Research and Pedagogy in 3D

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American Historical Association Annual Meeting
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Schedule

9:00 - 9:15  Welcome and introductions

9:15-9:45  Research questions, background, and terminology

9:45-10:15  Methods for generating/capturing 3D content

10:15-11:15  HANDS-ON (Objects and statuary)

HANDS-ON (Environments)

HANDS-ON (AR and VR)

11:15 - 11:50  Case study: VSim and the World’s Columbian Exposition

HANDS-ON (VSim)

11:50 - 12:00  Final discussion
Introductions
Definitions:

Virtual reality / 3D content
Virtual reality according to Google:
the computer-generated simulation of a three-dimensional image
or environment that can be interacted with in a seemingly real or
physical way by a person using special electronic equipment, such
as a helmet with a screen inside or gloves fitted with sensors.

3D content:
a general term to describe a range of three-dimensional,
computer-generated objects or environments that can be used and
disseminated for research and pedagogy
3D = X, Y, Z coordinates in virtual space

Venus of Willendorf made with MeshMixer

Neuschwanstein Castle
http://www.markoljubez.com/wordpress/?category_name=matte_painting

http://vislab-ccom.unh.edu/~schwehr/photoRealVR/docs/wireframe.gif

Why 3D?

What are the research questions?

What’s the context of this new form of scholarship?
Design visualization

• Architectural renderings/drawing
• Scale architectural models

The LAX Theme Building of LAX in a 1961 architectural rendering used to publicize the Getty Museum’s ‘Overdrive’ exhibit.

The VR/3D equivalent

- Architectural renderings/drawing
- Scale architectural models
- Animations
- Interactive pre-visualizations

Lifang animation posted on YouTube
http://www.youtube.com/watch?v=8dEXPA-ma7g

3D Model to Print service promoted to architects
http://www.solidsmack.com/fabrication/3dmtp-makes-it-easy-to-3d-print-architectural-models/

SketchUp rendering from http://jsdajsh.blogspot.com/2012_11_01_archive.html
Didactic tool

- 1:1 copies for art and architectural history
- Teaching objects for medical education


The Museum of Zoology and Natural History in Florence.
The VR/3D equivalent

- Virtual anatomy
- Digital equivalents of art and architecture

http://www.digitalsculpture.org/laocoon/index.html

Biodigital Systems' Human Visualization Platform
https://twitter.com/biodigitalhuman/media
‘Experience’ surrogate

- Panoramas
- Dioramas
- Theatrical spectacle

New York’s Museum of Natural History, Image from laurenpiro.tumblr.com

Barker’s panorama rotunda in London’s Leicester Square, 1793. Image from www.panoramapainting.com

Ben Hur Live at the O2 Arena. Image from theguardian.com
Yadegar Asisi’s new Panorama of ancient Rome. Image from www.panoramapainting.com
The VR/3D equivalent

• Virtual training
• Immersive experiences
• CAVES etc.

U.S. Navy personnel using a mock VR parachute trainer.

HTC Vive VR Demo - theBlu’ by WEVR Labs
http://www.virtusphere.ca/
Virtual Travel

- Stereoscopy
- Reconstructed/themed environments

*Poble Espanyol, an open-air architectural museum built for the 1929 Barcelona International Exhibition. Image from www.localizationworld.com*

*3D film screening. Image from www.scandigital.com*
The VR/3D equivalent

- Virtual worlds
- Stereo hardware

http://bgr.com/tag/oculus-rift/

The Second Life version of Lakeport Plantation built by Arkansas
http://inworldbits.wordpress.com/tag/perspective/page/2/

Locus for storytelling/narrative

- Early cinema and film (establishes CG conventions)
The VR/3D equivalent

- Computer games
- Computer-generated films
- Special effects

Screen shot from “Assassin’s Creed”.

Main Road Post Visual Effects Stalingrad 2013 Making of.

http://www.eurogamer.net/articles/digitalfoundry-2014-lego-the-movie-next-gen-face-off
Other research questions?
Know that your research questions will guide your technology choices

- Static single-frame rendering
- Animation
- 3D pdf
- Web object viewer
- 3D printing
- Point clouds
- Panorama (possible with both model and real world)
- Augmented reality
- Real-time environment
- Virtual world environment
- Game engine
Terms you should know …1

Based on www.ericchadwick.com/portfolio/glossary/

Geometry: all polygonal objects in the model

Polygon (face), vertex, edge: A series of vertices that define a plane in 3D space.

Triangle: the building block of 3D modeling; triangular face by definition a true plane

Mesh: a variant of geometry that is a continuous surface of triangles

Wireframe: edge or skeletal representation of the modeled object

Point Cloud: a set of data points usually defined by XYZ coordinates

XYZ/xyz: convention to use Cartesian coordinates to describe and delineate 3D space … three vectors at right angles to each other, labeled by longtime convention as X, Y, and Z, and starting at a center point called the Origin.

