilate Occupied Cells
Show Dilate Unknown Cells
Show Free Cells
Show Quality of Voxels
Show Octree
Show Dilate Tree
Reset View
System Overview

Rendering captured optical Material Properties



web|3D CONSORTIUM

vancouver SIGGRAPH2014
The 41st International Conference and Exhibition on Computer Graphics and Interactive Techniques

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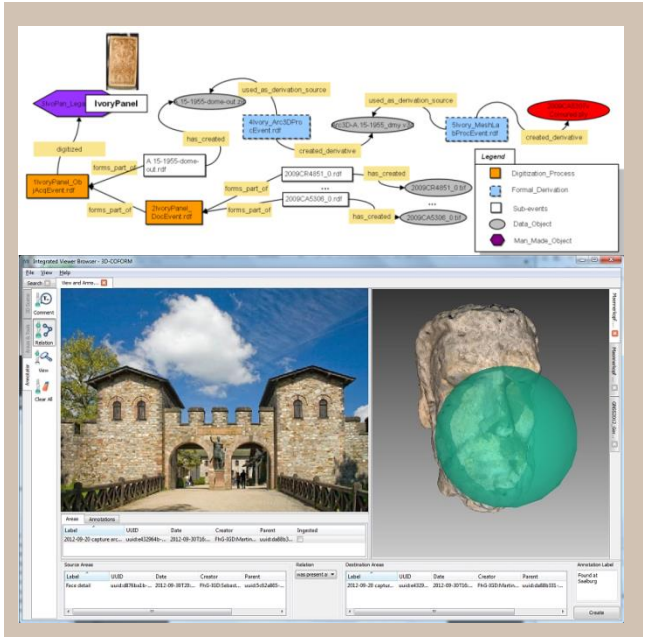
3_ABTF_samples_in_virtual_scene.wmv

