ÖAW AUSTRIAN ACADEMY OF SCIENCES

IKANT – INSTITUTE FOR THE STUDY OF ANCIENT CULTURE

IKANT

Estimating Vessel Properties from 3D Scans for Comparison, Categorization and Archiving

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Digital Humanities Austria 2017, Innsbruck
04.12. – 06.12.2017

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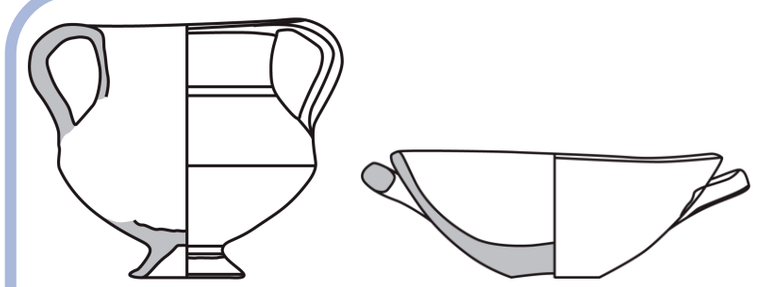
Overview

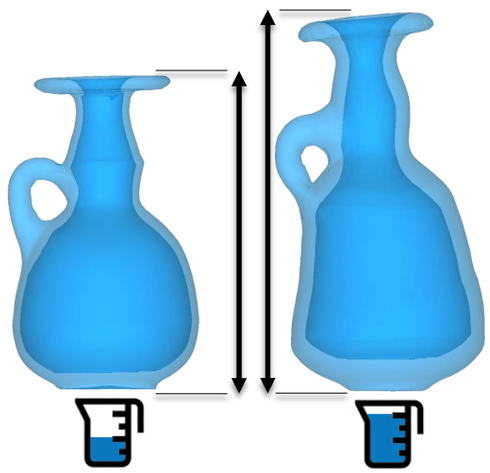
3D Acquisition

Measurement



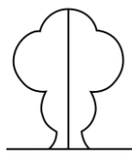
Visualization

Archiving



Comparison

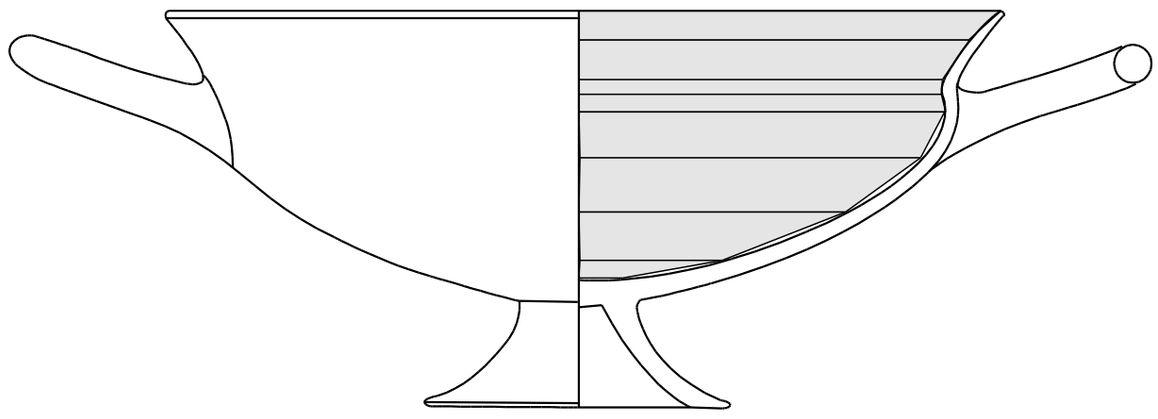
Vessel Properties

- Weight 
- Dimensions & other lengths 
- Filling capacity 
- Axis of rotation
- Symmetrical properties 

Methods for Calculating Capacities (I)

- From vessel profiles

- Drawbacks
  - Assumption: Surface of revolution



Engels et al. 2009

Methods for Calculating Capacities (II)

- With filling material (sand, water, rice, …)

- Drawbacks
  - Labor intense
  - Only for complete vessels (no holes)
  - Protection for surface necessary

Methods for Calculating Capacities (III)

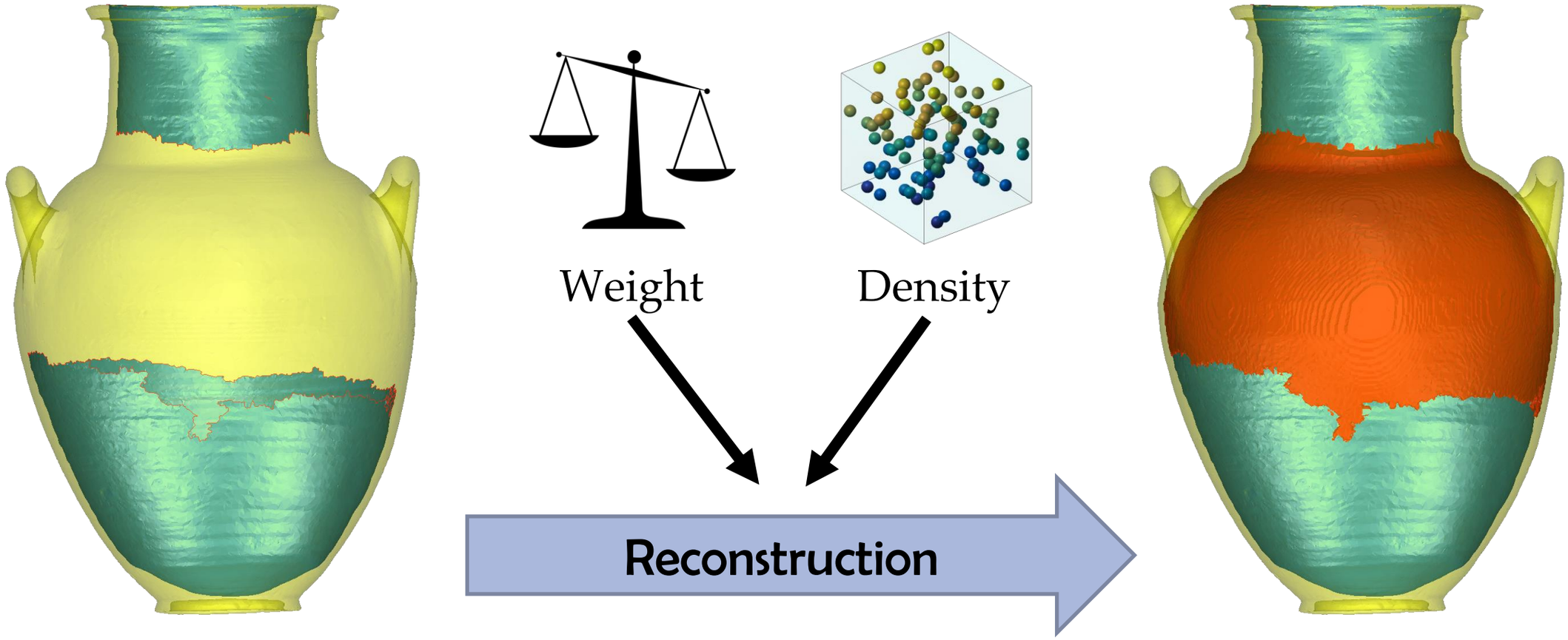
- Computed Tomography (CT)
- Drawbacks
  - High costs
  - Radiation might interfere with further examinations

Trinkl 2013

3D Scanning to the Rescue?

- Scan each vessel
  - e.g. with laser, structured-light
- Automatic calculations with 3D geometry
- Less mistakes than manual processing

- But: Missing inner geometry!
  - Therefore unknown capacity
  - → Reconstruction necessary!

