

## II. DIGITISATION AND DATA MANAGEMENT

# 4. Digitisation in 3D

Prof. Dr. Martin Langner

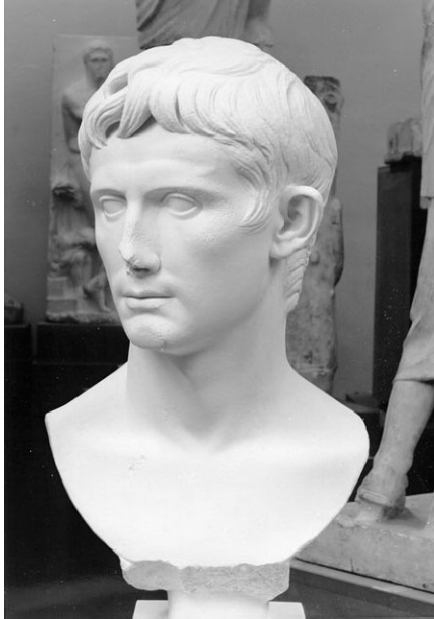
Marinos Ioannides and Ewald Quak (ed.), *3D Research Challenges in Cultural Heritage. A Roadmap in Digital Heritage Preservation* (Berlin / Heidelberg, 2014);

Schreibman / Siemens / Unsworth (2016) Kap. 22

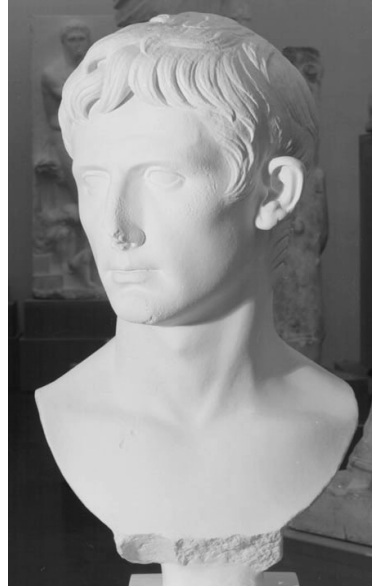
[https://en.wikipedia.org/wiki/3D\\_scanning](https://en.wikipedia.org/wiki/3D_scanning)



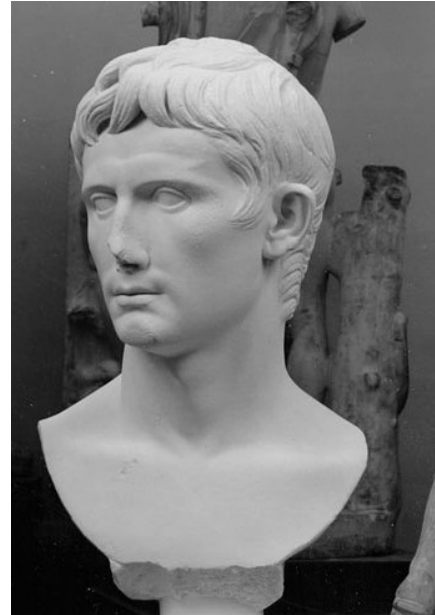
## Importance of viewing angle and illumination



Uniform Lighting



Dramatisation (Lighting  
from one side)



Heroisation  
(Eyepoint too low)



Romantisation  
(Eyepoint too high)

Klaus Fittschen, Über das Photographieren römischer Porträts, Archäologischer Anzeiger 1974, 484–494.

[http://www.aeria.phil.uni-erlangen.de/tutorials\\_html/photoschule.html](http://www.aeria.phil.uni-erlangen.de/tutorials_html/photoschule.html)



1



2

(SH 836)



3



4

(SH 836)

## Ortho-Photography

- Distortion-free
- High depth of field due to long exposure time and wide distance (telephoto lens)



# What is the significance of 3D models?

3D is cool and currently very present:

- Film
- YouTube
- Computer Games
- Advertisement
- 3D Prints



Meanwhile, 3D tools and storage options are better than ever before:

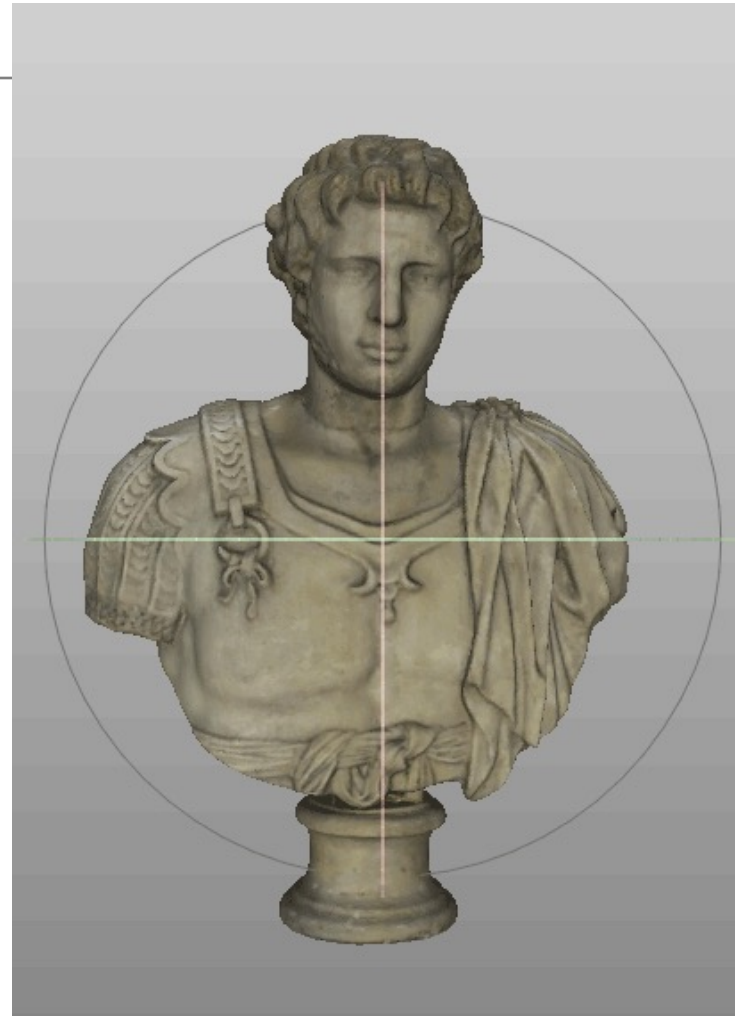
- 3D from digital photographs
- 3D software (e.g. Blender)
- Games
- 3D user interfaces
- 3D printing

## What is the significance of 3D models?



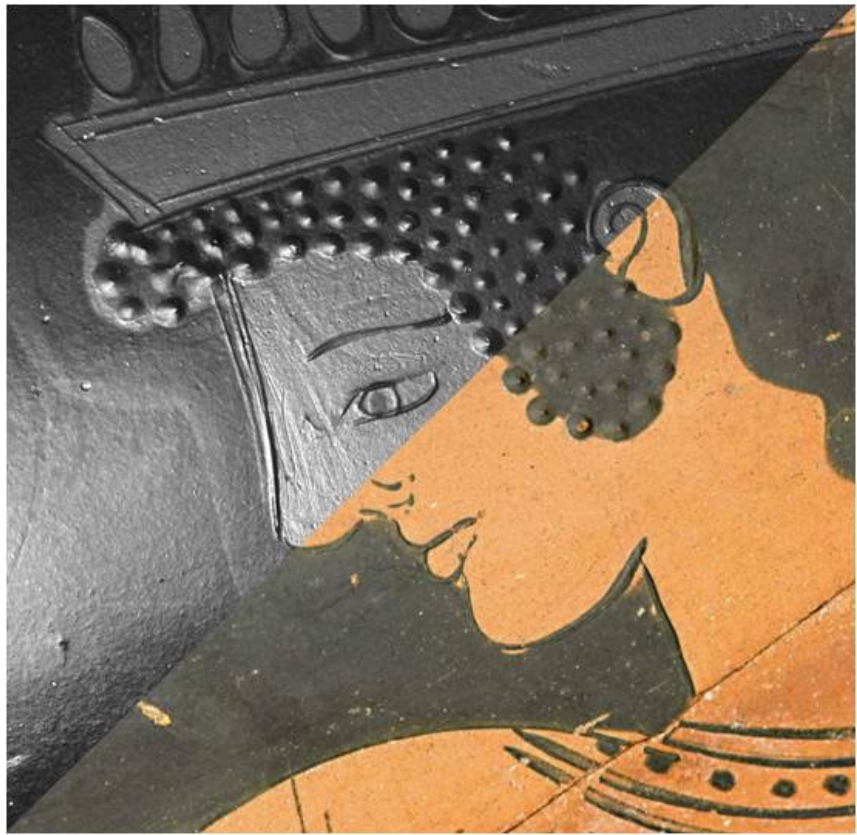
- "3D makes nice animations, that's all."
- "3D modellers just take a few buildings and put them together."
- "3D can never comprehensively represent reality / the object."
- "At university we never learned how to make 3D models."

- 3D models are globally available
- handling is simple and takes place without contact
- reproducible at will
- it is easy to individually change the viewer's point of view (e.g. rotating, zooming, juxtaposing)
- measurements on the model (e.g. to determine the dimensional uniformity of copies)
- historical states can be restored, reconstructions can be made and fragments can be assigned



## Current methodological discussion of digitisation processes

- How can the material quality of an artefact be comprehensively documented and standardised?
- Which procedure is appropriate for the object in question?
- How can the procedures be automated without sacrificing conservation and restoration care?



# ARTEFACT DIGITISATION AS A COMPONENT OF INTENSIVE ACQUISITION OF MATERIALITY

MÜNCHEN 17

TAFEL 9



1



2

(SH 836)

= Determination of the preconditions for the historical perception of the objects in the sense of a microhistory ('thing history', 'object biography').

= Reflecting on the associated schematisation and its scientific usefulness.

Develop good practice examples for metadata and classification systems!



## 1. VISUALISATION METHODS IN 2D

- a) 360° photo series
- b) RTI
- c) Stereovision

## 2. ACQUISITION IN 3D

- a) 3D Konstruktion (CAD)
- b) 3D Laser Scanner
- c) Structured Light Scanner
- d) Photogrammetry
- e) Computer Tomography

## 3. CHALLENGES

- a) Post-processing
- b) Tools
- c) Publication
- d) Annotation
- e) Automatisations

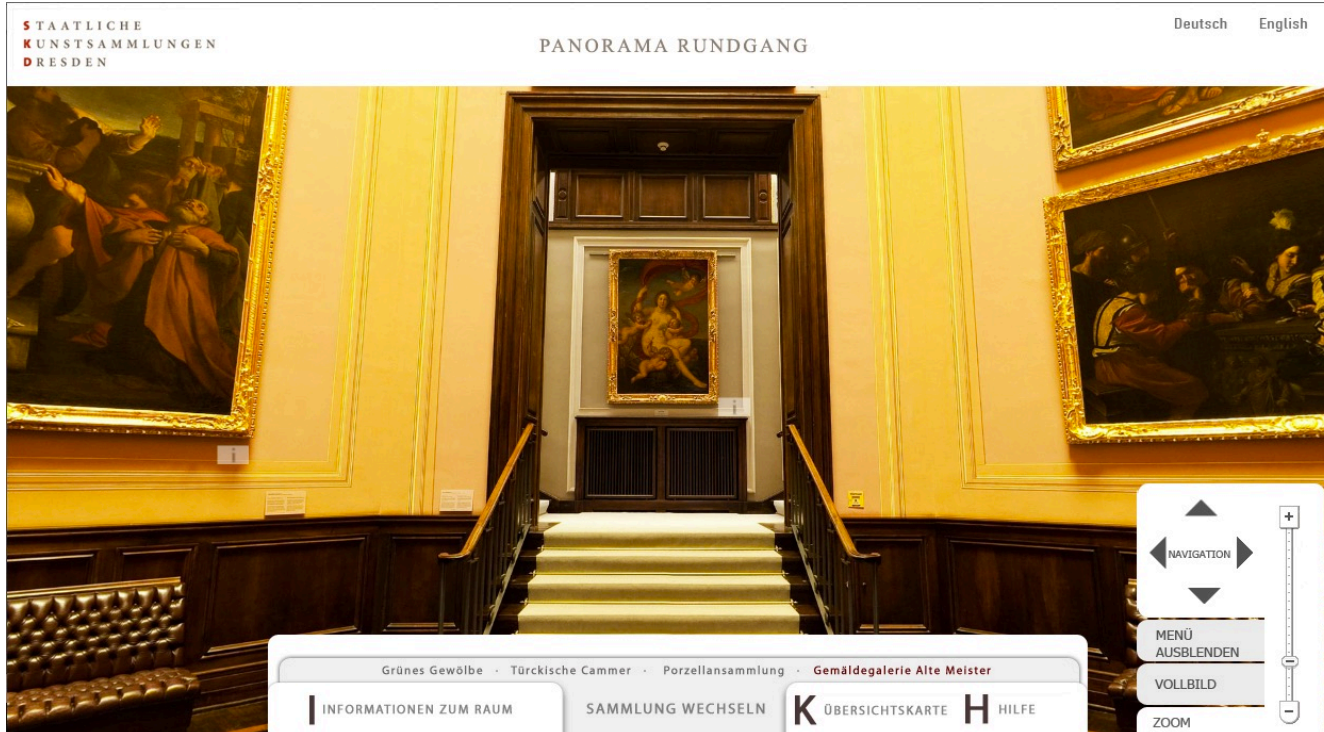


# 1. VISUALISIERUNG METHODS IN 2D





# 360° Panoramas



<http://www.skd.museum/fileadmin/panoramav103/> ;

s.a. Cluny Augmented Reality System: <http://www.youtube.com/watch?v=Z-EwXWjU0nw>



# Google Arts and Culture



<https://artsandculture.google.com/streetview/deutsches-museum/>



# Product photography



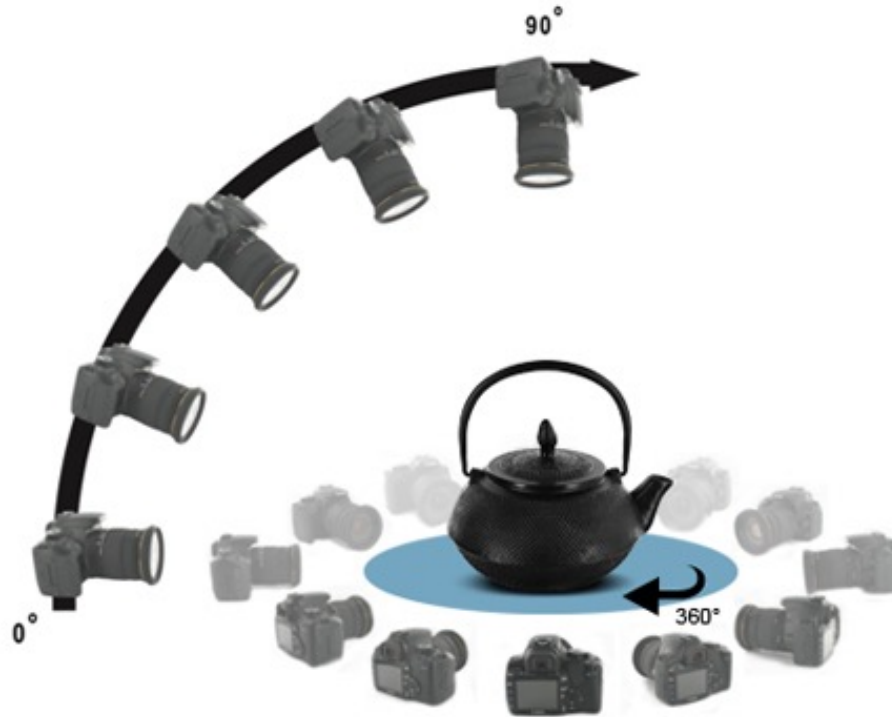
Scancube (<http://www.scancube.com>)



Topshow3d (<http://www.topshow3d.net>)



# Product photography



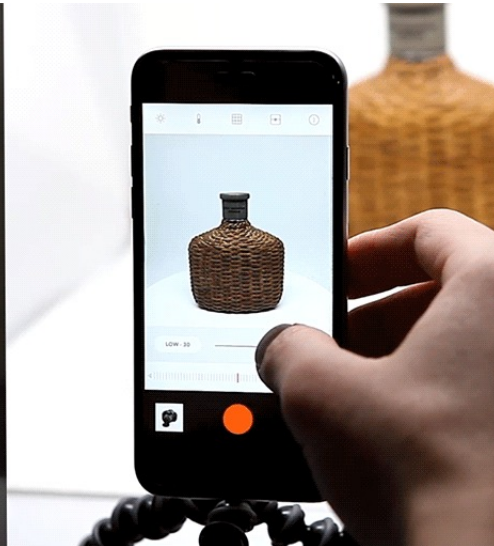
OrbitVU  
(<http://orbitvu.de>)



mode360 (<http://mode360.eu/de/product/jumbo>)



# Product photography

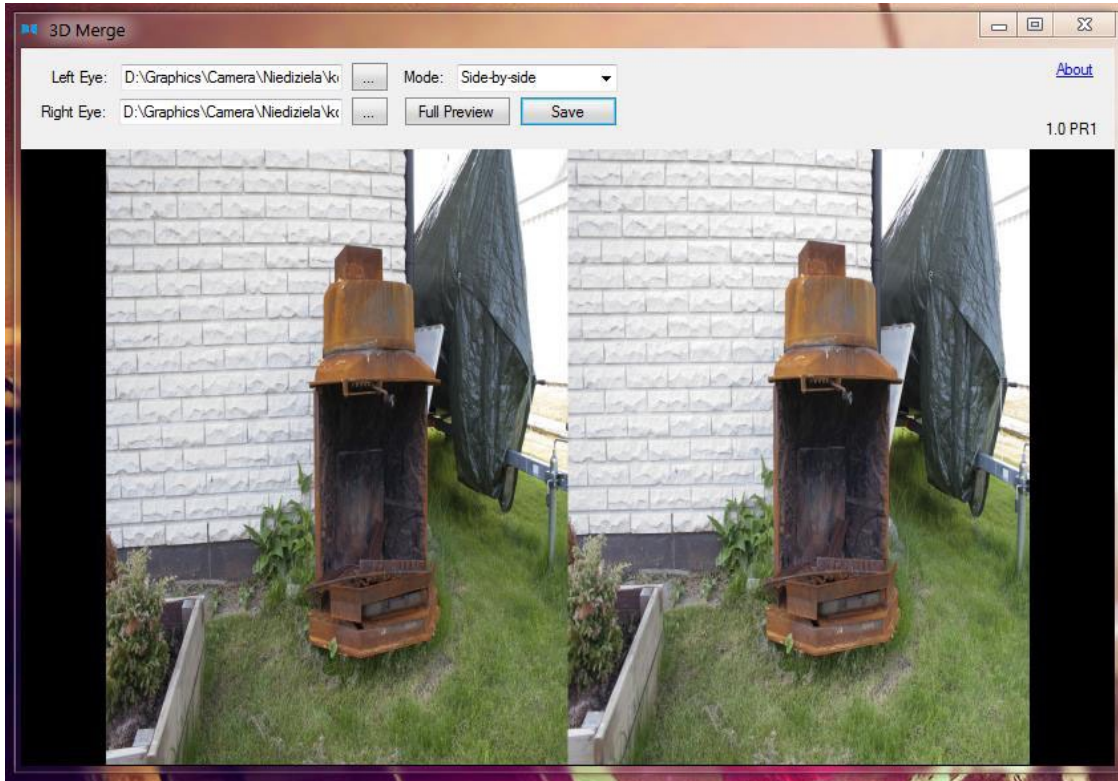


Object2VR (<http://orbitvu.de>)

<http://orangemonkie.com/foldio360/>



# Stereovision



## 3D Merge

(<http://sourceforge.net/projects/threedmerge/>)

## 3D Image Maker

(<http://sourceforge.net/projects/as3dimagemaker/>)

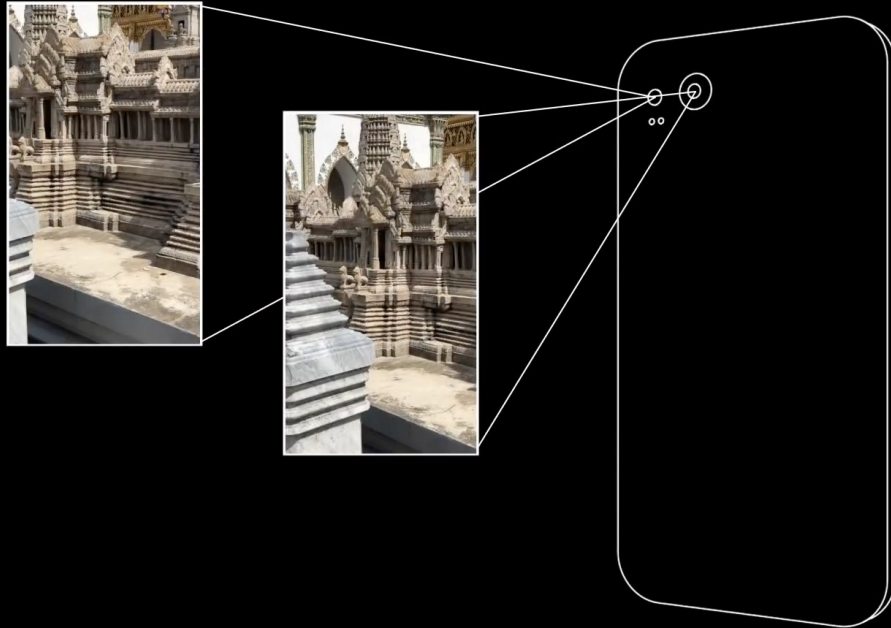
## Image 2D to 3D converter

(<http://sourceforge.net/projects/i3d-converter/>)





## Facebook's Instant 3D Photography



Peter Hedman and Johannes Kopf, „Instant 3D Photography,“ ACM Transactions on Graphic 37, no. 4, Article 101 (2018): <http://visual.cs.ucl.ac.uk/pubs/instant3d/>



## Polynomial Texture Mapping (or Reflectance Transformation Imaging)

- is a process in which a series of photographs is taken under constantly changing light.

So you don't change the viewer's point of view but the way the object reflects light and in this way you model the surface of the object.



