3D DATA CAPTURE, RESTORATION, AND ONLINE PUBLICATION OF SCULPTURE

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Digital Sculpture Project started in 2009 as activity of the new Virtual World Heritage Laboratory
Virtual World Heritage Laboratory

bringing 3D technologies to humanities research
DSP started in 2009 as activity of the new Virtual World Heritage Laboratory

Mission of the VWHL: study ways to apply 3D technologies to research in the arts and humanities.

Mission
In recent years, humanists in many disciplines have been using 3D digital technologies to capture and model their objects of study, from humble artifacts such as vases or furniture to entire cities such as ancient Rome. 3D has become a new and powerful form of scholarly expression and communication. The mission of the Virtual World Heritage Laboratory is to apply these new tools not only as interactive illustrations but also as heuristic instruments of discovery. The scope of our interests--as implied by the phrase "World Heritage"--includes the entire human record. The focus of our investigations, as is suggested by the phrase "Virtual World"--is the metaverse and how it can make possible experiences and experiments that--short of time travel--would otherwise not be possible. Click here to read a recent article by Director Bernard Frischer setting forth the key ideas behind the creation of the VWHL.
DSP started in 2009 as activity of the new Virtual World Heritage Laboratory

Mission of the VWHL: study ways to apply 3D technologies to research in the arts and humanities.

- Scale of a cylinder seal to an entire city
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- Scale of a cylinder seal to an entire city
- Two resolutions:
  - low for virtual worlds (object small part of a larger scene)
  - high for Digital Sculpture Project
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Primary technologies

- 3D data capture (“scanning”)
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  - When object exists fairly well intact
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Primary technologies

- 3D data capture (“scanning”)
  - When object exists fairly well intact
- Hand modeling
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Primary technologies

- 3D data capture (“scanning”)
  - When object exists fairly well intact
- Hand modeling
  - When object no longer exists or is very damaged
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Primary technologies

- 3D data capture (“scanning”)
  - When object exists fairly well intact
- Hand modeling
- Procedural modeling
Procedural modeling of typical apartment buildings in ancient Rome
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Primary technologies
  - 3D data capture ("scanning")
    - When object exists fairly well intact
  - Hand modeling
  - Procedural modeling
  - Hybrid
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Primary technologies

- 3D data capture (“scanning”)
  - When object exists fairly well intact
- Hand modeling
- Procedural modeling
- Hybrid: example – Rome Reborn
Italo Gismondi, “Plastico di Roma Antica,”
1933-1973 (1:250)
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Mission of the DSP:
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Mission of the VWHL: study ways to apply 3D technologies to research in the arts and humanities.
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Mission of the DSP: 3D and sculpture
Today’s talk:

- DSP’s research on sculpture
- DSP’s research on technologies
Research on sculpture
Research on sculpture

- Illustrating the history of restoration ("Pan-Nymph")
- Reconstruction from fragmentary data ("Marsyas")
- Value of casts ("Laocoon")
- Restoring geometry and polychromy ("Caligula")
- Research on sculpture
  - Illustrating the history of restoration ("Pan-Nymph")
Pan-Nymph, Dresden State Museums, ca. 1890
Pan-Nymph, Dresden State Museums, today
Model, 2010
Research on sculpture

Illustrating the history of restoration ("Pan-Nymph")
Research on sculpture

- Illustrating the history of restoration ("Pan-Nymph")
- Reconstruction from fragmentary data ("Marsyas")
Anaglyphs of Trajan, Curia Iulia, Rome. Marsyas, Ficus, Olea, Vitis
Coin, 79 BCE

Statuette, Paestum, IIIC BCE
Marysas, Ficus, Olea, Vitis statue group in the Roman Forum, IVC CE
Research on sculpture

- Illustrating the history of restoration ("Pan-Nymph")
- Reconstruction from fragmentary data ("Marsyas")
- Value of casts ("Laocoon")
Original and Magi cast compared; mean deviation of father is .5 mm; of elder son, .25 mm
Research on sculpture

- Illustrating the history of restoration ("Pan-Nymph")
- Reconstruction from fragmentary data ("Marsyas")
- Value of casts ("Laocoon")
- Restoring geometry and polychromy ("Caligula")
Restoration of lost limbs and polychromy: Caligula (Virginia Museum of Fine Arts)

- Portrait of Gaius (Caligula), Roman. Reigned 37-41 CE. 
  Marble: 203.2 cm x 67.3 cm x 49.5 cm. 
  Arthur and Margaret Glasgow Fund, 71.20.
Restoration of lost limbs and polychromy: Caligula (Virginia Museum of Fine Arts)

- Best-preserved full-length portrait
Restoration of lost limbs and polychromy: Caligula (Virginia Museum of Fine Arts)

- Best-preserved full-length portrait
- Goal: restore statue to its original appearance
Restoration of lost limbs and polychromy: Caligula (Virginia Museum of Fine Arts)

- Best-preserved full-length portrait
- Goal: restore statue to its ancient appearance
  - Digitally repairing damage to structure
Restoration of lost limbs and polychromy: Caligula (Virginia Museum of Fine Arts)

- Best-preserved full-length portrait
- Goal: restore statue to its ancient appearance
  - Digitally repairing damage to structure
  - Digitally restoring the lost color: building on results from Copenhagen