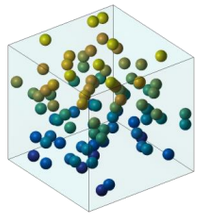


Inner Surface Reconstruction

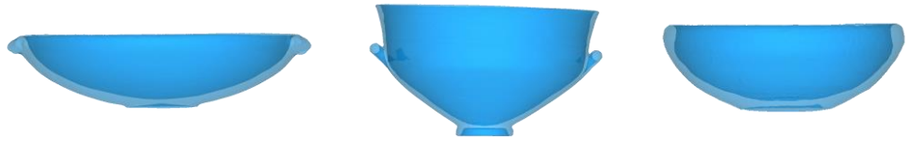
- Complement missing inner geometry
- Respect existing interior constraints
- Calculate the filling capacity

Algorithm – Input (I)

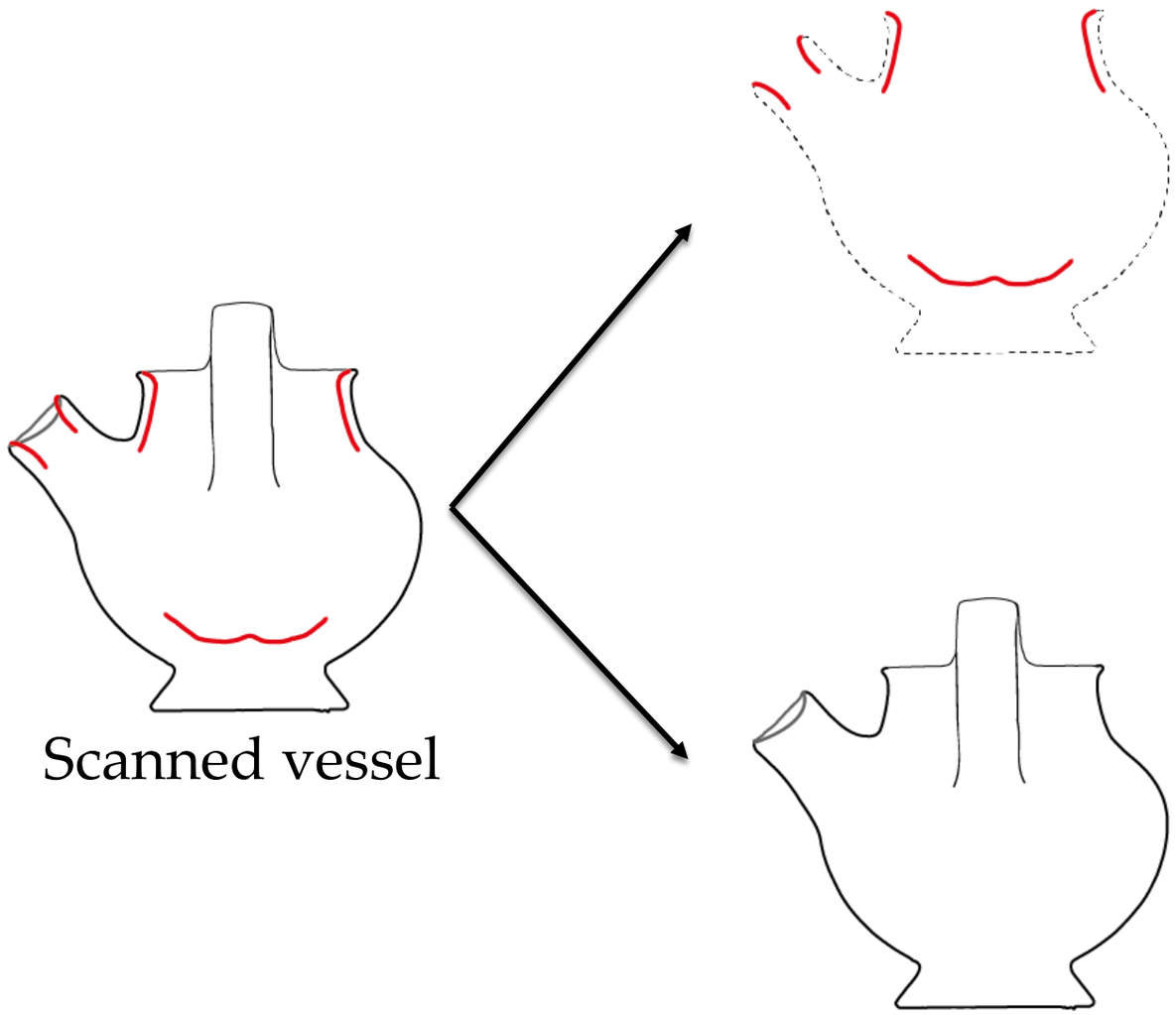
- Result's target volume *[cm³]* using
  - Weight *[g]*
  - Material density *[g/cm³]*



- Weight is known
- Material density can be estimated
  - From complete scans
  - Empirical material studies



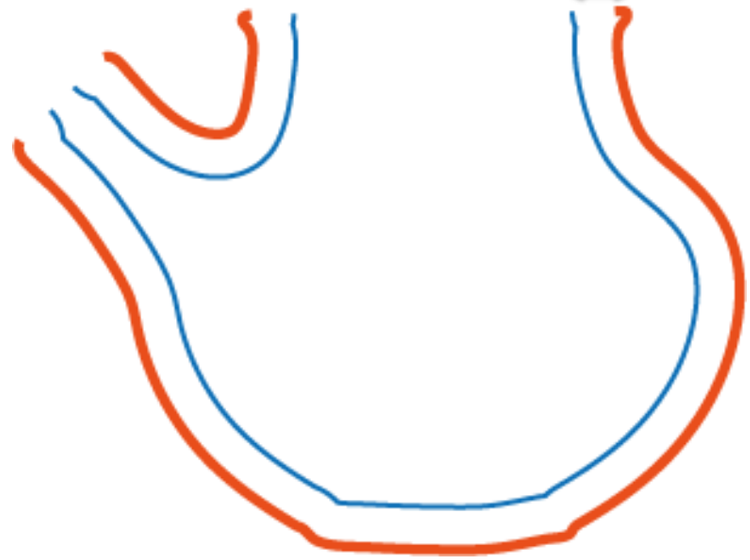
Algorithm – Input (II)



- Existing interior parts
- Outer shell

Algorithm

1. Create offset surface
2. Respect existing interior
3. Connect inside & outside
4. Repeat until target volume is reached



Algorithm

1. Create offset surface
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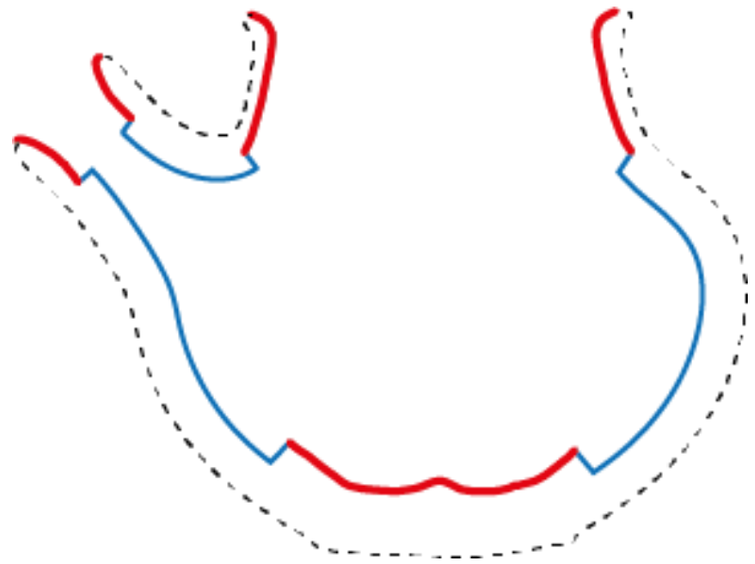
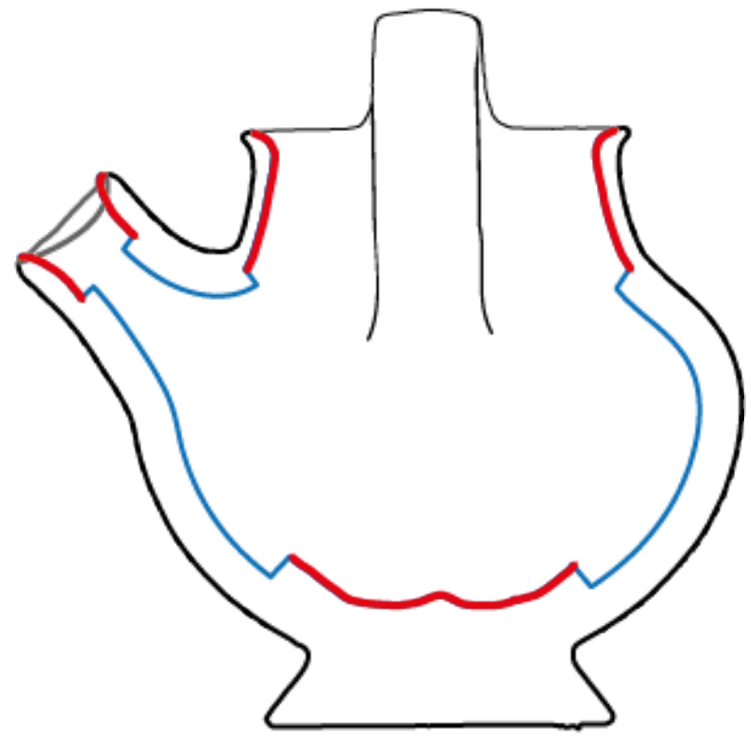