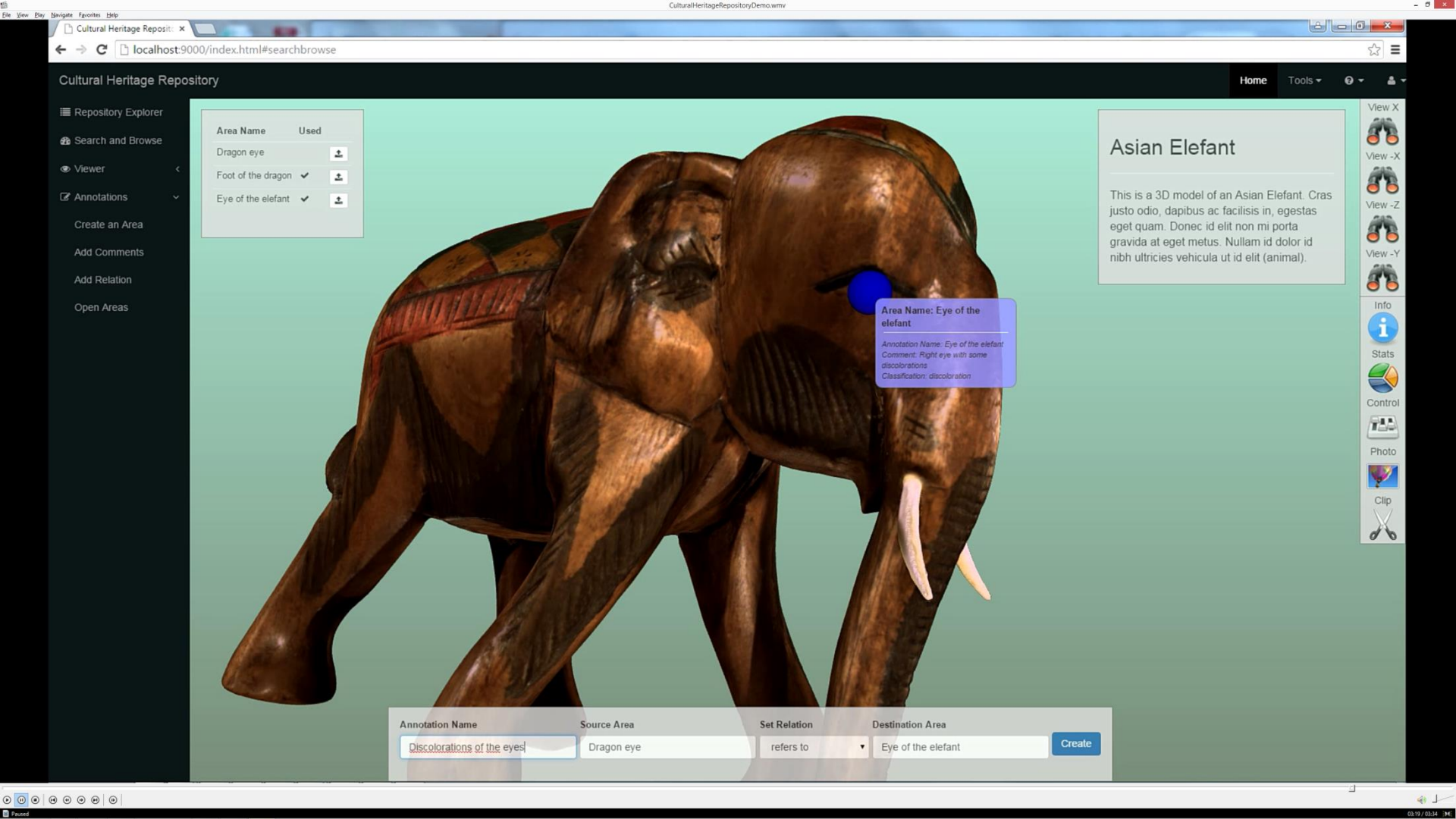
File View Play Navigate Favorites Help

Challenges for 3D mass digitization in Cultural Heritage

- Artefact Classification:
  - Using prior knowledge of already digitized (similar or related) content
- Artefact Annotation:
  - Visual, 3D centered, linking with media-, meta- and provenance data
  - Fostering adoption of standards concerning the description of cultural heritage concepts and relationships (e.g. CIDOC-CRM)



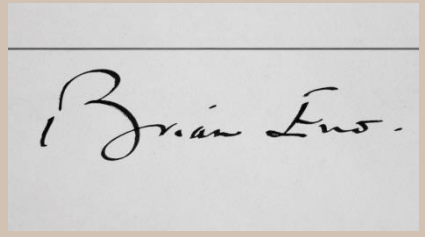
3D-COFORM


CulturalHeritageRepositoryDemo.wmv
Cultural Heritage Repository
localhost:9000/index.html#searchbrowse
Cultural Heritage Repository
Home
Tools
Repository Explorer
Search and Browse
Viewer
Annotations
Create an Area
Add Comments
Add Relation
Open Areas
Area Name
Used
Dragon eye
Foot of the dragon
Eye of the elefant
Asian Elefant
This is a 3D model of an Asian Elefant. Cras justo odio, dapibus ac facilisis in, egestas eget quam. Donec id elit non mi porta gravida at eget metus. Nullam id dolor id nibh ultricies vehicula ut id elit (animal).
Area Name: Eye of the elefant
Annotation Name: Eye of the elefant
Comment: Right eye with some discolorations
Classification: discoloration
View X
View -X
View -Z
View -Y
Info
Stats
Control
Photo
Clip
Annotation Name
Source Area
Set Relation
Destination Area
Discolorations of the eyes
Dragon eye
refers to
Eye of the elefant
Create

Challenges for 3D mass digitization in Cultural Heritage

- Digital rights:
  - Prompt legislators to act and define laws to govern ownership of 3D virtual models
  - Similar (very extensive) laws govern ownerships of photos
- Signatures:
  - Define procedures for 3D virtual models to be signed and easy to authenticate as to their source and the technology used to create them