<http://culturalheritageimaging.org>. z.B. Papyrus fragment von Cultural Heritage Imaging: <http://vimeo.com/33245119>

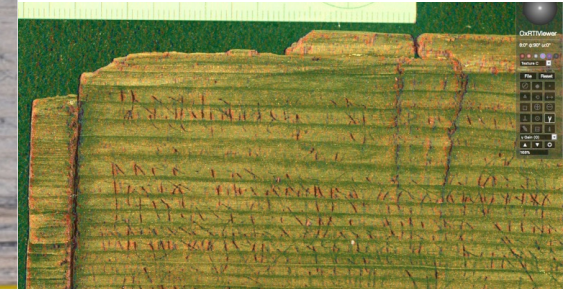
H. Mytum and J. R. Peterson, The Application of Reflectance Transformation Imaging (RTI) in Historical Archaeology, *Historical Archaeology* 52, no. 2 (2018), 489–503: <https://link.springer.com/content/pdf/10.1007/s41636-018-0107-x.pdf>

# Polynomial Texture Mapping (or Reflectance Transformation Imaging)



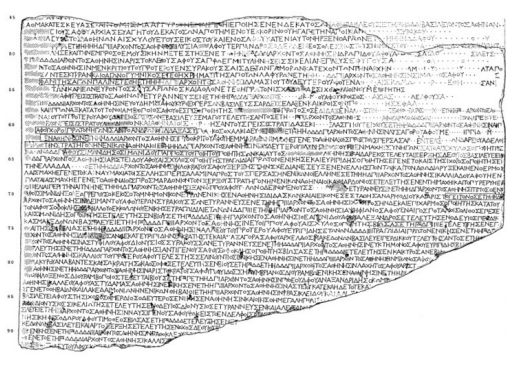
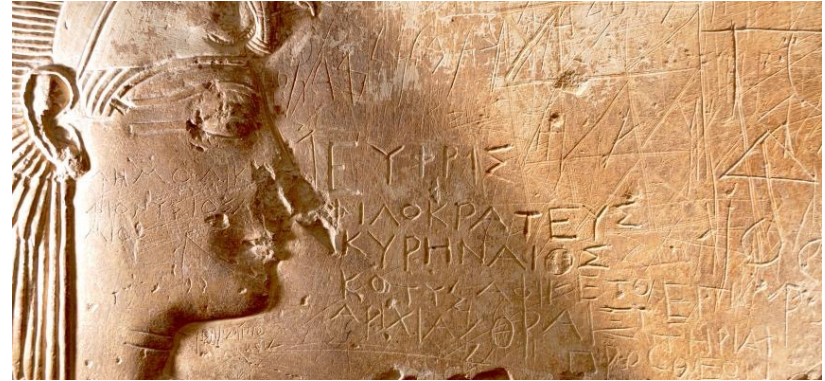
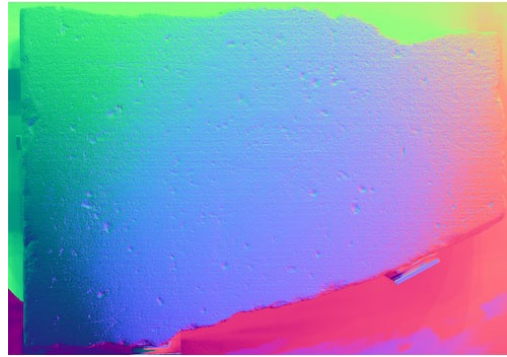
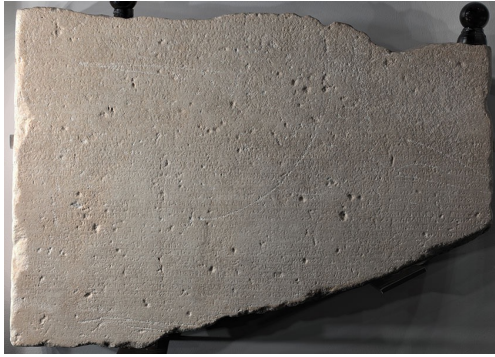
Visual Computing Lab - ISTI - CNR, „Reflectance Transformation Imaging (RTI) Tools“.

<http://vcg.isti.cnr.it/rti/index.php>



Graeme Earl et al., "Archaeological applications of polynomial texture mapping: analysis, conservation and representation," *Journal of Archaeological Science*. 37 no. 8 (2010), 1–11;

<https://eprints.soton.ac.uk/156253/1/EarlMartinezMalzbender2010.pdf>; <http://vindolanda.csad.ox.ac.uk/>

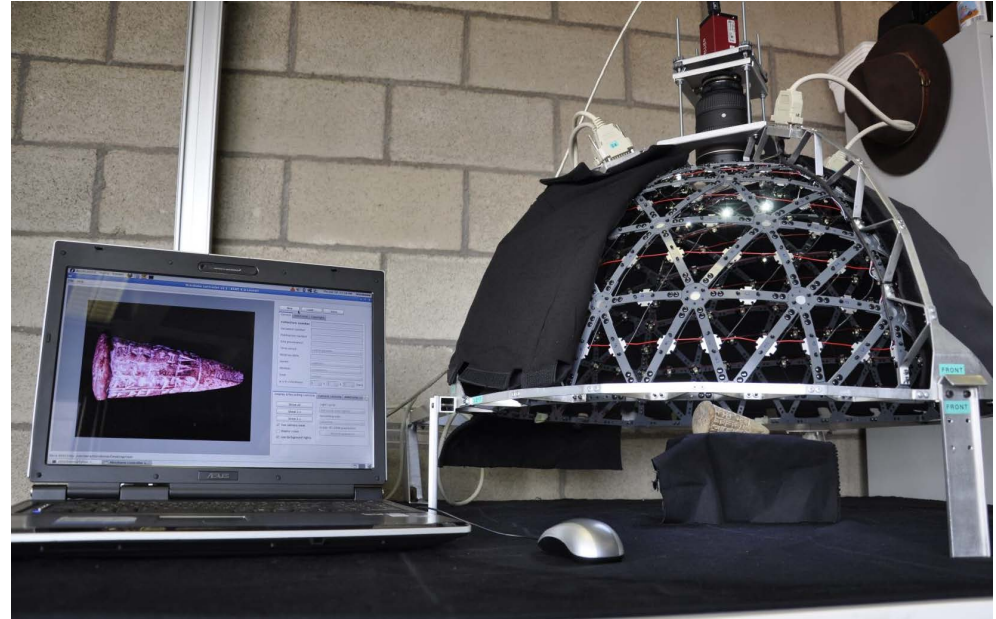
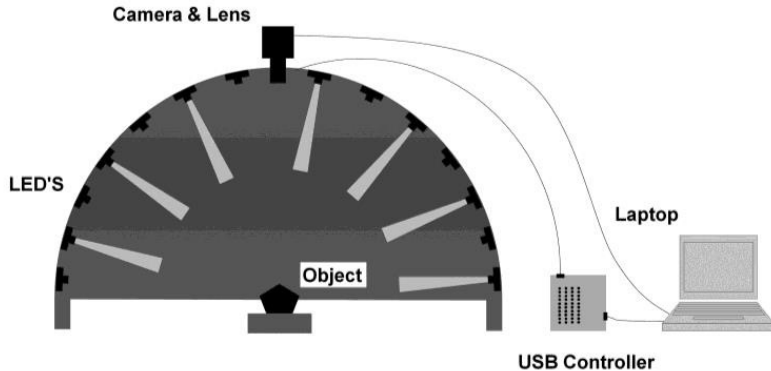


Ben F. S. Altshuler and Thomas Mannack, Shedding New Light on Ancient Objects, *Arion: A Journal of Humanities and the Classics* 22, no. 1 (2014), 53-74; <http://cpi.csad.ox.ac.uk/>; <http://digitalmarmorparium.org/>



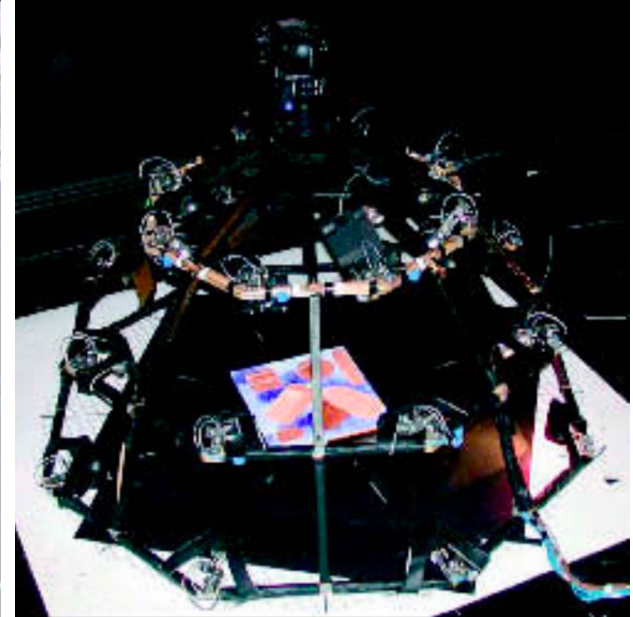
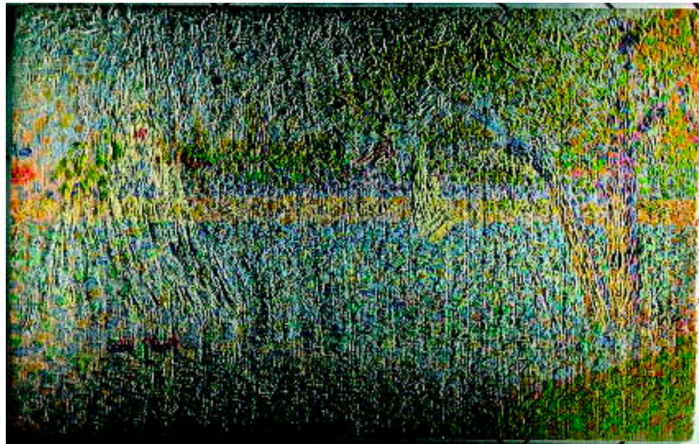
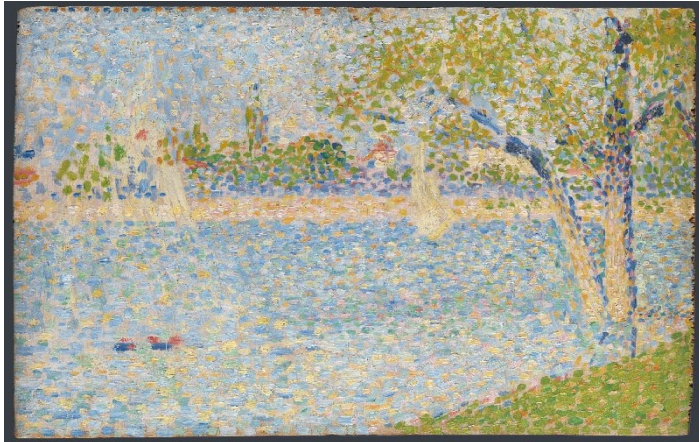
# Reflectance Transformation Imaging

- with the aid of a dome (e.g. <http://vimeo.com/67164689>)

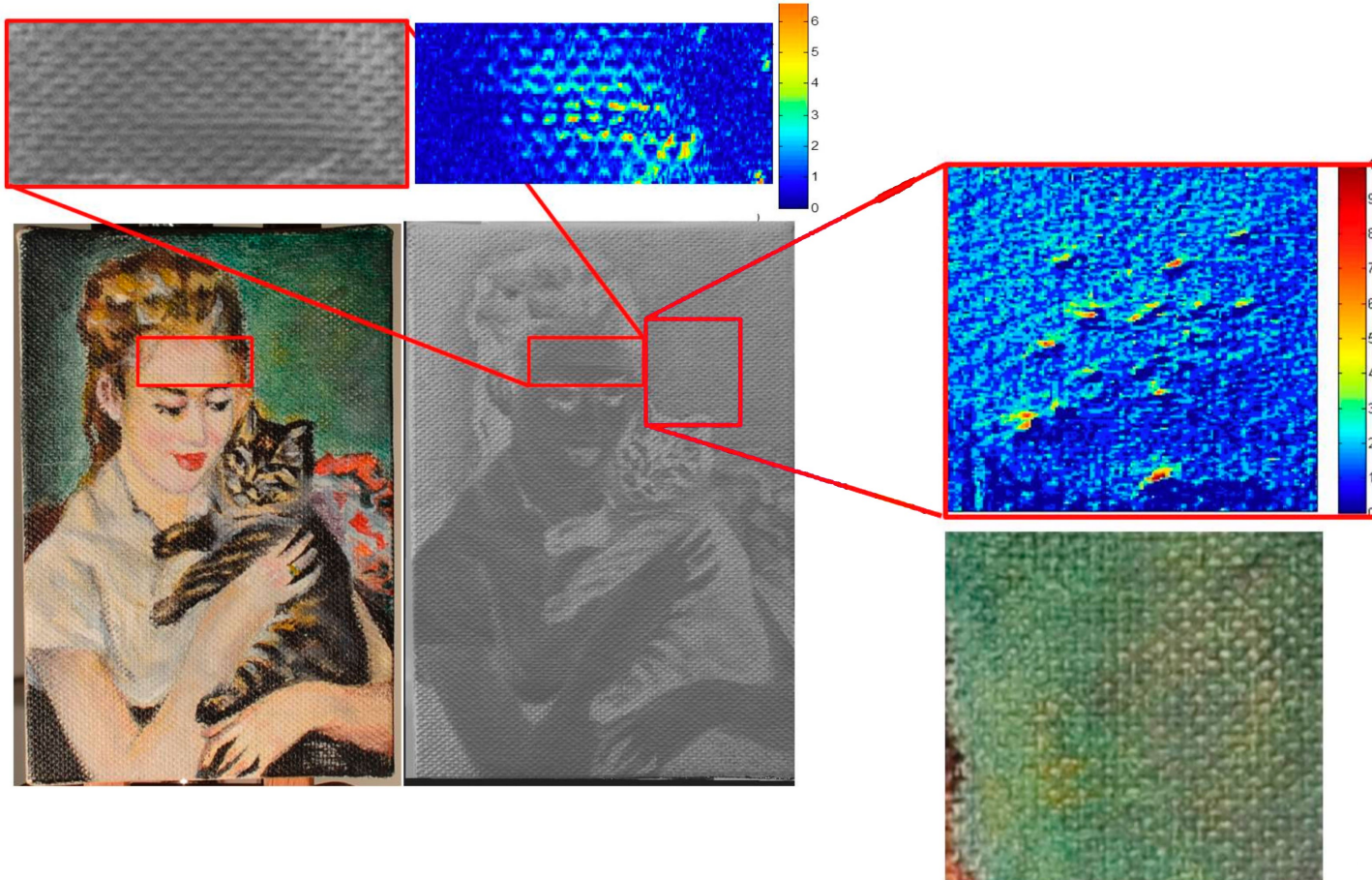


Portable light dome der Universität Leuven:

[https://portablelightdome.files.wordpress.com/2014/12/portable-light-dome-system-from-registration-to-online-publication-within-the-hour\\_1-1.pdf](https://portablelightdome.files.wordpress.com/2014/12/portable-light-dome-system-from-registration-to-online-publication-within-the-hour_1-1.pdf)

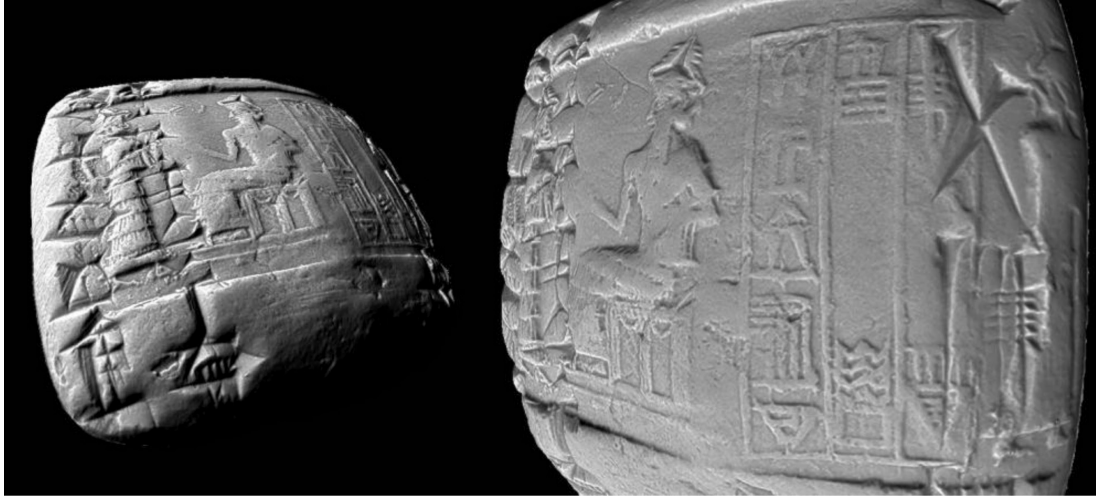


Marie Payne, „Imaging Techniques in Conservation,“ *Journal of Conservation and Museum Studies* 10 no. 2 (2012), 17–29;  
<https://discovery.ucl.ac.uk/id/eprint/1443164/1/56-566-2-PB.pdf>

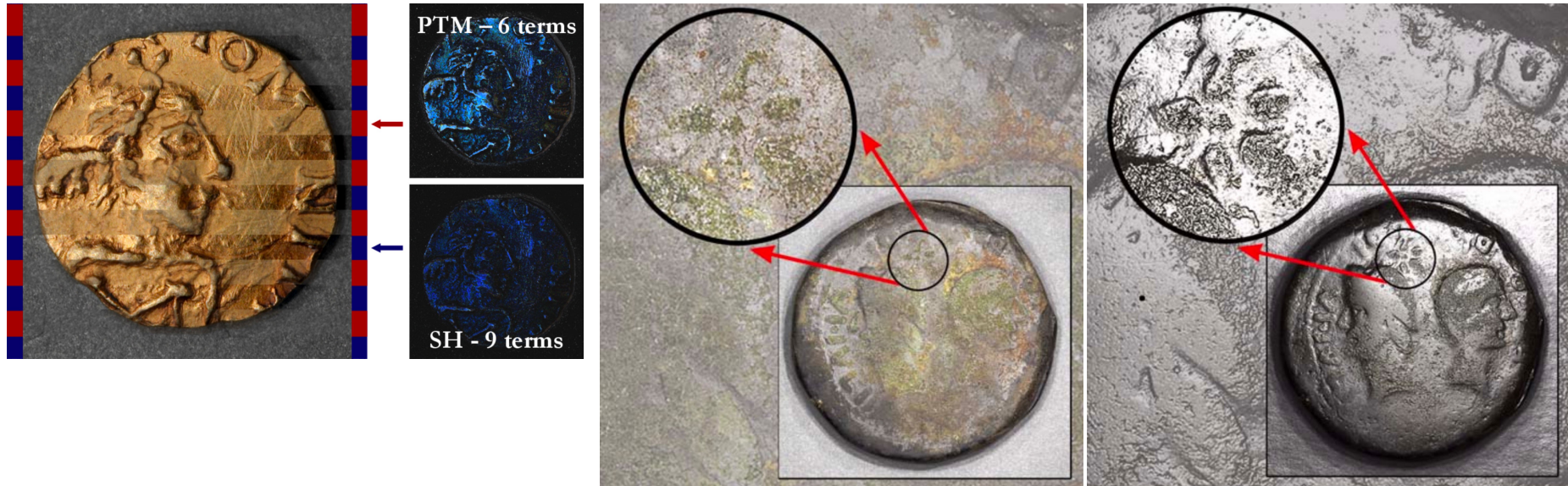


M. Manfredi et al., A new quantitative method for the non-invasive documentation of morphological damage in paintings using RTI surface normals, *Sensors* 14, no. 7 (2014), 12271–12284. [https://res.mdpi.com/d\\_attachment/sensors/sensors-14-12271/article\\_deploy/sensors-14-12271.pdf](https://res.mdpi.com/d_attachment/sensors/sensors-14-12271/article_deploy/sensors-14-12271.pdf)





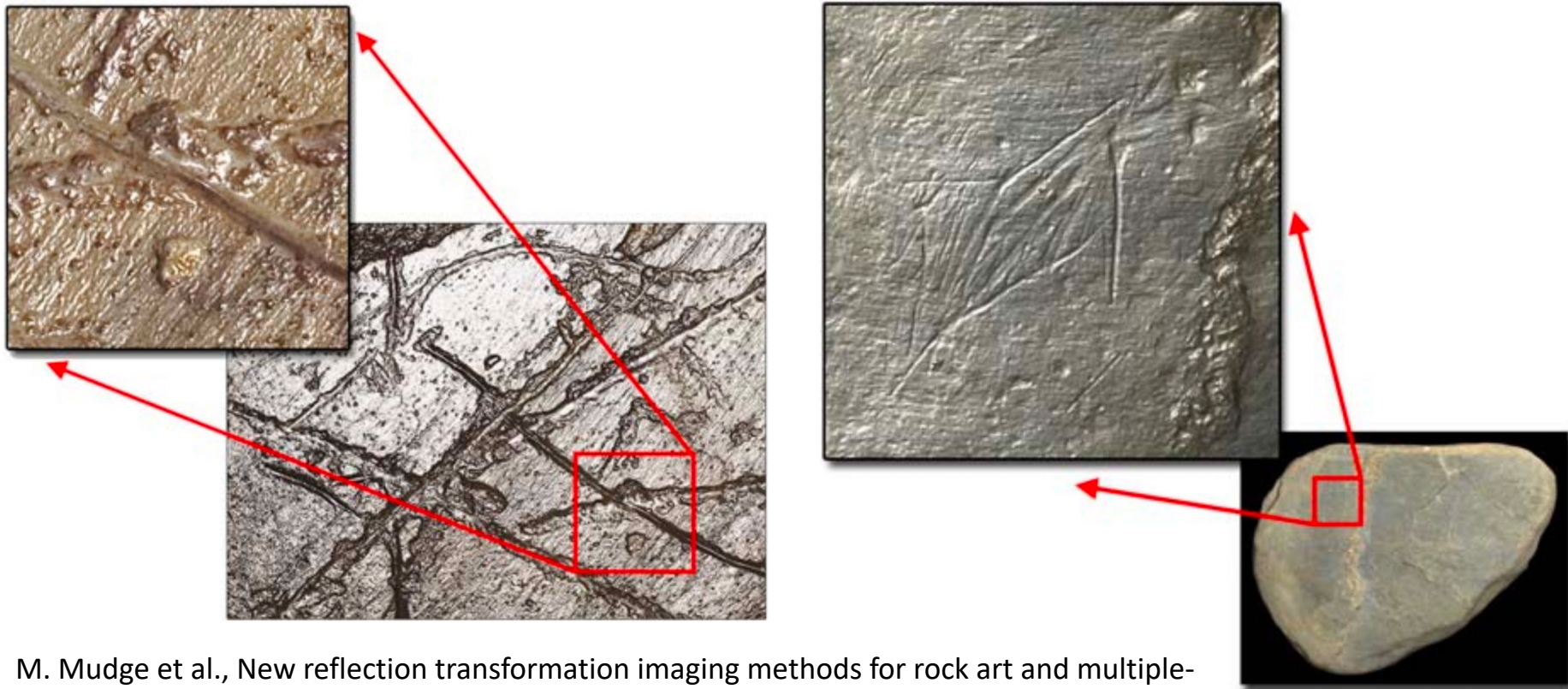
H. Hameeuw and C. Willems, New visualization techniques for cuneiform texts and sealings, *Akkadica* 132 (2011), 163–178.  
<https://biblio.ugent.be/publication/8572102/file/8572107>