Algorithm

1. Create offset surface
2. Respect existing interior
3. Connect inside & outside
4. Repeat until target volume is reached



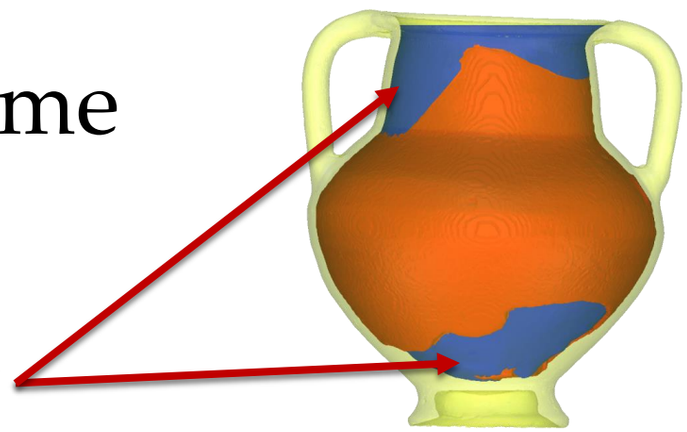
Algorithm

1. Create offset surface
2. Respect existing interior
3. Connect inside & outside
4. Repeat until target volume is reached

1. Offset too high

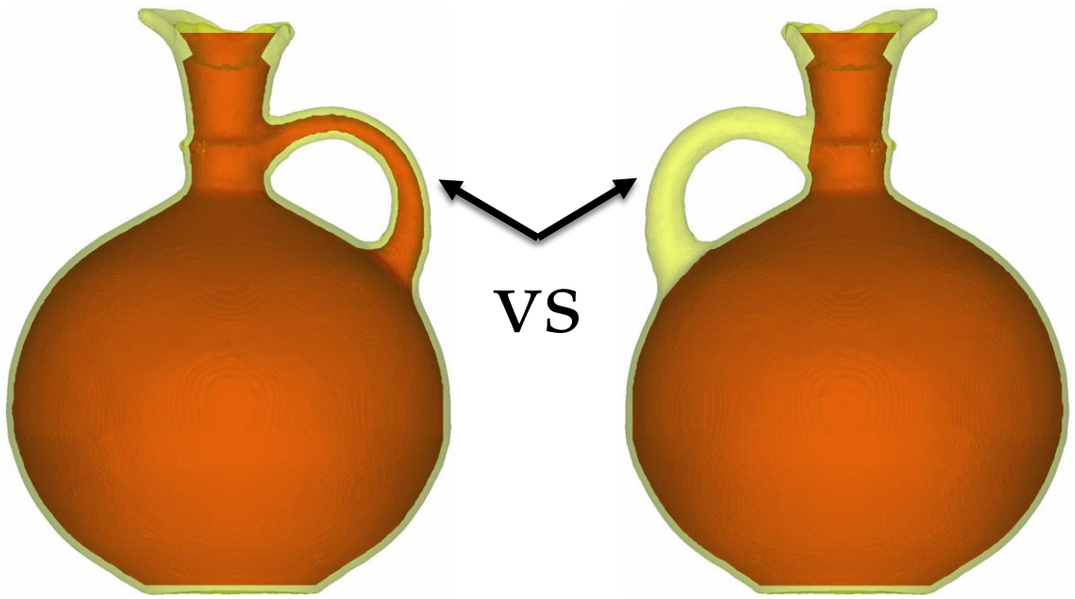
Reconstruction Goals

- Optimize for given material volume

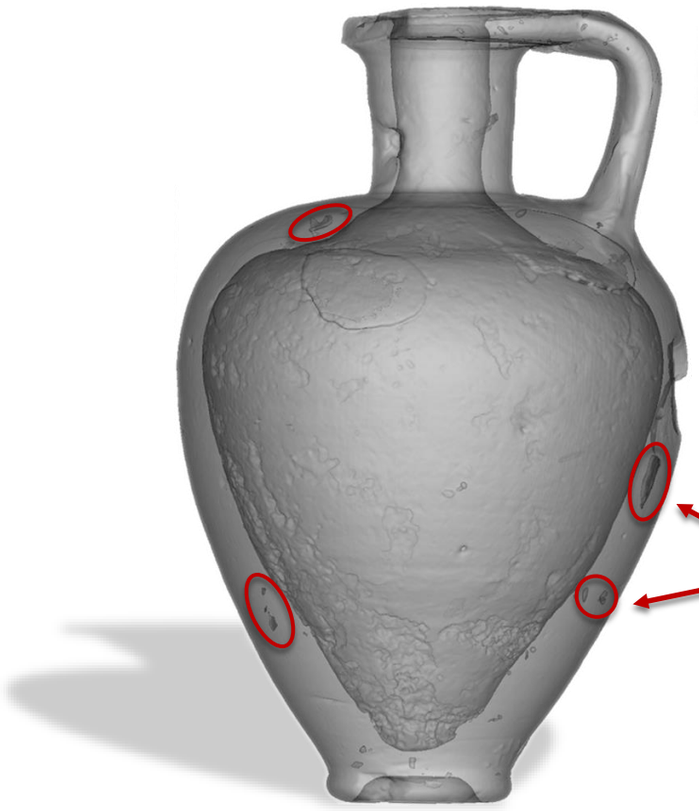


- Preserve existing inner geometry

- Control cavities



Reconstruction (46 ml)