![Original Restoration A Restoration B](image-url)
Restoration of lost limbs and polychromy: Caligula (Virginia Museum of Fine Arts)
• Step I: Scanning statue, creation of state model
Step I:
State model
Restoration of lost limbs and polychromy: Caligula (Virginia Museum of Fine Arts)

- Step II: Digital repair to missing parts
Restoration of lost limbs and polychromy: Caligula (Virginia Museum of Fine Arts)

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Restoration of lost limbs and polychromy: Caligula (Virginia Museum of Fine Arts)
• Step II: Analogue—L. Mammius Maximus (Herculaneum)

Step II:
Restoration of missing parts
Restoration of lost limbs and polychromy: Caligula (Virginia Museum of Fine Arts)
• Step III: Digital restoration of the lost color (polychromy)
Restoration of lost limbs and polychromy: Caligula (Virginia Museum of Fine Arts)

- Step III: Digital restoration of the lost color (polychromy)

“Photo-induced luminescence imaging of Egyptian blue pigment and microscopic examination have revealed faint vestiges of ancient painting within the recessed surfaces of two vertically oriented drill-channels defining the folds of the tunic on the right upper chest....

“Raman spectroscopic analysis on micro-samples from these areas has identified particles of pink madder lake and Egyptian blue in combination with gypsum....

“Egyptian blue and pink madder were frequently combined in classical painting to obtain purple colors, as evident in numerous surviving painted works of art and as defined explicitly by both Vitruvius and Pliny.”
Caligula Restoration #1: Toga praetexta
Caligula Restoration #2: Toga purpurea
Caligula Restoration #3: Toga purpurea with gilded embroidery
Research on technologies
- Reducing costs of data capture
- Facilitating communication on the Internet
Research on technologies
  Reducing costs of data capture
“Structure from Motion” (SfM)
“Structure from Motion” (SfM)
• Autodesk Photo Scene Editor (PSE)
Marysas, Ficus, Olea, Vitis statue group in the Roman Forum, IVC CE
Marysas, Ficus, Olea, Vitis statue group in the Roman Forum, IVC CE
Drawing of area of Roman Forum in ca. 1530 by Martin van Heemskerck
Marforio in courtyard of the Palazzo Nuovo, Capitoline Museums, Rome
PSE model of the cast

Cast of the Lansdowne Hercules in Dresden
The Virtual World Heritage Laboratory presents

3D Model of the Dying Gaul
based on the original and a cast

(September 2011)

PSE model of the cast

Original statue (Rome)

Cast of the Dying Gaul
(Basel)
Research on technologies

- Reducing costs of data capture
- Facilitating communication on the Internet
Research on technologies
- Reducing costs of data capture
- Facilitating communication on the Internet. Goal:
- Research on technologies
  - Facilitating restoration of polychromy
  - Reducing costs of data capture
  - Facilitating communication on the Internet. Goal:
    - Take advantage of WebGL without paying price of small model size
Research on technologies
- Facilitating restoration of polychromy
- Reducing costs of data capture
- Facilitating communication on the Internet. Goal:
  - Take advantage of WebGL without paying price of small model size
  - WebGL: runs in Chrome, Firefox, Safari (August 2011)
WebGL is a Web-based Graphics Library. It extends the capability of the JavaScript programming language to allow it to generate interactive 3D graphics within any compatible web browser.

WebGL is a context of the canvas HTML element that provides a 3D computer graphics API without the use of plug-ins. The specification was released as version 1.0 on March 3, 2011. WebGL is managed by the non-profit Khronos Group.
Research on technologies

- Facilitating restoration of polychromy
- Reducing costs of data capture
- Facilitating communication on the Internet. Goal:
  - Take advantage of WebGL without paying price of small model size
  - WebGL: cf. Chrome WebGL Experiments generally lack:
    - Geometrical detail
    - Interactivity
Research on technologies facilitating restoration of polychromy
• Reducing costs of data capture
• Facilitating communication on the Internet

Goal: Take advantage of WebGL without paying the price of small model size.

WebGL Experiments

WebGL is a new web technology that brings hardware-accelerated 3D graphics to the browser without installing additional software.
- Research on technologies
  - Facilitating restoration of polychromy
  - Reducing costs of data capture
  - Facilitating communication on the Internet. Goal:
    - Take advantage of WebGL without paying price of small model size
    - Answer: “Venus”
Screen capture of Google Chrome running a 3D Mesh with vertex color

(September 6, 2011)
Research on technologies

- Facilitating restoration of polychromy
- Reducing costs of data capture
- Facilitating communication on the Internet. Goal:
  - Take advantage of WebGL without paying price of small model size
  - Bonus: “Venus” runs on iPhones and iPads
Add more PSE models for virtual world.

Villa (NSF grant IIS-1018512)
Next steps

- Add more PSE models for virtual world of Hadrian’s Villa (NSF grant IIS-1018512)
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- Create library of 3D models of world’s great sculpture
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- Create library of 3D models of world’s great sculpture
- Launch scientific journal with Elsevier for the online, peer-reviewed publication of real-time 3D models of cultural heritage artifacts, monuments, and cities along with related monographs
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