P. Gunawardane et al., Optimized image sampling for view and light interpolation, in Proceedings of the 10th International conference on Virtual Reality, Archaeology and Cultural Heritage, Eurographics Association (2009), 93–100: [http://shiftright.com/mirrors/www.hpl.hp.com/personal/Tom\\_Malzbender/papers/p1027-vast09-fin.pdf](http://shiftright.com/mirrors/www.hpl.hp.com/personal/Tom_Malzbender/papers/p1027-vast09-fin.pdf)

M. Mudge et al., Reflection transformation imaging and virtual representations of coins from the hospice of the grand St. Bernard, in Proceedings of the 6th International conference on Virtual Reality, Archaeology and Intelligent Cultural Heritage, Eurographics Association (2005), 29–39:

[www.researchgate.net/profile/Dimitrios\\_Buhalis/publication/220955241\\_Visitors'\\_Evaluations\\_of\\_ICTs\\_Used\\_in\\_Cultural\\_Heritage/links/02e7e52bde3efea535000000.pdf#page=29](http://www.researchgate.net/profile/Dimitrios_Buhalis/publication/220955241_Visitors'_Evaluations_of_ICTs_Used_in_Cultural_Heritage/links/02e7e52bde3efea535000000.pdf#page=29)



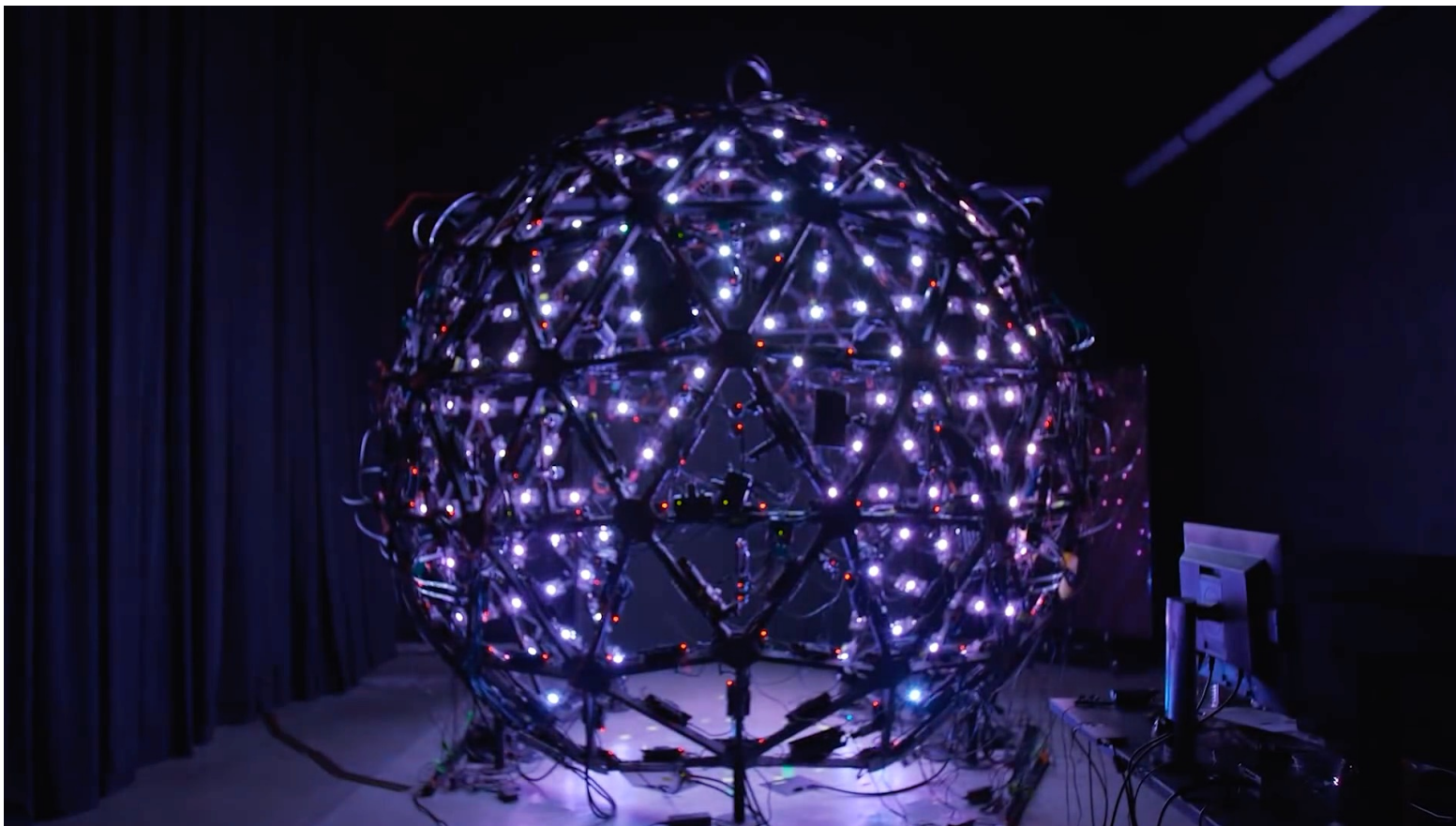
M. Mudge et al., New reflection transformation imaging methods for rock art and multiple-viewpoint display, in Proceedings of the 7th International conference on Virtual Reality, Archaeology and Intelligent Cultural Heritage, Eurographics Association (2006), 195–202:

<https://comum.rcaap.pt/bitstream/10400.26/25748/1/Mudgeetal2006.pdf>



<https://blogs.getty.edu/iris/uncovering-ancient-preparatory-drawings-on-greek-ceramics/>

P. Artal-Isbrand and P. Klausmeyer, Evaluation of the relief line and the contour line on Greek red-figure vases using reflectance transformation imaging and three-dimensional laser scanning confocal microscopy, *Studies in Conservation* 58, no. 4 (2013), 338–359.



<https://www.youtube.com/watch?v=anBRroZWfzI>; s.a. [https://www.youtube.com/watch?v=fj8n76shZ\\_g](https://www.youtube.com/watch?v=fj8n76shZ_g)



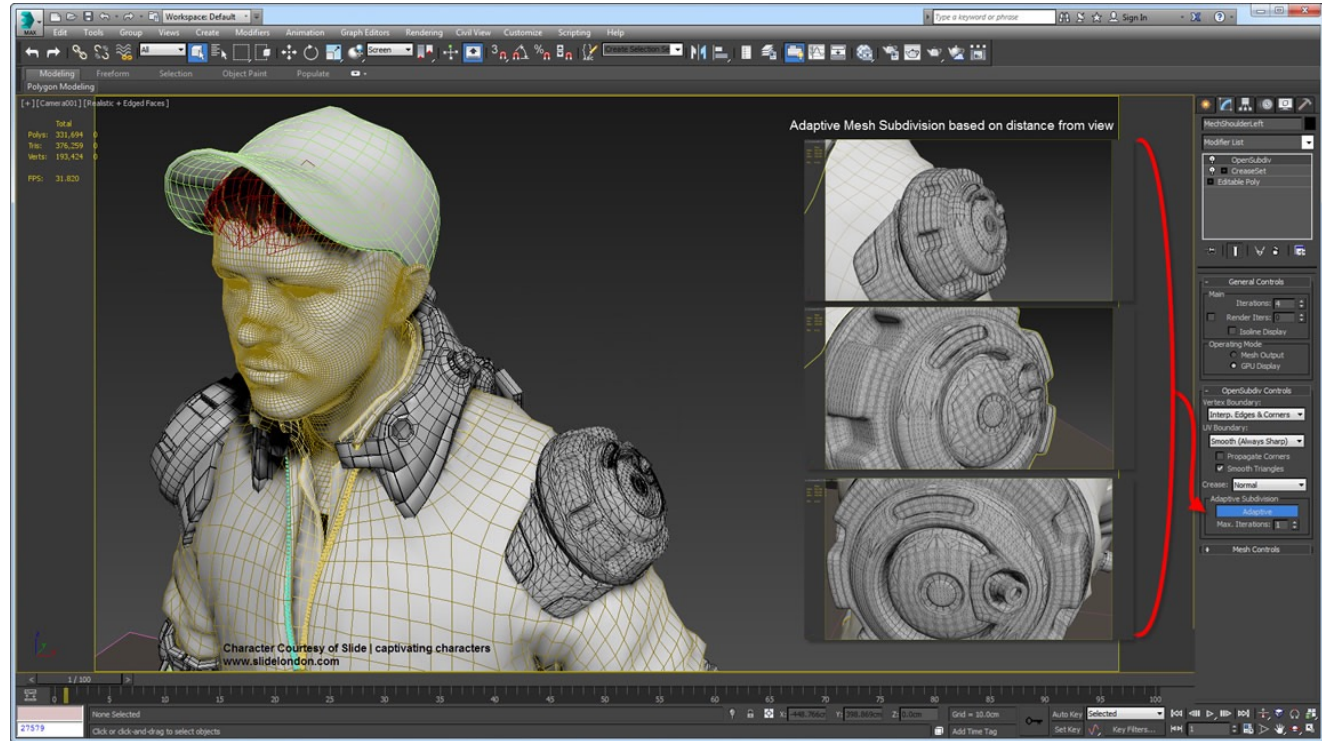
## 2. ACQUISITION IN 3D



# 3D Modellierung und Rendering

3D modelling implies a complete construction drawing ex novo on the screen. Technologies have been developed for the film market that make it relatively easy to create complex 3D models.

A CAD model is usually "watertight".



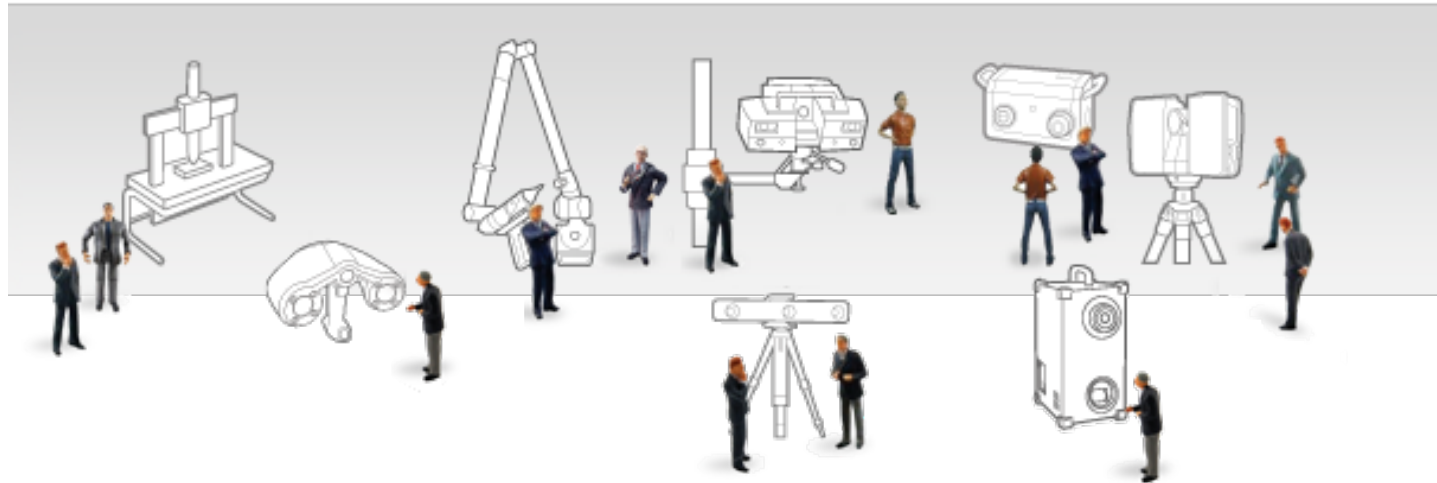


## 3D-Scanners

- use optical devices (e.g. a laser and a camera) to measure the curvature of the surface and thus map the geometry of physical objects as point clouds or meshes.

### Problems:

- What is not visible (e.g. undercuts) cannot be measured.
- Reflective surfaces
- Opaque (translucent) surfaces







## Laser surveying 3D scanners

- short range (<1 metre focal distance)

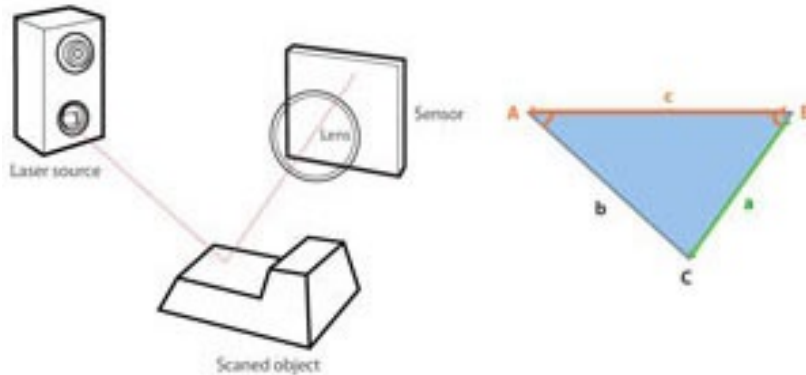


*Nikon ModelMaker MMDx-MMC 3d laser scanning presented at RAPID 2010.*



## Laser Triangulation Scanners

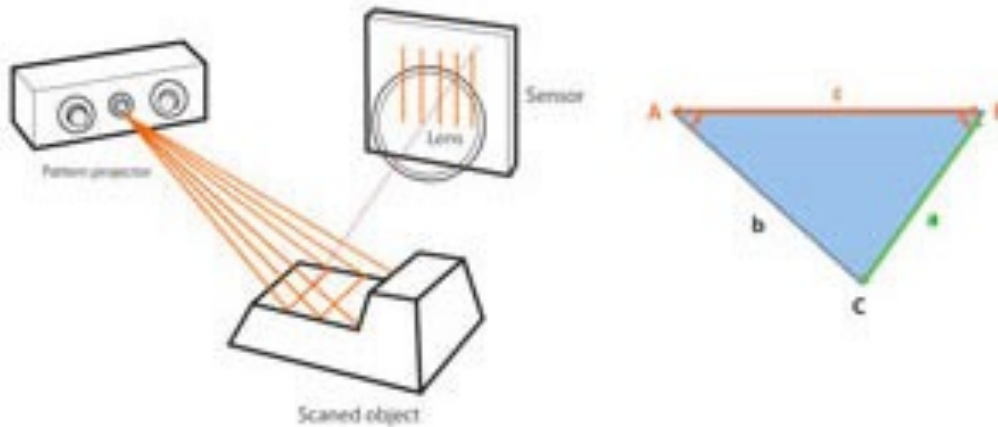
The distance between the laser output and the sensor ( $c$ ) is known. The distance to the object ( $a$ ) is measured by the sensor. This allows the exact position of the measuring point in relation to the laser source to be calculated and entered into a coordinate system.



*NextEngine Desktop 3d scanner with its Multidrive accessory, that allows non-contact 3d scanning.*

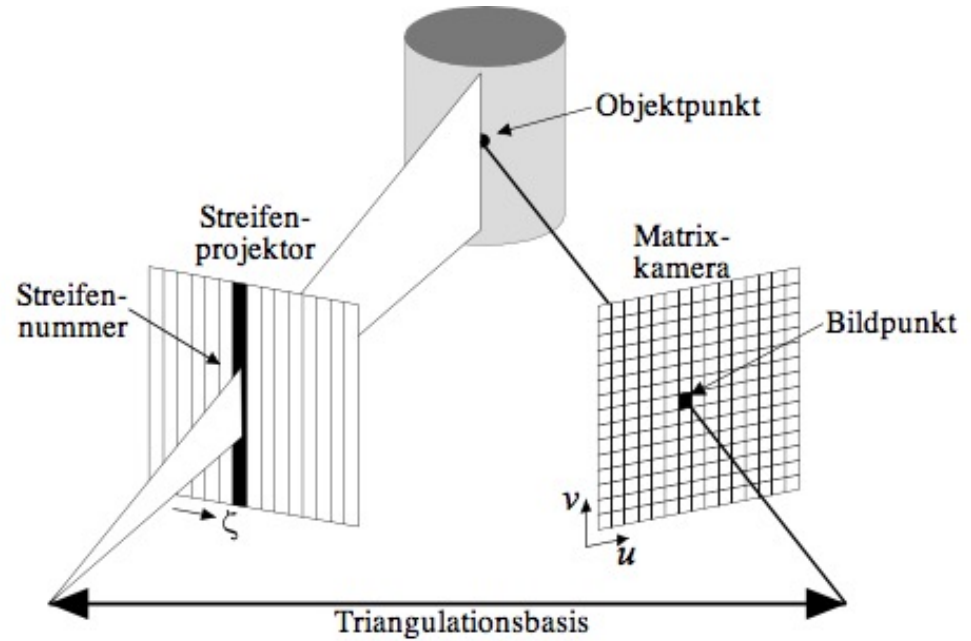
# Structured Light Scanners (White Light Scanners)

Die Kamera erfasst keine Laserlinie, sondern den Rand eines projizierten Musters



# Triangulation

through a series of linear patterns on the object surface



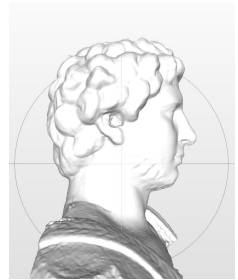
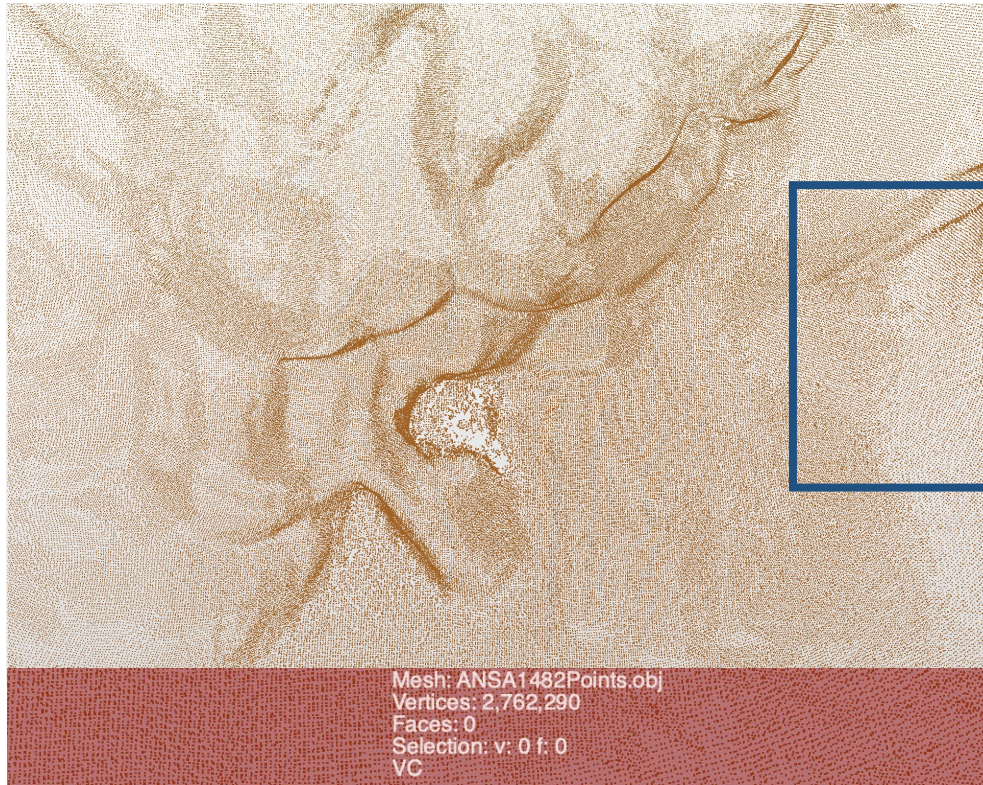
## Portable 3D-Scanners



[www.3dnatives.com/de/top10-low-cost-3d-scanner-191020161/](http://www.3dnatives.com/de/top10-low-cost-3d-scanner-191020161/)



# Point Cloud





## Triangulation

Triangulation is an old mathematical method (Thales) that breaks a curved surface into triangles that can be easily calculated.

Instead of a point cloud, triangulated surfaces can be displayed much faster (300,000 pt/s) even with a high accuracy rate (0.05 mm)

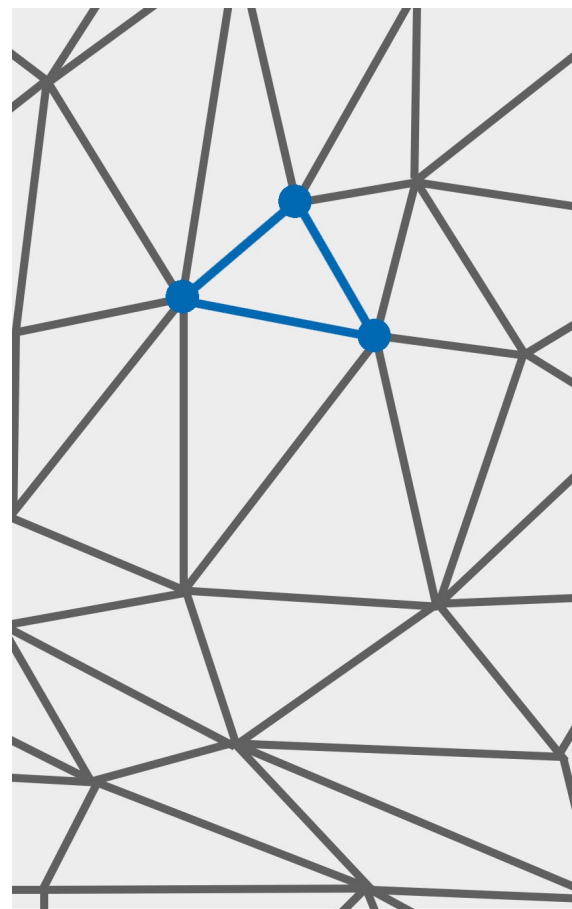
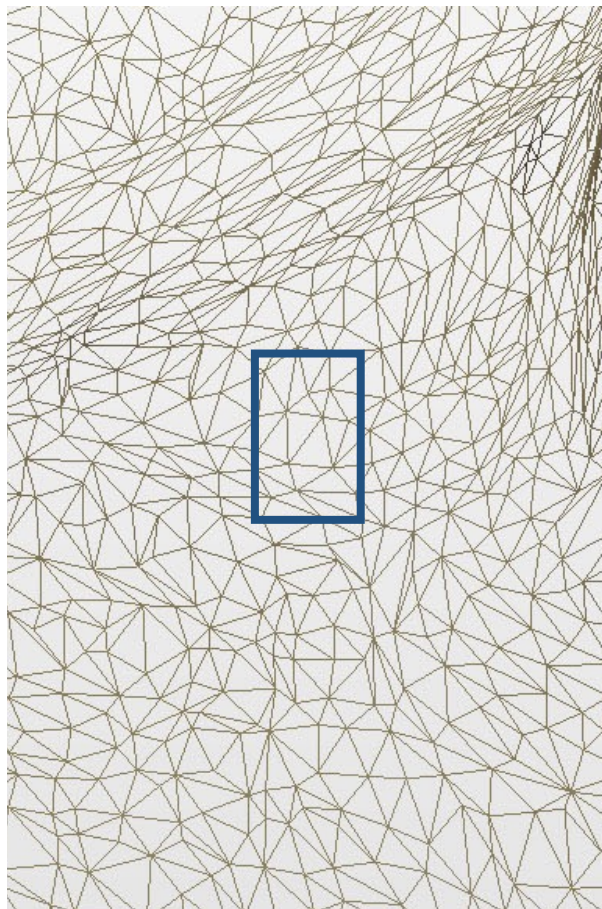




## Vertex

In 3D computer graphics, a vertex is a corner or node point, i.e. a point where several directions meet.