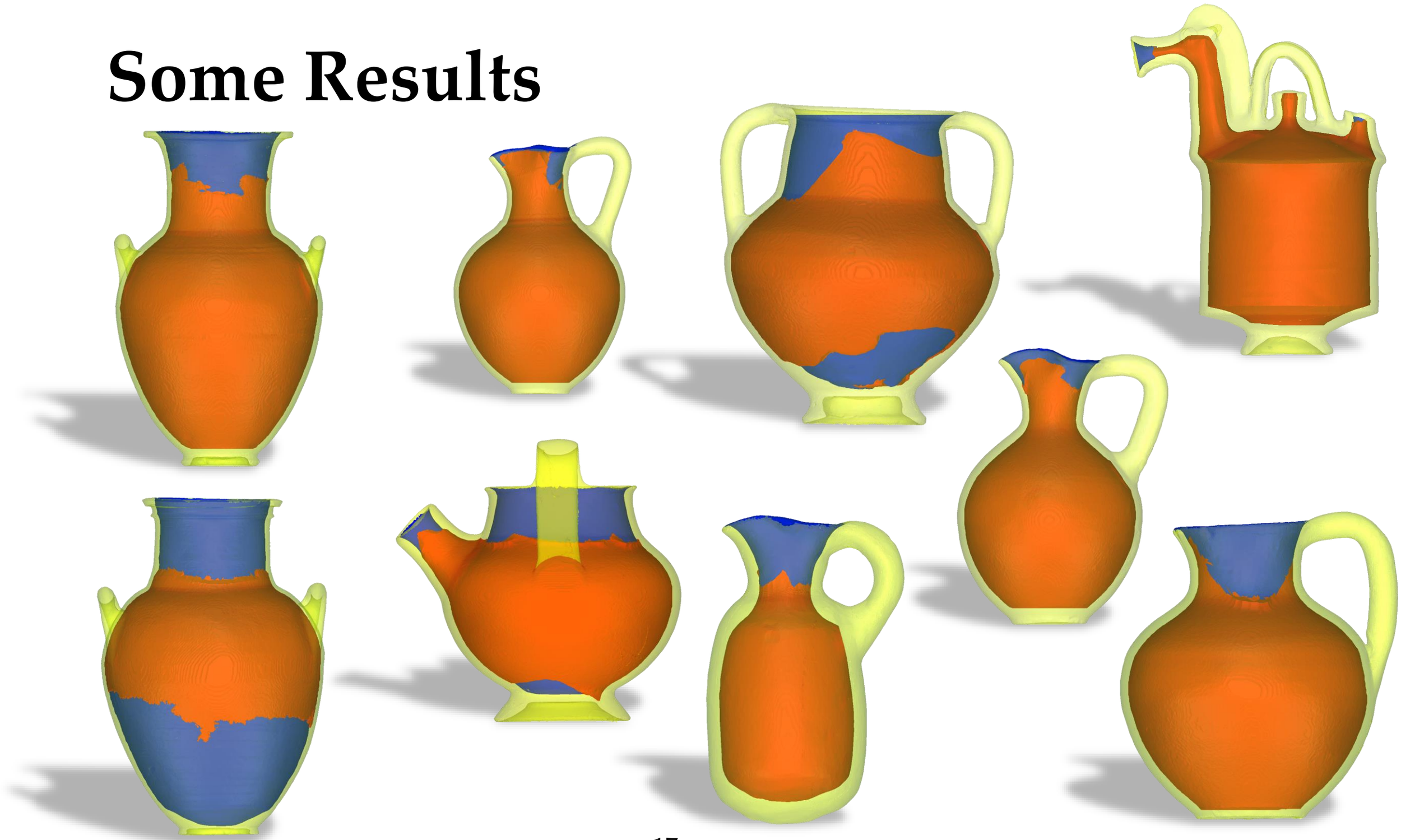


CT Scan (44 ml)

Ground Truth Comparison

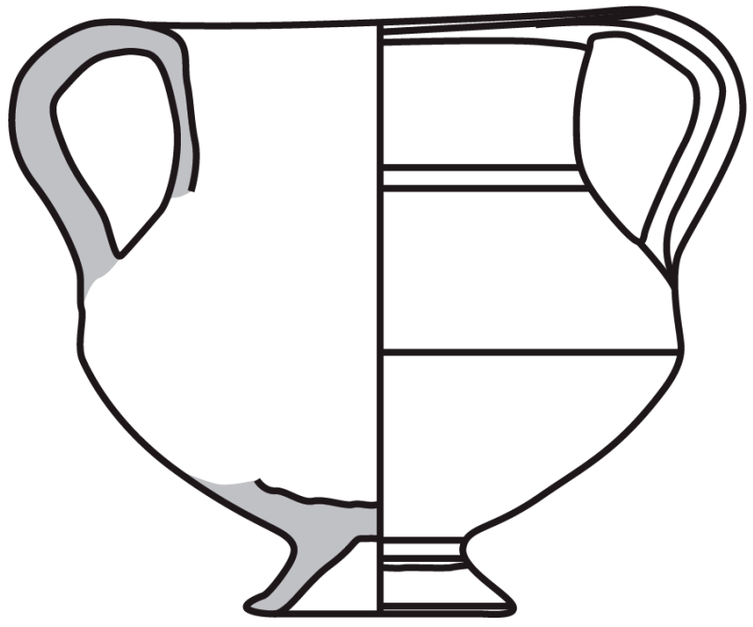
- Identical Ceramic Volume
- Similar Capacities
- Non-homogeneous material mix with air bubbles

Some Results



Visualization

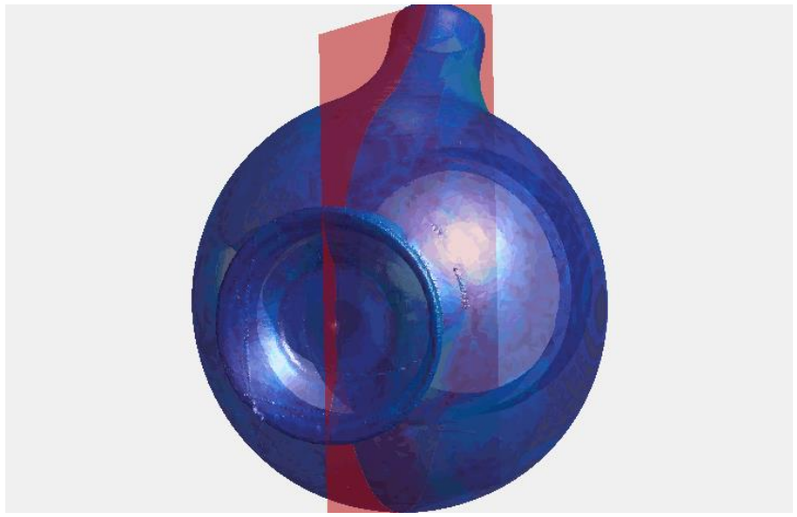
- Outer contour
- Inner cross-section
- True-to-scale



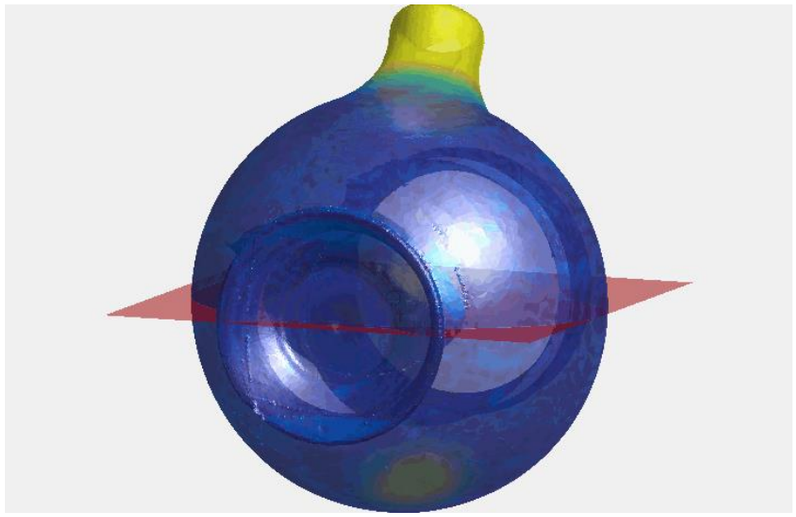
- What is the most suitable viewpoint?

Symmetries

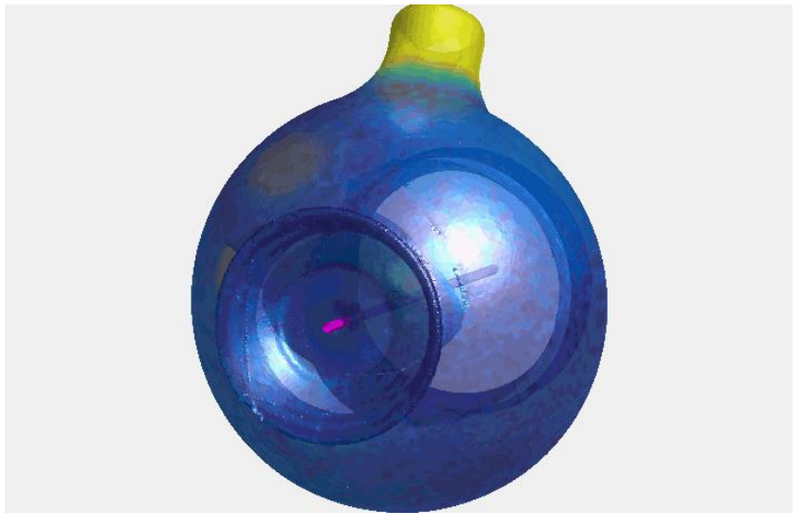
- Approximate symmetries *(Korman et al., 2015)*



