UCLA Research Workshop Series Summer 2020

Cultural heritage modeling

Anthony Caldwell

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Cultural heritage modeling

Different things to different disciplines and researchers

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Archeologist

Image Source: Easter Island statue project UCLA

Classicist

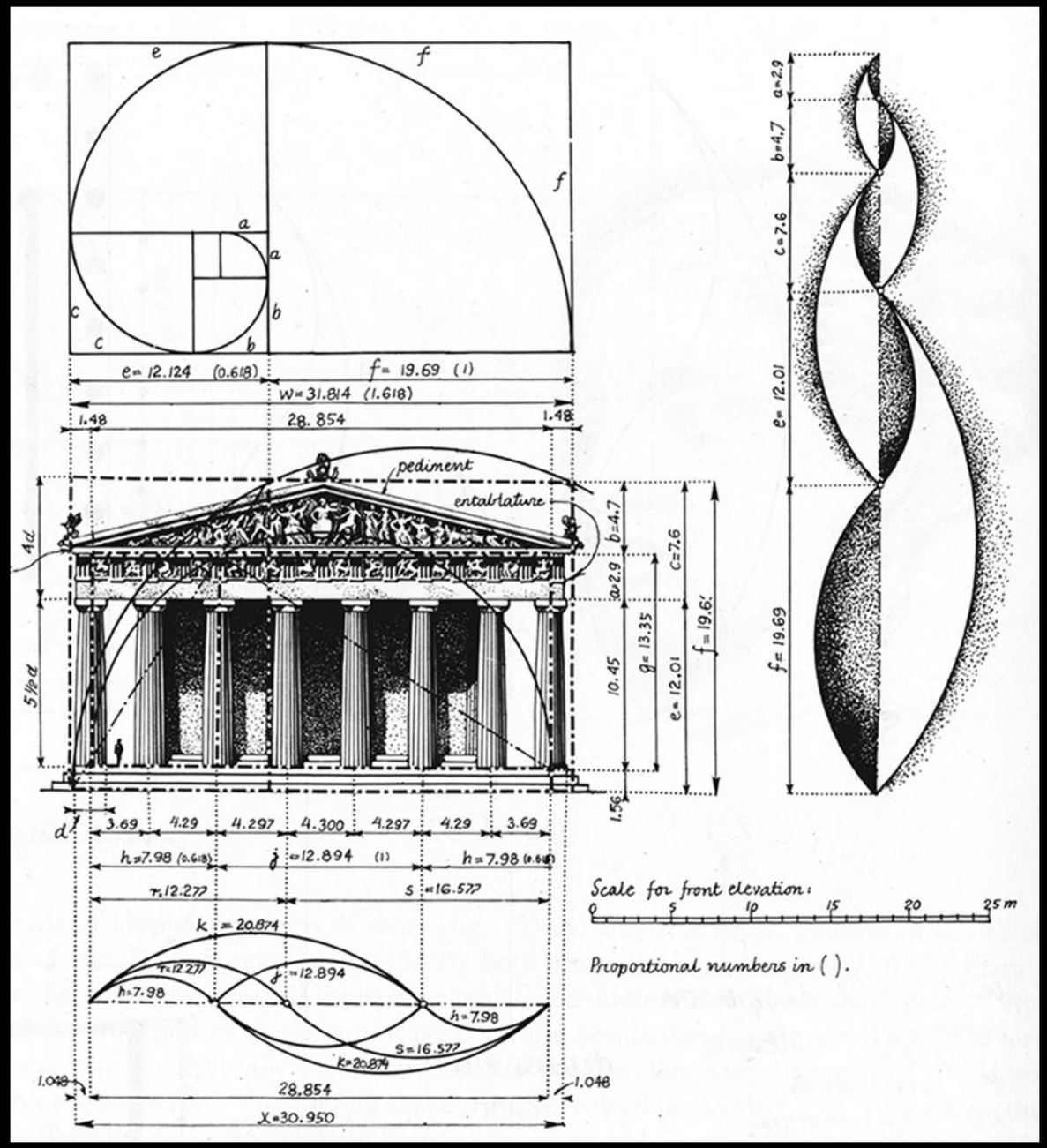

Image Source: Donnally Architects Seattle, Washington

Art Historian

Image Source: UCLA Scholarly Innovation Lab

Architectural Historian

Image Source: Historic American Buildings Survey

Anthropologist

Image Source: University of Canterbury New Zealand

Ethnomusicologist

Image Source: https://acoustics.org/the-origins-of-building-acoustics-for-theatre-and-music-performances-john-mourjopoulos/

Cultural heritage modeling:

Tangible culture: Buildings, monuments, landscapes, books, works of art, and other artifacts

Intangible culture: Folklore, traditions, language, music, and knowledge

Natural heritage: Culturally significant landscapes, geological elements, and biodiversity

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Tangible culture:

Buildings and monuments

Image Source: https://commons.wikimedia.org

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Digital terrain modeling (DTM)