Justitia, CC BY 2.0, Markus Daams



Hum - "Eighteenth Century" Signature and Electric Guitar String - Brian Eno Speaker Flowers Sound Installation at Marlborough House, CC BY 2.0, Dominic Alves

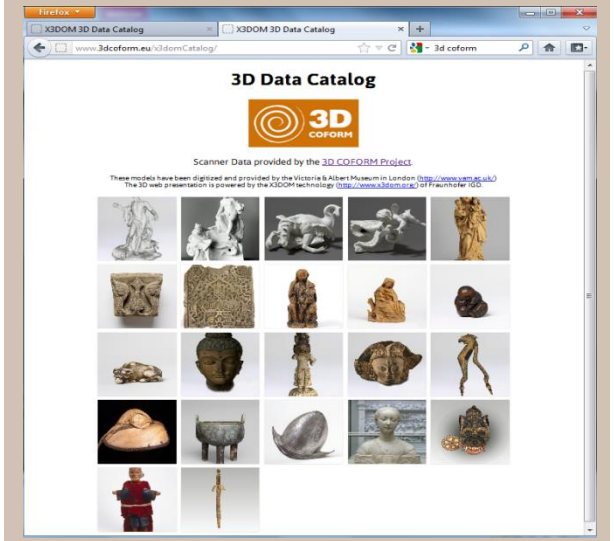
Challenges for 3D mass digitization in Cultural Heritage

- Certification:
  - We need suitable governmental or government-accredited entities to issue certificates for virtual 3D reproductions
- Formats:
  - Need to be easy to read-/write 100+ years from now
- Longterm storage:
  - storage hardware or approach needs to ensure safe and secure longterm preservation of data:
    - e.g. Fraunhofer Cloud Services

Data Center, CC BY 2.0, NeoSpire

Challenges for 3D mass digitization in Cultural Heritage

- 3D Internet:
  - from websites to web applications
  - Increased interest:
    - Product presentations
    - Visualization of abstract information
    - Immersive applications for tourism or cultural heritage
  - Improved user experience:
    - Today: Adobe Flash-based web sites
    - Tomorrow: Immersive and embedded 3D