Reflective
through spout



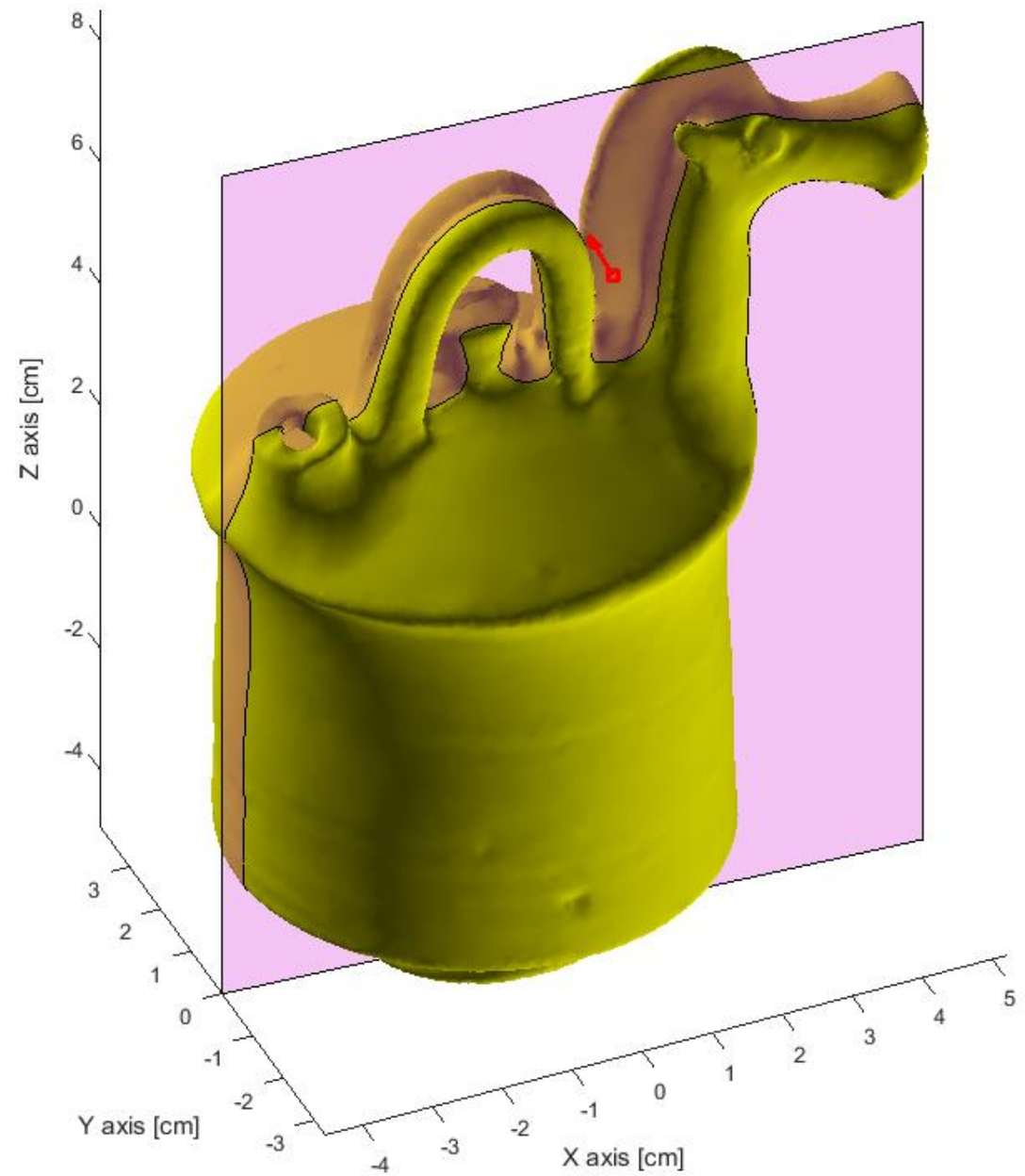
Reflective
through handle



Rotational

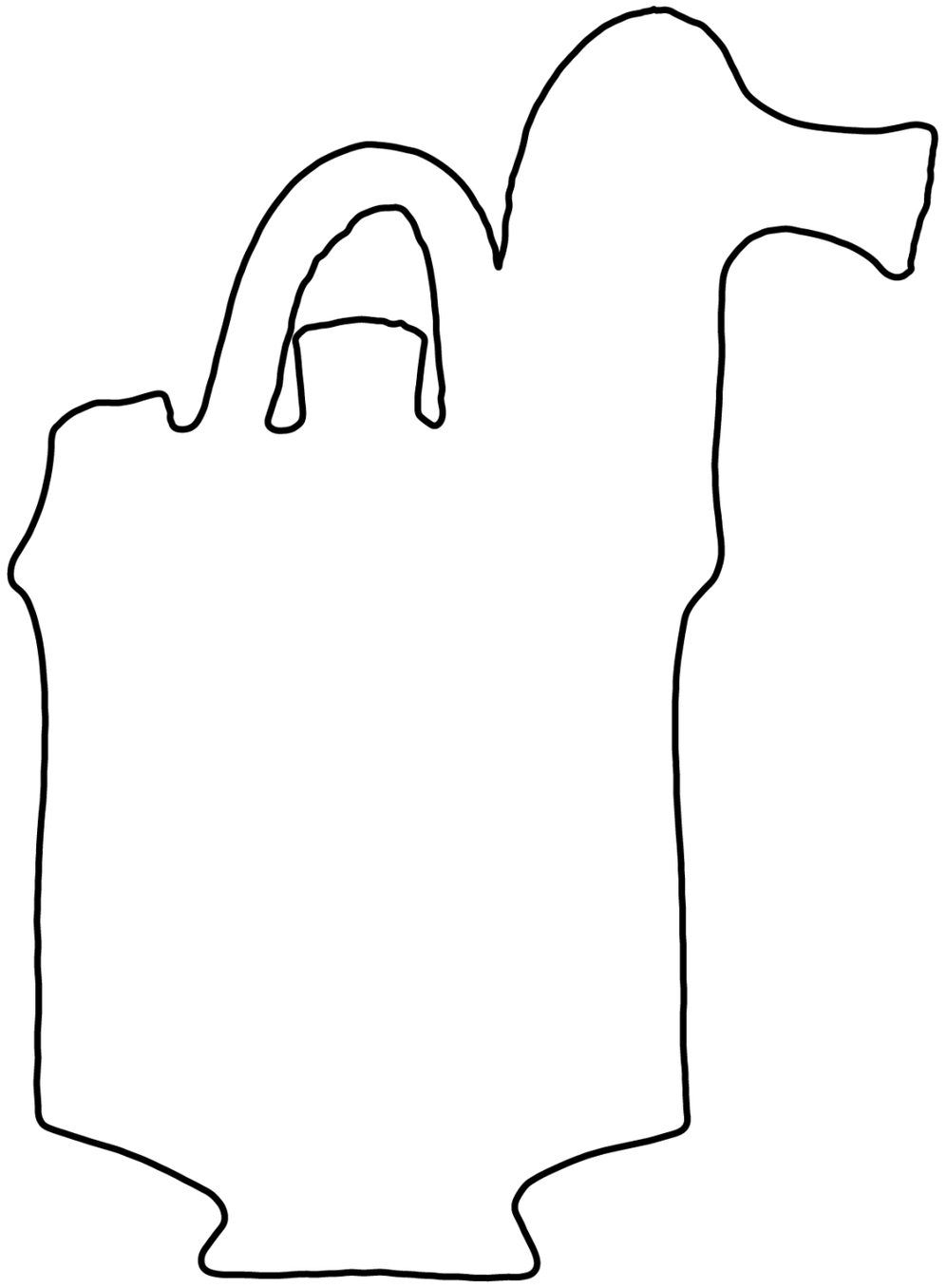
Current Approach

- Use symmetry plane



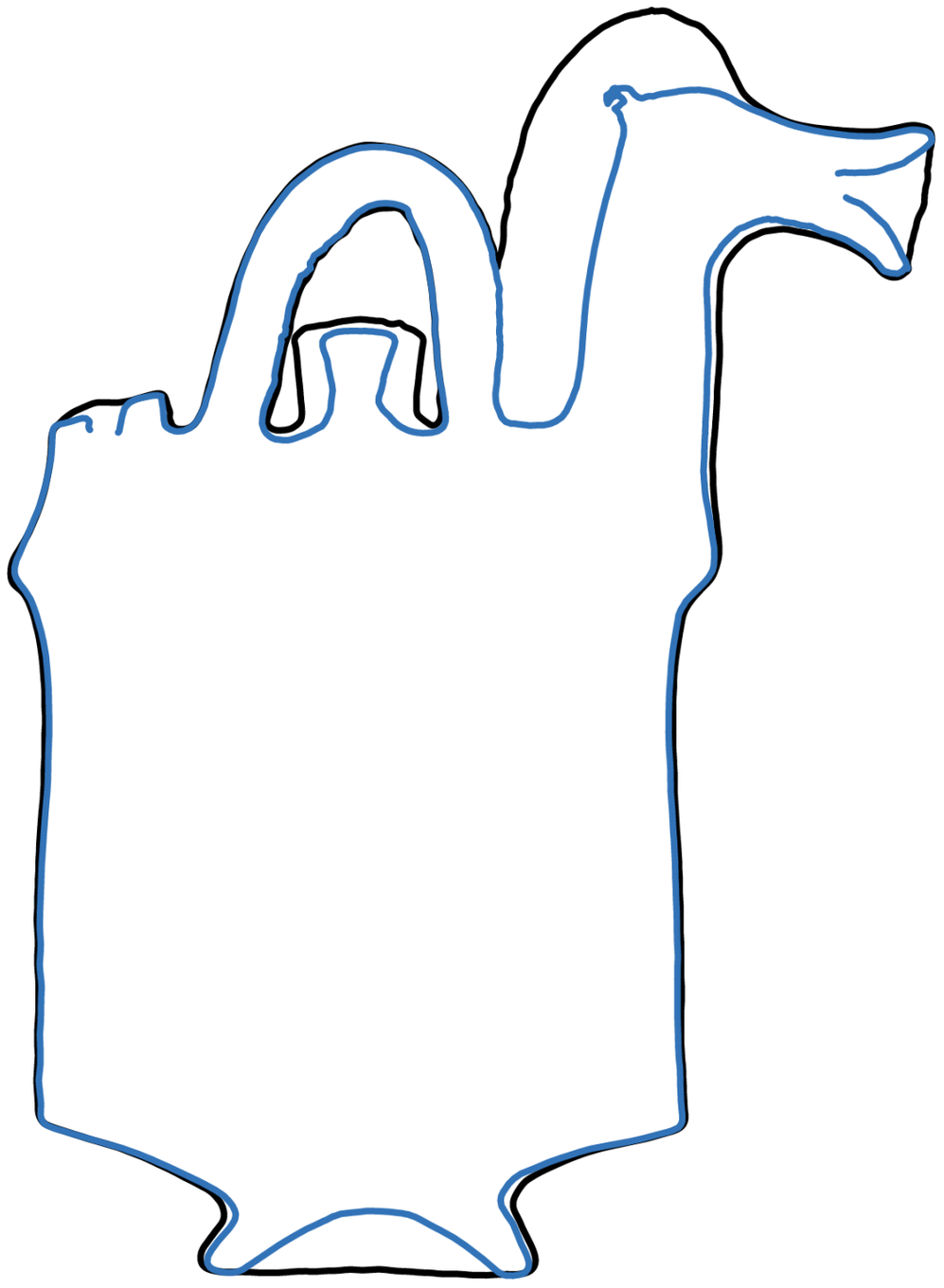
Current Approach

- Use symmetry plane
- Create contour