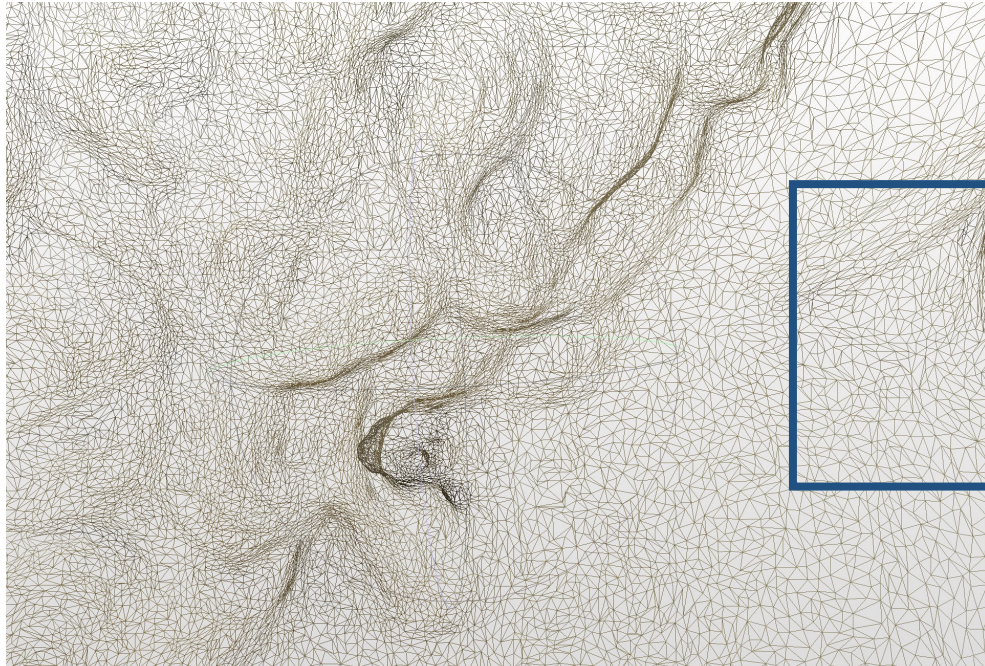
In addition to the position information in the form of a 3D vector, it can also contain other information such as a colour, transparency or a second position information that is used, for example, for the texture coordinates.



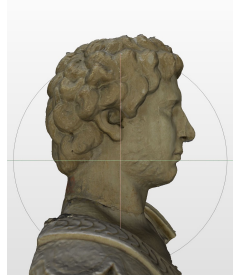
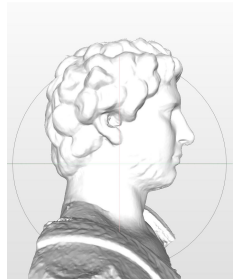




# Mesh



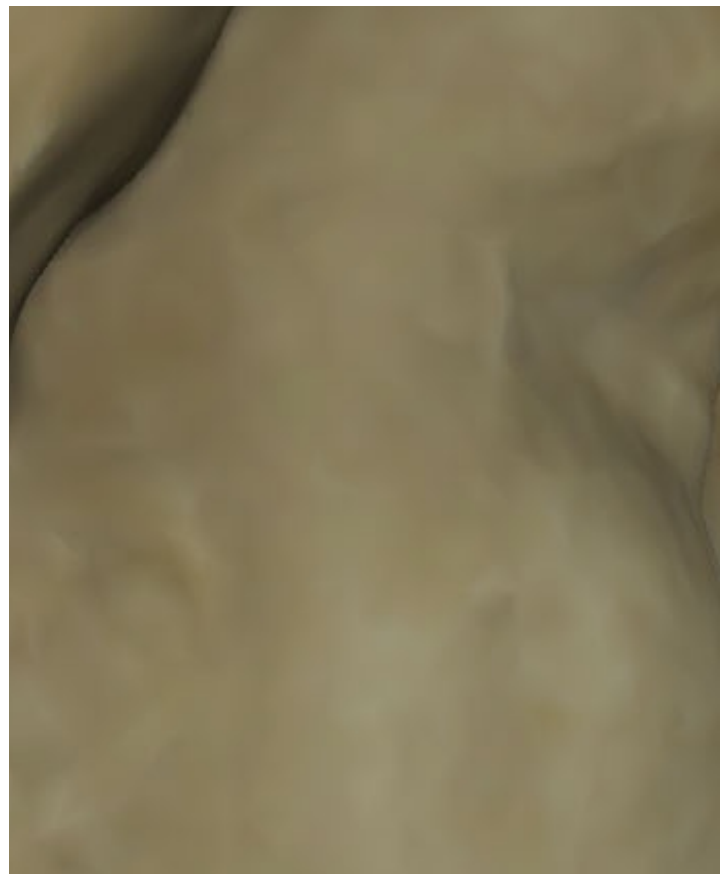
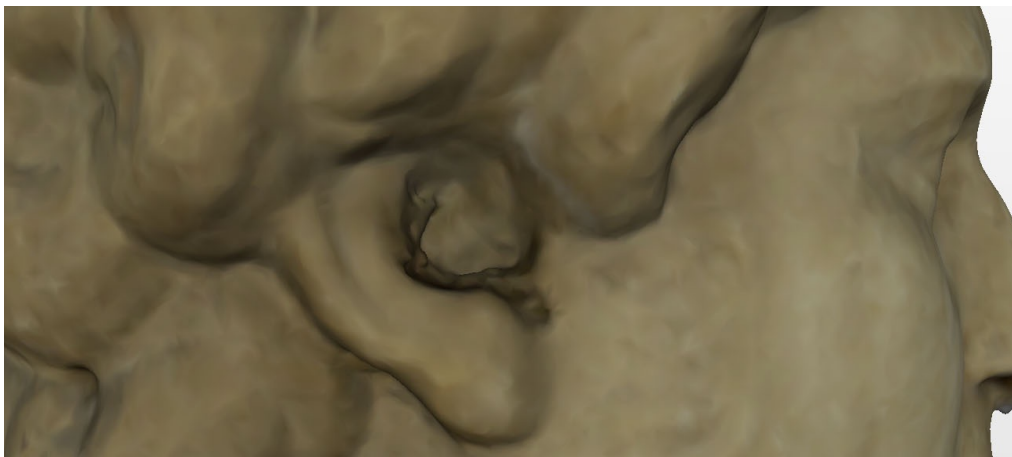
Mesh: ANSA1482Neu.obj  
Vertices: 191,306  
Faces: 380,616  
Selection: v: 0 f: 0  
VC FC WT





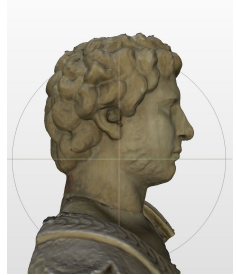
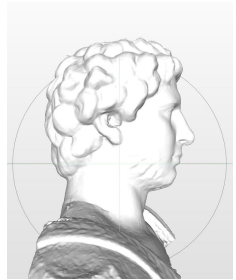
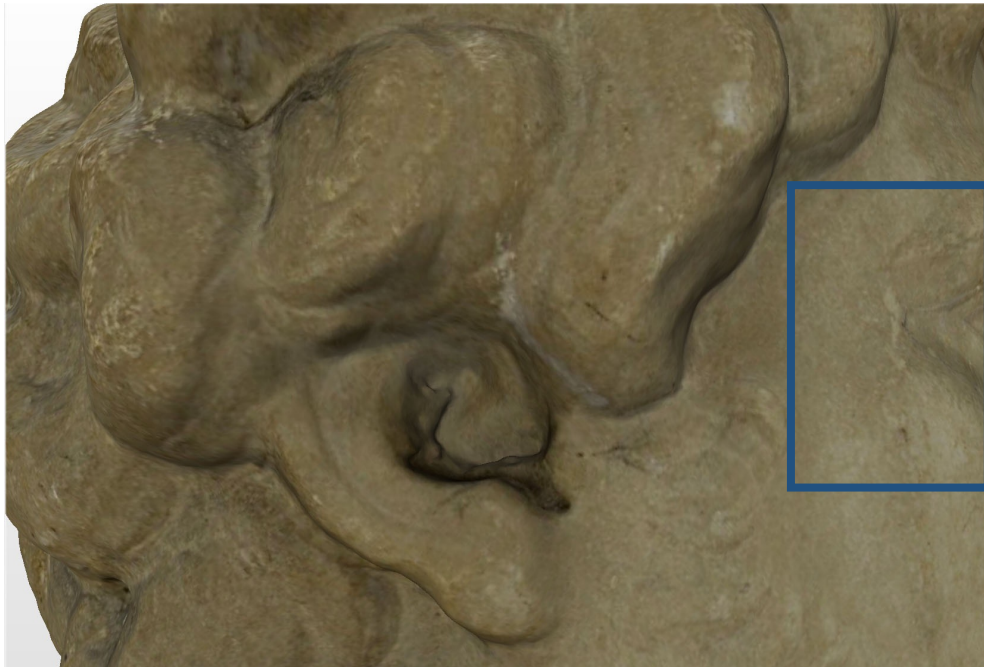
## Vertex Color

Each vertex can be assigned a colour. The vertex colour (colour per vertex) represents either a directly representable colour or a reflectance property, mainly an albedo, the measure of diffuse scattering power of different materials.





# Textured Mesh



Mesh: ANSA1482Neu.obj  
Vertices: 191,306  
Faces: 380,616  
Selection: v: 0 f: 0  
VC FC WT



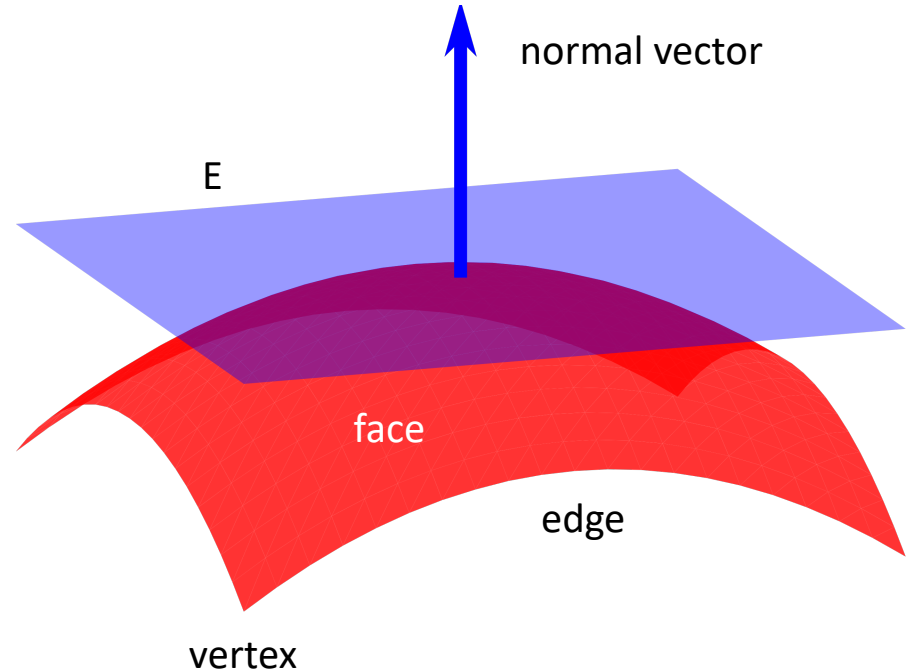
# Texture Mapping





## 3D model in .obj file format

stores geometric properties of an object as a mesh, i.e. vertices, faces, normals, smoothing, texture coordinates. Optical material properties (e.g. reflection, transparency, specularity, etc.) are defined in a separate material file (.mtl, material template library), which can also contain information on texturing.





# Photogrammetry

Via matching points a sequence of photos is connected to each other. This allows the position and distance of the camera to be calculated for each point in the photo.

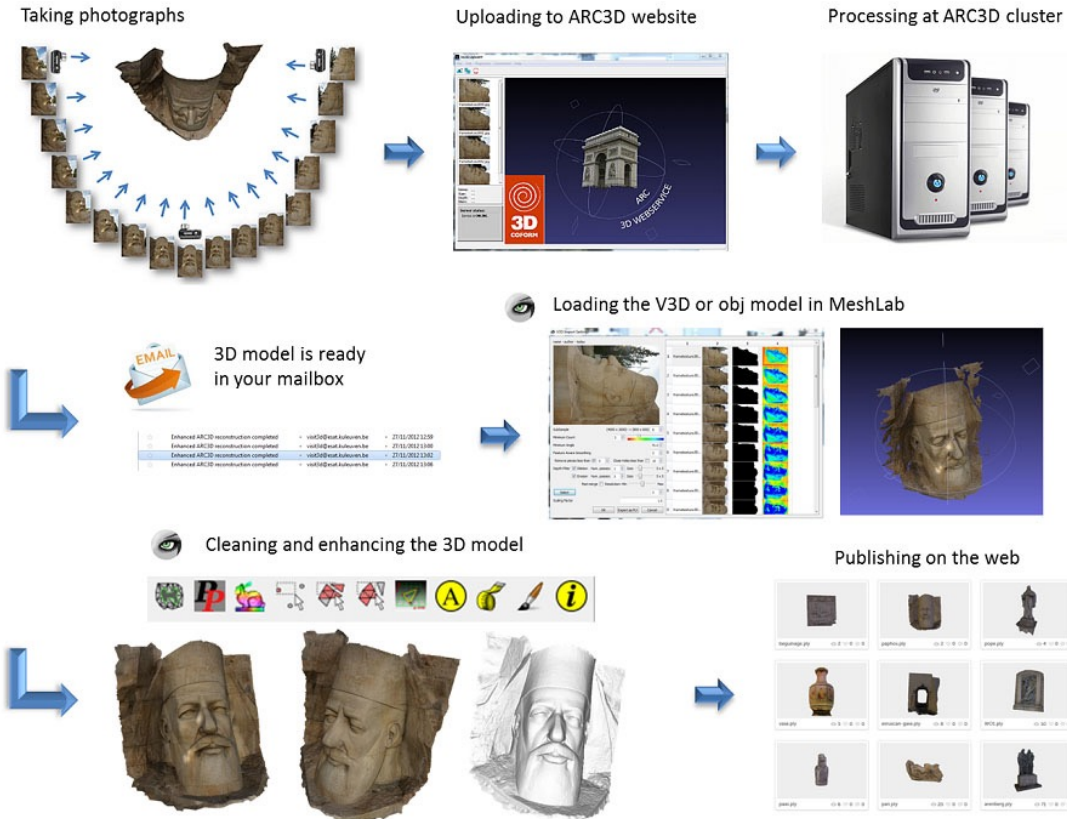




# Photogrammetry

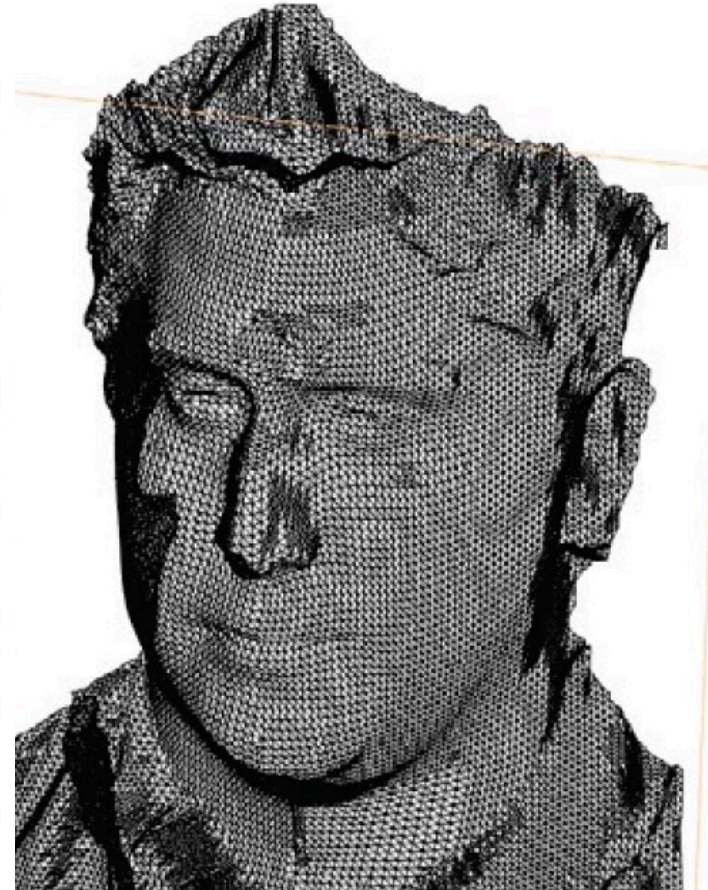
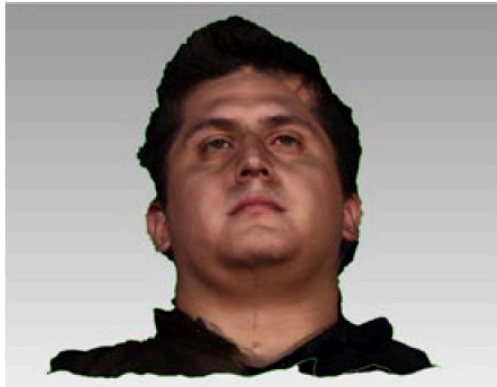
Software with so-called multi-view stereo matching algorithms automate the matching of reference points if there are enough closely overlapping photos.

- arc3D (<http://www.arc3d.be>)
- Metashape (<http://www.agisoft.com>)





# Photogrammetry







# Photogrammetry





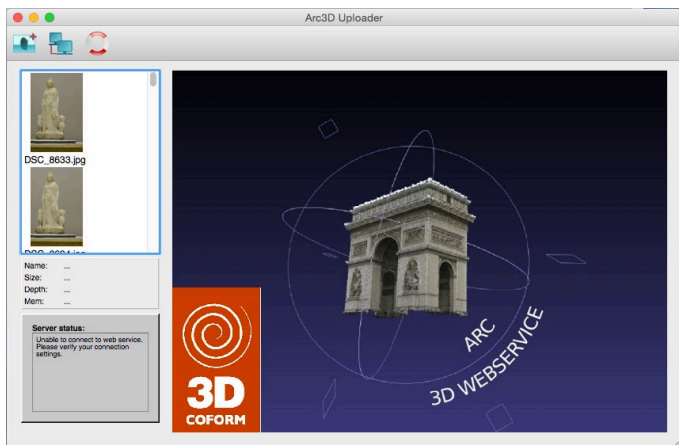


# Infrared scanning / Photogrammetry



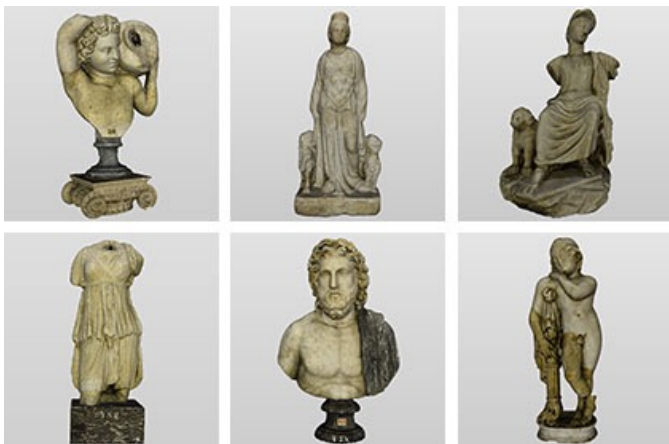
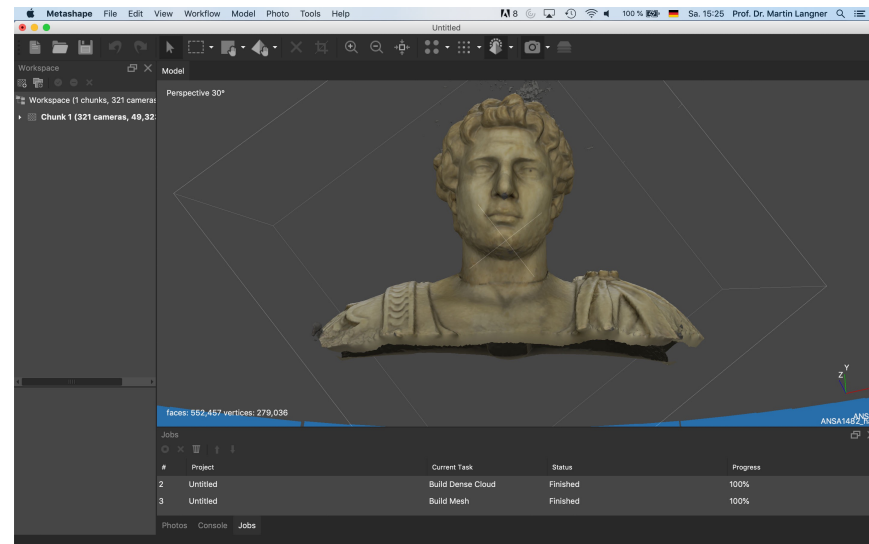
Occipital Structure Sensor  
(<https://structure.io/>)