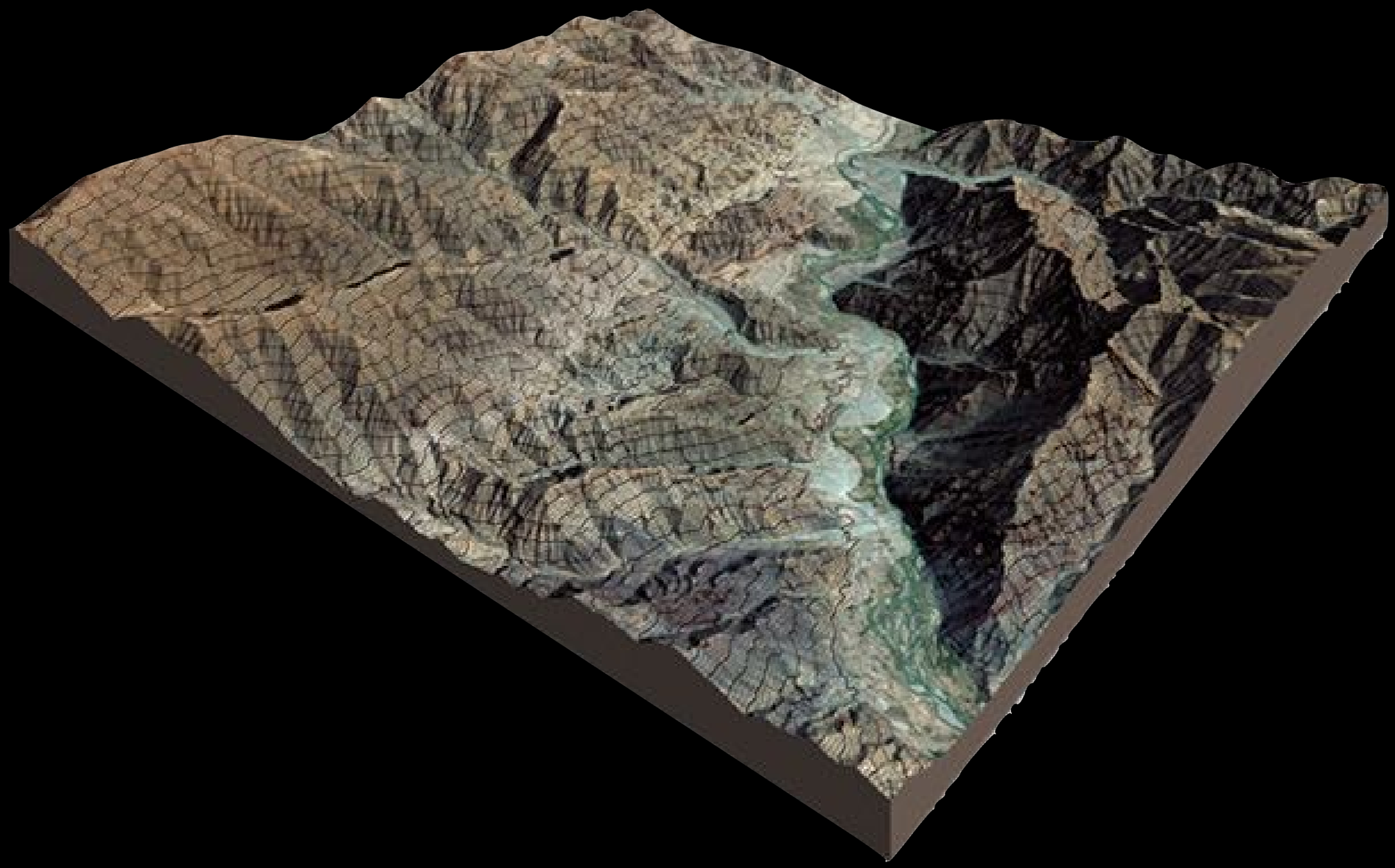

Image Source: http://www.landinfo.com

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Geographic information system (GIS)

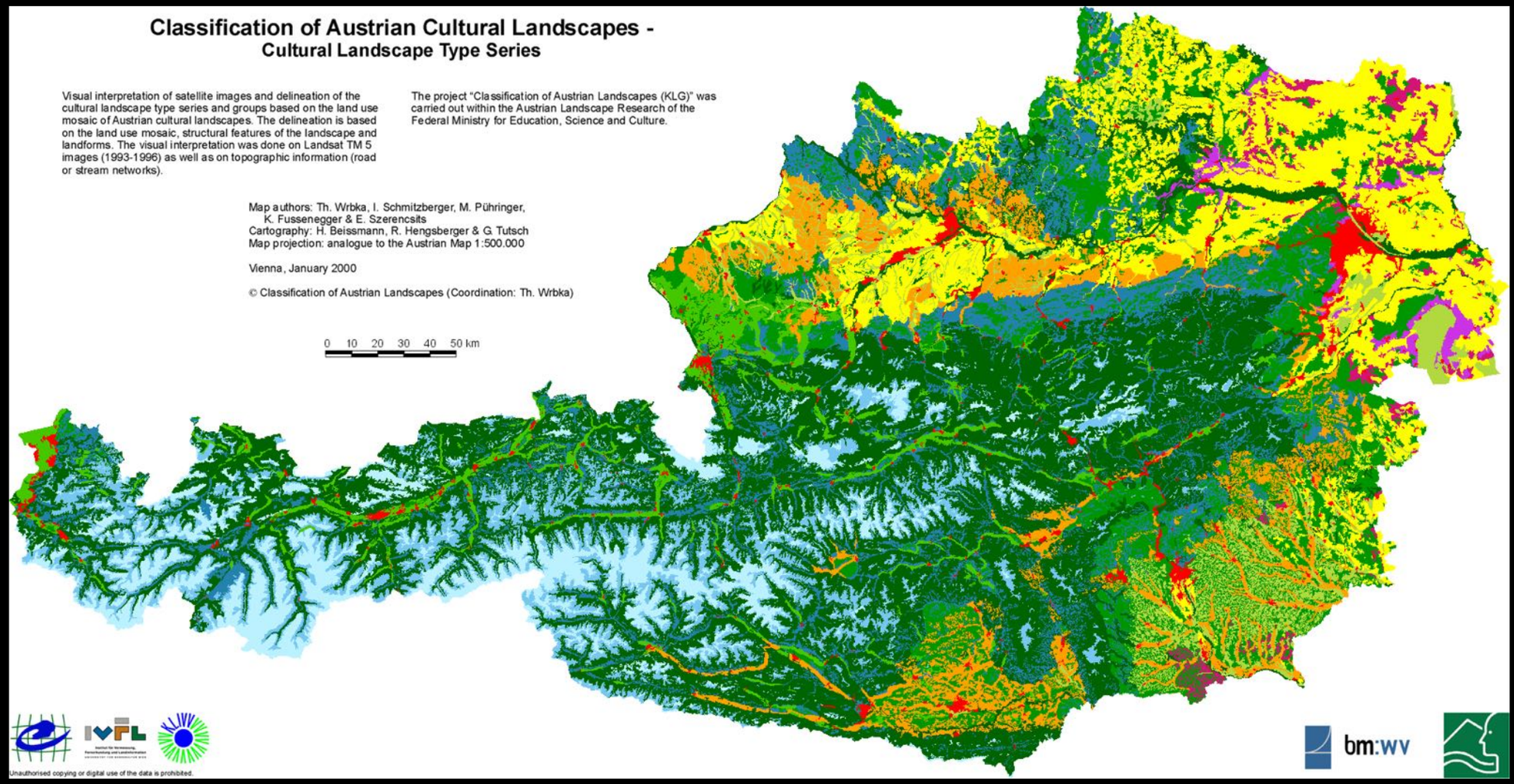

Image Source: https://www.sciencedirect.com

Building information modeling (BIM)