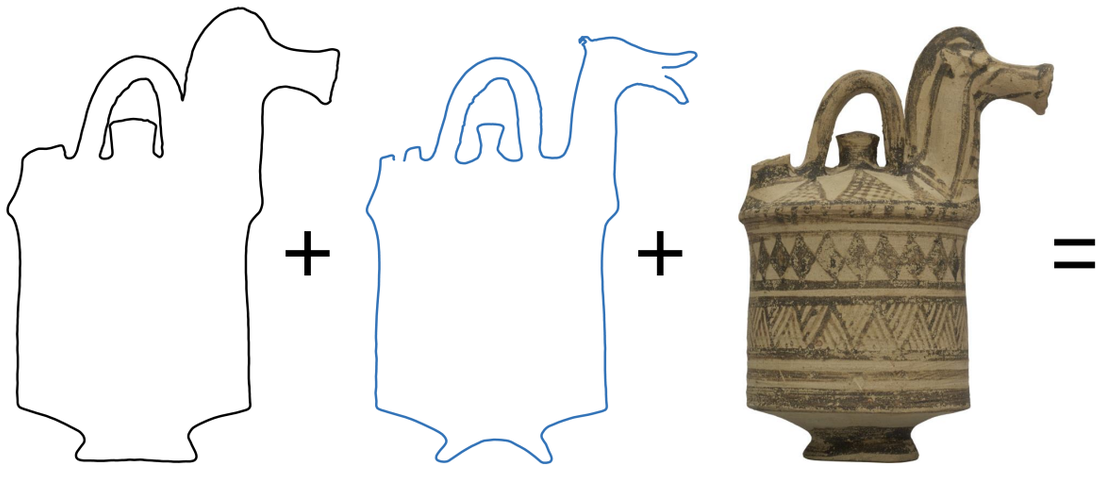
Current Approach

- Use symmetry plane
- Create contour
- Cut geometry with plane



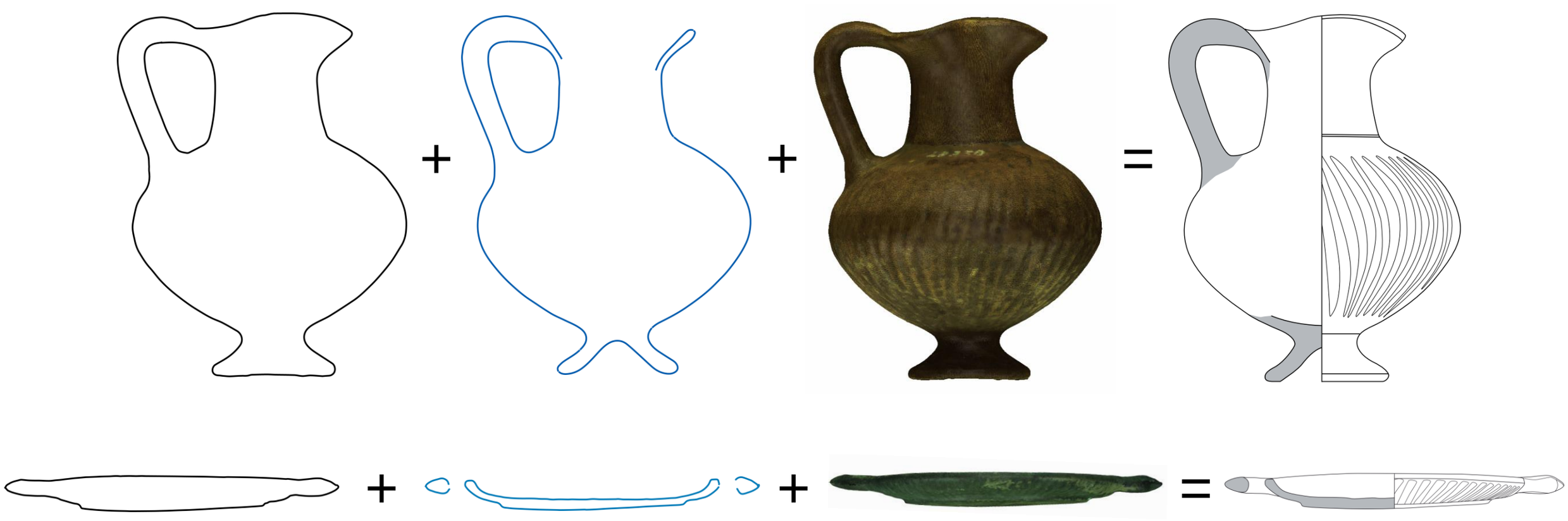
Current Approach

- Use symmetry plane
- Create contour
- Cut geometry with plane
- Illustrator post-processing