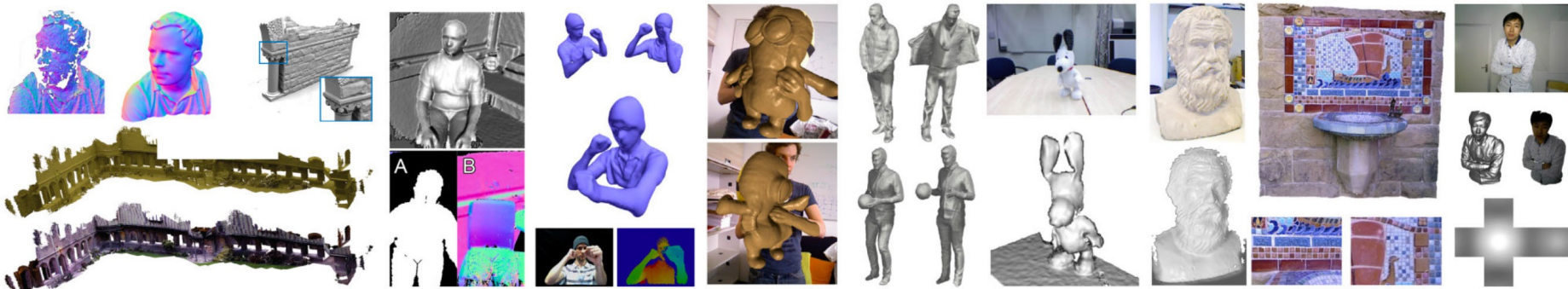
Arc3D  
[www.arc3d.be](http://www.arc3d.be)

Agisoft Metashape  
<https://www.agisoft.com/>



s.a. <https://www.3dnatives.com/de/top-10-der-besten-photogrammetrie-software-190920191/>

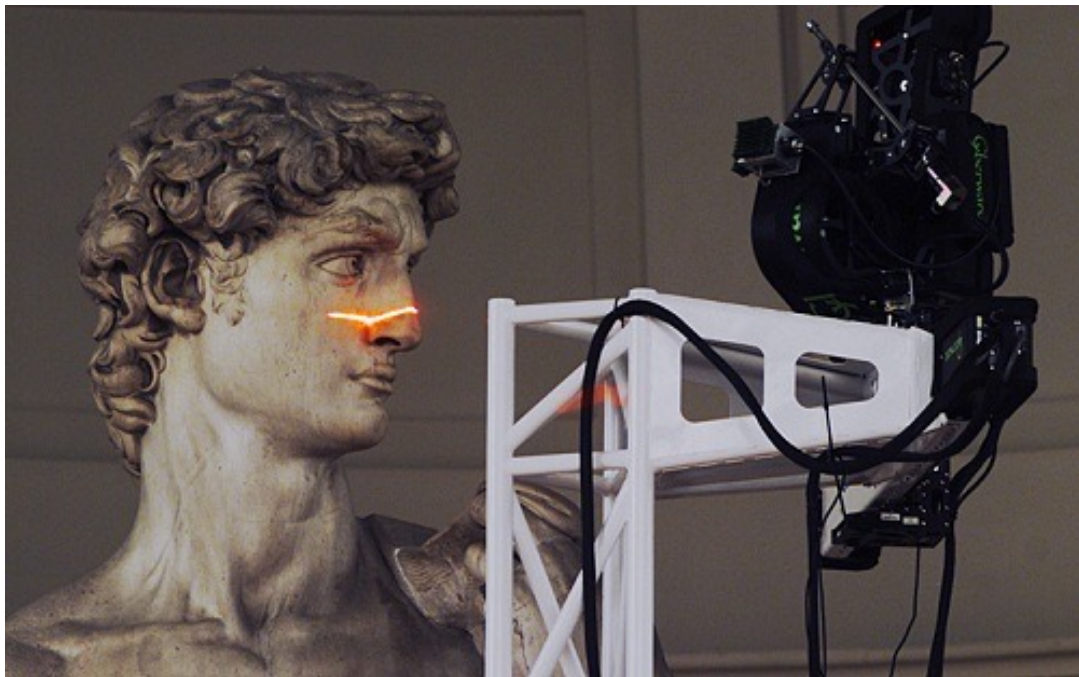
# Photogrammetry: State of the Art



Michael Zollhöfer et al., State of the Art on 3D Reconstruction with RGB-D Cameras, Computer Graphics Forum 37 (2018), 625-652 : [http://www.zollhoefer.com/papers/EG18\\_RecoSTAR/paper.pdf](http://www.zollhoefer.com/papers/EG18_RecoSTAR/paper.pdf)



# The Michelangelo Project

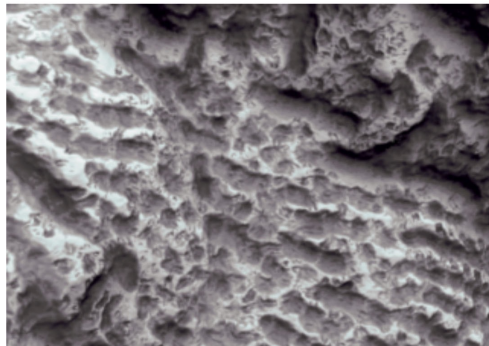
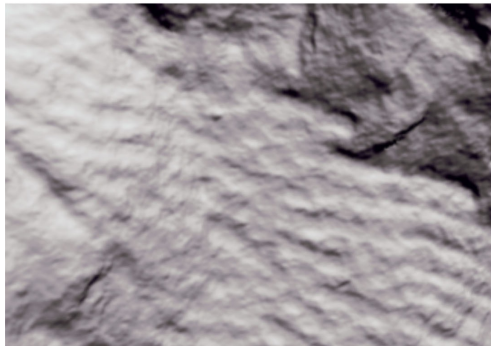
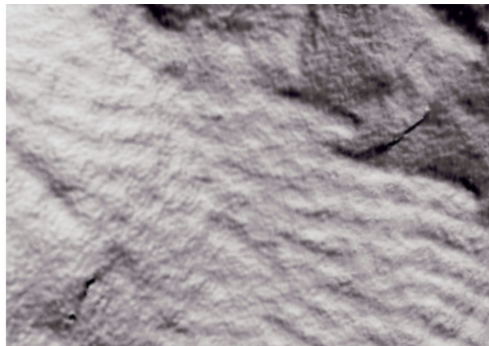


<https://accademia.stanford.edu/mich/>





## The Michelangelo Project



Der hl. Matthäus, 1505/06,  
Höhe 216 cm. Florenz, Galleria  
dell'Accademia inv. 1077



M. Levoy et al., „The digital Michelangelo project: 3D scanning of large statues,“ in *Proceedings SIGGRAPH* (2000), 131–144: <https://dl.acm.org/doi/pdf/10.1145/344779.344849>



# Other Michelangelo Projekts

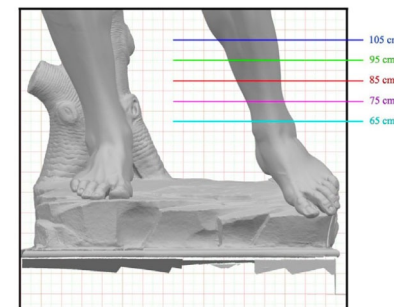
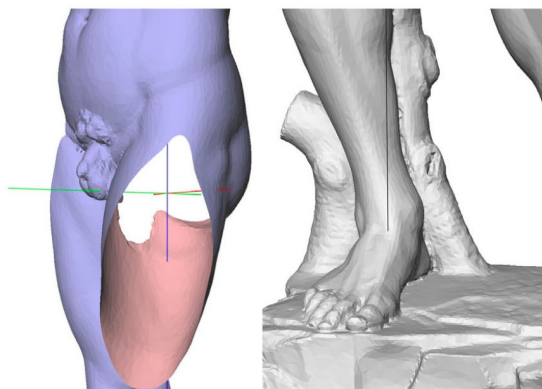
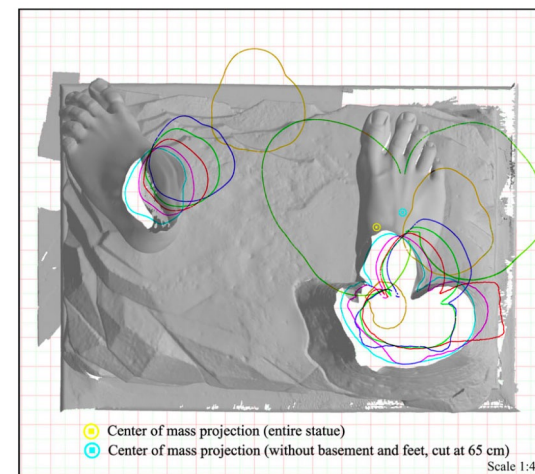
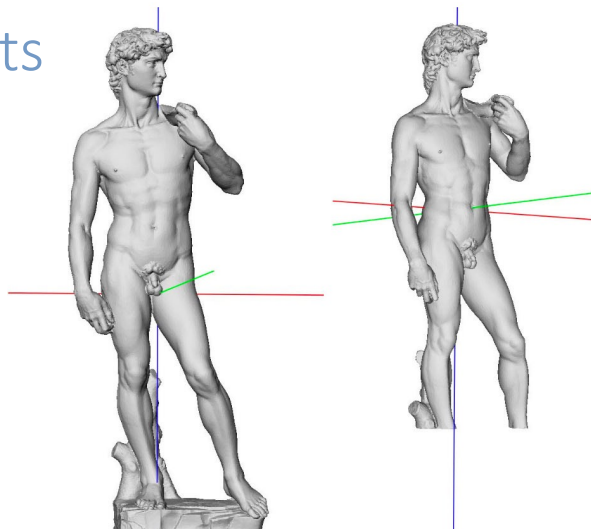
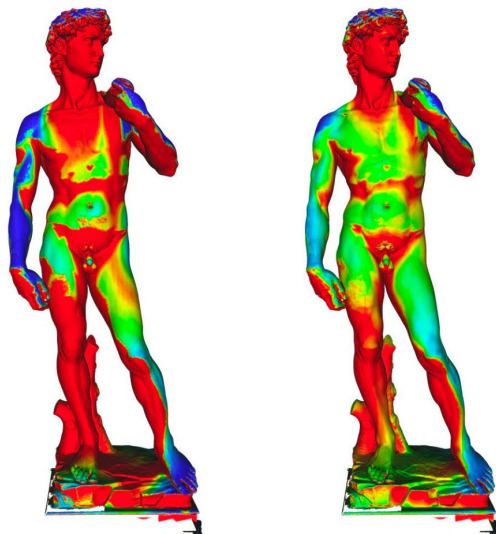
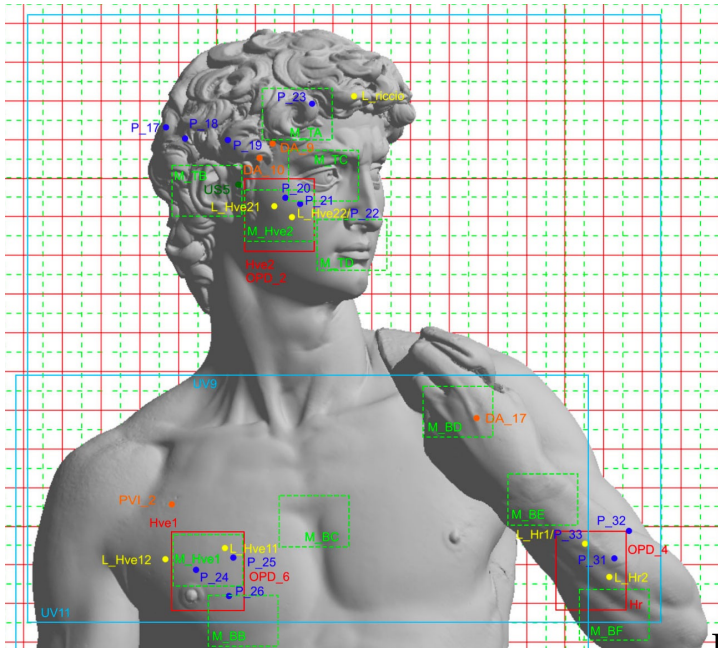


Figure 1: Exposure of David's surface to dust or other contaminations. This visualization shows, using a false-color ramp, the different classes of exposition produced by the simulation (red: absence of fall, blue: high density of fall), under a maximal angle of fall of 5 degrees (on the left) and 15 degrees (on the right).





# Michelangelo-Projekte



M. Callieri et al., „Visualization and 3D data processing in the David restoration,“ *Computer Graphics and Applications*, IEEE 24, no. 2 (2004), 16–21



F. Bernardini et al., Building a digital model of Michelangelo's Florentine Pietà. *Computer Graphics and Applications*, IEEE 22, no. 1 (2002), 59–67; Jack Wasserman et al., *Michelangelo's Florence Pietà* (Princeton University Press, 2003) mit 3D-Modell auf CD-ROM.

[http://www.hunter.cuny.edu/cs/Faculty/Stamos/3DP\\_F03/PAPERS/pieta-cga.pdf](http://www.hunter.cuny.edu/cs/Faculty/Stamos/3DP_F03/PAPERS/pieta-cga.pdf)



# Body Scanner

Cartesia 3D  
Body Scanner >



Cyberware Custom Scanners  
(<http://www.cyberware.com>)

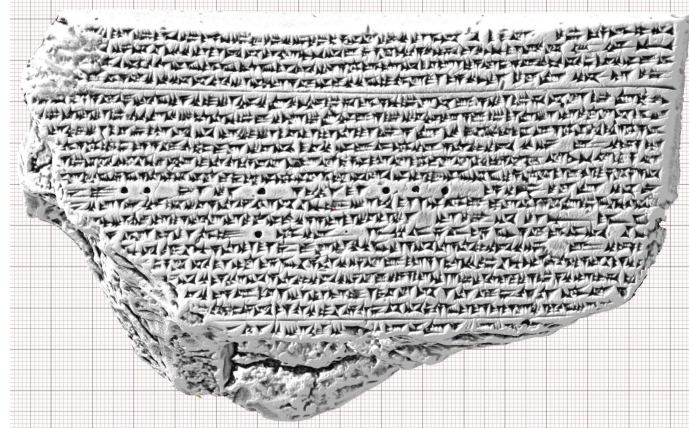




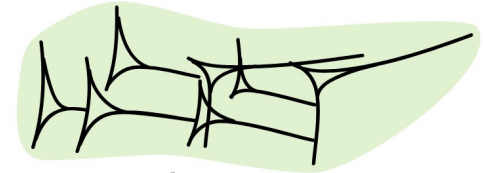
# GIGAMESH

Hubert Mara and Susanne Kromker, „Vectorization of 3D-characters by integral invariant filtering of high-resolution triangular meshes,“ in *12th International Conference on Document Analysis and Recognition (ICDAR)*, 2013 (2013), 62–66;

Hubert Mara et al., „Gigamesh and Gilgamesh: 3D multiscale integral invariant cuneiform character extraction,“ in *Proceedings of the 11th International conference on Virtual Reality, Archaeology and Cultural Heritage* (2010), 131–138.

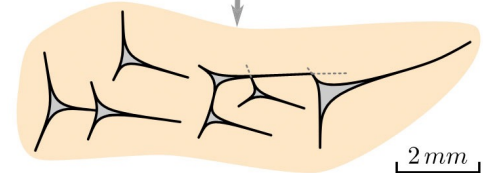
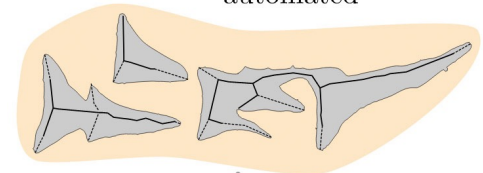


photograph



manual

automated ka



2mm



# ARCHÄOLOGICAL DOCUMENTATION



Photograph



3D model



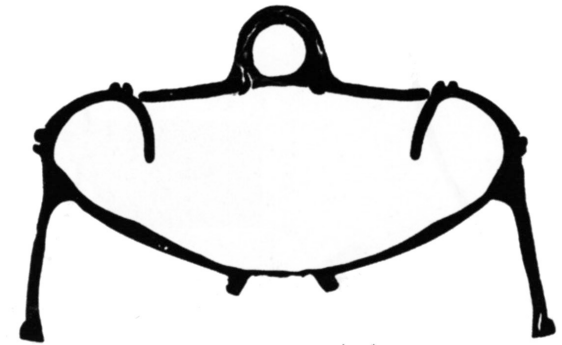
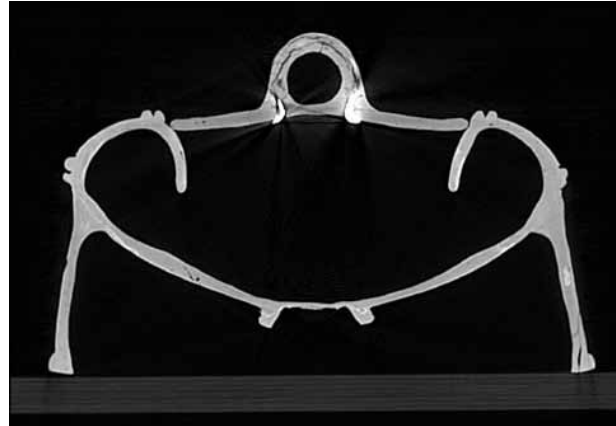
Line drawing

Ayelet Gilboa et al., „Computer-based, automatic recording and illustration of complex archaeological artifacts,“  
*Journal of Archaeological Science* 40, no. 2 (2013), 1329–1339.



## Computer Tomography (CT)

- Medical imaging technique, produces a three-dimensional image of the inside of an object from a large series of X-ray images.



Exaleiptron des Polos-Malers, Amsterdam Inv. 1942 (CVA Amsterdam 5 Taf. 283–286 Abb. 45)



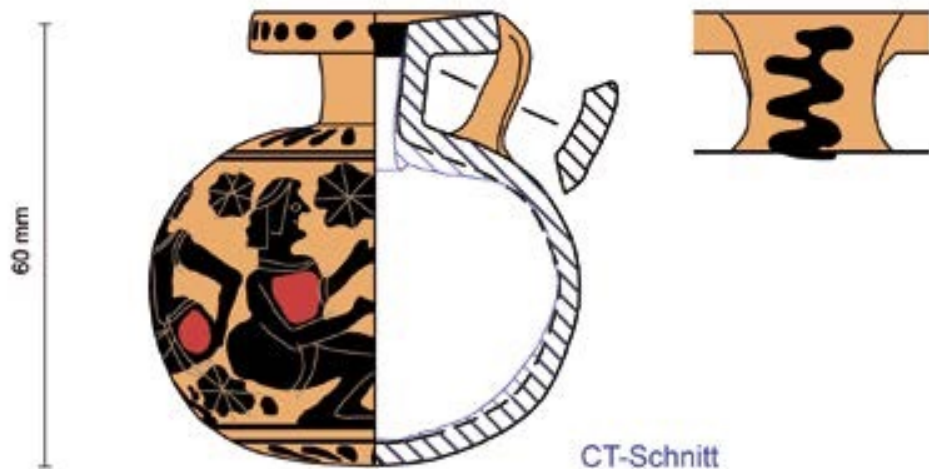
## XRay Micro-Computertomography



Chess piece assembled (h. 9.8 cm) and disassembled, scanned with Xray Micro-CT, the sphere as a 3D model and tenfold enlarged printout of the piece.

Steven D. Laylock et al., „Combining x-ray micro-ct technology and 3D printing for the digital preservation and study of a 19th century cantonese chess piece with intricate internal structure,“ *Journal on Computing and Cultural Heritage* 5, no. 4 (Jan. 2013), 13:1–13:7: <http://doi.acm.org/10.1145/2399180.2399181>

## Computertomography (CT) und Structured Light



S. Karl u.a., Berührungsfreie und nicht invasive Untersuchung antiker Keramik mittels industrieller Röntgen-Computertomografie, in: Interdisziplinäre Dokumentations- und Visualisierungsmethoden, CVA Österreich, Beih. 1 (2013) 73–114: <http://www.austriaca.at/0xc1aa5576%200x002ec069.pdf>;

S. Karl u.a., An interdisciplinary approach to studying archaeological vase paintings using computed tomography combined with mineralogical and geochemical methods. A Corinthian alabastron by the Erlenmeyer Painter revisited, *Journal of Cultural Heritage* 31, 2018, 63-71.



# Comparison of Acquisition Methods

Analoge und digitale Erfassung von Sammlungsobjekten im Vergleich

Dieses Booklet können Sie unter [www.uni-goettingen.de/digitalhumanities/download](http://www.uni-goettingen.de/digitalhumanities/download).

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN  
Institut für Digital Humanities

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN  
Institut für Digital Humanities

Fazit

Analoge Erfassungsmöglichkeiten werden durch digitale Methoden nicht vollständig abgelöst. Die Handschriftliche Details (wie eine umlaufende Fibel) lassen sich nur durch die digitale Matrikalisierung (z. B. als 3D-Modell) für den Vergleich mit der Orthografie nach wie vor sinnvoll. Handschriftliche und Orthografie können aber digitale Verfahren nutzen, um die Ergebnisse zu optimieren. Die Form eines Objekts kann durch Fotogrammetrie gut erfasst werden. Das gilt vor allem für die Identifizierung, Klassifizierung und Quantifizierung der Objekte. Für genaue Maßvergleiche sind aber die hochauflösenden Scans mit Struktur Light (Photogram) zu empfehlen, deren Auflösung von der Qualität der verwendeten Objektivs abhängt. Hiermit werden kleinste Details vermessen, die sich auch mit RTI visualisieren lassen. Das Innere eines Objekts lässt sich hingegen mit Hilfe der Computertomografie am besten untersuchen.

Libertus: DTG-Forschung „Digitalisierung“.  
DOI: 10.21203/3.15112.111, da.pdf, Postfach 30155, 37075 Göttingen, Institut für Digital Humanities, Georg-August-Universität Göttingen, 2018.  
doi:10.21203/3.15112.111, da.pdf, Postfach 30155, 37075 Göttingen, Institut für Digital Humanities, Georg-August-Universität Göttingen, 2018.  
doi:10.21203/3.15112.111, da.pdf, Postfach 30155, 37075 Göttingen, Institut für Digital Humanities, Georg-August-Universität Göttingen, 2018.  
doi:10.21203/3.15112.111, da.pdf, Postfach 30155, 37075 Göttingen, Institut für Digital Humanities, Georg-August-Universität Göttingen, 2018.