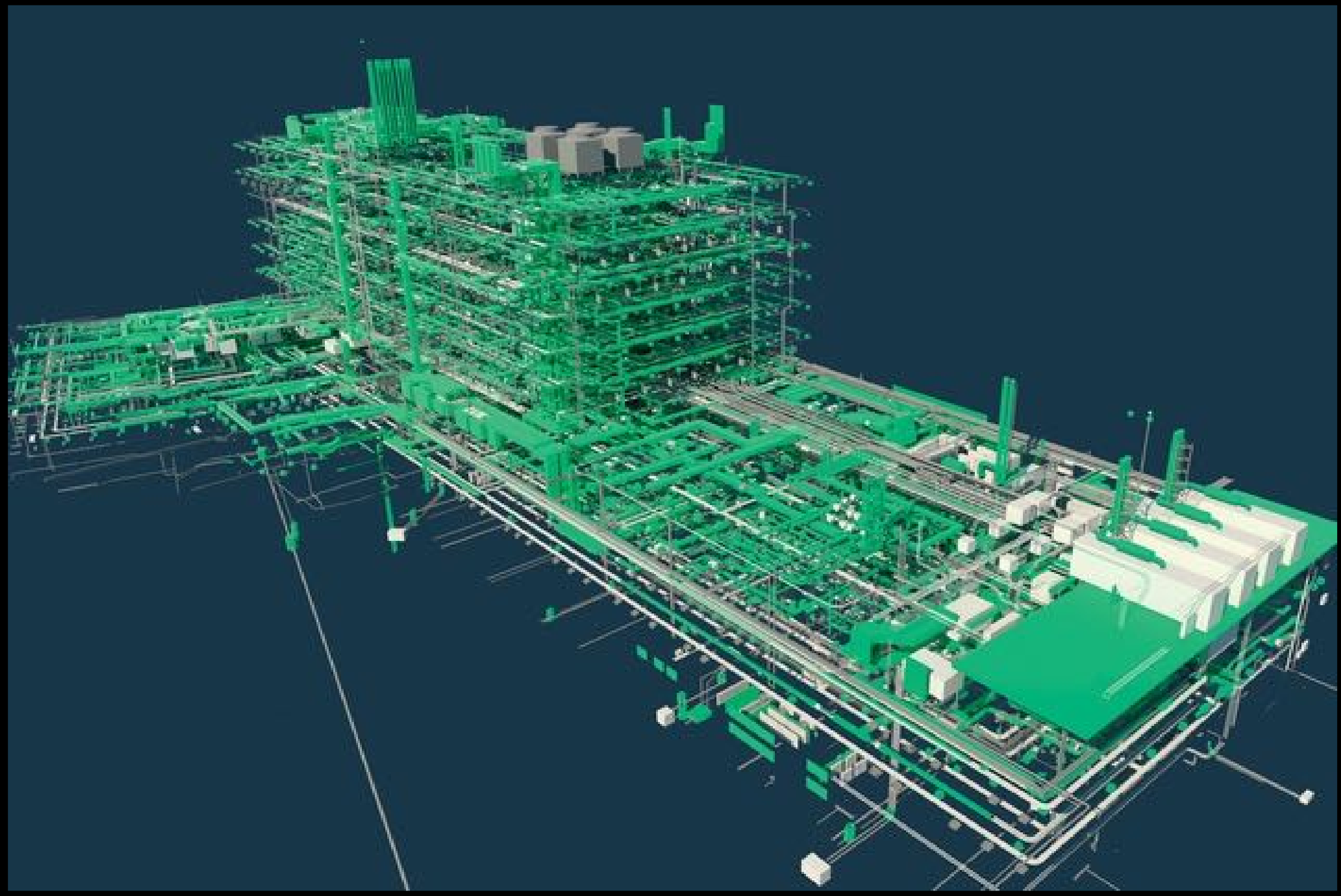

Image Source: Warren and Mahoney & Katoa Health Design.

Scholarly building information modeling (SBIM)