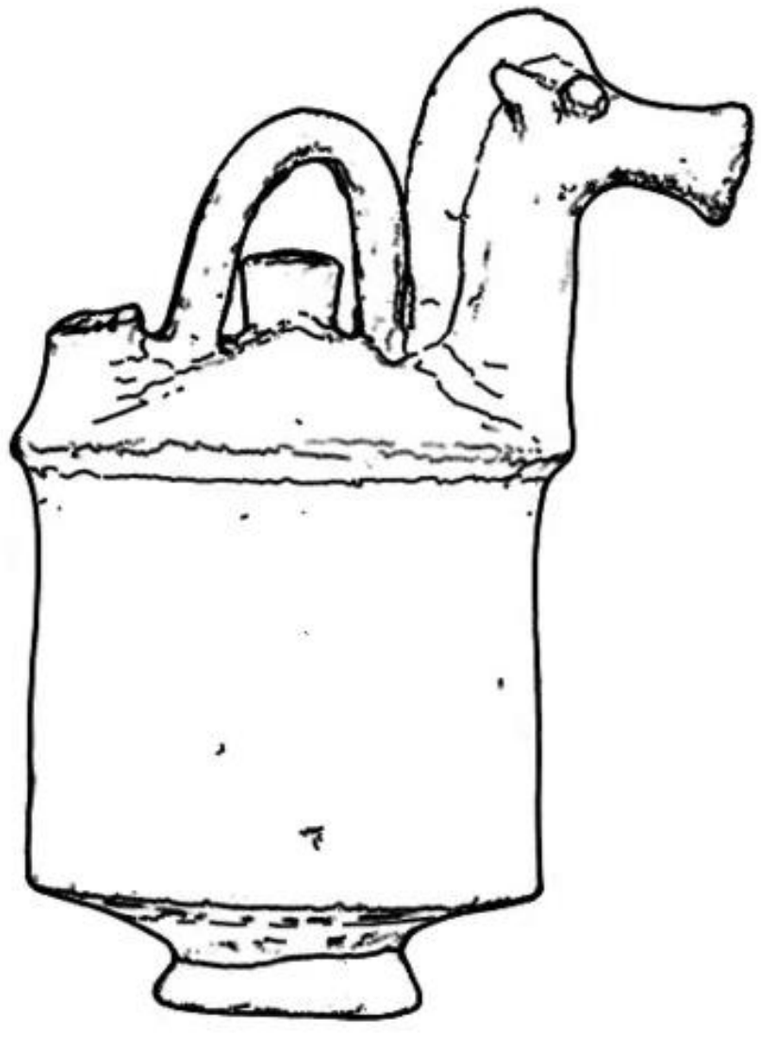
Current Approach

- Works well for simple vessels

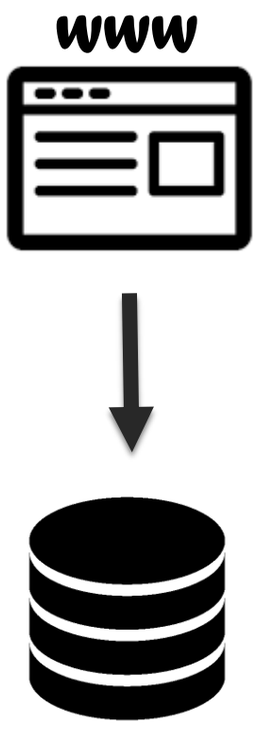


Future Approach

- Support illustrator with more information
- Extract important edges
  - Suggestive Contours *(DeCarlo et al., 2003)*
  - Apparent Ridges *(Judd et al., 2007)*
  - Salient Edges *(Weinkauf et al., 2009)*

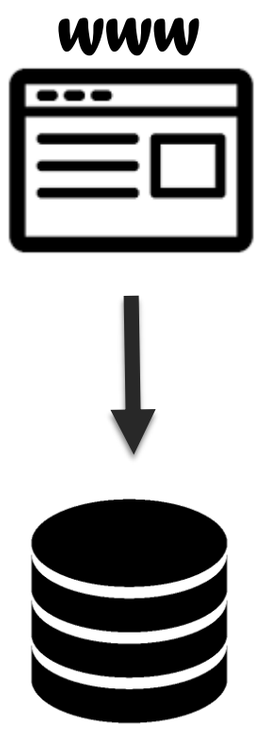


Documenting, Archiving & Sharing



Documenting, Archiving & Sharing

- Greek vessels, 10th-4th c. AD
  - Metadata & Paradata
  - 3D & 2D data
- Online database (IKAnt/ACDH)
  - Digital repository
  - Long-term digital preservation
- Analysis & Comparison
  - Research, conservation & restoration, ...
- Connect to Beazley Archive Pottery Db (Oxford)



Metadata & Paradata

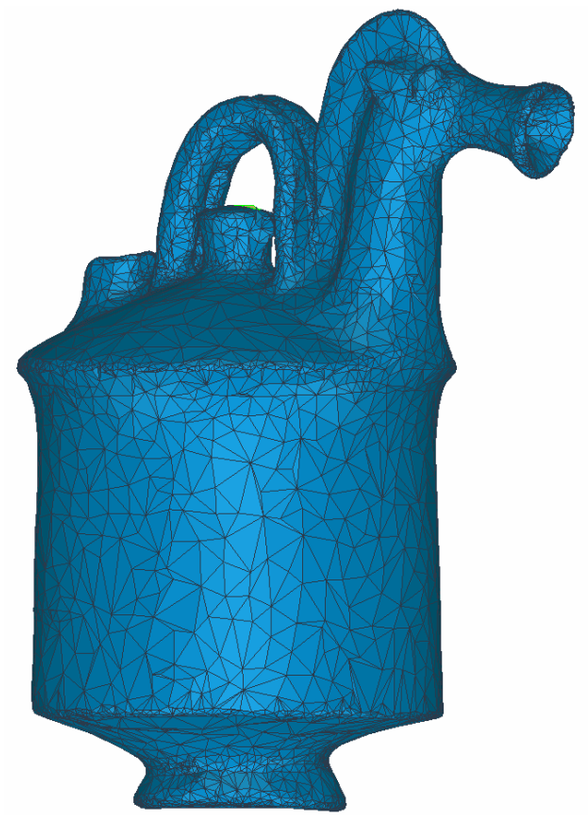
- Object information
  - e.g. provenance (workshop/painter, finding, collection), date, type, shape
- Measurements
  - e.g. height, width, depth, thickness, weight, volume (outer, filling, material)
- Fabric
- Publications
- Digital asset
  - 2D/3D imaging methods, techniques, procedures and parameters

3D Data

Raw data
(SLS, LS, CT scan: with noise data, incomplete)