HPR/hpr: convention to describe viewing direction as coordinate that references Heading, Pitch, and Role (you'll also hear it 'Yaw' in place of Heading)
Terms you should know … 2

Textures: An image file, either scanned or painted, made up of a bunch of pixels. Common file formats are .BMP, .GIF, .TGA, etc. Also called bitmap, map, texture map.

Materials: A set of parameters that determine the color, shininess, smoothness, etc. of a surface. Usually a material is used to assign a texture to a face.

Real-time environment: An interactive environment where the visual elements are generated on the fly in response to the users’ actions (as opposed to a fixed animation).

Rendering engine/game engine/physics engine: Software framework that provide core functionality for interaction and streamlines project development by providing tools to easily implement interactions, animations, effects, etc.

Viewer: A web plug-in or otherwise simplified piece of software that enables interaction with 3D content (often paired with a development toolkit).
Ways to build/generate 3D content

There is a range of software and hardware available, literally hundreds of programs, each with their own strengths and weaknesses.

It is important to choose software appropriate to the task at hand, the project’s research objective, the budget, the skill set of the workers involved, and the project’s dissemination plan.

To be discussed:

- Manual modeling
- Laser scanning
- Photogrammetric modeling
- Procedural modeling
Manual modeling

Software ranges from extremely simple to extremely complex

**SketchUp**: Free software, aimed at novice with claims that one can ‘get good fast’

**Autodesk’s 3ds Max**: $3,675 for a single license (though free educational version are available through Autodesk): ‘3ds Max delivers efficient new tools, accelerated performance, and streamlined workflows to help increase overall productivity for working with complex, high-resolution assets.’
Manual modeling

Blender (free)
- Photorealistic Rendering
- Fast Modeling
- Realistic Materials
- Animation Toolset
- Sculpting
- Fast UV Unwrapping
- Full Compositor
- Game Creation
- Camera and Object Tracking
- Library of Extensions
- Video Editing
- Flexible Interface

Vectorworks
- Designer aimed at professional with design tools to ‘draft, model, and present’
- Architect includes BIM (Building Information Management) tools
- Landmark includes landscape-specific tools
- Spotlight is aimed at lighting designers
- Fundamentals is their basic CAD package
- Renderworks works with the CINEMA 4D render engine to generate presentation output

Creator
- Models intended for real-time simulation
- Polygonal surface modeler
- Scenegraph control
- ‘Wizards’ for common elements
- Toolsets for geometric and organic shapes
- Easy texture mapping
- Auto generation of light maps
- Real-world unit and geo-coordinate authoring
- Simple placement of external references
- Shader palette in latest version
Manual modeling

What are the problems?

- Incredibly time consuming!
- Requires modeling skill and artistic sensibility
- Potentially inaccurate
- As a result, projects that depend on manual modeling are expensive and slow to realize

There are alternatives …
Laser scanning

For three-dimensional objects …

The Digital Michelangelo Project
https://graphics.stanford.edu/projects/mich/

“Recent improvements in laser rangefinder technology, together with algorithms developed at Stanford for combining multiple range and color images, allow us to reliably and accurately digitize the external shape and surface characteristics of many physical objects.”

“As an application of this technology, a team of 30 faculty, staff, and students from Stanford University and the University of Washington spent the 1998-99 academic year in Italy scanning the sculptures and architecture of Michelangelo.”

“Our largest dataset was of the David - 2 billion polygons and 7,000 color images.”
Laser scanning

For three-dimensional objects …
Laser scanning

For archaeological sites … CAST (Arkansas)

TOP: The site. BOTTOM: Top-down, planimetric view of 3D data produced from survey with the Optech laser scanner
Laser scanning

For archaeological sites …

Cyark
http://archive.cyark.org/project-world

“CyArk works with experienced teams worldwide to record heritage sites using reality capture technologies such as 3D laser scanning, photogrammetry and traditional survey. The resultant 3D, engineering-grade data can then be used to create highly accurate documentation drawings for site conservation and realistic visualizations for education and interpretation.”
Laser scanning

Primary output is a point cloud (i.e., a collection of xyz coordinates)

http://grail.cs.washington.edu/rome/col-sfm0.JPG
Laser scanning

For small-scale objects ...

Center for Advanced Spatial Technologies (CAST)
http://cast.uark.edu/home.html

The Virtual Hampson Museum
http://hampson.cast.uark.edu/
Photo-based model generation

• Photogrammetry / SFM: Surface From Motion (also referred to as Structure From Motion)
• 123D Catch (an AutoDesk product) and PhotoScan (an Agisoft product)
• “Agisoft PhotoScan Standard automatically builds professional quality textured 3D models from still images. The program provides robust photo alignment, no coded targets or special shooting conditions being needed.”