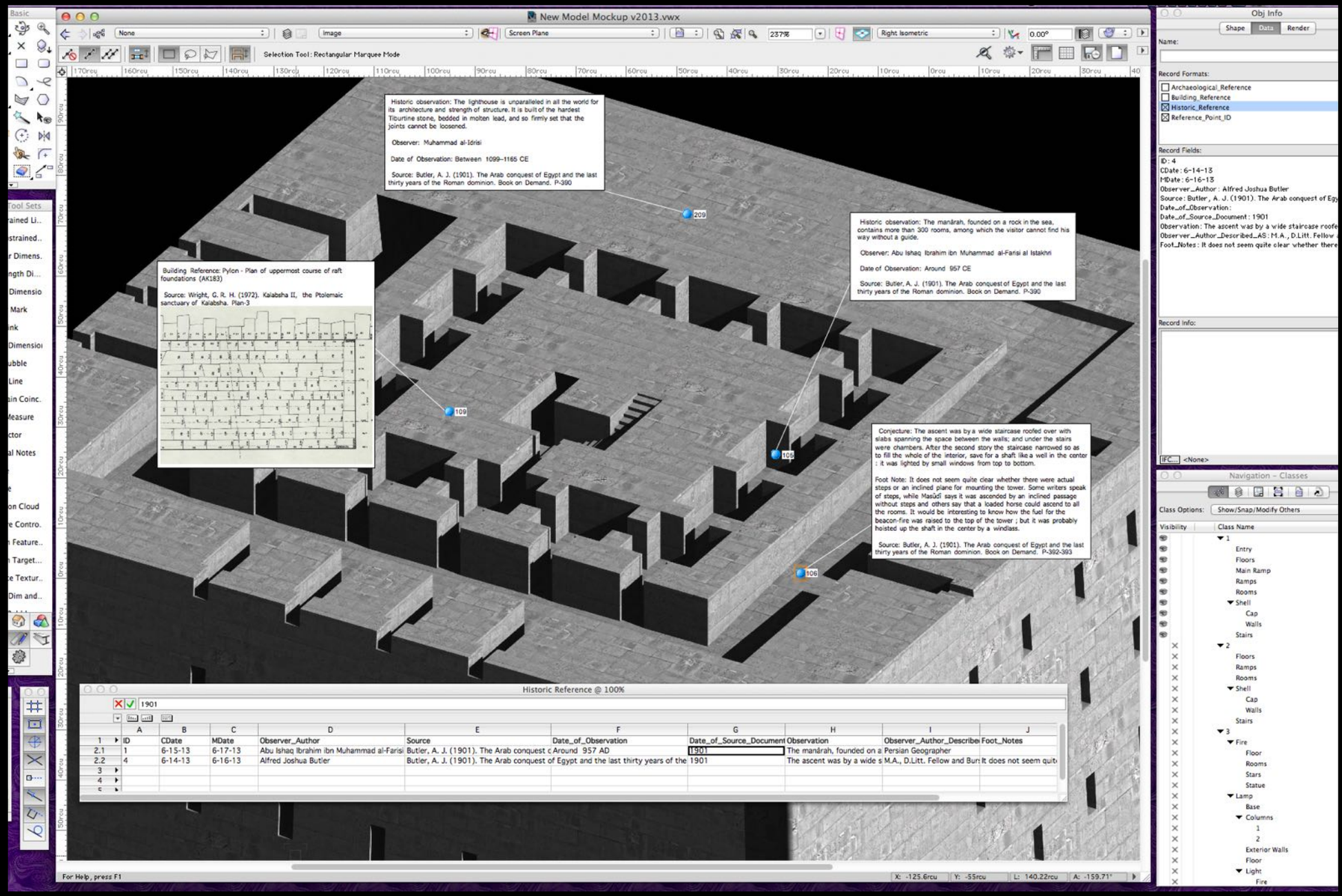

Image Source: UCLA Experiential Technologies Center

Intangible

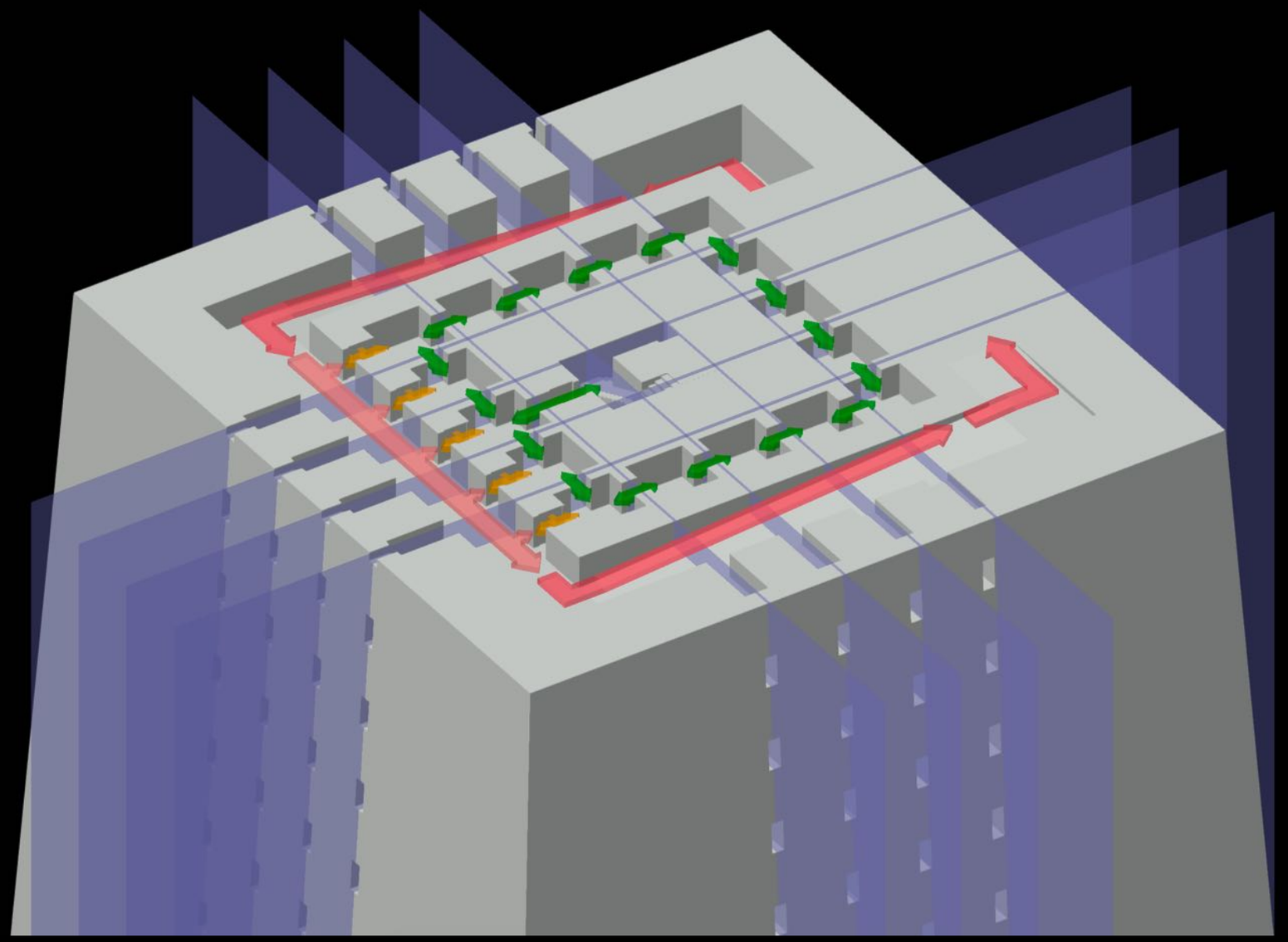

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Image Source: UCLA Experiential Technologies Center

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4D Modeling:

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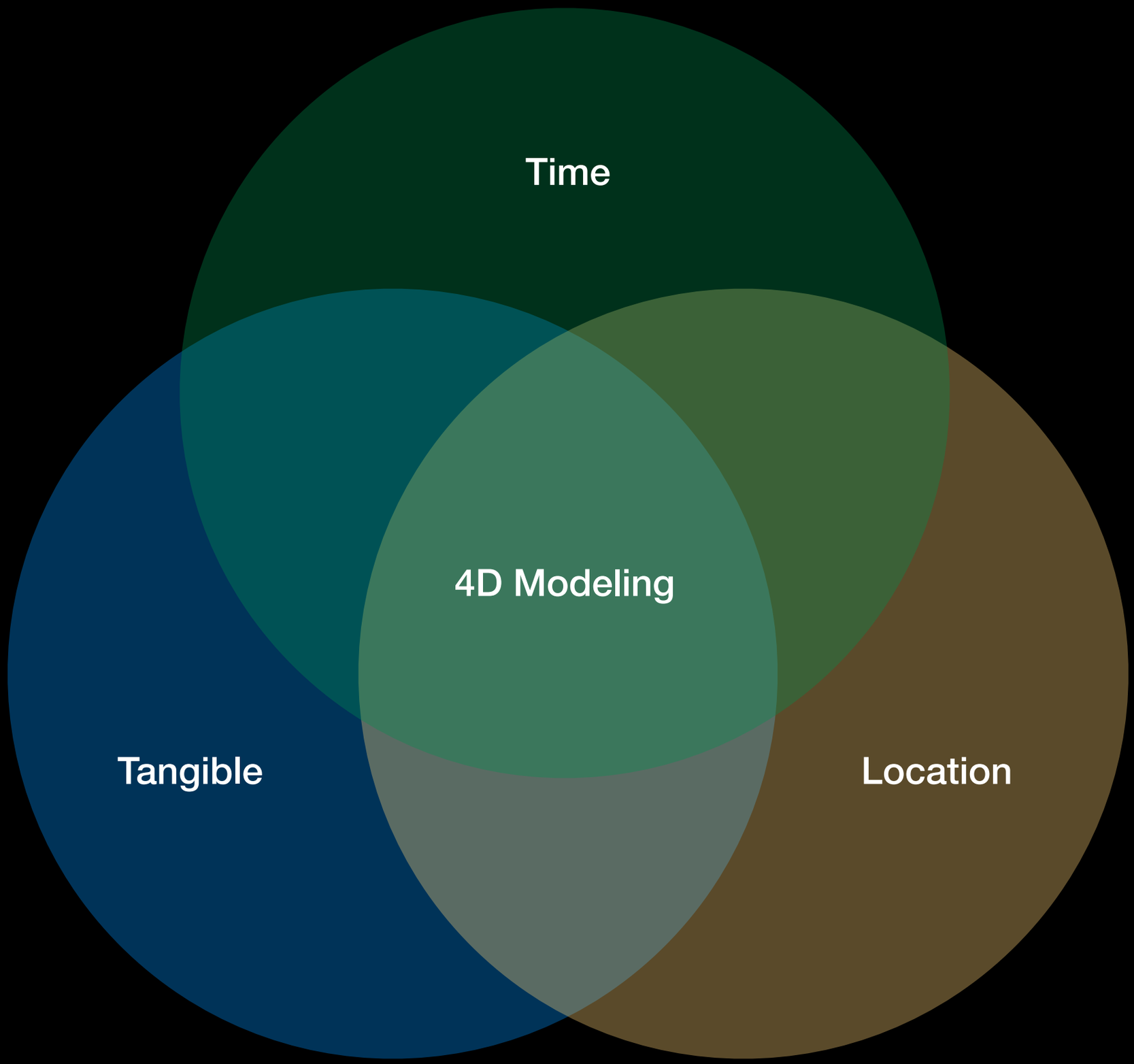

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Cultural heritage modeling

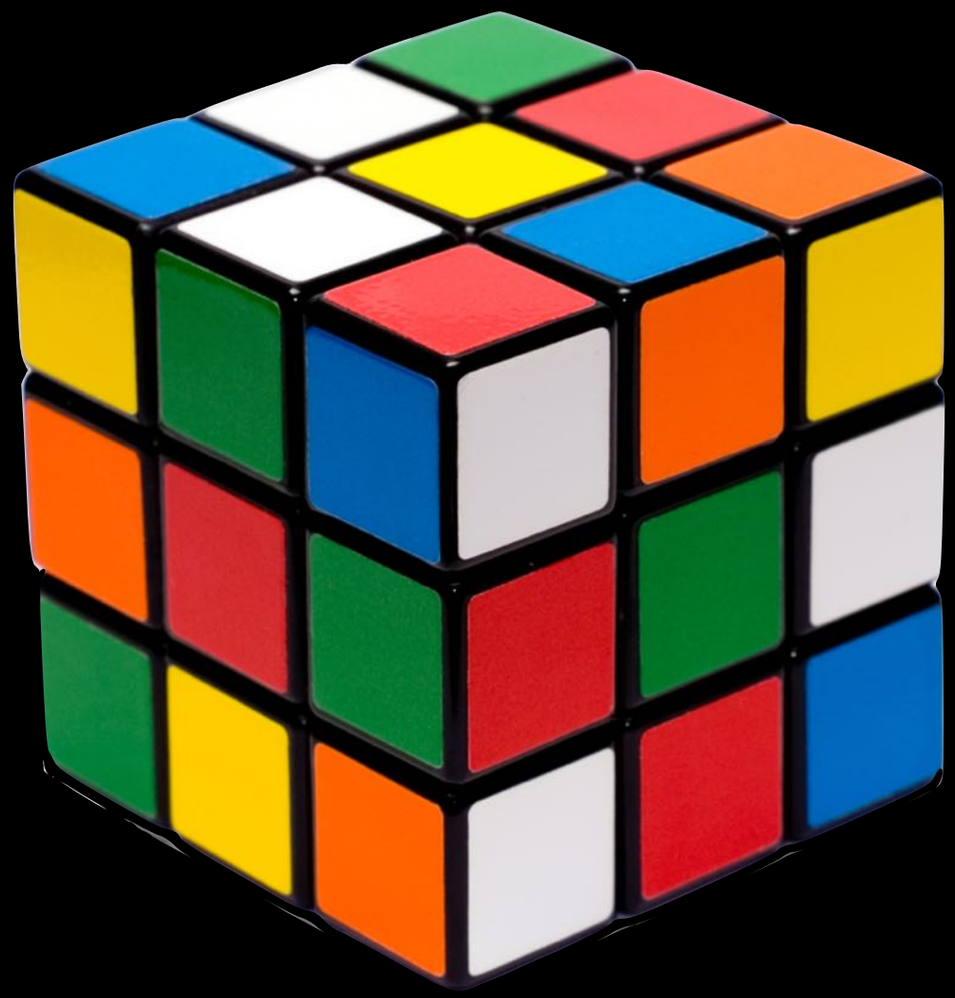

Image Source: https://platinumproprentals.com

How Cultural heritage modeling benefits research

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Cultural heritage modeling:

Conservation

Documentation

Restoration

Monitoring

Research

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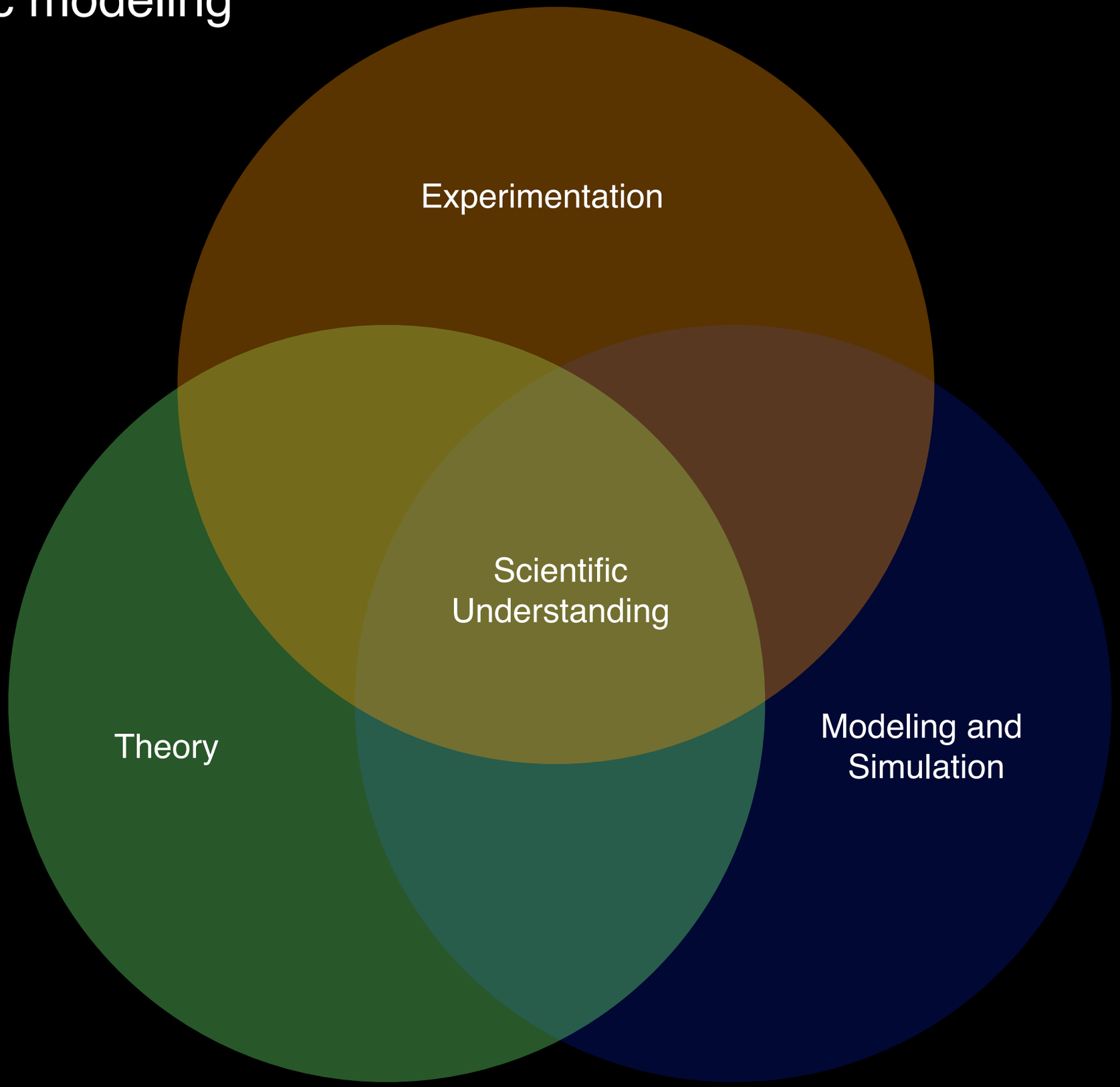
Scientific modeling



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Iterative modeling

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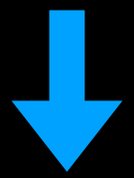
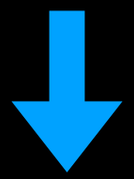
What we think we know



Try to build it



Revels what we don’t know

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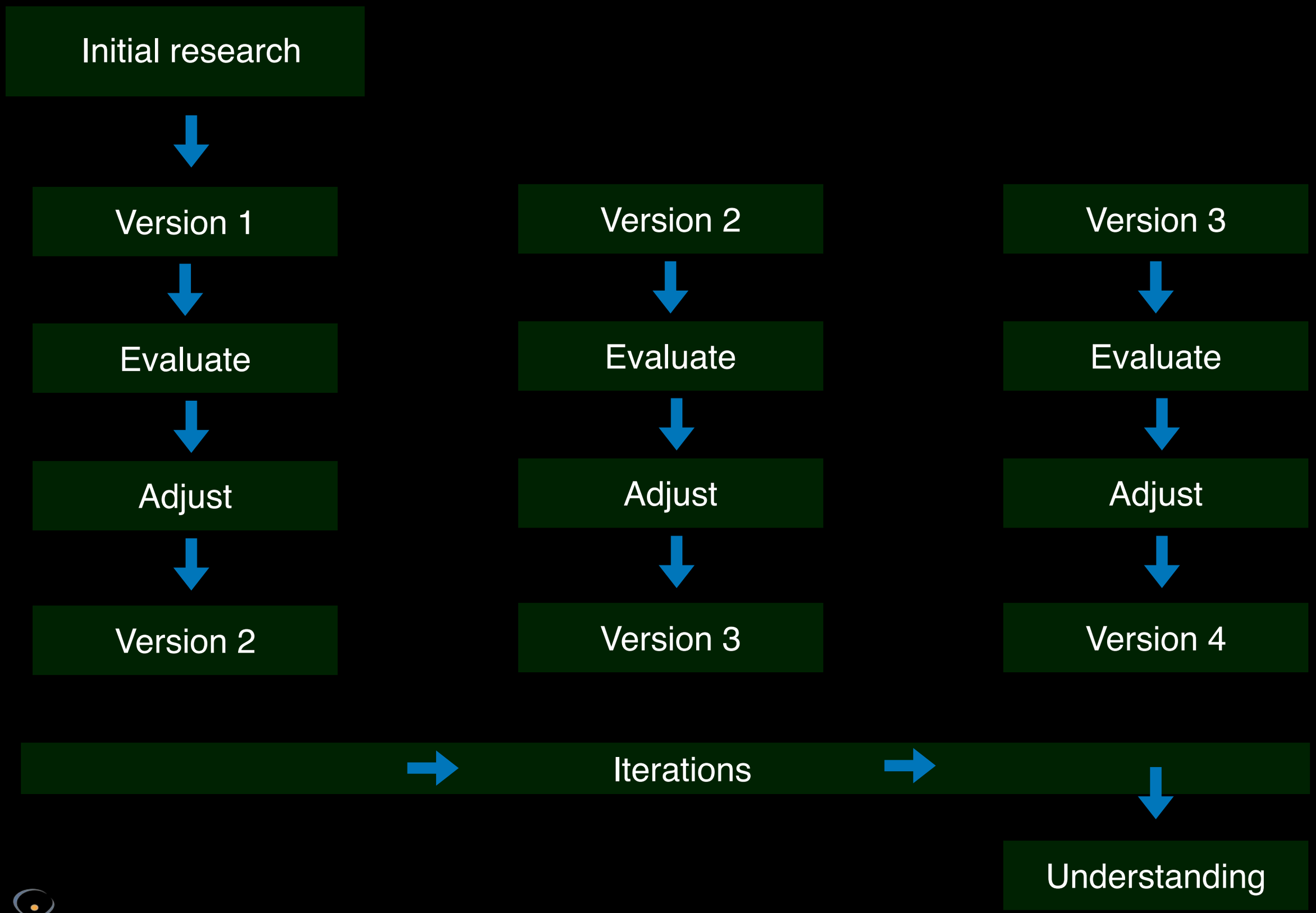
Iterative modeling process