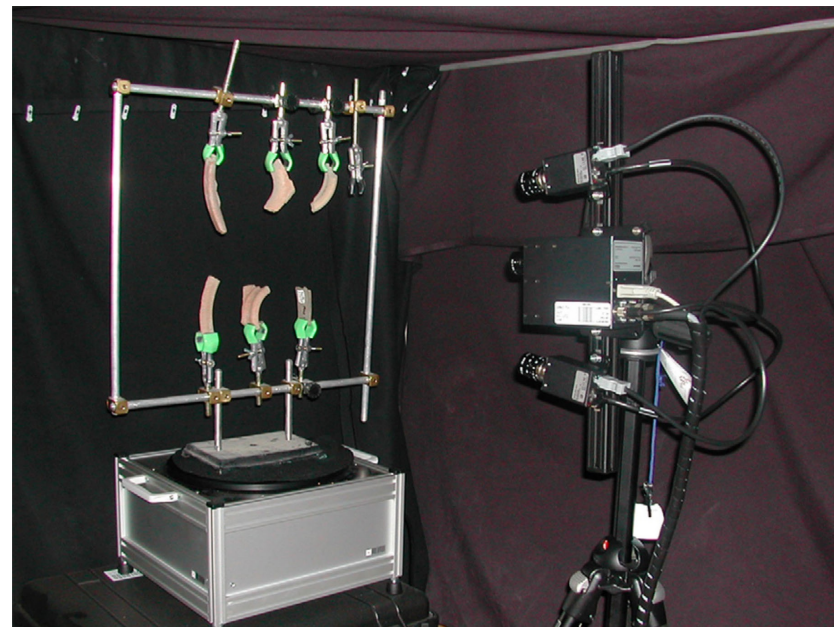
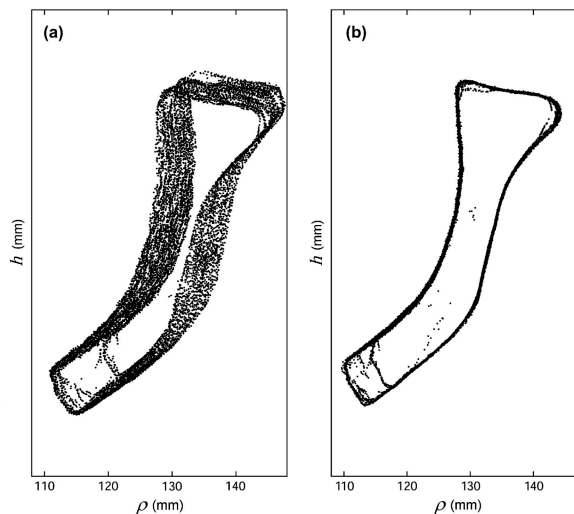
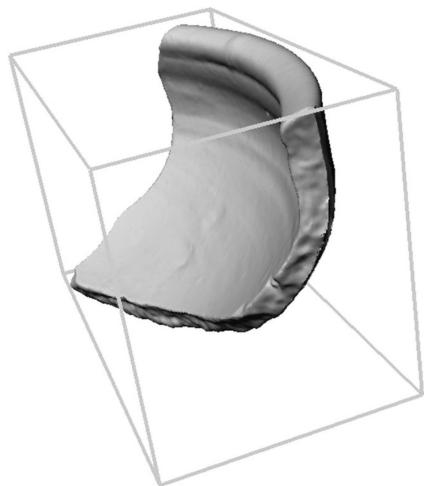
Die Darstellung der verschiedenen Verfahren ist im Vergleich gut erkennbar (rot: Handschriftliche vs. Fotogrammetrie; blau: Weibstich).

<https://www.uni-goettingen.de/de/dh-ausstellung+im+kwz+2019/614746.html>

Mona Hess, Lindsay W. MacDonald and Jaroslav Valach, „Application of multi-modal 2D and 3D imaging and analytical techniques to document and examine coins on the example of two Roman silver denarii,“ *Heritage Science* 6, no. 5 (2018): <https://heritagesciencejournal.springeropen.com/articles/10.1186/s40494-018-0169-2>

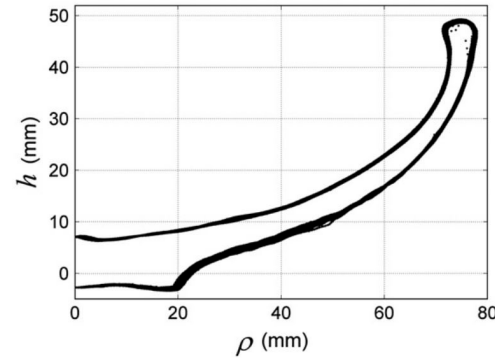
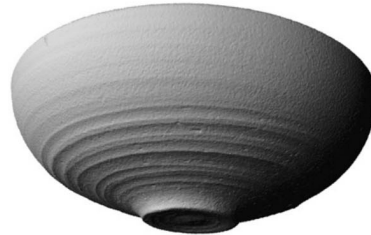
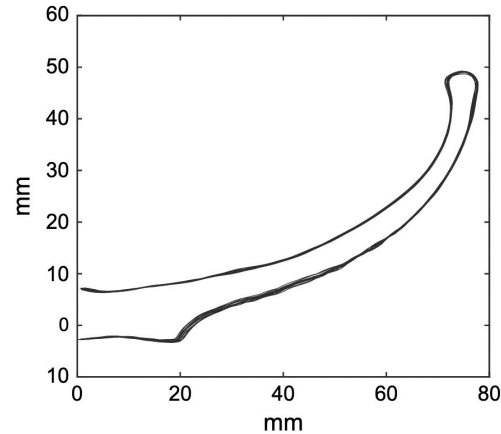
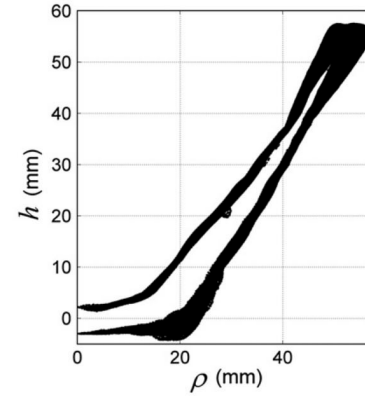
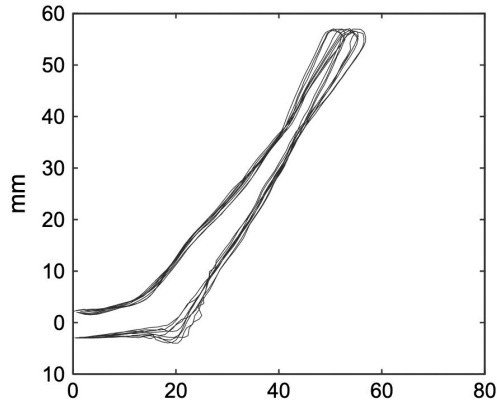


## Publication of Ceramic Profiles

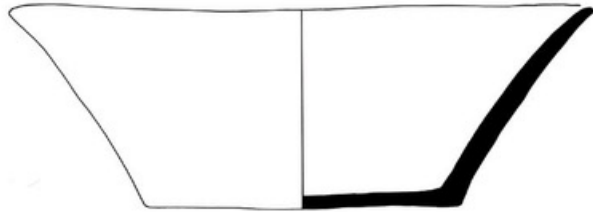


Avshalom Karasika and Uzy Smilanskyba, „3D scanning technology as a standard archaeological tool for pottery analysis: practice and theory,” *Journal of Archaeological Science* 35 (2008), 1148–1168:

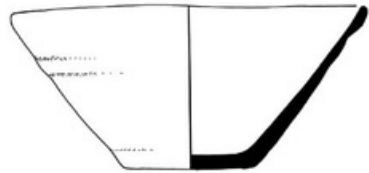
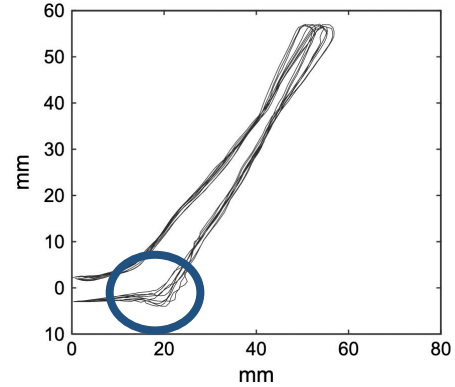
<https://pdfs.semanticscholar.org/3792/b0a90b1c244501d46839b6b868f280d3a0c4.pdf>



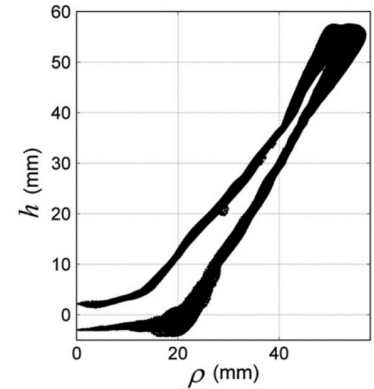
Avshalom Karasika and Uzy Smilanskyba, „3D scanning technology as a standard archaeological tool for pottery analysis: practice and theory,” *Journal of Archaeological Science* 35 (2008), 1148–1168



12



7



Edwin C. M. van den Brink et al., „Late Chalcolithic Settlement Remains East of Namir Road, Tel Aviv,“ *Journal of the Israel Prehistoric Society* 46, (2016), 52 Abb. 42:

[https://www.researchgate.net/publication/312154701\\_Late\\_Chalcolithic\\_Settlement\\_Remains\\_East\\_of\\_Namir\\_Road\\_Tel\\_Aviv](https://www.researchgate.net/publication/312154701_Late_Chalcolithic_Settlement_Remains_East_of_Namir_Road_Tel_Aviv)



### 3. CHALLENGES





# Decimation

Reducing the number of polygons



N° of faces: 65.672  
6.6 MB



32.936  
3.4 MB

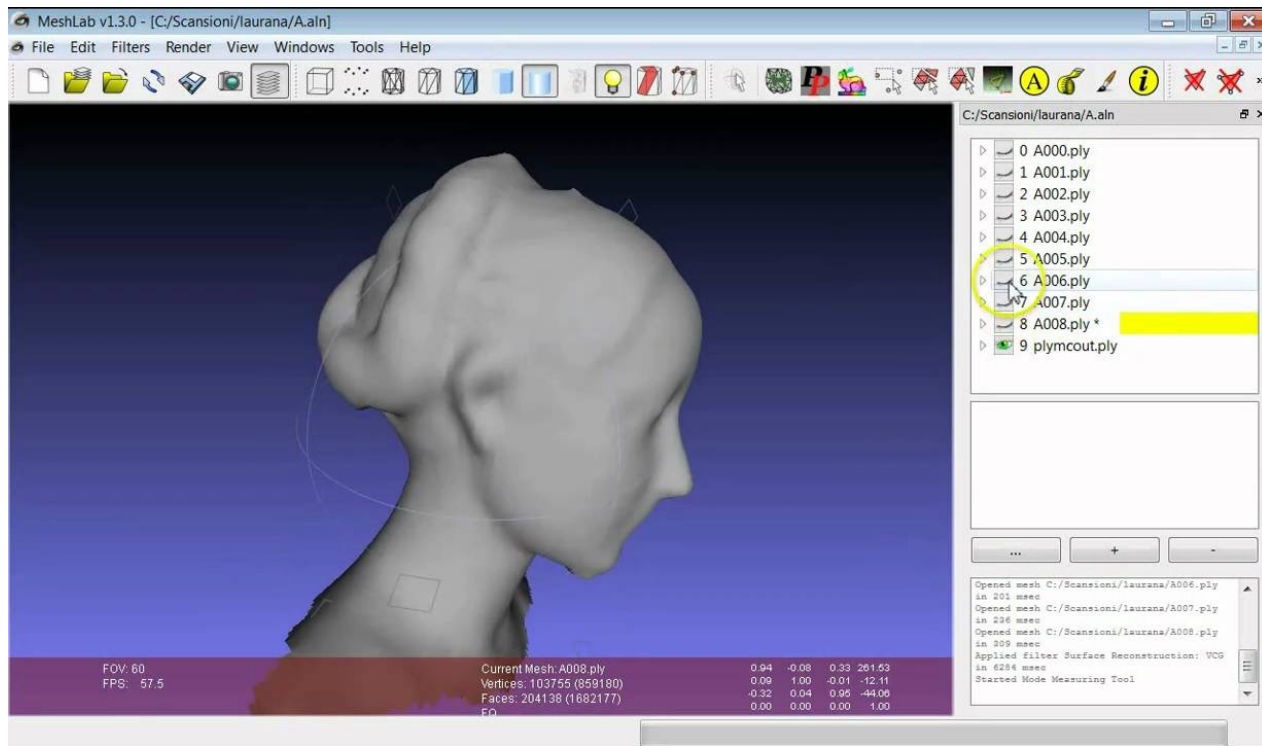


29.466  
3.0 MB



## Merging

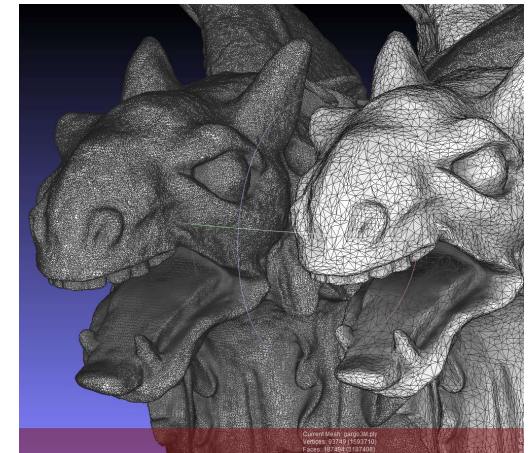
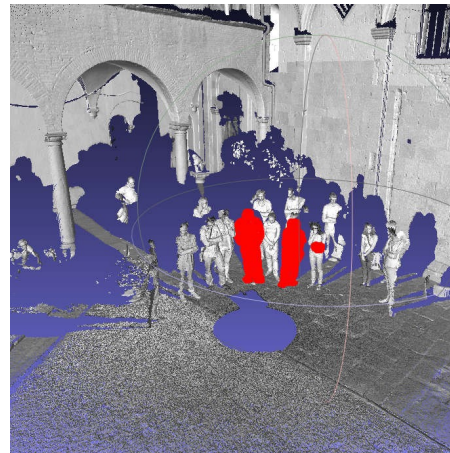
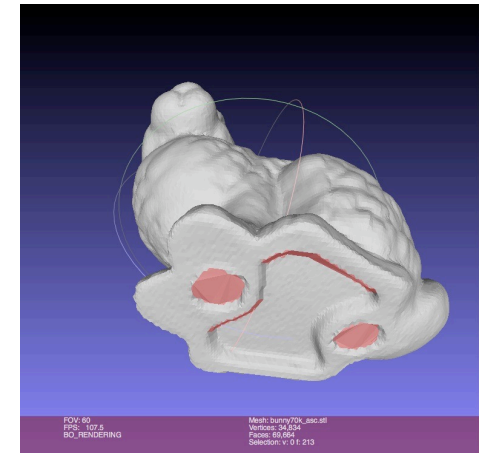
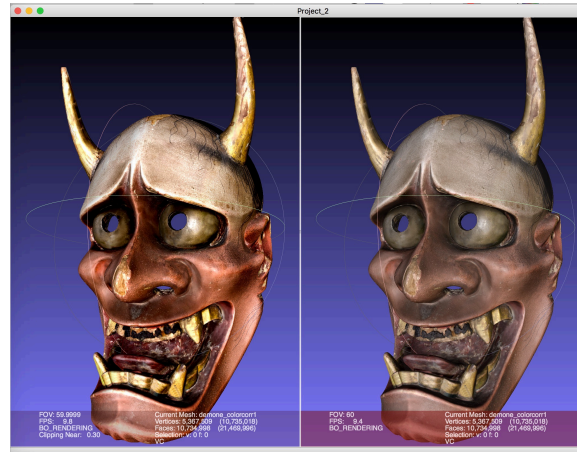
- In a way, merging means a loss of data by calculating an average value.
- Possibility to remove image noise.
- Some prefer a sample of the point clouds





# Processing

Steps of scientific intervention in a 3D model, starting from the initial structured model and all resulting processed models. The processing performed to move from one state to another must be entered into the paradata.

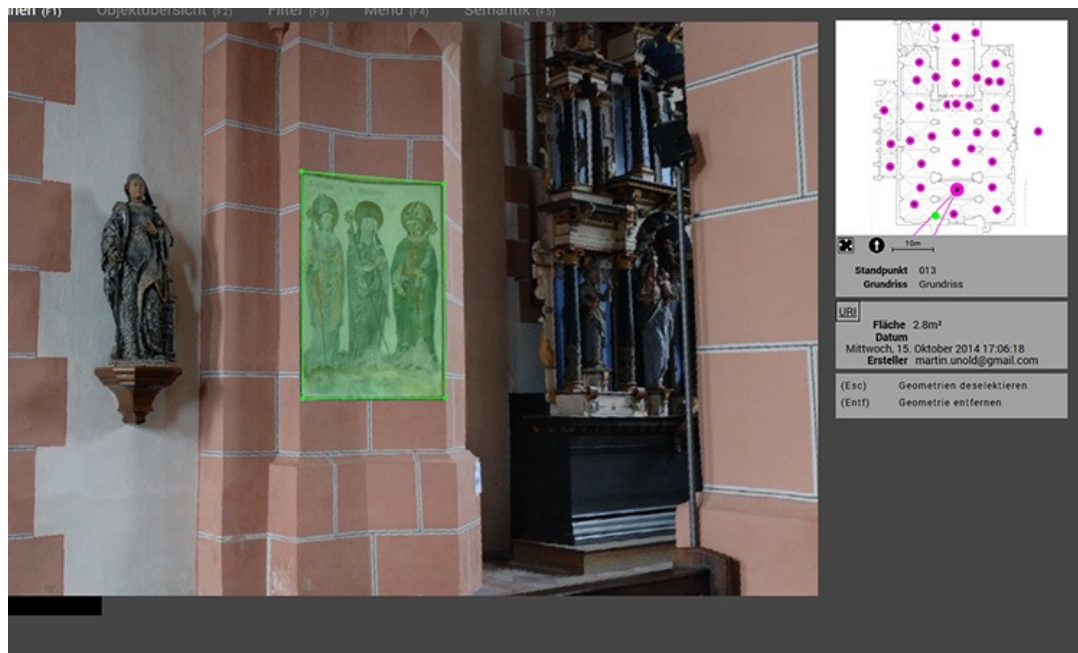




## Semantic Enrichment

Adding information to 3D data. This enrichment is an interpretation of the acquired data and is often necessary for understanding the object of study.

Textual semantic enrichment can use thesauri or even ontologies to structure the relationships between the terms used.



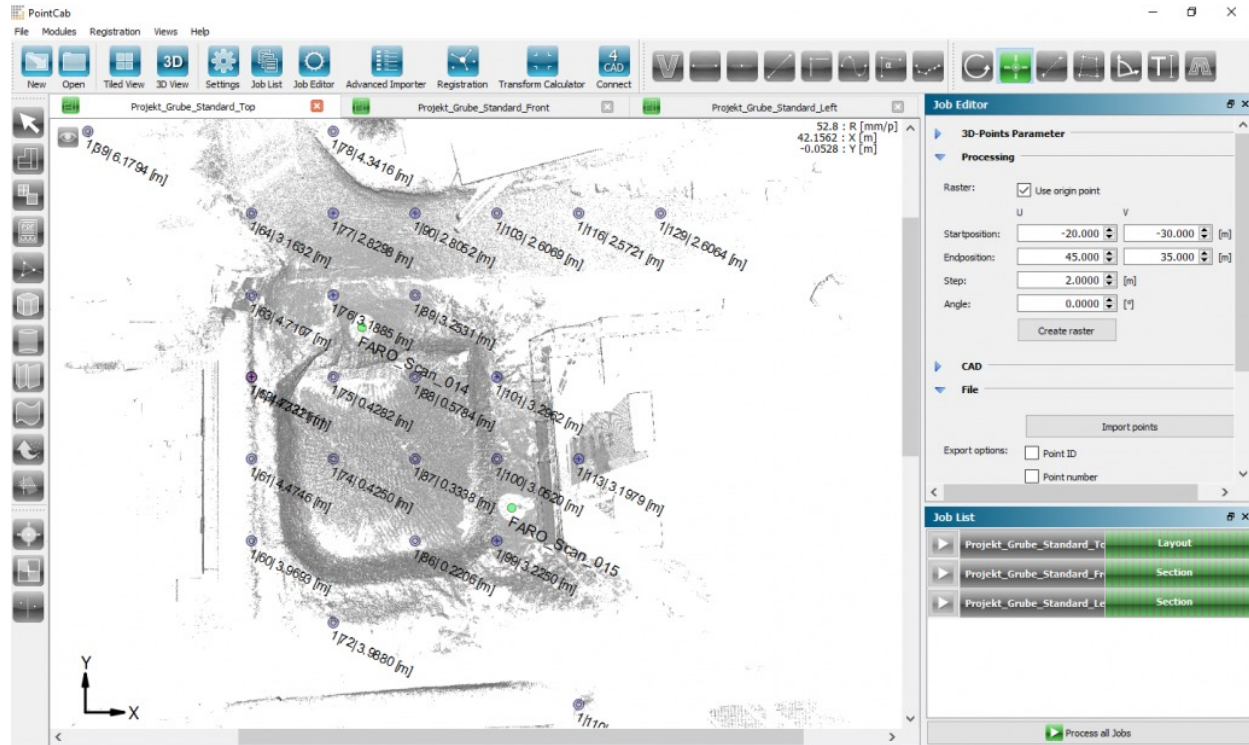
Felix Lange and Martin Unold, Semantisch angereicherte 3D-Messdaten von Kirchenräumen als Quellen für die geschichtswissenschaftliche Forschung. in Grenzen und Möglichkeiten der Digital Humanities ed. Constanze Baum and Thomas Stäcker (2015) DOI: 10.17175/sb001\_015



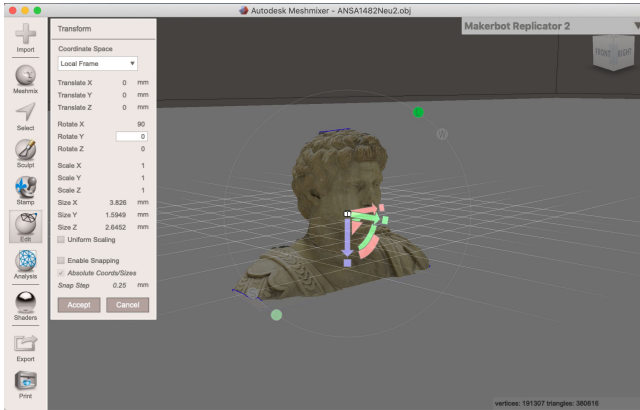


## Georeferencing

Positioning and geographic orientation of 3D models without modification of the original source data. This operation consists of changing from a relative position of the 3D data to an absolute position in a standardised geographical coordinate system.