Example 3D-COFORM: historic 3D object browser

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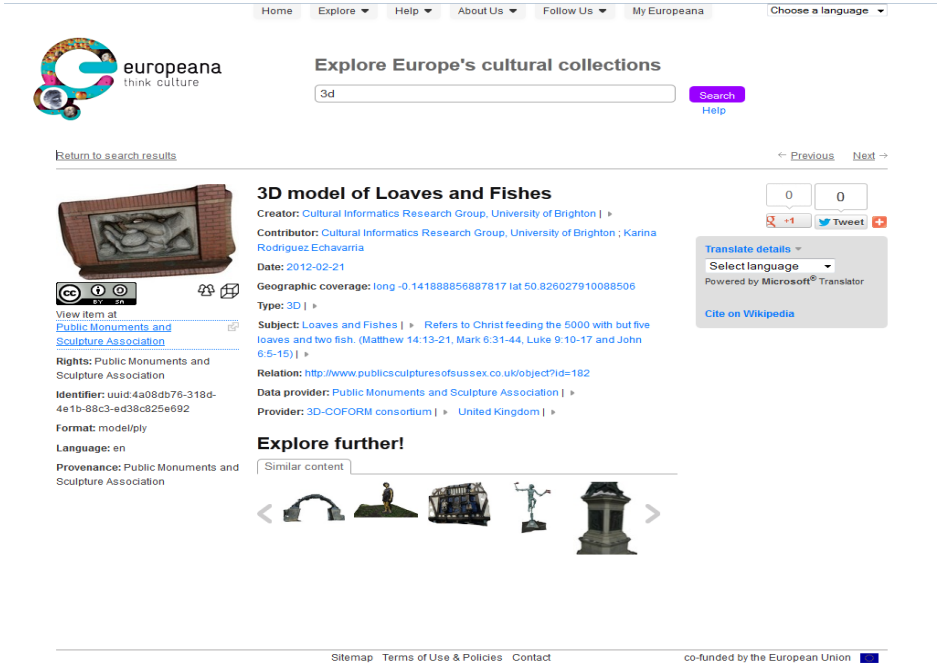
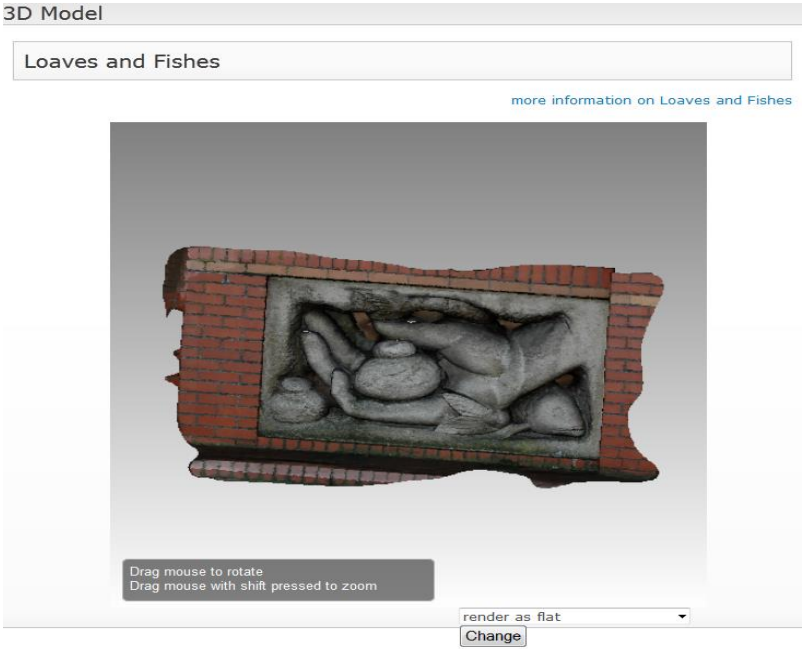
Example: 3D Artifacts in Europeana



Europeana



3D Web presentation

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CultLab3D to be shown at Digital Heritage 2015 in Granada, Spain

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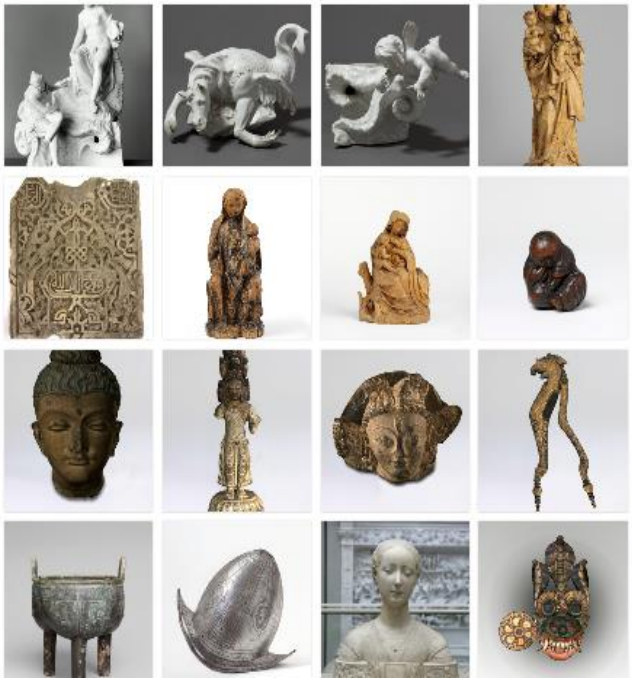

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