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Examples:

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Paris Past and Present

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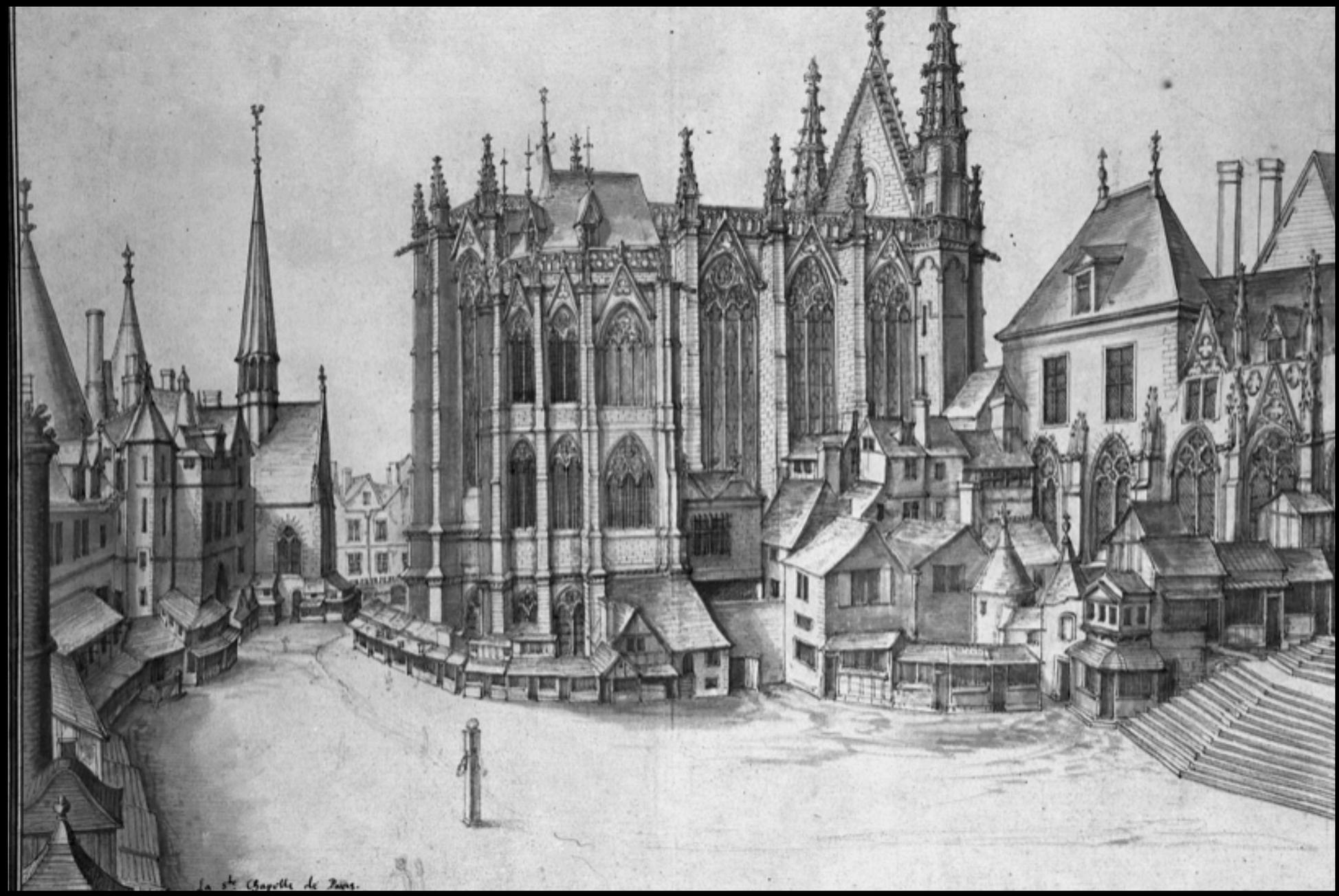
Paris Past and Present