Cleaned / Reconstructed

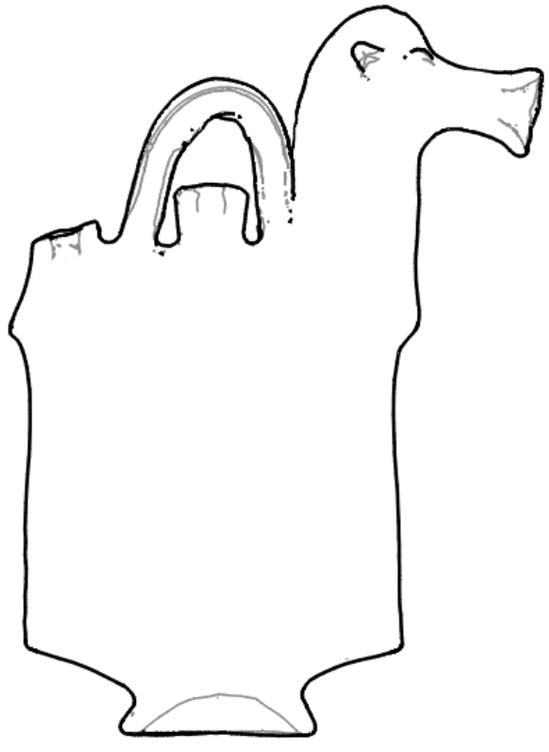
High resolution

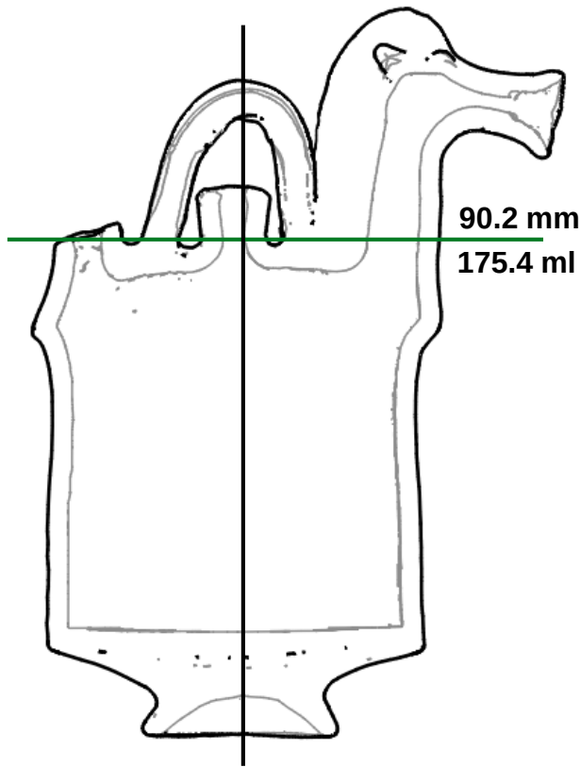


Low resolution

2D Data

Photograph

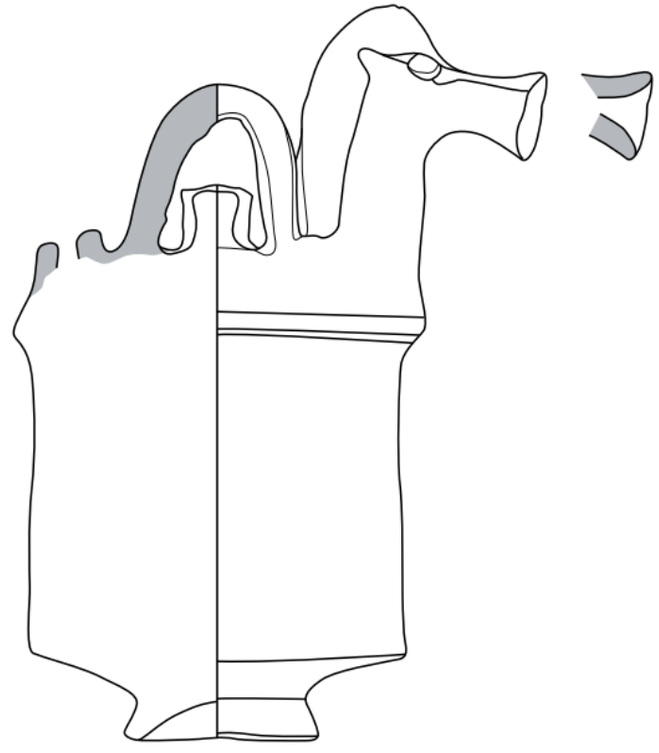




Automatic vector graphic from 3D

Known interior

Reconstructed interior

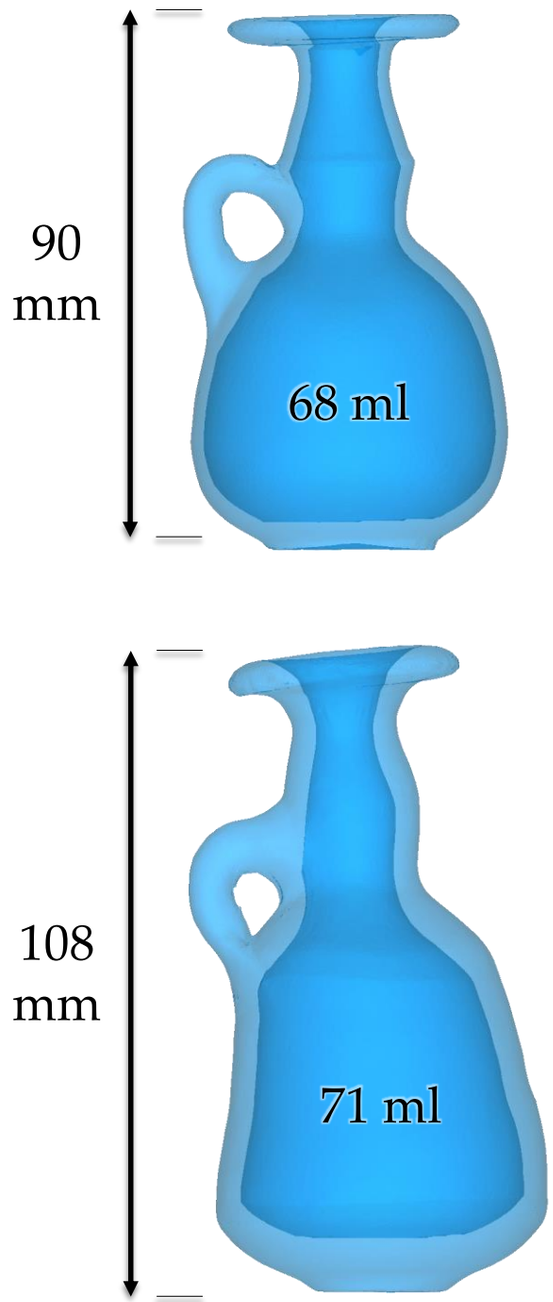


Manual illustration

(after 3D and photo)

Analysis & Comparison

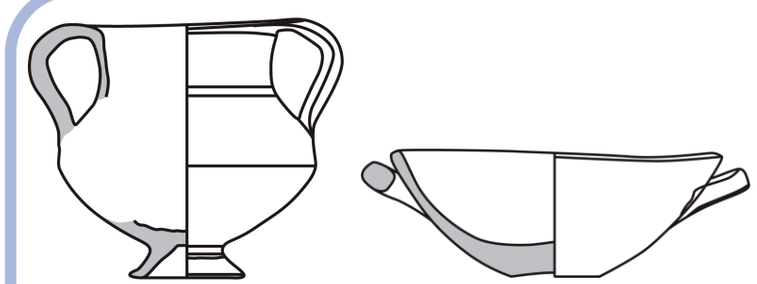
- Shapes
- Filling capacities
- Were there shape/filling standards?
- Relation between shape, filling cap., function?
- Regional/workshop differentiation?
- Chronological differentiation?
- Economical, social, knowledge networks?
- How stable is the material/structure?
- ...



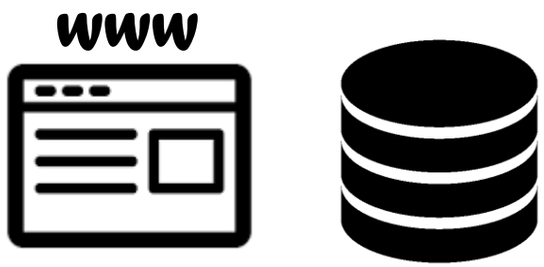
Thank you for your attention!

3D Acquisition

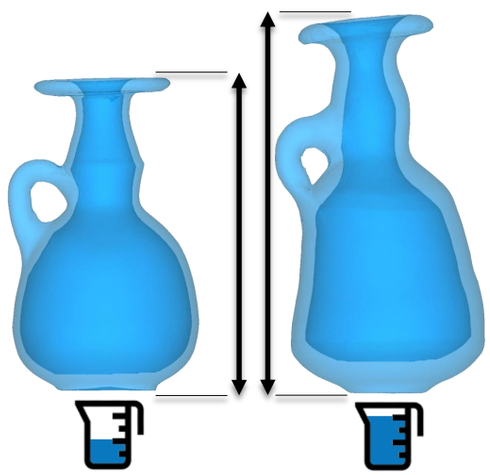
Measurement



Visualization



Archiving



Comparison

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