Edward Triplett at UVA: “Point cloud of the fortress-monastery of Montesa in Valencia. This cloud was processed from more than 10 thousand images using ChangChang Wu’s VisualSFM and registered/compiled using Cloud Compare. The cloud is composed of more than 91 million points.” 

Photo-based model generation

Building meshes and point clouds from photos ...

Photo-based model generation

Autodesk’s 123D Catch example …

http://www.123dapp.com/catch/Capture_2015_12_09_16_39_55/4850283
Procedural modeling

Rule-based generation of content …

- CityEngine (an ESRI product): “The CityEngine City Wizard is the easiest way to generate a procedural city. Create and generate whole cities from pre-defined templates with only a few mouse clicks.”
- Also 3D content from 2D GIS data

CityEngine Web Scenes

http://www.esri.com/software/cityengine/features

Philadelphia Redevelopment  LA Metro  Desert City  Oestra/Volda Airport OIS
Questions?
Play time: Objects/statuary

All links posted at http://sandbox.idre.ucla.edu/sandbox/research-pedagogy-in-3d

- Smithsonian X3D beta
  http://3d.si.edu/

- The Virtual Hampson Museum
  http://hampson.cast.uark.edu/browse.htm
  Use Internet Explorer

- 3D Heritage Online Presenter
  http://vcg.isti.cnr.it/3dhop/

- Cenobium
  http://cenobium.isti.cnr.it/index.php
Comments?
Play time: Structures/environments

Websites

• Digital Karnak [http://dlib.etc.ucla.edu/projects/Karnak/](http://dlib.etc.ucla.edu/projects/Karnak/)  
  Emphasis on pre-rendered imagery combined with supplementary resources and textual information; also cultural heritage use of Google Earth


Unity environments

• Digital Pompeii (Unity model of House of the Prince of Naples)  
  [http://pompeii.uark.edu/DigitalPompeii_Content/Model_PrinceNaplesMain.html](http://pompeii.uark.edu/DigitalPompeii_Content/Model_PrinceNaplesMain.html)

• Contested memories: The battle of Mount Street Bridge  

City Engine environment

• Augustan Rome  
  [http://www.arcgis.com/apps/CEWebViewer/viewer.html?&3dWebScene=586be0364e994018bae4878813222ffd&view=291300.12,-325.35,-4641567.99,293458.63,3239.1,-4635521.05,0.95&lyr=1,1,1,1,1,0,0,a,0,1,1,1,1,1,1,1,1,1,1,1,0,0,0&wkid=32633&v=2](http://www.arcgis.com/apps/CEWebViewer/viewer.html?&3dWebScene=586be0364e994018bae4878813222ffd&view=291300.12,-325.35,-4641567.99,293458.63,3239.1,-4635521.05,0.95&lyr=1,1,1,1,1,0,0,a,0,1,1,1,1,1,1,1,1,1,1,1,1,0,0,0&wkid=32633&v=2)
Comments?
Play time: AR and VR

- **Augmented Asbury Park**: Free augmented reality tour of the boardwalk on your cellphone. Available at [http://www.augmentedasburypark.com/](http://www.augmentedasburypark.com/)

- **HTC Vive VR Demo**. 2015. Available at [https://www.youtube.com/watch?v=MFKbL-GU-U](https://www.youtube.com/watch?v=MFKbL-GU-U)

- **360-degree video** example: Experience the Blue Angels. 2015. (Must run with Firefox or Chrome) Available at [https://www.youtube.com/watch?v=H6SsB3JyqQg](https://www.youtube.com/watch?v=H6SsB3JyqQg)


- **HoloLens** Product Demo available at [https://www.youtube.com/watch?v=29xnzxgCx6I](https://www.youtube.com/watch?v=29xnzxgCx6I)
Comments?
VSim: Theory to methods

As an architectural historian:

• 3D is better than 2D for teaching and learning about the built environment
VSim: Theory to methods

As an educator:
• Instructor/teacher is gatekeeper to use of technology in the classroom
• Larry Cuban was right: Simplicity, Versatility, Efficiency
• Technology cannot be trusted (connectivity issues, latency, etc.)
• Active learning is better than passive

As an instructional designer:
• Richard Mayer was right ("Cognitive Theory of Multimedia Learning")
• People have a limited capacity for processing information (cognitive capacity, dual processing, nods to Paivio)
• Integration of words and images
• Active learning is better than passive
VSim: Theory to methods
Play time: VSim/Pantheon

VSim and sample model: https://idre.ucla.edu/research/active-research/vsim/vsim-downloads
Final discussion

- Thoughts?
- Research applications?
- Pedagogical applications?
- Opportunities?
- Wish lists?
- Concerns?
- Plans for your own projects?
Fini!