[www.pointcab-software.com](http://www.pointcab-software.com)



## Autodesk MeshMixer

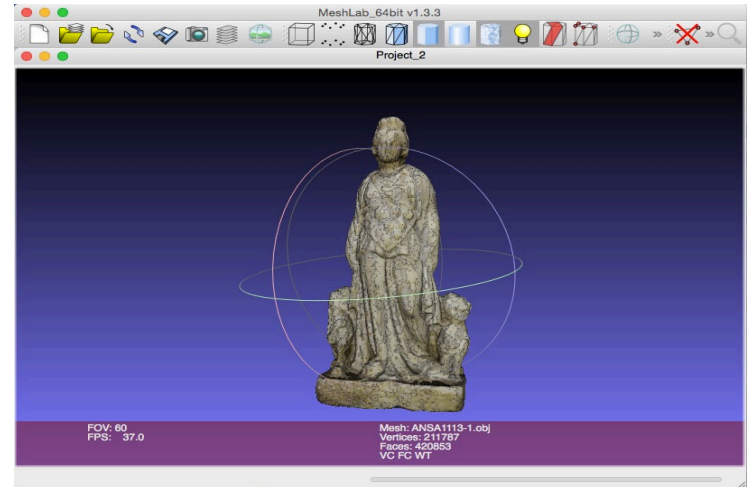
<http://www.meshmixer.com/>

## MeshLab

<http://meshlab.sourceforge.net>



[www.youtube.com/playlist?list=PLiCu\\_oTQj6jz\\_SpUnWHYP0A7B1C711-JZ](http://www.youtube.com/playlist?list=PLiCu_oTQj6jz_SpUnWHYP0A7B1C711-JZ)





## International Research Projects

EPOCH, von der EU 2004–2008 gefördert (<http://epoch-net.org/site/tools/>)

3D-COFORM, von der EU 2008–2012 gefördert (<http://www.3d-coform.eu/index.php/tools/>)

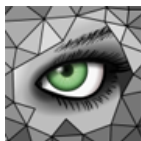
3D-ICONS, von der EU 2012–2015 gefördert (<http://www.3dicons-project.eu/eng/Resources>)



The CityEngine  
([www.procedural.com](http://www.procedural.com))



The EPOCH Viewer  
(<http://www.cg.tugraz.at/EpochViewer>)



MeshLab  
(<http://meshlab.sourceforge.net/>)



InMan – Interpretation Management  
([http://public-repository.epoch-net.org/reports/CI Tool interpretation management v7.pdf](http://public-repository.epoch-net.org/reports/CI_Tool_interpretation_management_v7.pdf))



ARC 3D WebService  
([www.arc3d.be](http://www.arc3d.be))

GML generative modeling language  
([www.generative-modeling.org](http://www.generative-modeling.org))

PhotoCloud  
(<http://vcg.isti.cnr.it/photocloud/>)



# Publication of 3D Models at the WWW (PDF)



Search Home About

Foro Civile Bases in the Forum\_South side Sodalitium dei Saccarii

Casa di Cornelius Rufus Pompeji in seinen Gebäuden, Al... Bases in the Forum\_West side

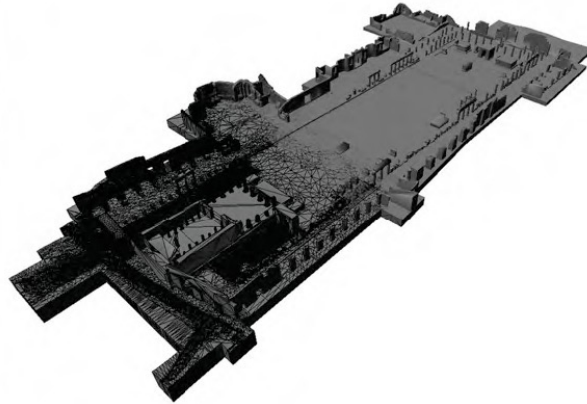
Forum Holitorium Casa di Giasone Terme del Sarno

1 2 3 4 5 →

Kartendaten © 2015 Google Nutzungsbedingungen Fehler bei Google Maps

CARARE is funded by the European Commission's ICT Policy Support Programme eCultureLab

Europeana / CARARE  
(<http://carare.eculturelab.eu/>)



Forum von Pompeji  
([http://pompei.sns.it/uploads/  
2012\\_09\\_6\\_13\\_42\\_22.pdf](http://pompei.sns.it/uploads/2012_09_6_13_42_22.pdf))

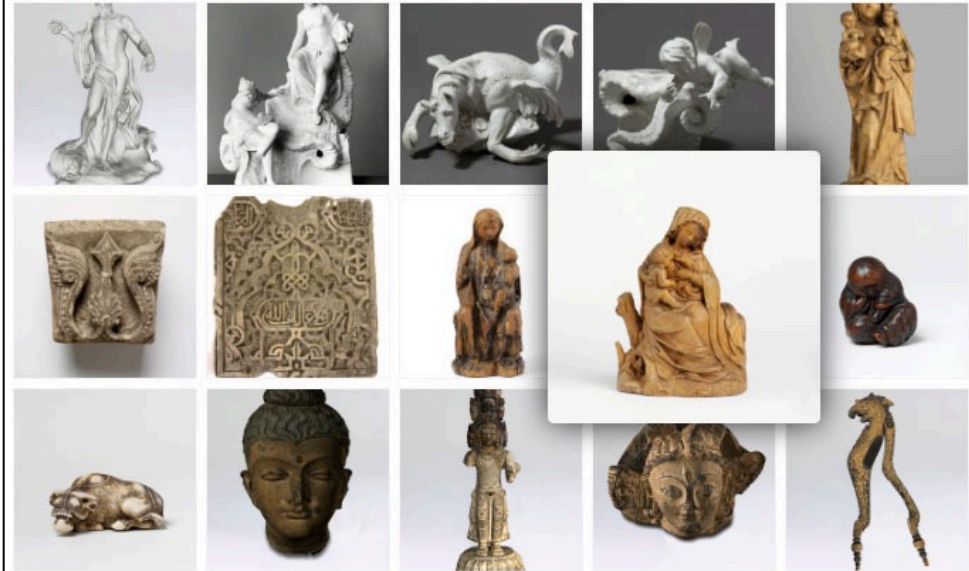
# Google Standard jsc3d

<https://github.com/humu2009/jsc3d>

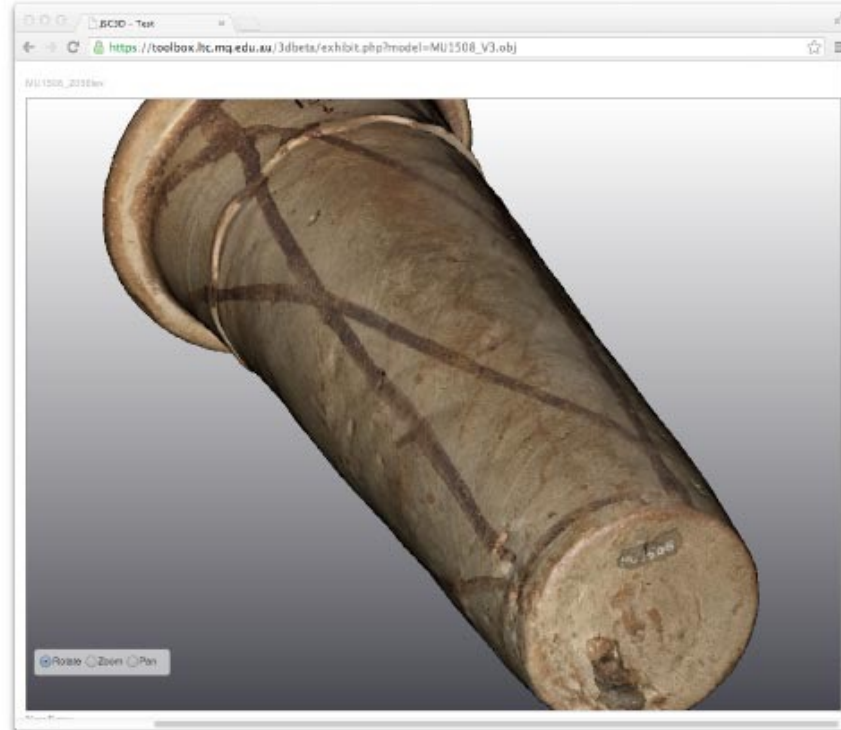
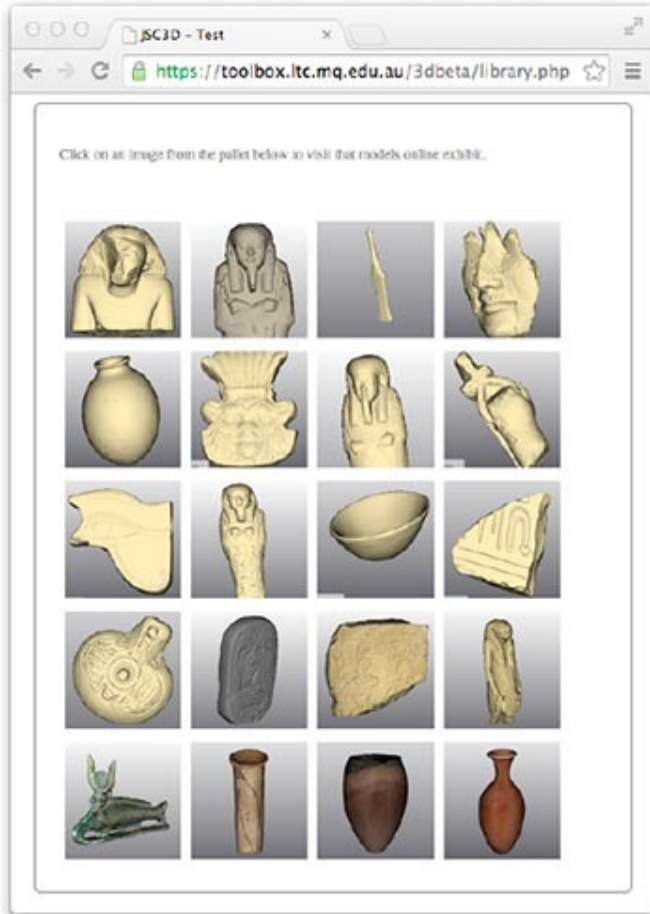


Scanner Data provided by the [3D-COFORM Project](#).

These models have been digitized and provided by the Victoria & Albert Museum in London (<http://www.vam.ac.uk/>)  
The 3D web presentation is powered by the X3DOM technology (<http://www.x3dom.org/>) of Fraunhofer IGD.



<http://www.3dcoform.eu/x3domCatalogue//#!prettyPhoto>

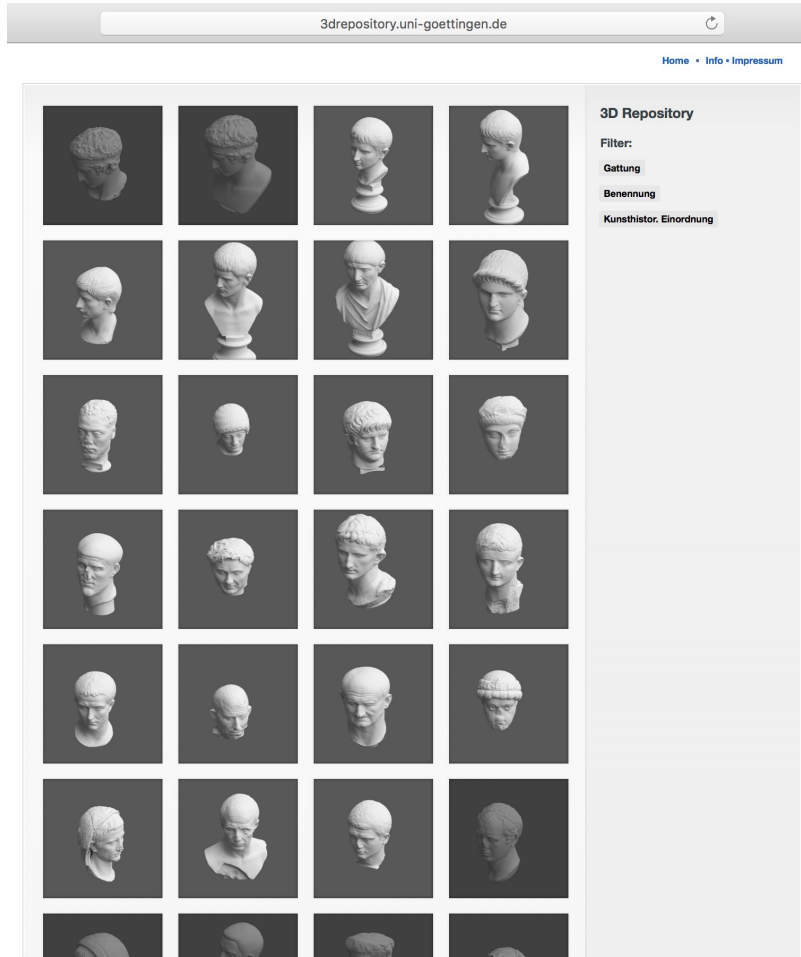


Macquarie University in Sydney, Ägyptologie  
([https://staff.mq.edu.au/teaching/workshops\\_programs/fpp\\_overview/showcase/3d/](https://staff.mq.edu.au/teaching/workshops_programs/fpp_overview/showcase/3d/))



# 3D Lab Göttingen

## Campuslab Digitization and Computational Analytics (DCA)



<http://3drepository.uni-goettingen.de>

Benutzername:  
3drepository

Kennwort:  
N362Vf4h

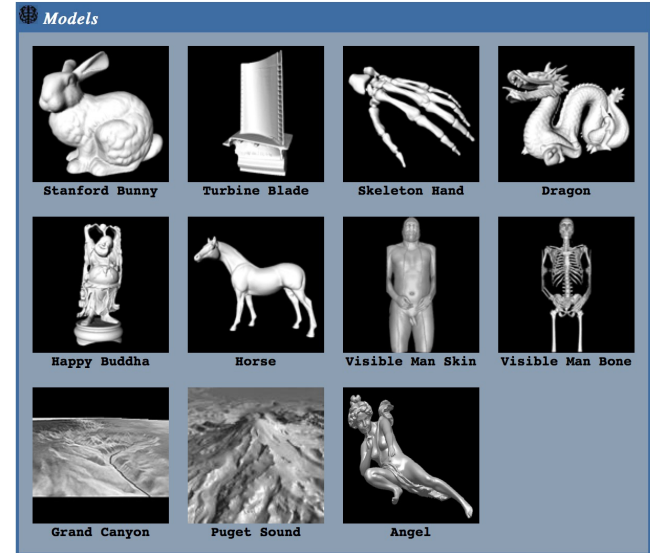


# Collection of (free) 3D Models

## Standard Testing Models:

- The Stanford 3D Scanning Repository:  
<http://graphics.stanford.edu/data/3Dscanrep/>
- Large Geometric Models Archive des Georgia Institute of Technology:  
[https://www.cc.gatech.edu/projects/large\\_models/](https://www.cc.gatech.edu/projects/large_models/)
- The Utah 3D Animation Repository:  
<http://www.sci.utah.edu/~wald/animrep/>
- MGF Example Scenes of Interiors: <https://floyd.lbl.gov/mgf/scenes.html>

s.a. [https://en.wikipedia.org/wiki/List\\_of\\_common\\_3D\\_test\\_models](https://en.wikipedia.org/wiki/List_of_common_3D_test_models)



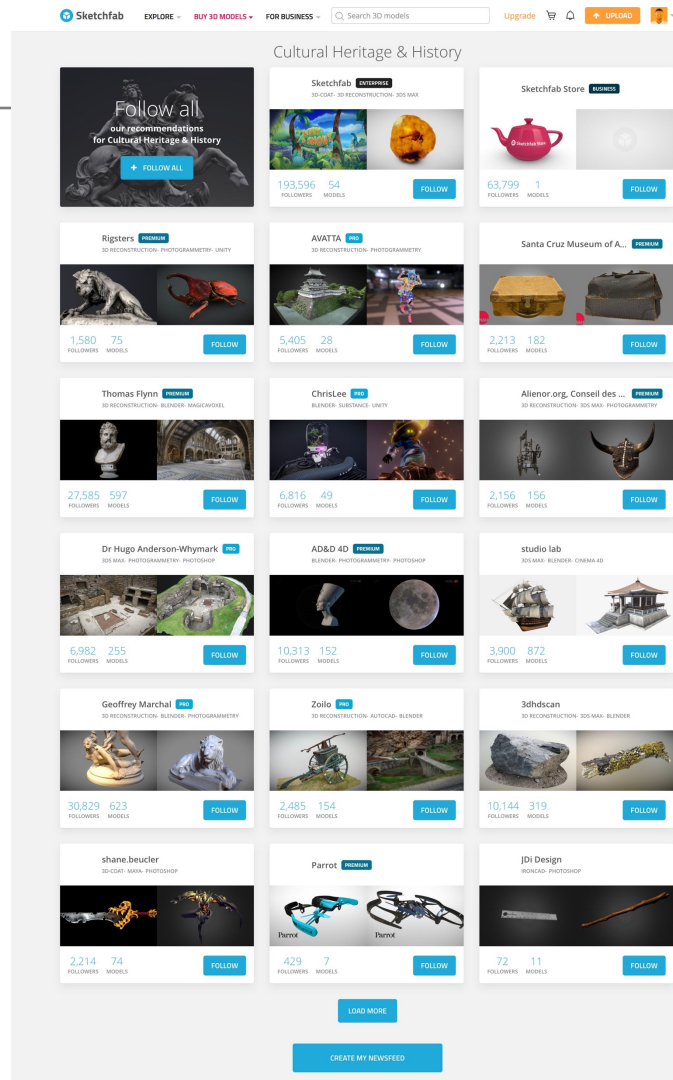
Welcome to the Large Geometric Models Archive at Georgia Tech!

# Collection of (free) 3D Models

## Popular Collections:

- archive3D: <https://archive3d.net>
- 3DBar: <http://3dbar.net>
- VRML Models von ORC Incorporated: <http://www.ocnus.com/models/>
- Sketchfab: <https://sketchfab.com/feed>
- 3dwarehouse: <https://3dwarehouse.sketchup.com>
- Thingiverse: <https://www.thingiverse.com>
- cgtrader: <https://www.cgtrader.com>
- Autos von Hum3D: <https://hum3d.com>
- NASA 3D Modelle: <https://nasa3d.arc.nasa.gov>
- 3dRender.com: Lighting Challenges (Übungsseite für Spieleentwickler):  
<http://www.3drender.com/challenges/index.htm>

s.a. <https://all3dp.com/de/1/3d-drucker-vorlagen-3d-druck-modelle-kostenlos-download-stl-datei/>



# Apollo

3D Model



**Geoffrey Marchal** PRO

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◀
Triangles: **551.4k**
♀
Vertices: **278.8k**
[More model information](#)

Apollo, Rome, 150 CE, marble, restored in 1790 CE. Ny Carlsberg Glyptote Made with ReMake and ReCap from AutoDesk.

The god Apollo is standing with his lyre. The holy snake, python, is wound which is written, in Greek: "Apollonios made it."

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Compatible with:

Published 2 years ago

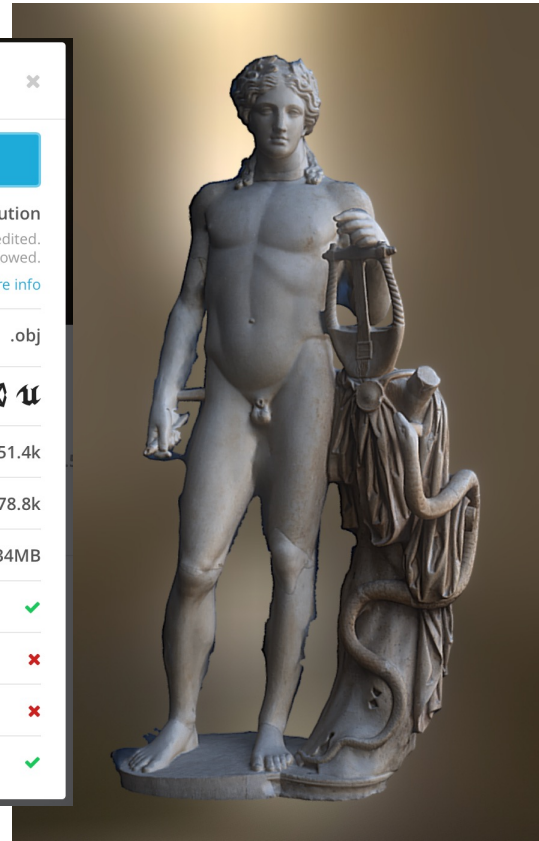
Cultural Heritage & History 3D Models

- Missing:**
- Camera data
  - Number of photos
  - Lighting conditions

Model Information ✕

**INSPECT THE 3D MODEL**  
MATERIALS AND MORE

License	CC Attribution Author must be credited. Commercial use is allowed. <a href="#">more info</a>
Source format	.obj
Compatible with	
Geometry	Triangles 551.4k
Vertices	278.8k
Uploaded size	34MB
Textures	1 Normals <span style="color: green;">✔</span>
Materials	1 Vertex color <span style="color: red;">✘</span>
	Rigged <span style="color: red;">✘</span>
	UV Mapped <span style="color: green;">✔</span>

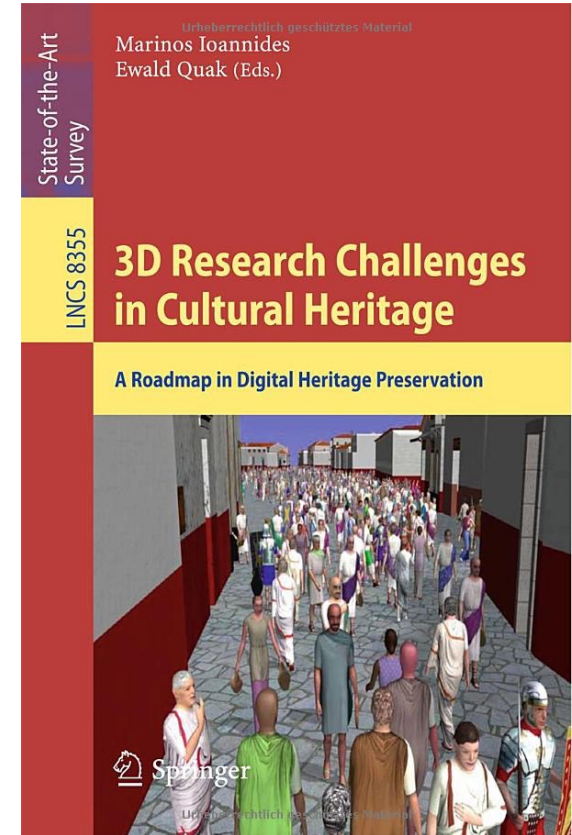


<https://sketchfab.com/3d-models/apollo-c5fae6184cb641638a8b303b11294487>

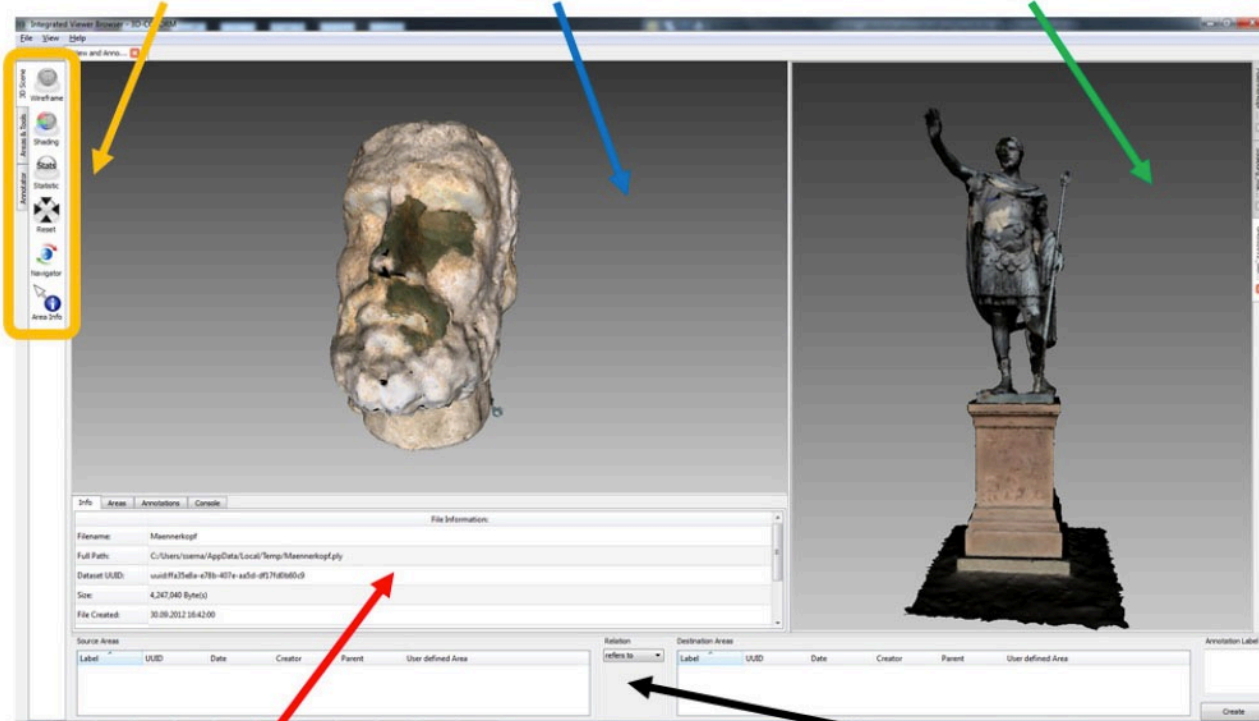
Results of the workshops “Computational Geometry and Ontologies for Cultural Heritage 3D Digital Libraries: What are the future alternatives for Europeana?”, International Conference on Cultural Heritage EuroMed2012 ([www.euromed2012.eu](http://www.euromed2012.eu)) auf Zypern, October 2012:

Marinos Ioannides – Ewald Quak (Hrsg.), 3D Research Challenges in Cultural Heritage: A Roadmap in Digital Heritage Preservation (Heidelberg: Springer 2014)

Sander Münster – Mieke Pfarr-Harfst – Piotr Kuroczynski– Marinos Ioannides (Eds.), 3D Research Challenges in Cultural Heritage II. How to Manage Data and Knowledge Related to Interpretative Digital 3D Reconstructions of Cultural Heritage (Heidelberg: Springer 2016)



*Action Sets*    *Working Window*    *Browsing Window*

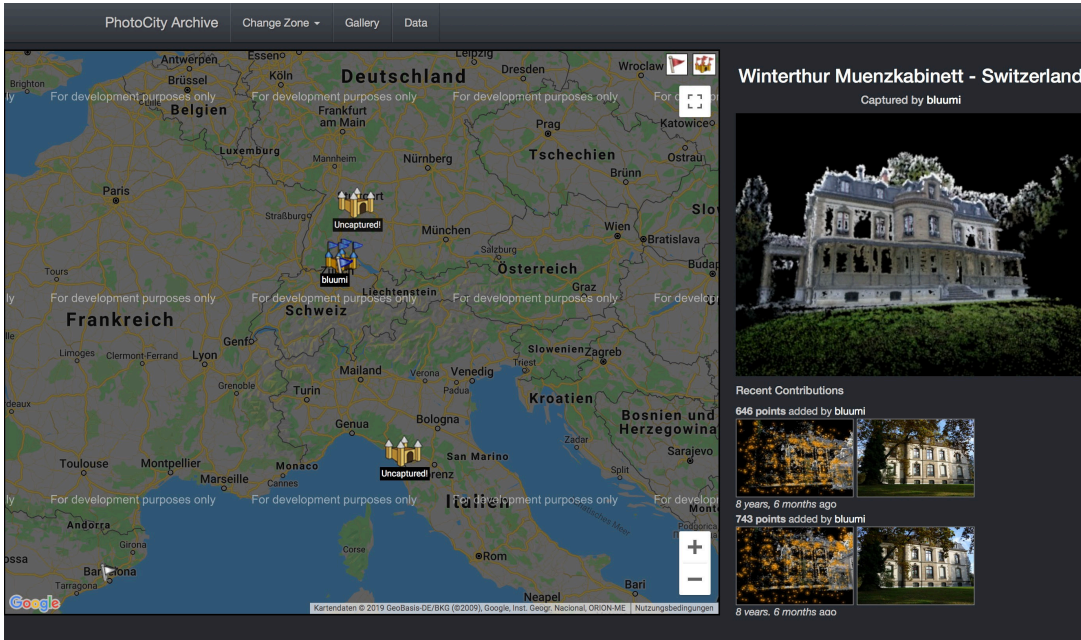


*Metadata Viewing*

*Annotation Interface*

Adnotation Tool für 3D-COFORM, s. M. Schröttner – S. Havemann – M. Theodoridou et al., A generic approach for generating cultural heritage metadata, in: M. Ioannides – D. Fritsch – J. Leissner et al. (eds.) EuroMed 2012. LNCS, vol. 7616 (Springer, Heidelberg 2012) 231–240

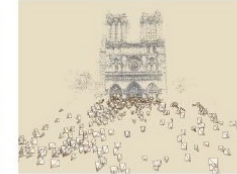
# Photo Tourism Project



## Photo Tourism Exploring photo collections in 3D



(a)



(b)



(c)

<http://phototour.cs.washington.edu>

<http://www.photocitygame.com>

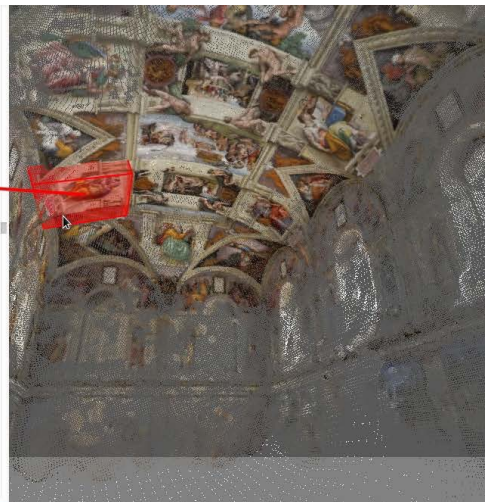
## Automatic 3D Modelling

- photogrammetric 3D reconstruction based on crowd-sourced data on the internet
- Combining text analysis and Google image search to combine web text with 3D shape data
- Experiments at several sites show that the system is relatively successful for famous places

- Jeremiah (HIEREMIAS) [Fig 14]
- Persian Sibyl (PERSICHA) [Fig 13]
- Ezekiel (EZECHIEL) [Fig 14]
- Erythraean Sibyl. (ERITHRAEA) [Fig 15]
- Joel (IOEL) [Fig 16]
- Zechariah (ZACHERIAS) – above the main door of the chapel [Fig 17]
- Delphic Sibyl (DELPHICA) [Fig 18]
- Isaiah (ESAIAS) [Fig 19]
- Cumaean Sibyl. (CVMAEA) [Fig 20]
- Daniel (DANIEL) [Fig 21]
- Libyan Sibyl (LIBICA) [Fig 22]



The Libyan Sibyl



### Prophets [edit]

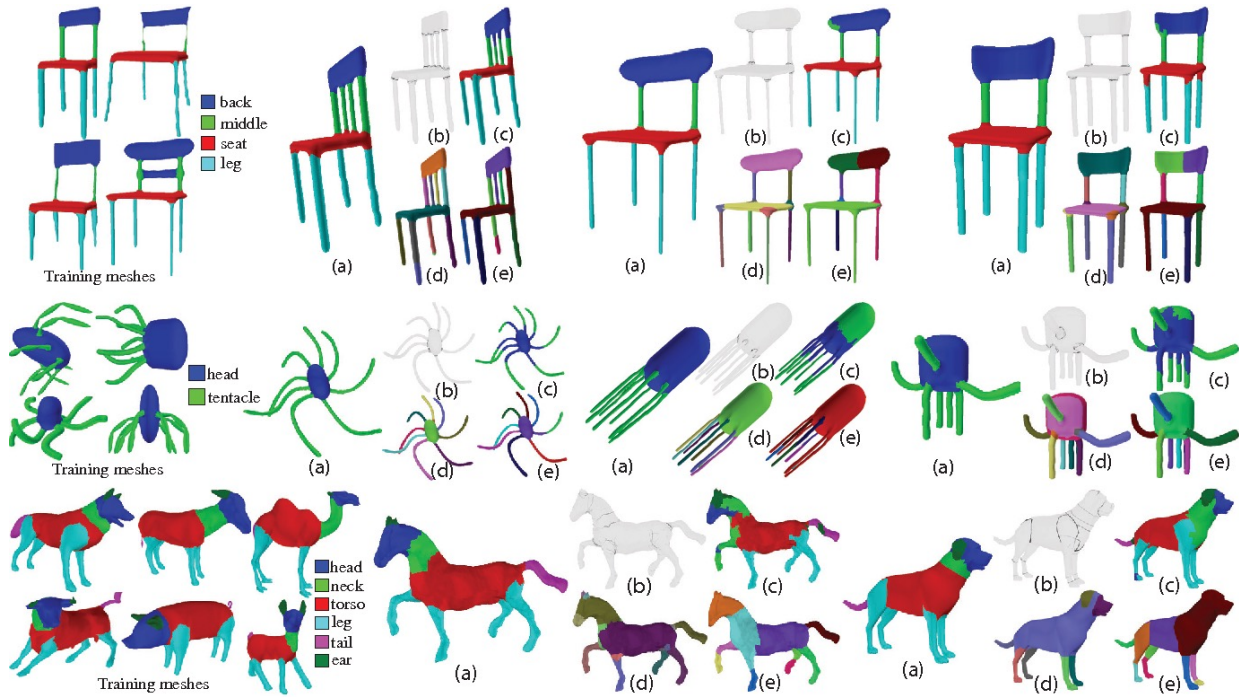
The seven prophets of Israel chosen for depiction on the ceiling include the four so-called **Major Prophets**, Isaiah, Jeremiah, **Ezekiel** and **Daniel**. Of the remaining twelve possibilities among the **Minor Prophets**, the three represented are Joel, **Zechariah** and Jonah. Although the **prophets Joel** and **Zechariah** are considered "minor" because of the comparatively small number of pages that their prophecy occupies in the Bible, each one produced prophecies of profound significance.



They are often quoted, Joel for his "Your sons and your daughters shall prophesy, your elderly shall dream dreams and your youth shall see visions".<sup>[Src 5]</sup> These words are significant for Michelangelo's decorative scheme, where women take their place among men and

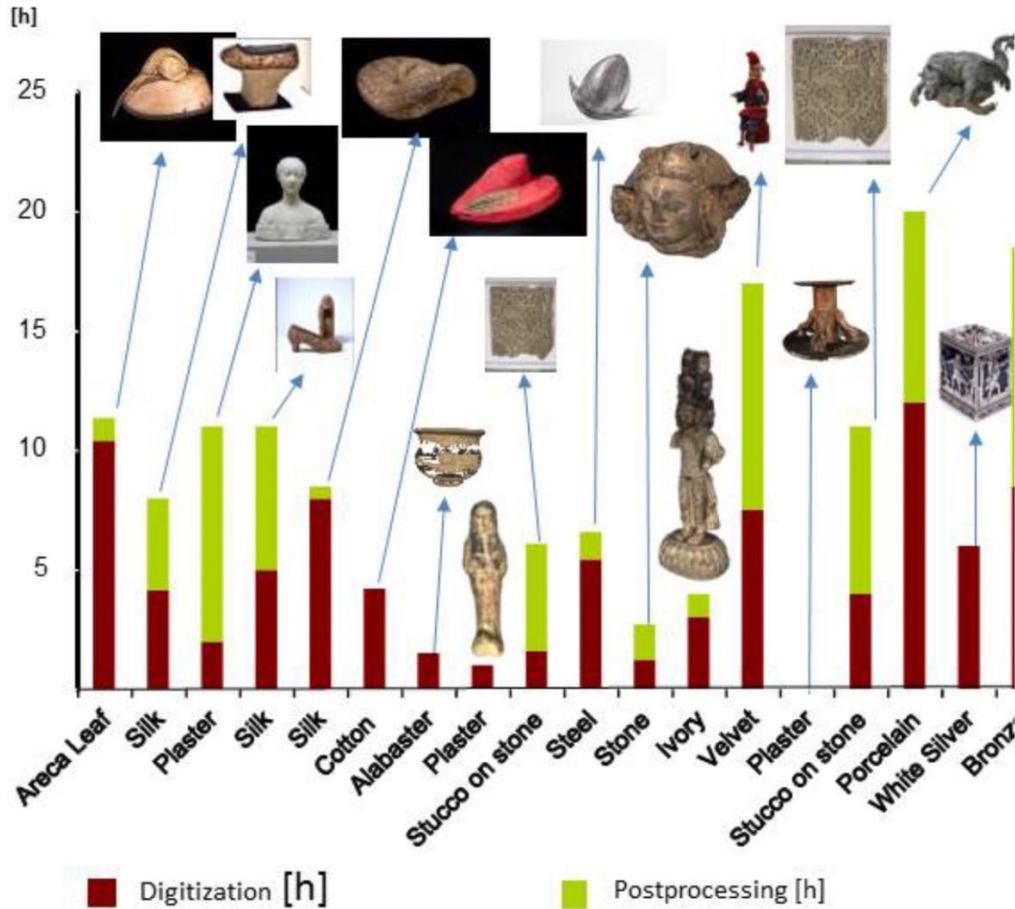
[https://grail.cs.washington.edu/projects/label3d/3D\\_Wikipedia\\_SIGGRAPH\\_Asia\\_2013.pdf](https://grail.cs.washington.edu/projects/label3d/3D_Wikipedia_SIGGRAPH_Asia_2013.pdf)

# 3D mesh Segmentation and Labeling



<https://www.semanticscholar.org/paper/Learning-3D-mesh-segmentation-and-labeling-Kalogerakis-Hertzmann/0bf390e2a14f74bcc8838d5fb1c0c4cc60e92eb7>



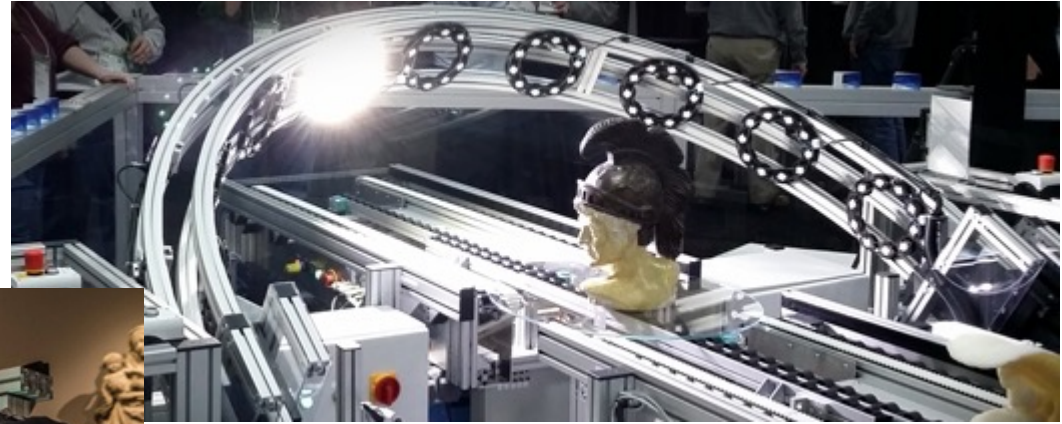


## Mass Digitisation

Pedro Santos et al., „The Potential of 3D Internet in the Cultural Heritage Domain,“ in (Hrsg.), *3D Research Challenges in Cultural Heritage*, ed. Marinos Ioannides and Ewald Quak (Heidelberg: Springer 2014), 2.

## Fraunhofer Scanning line

[www.fraunhofer.de/de/forschung/aktuelles-aus-der-forschung/kulturerbe-erhalten/3d-digitalisierung.html](http://www.fraunhofer.de/de/forschung/aktuelles-aus-der-forschung/kulturerbe-erhalten/3d-digitalisierung.html)



## Google Art Project



## CHALLENGES IN THE 3D DIGITISATION OF MATERIAL CULTURE

- Integration of heterogeneous information into a uniform frame of reference
- Object-oriented acquisition and indexing of material culture
- Automatic Acquisition (Object Mining)
- Semantic enrichment of the 3D models and semantic extraction from the geometry of the shape
- Structure of scientific repositories



- Methods of spatial visualisation of monuments and collection objects
- Advantages and disadvantages of the different methods for 3D acquisition
- File formats for storing 3D models
- Online repositories for 3D models and their possibilities
- Workflows for the photogrammetric documentation of collection objects
- Basics of geometry



- Practical 3D acquisition from photo series (photogrammetry)
- Editing of 3D models (cropping, manipulating, texturing) with the help of a 3D editing programme.
- Scientific documentation of the meta- and paradata



What is the common basis of laser scanning and white light scanning? What are the differences?

Folie 32–36

What methods and procedures would you use for the acquisition of Greek vases and why?

Folie 28. 61. 63

What are the advantages of the digital acquisition and publication of collection objects as 3D models?

Folie 6

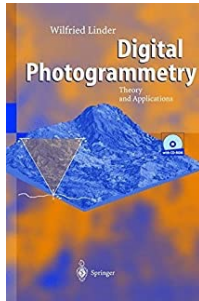
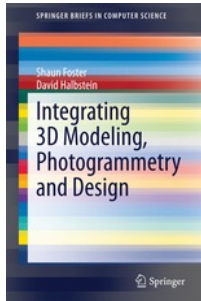
Describe the structure (geometry) of a 3D model.

Folie 45

Which objects can only be incompletely digitised with a laser or white light scanner?

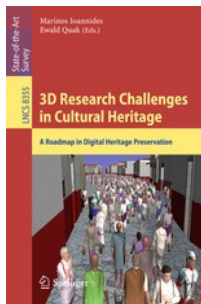
Folie 32

What challenges do you see for the digital indexing of artworks in 3D?



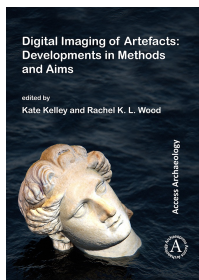
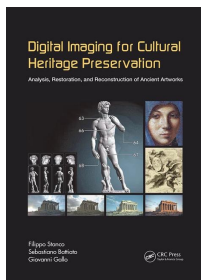
Shaun Foster and David Halbstein, *Integrating 3D Modeling, Photogrammetry and Design* (Heidelberg: Springer, 2014).

Wilfried Linder, *Digital Photogrammetry: A Practical Course, 4. Auflage* (Heidelberg: Springer, 2016).



Marinos Ioannides and Ewald Quak (eds.), *3D Research Challenges in Cultural Heritage: A Roadmap in Digital Heritage Preservation* (Heidelberg: Springer, 2014).

Sander Münster u.a. (eds.), *3D Research Challenges in Cultural Heritage II: How to Manage Data and Knowledge Related to Interpretative Digital 3D Reconstructions of Cultural Heritage* (Heidelberg: Springer, 2016).



Filippo Stanco, Sebastiano Battiato and Giovanni Gallo (eds.), *Digital Imaging for Cultural Heritage Preservation: Analysis, Restoration, and Reconstruction of Ancient Artworks* (Taylor & Francis Ltd, 2017).

Kate Kelley and Rachel K. L. Wood (eds.), *Digital Imaging of Artefacts: Developments in Methods and Aims* (Paperbackshop, 2018).



Folie 7: P. Artal-Isbrand and P. Klausmeyer, Evaluation of the relief line and the contour line on Greek red-figure vases using reflectance transformation imaging and three-dimensional laser scanning confocal microscopy, *Studies in Conservation* 58, no. 4 (2013), 338–359.

Folie 8: CVA München 17 Taf. 9.

Folie 34. 35: [www.xtura.se/3dscanners](http://www.xtura.se/3dscanners)

Folie 36:  
[https://upload.wikimedia.org/wikipedia/commons/thumb/4/4e/Principle\\_of\\_3d\\_fringe\\_projection.png](https://upload.wikimedia.org/wikipedia/commons/thumb/4/4e/Principle_of_3d_fringe_projection.png)

Folie 46. 47: <https://homes.esat.kuleuven.be/~konijn/3d/>

Folie 68: <https://www.scope-online.de/additive-fertigung/bilder/additive-fertigung-kunst-im-3d-metalldruck-1.htm>

Folie 70: <https://i.ytimg.com/vi/Ye95yhvjYJM/maxresdefault.jpg>

Folie 71: [www.meshlab.net/](http://www.meshlab.net/)

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