Palais de la Cité Sainte-Chapelle Martellange image

PARIS PAST & PRESENT

Image Source: http://paris.cdh.ucla.edu

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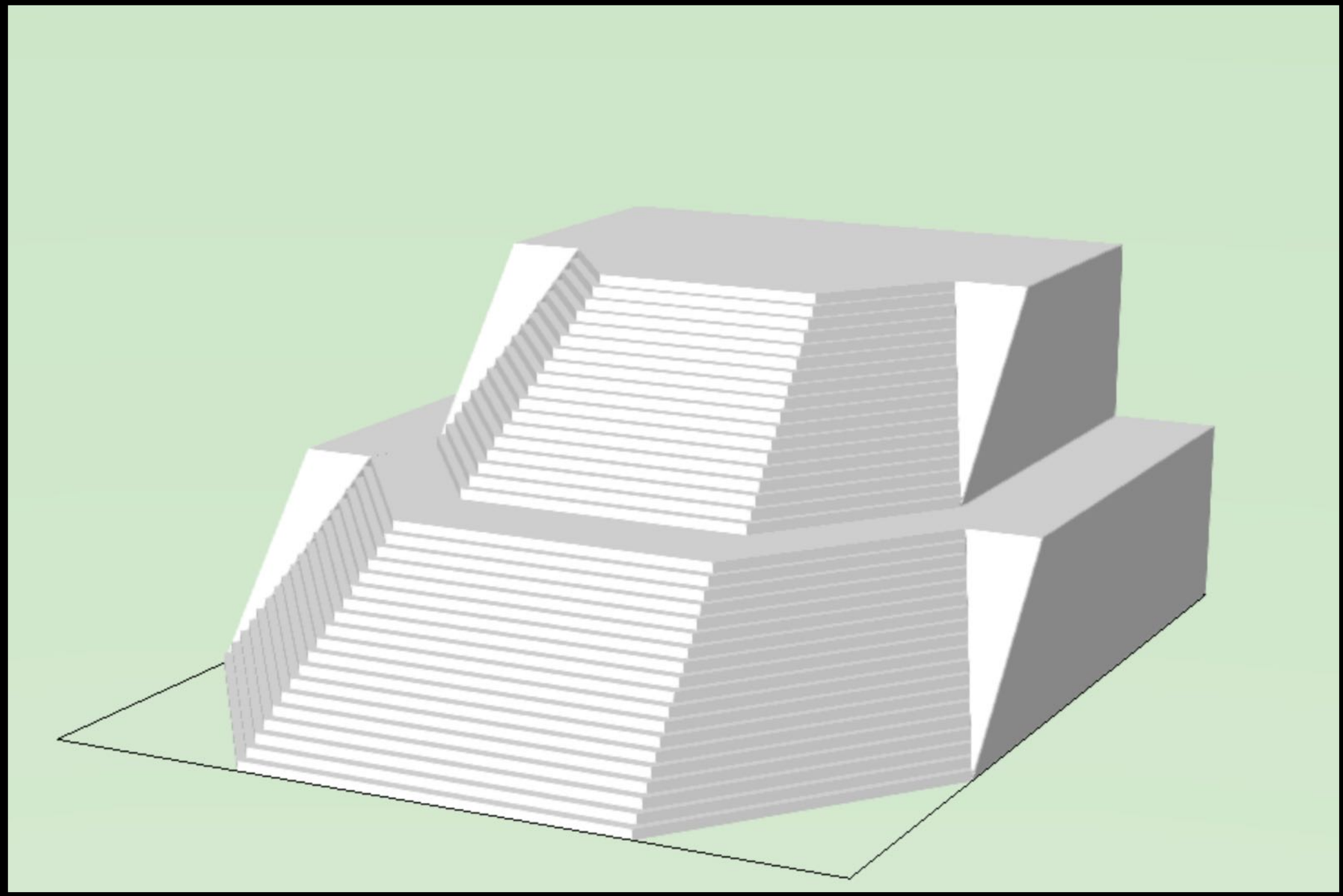
Paris Past and Present



Galerie des Merciers Proposed reconstruction of staircase

PARIS PAST & PRESENT

Image Source: http://paris.cdh.ucla.edu

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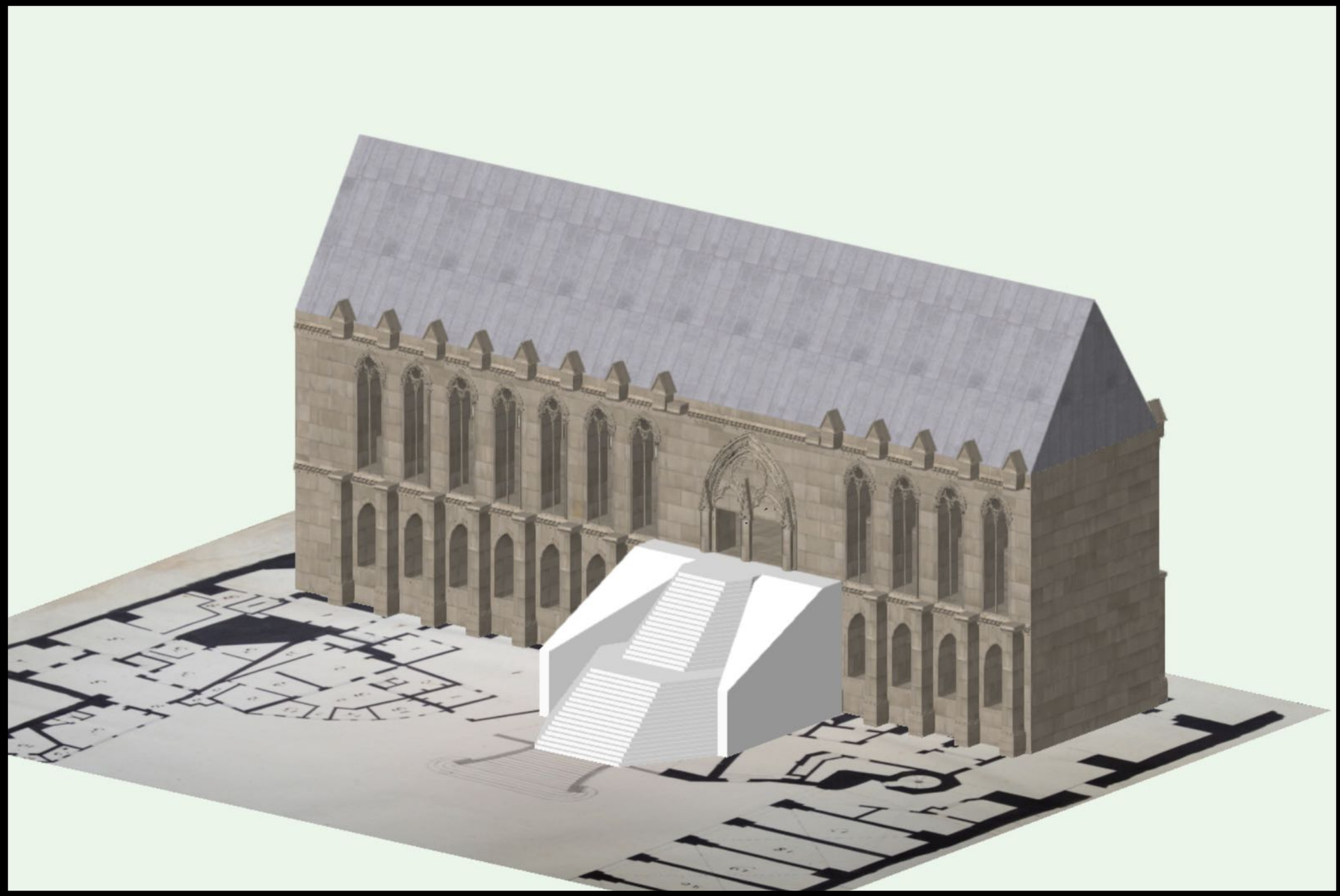
Paris Past and Present



Reconstruction of the Galerie des Merciers of the Palais de la Cité

PARIS PAST & PRESENT

Image Source: http://paris.cdh.ucla.edu

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Pharos Lighthouse

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Pharos Lighthouse

Pliny the Elder
23–79 AD

Lighthouse Inscription and cost

Lucian of Samosata
125–180 AD

Tells us the name of the Architect

Strabo
63 BC – 24 AD

Color, Material, Size, and location

Eusebius of Caesarea
263–339 AD

Dates for construction

Titus Flavius Josephus
37–100 AD

How far the light could be sean

Ammianus Marcellinus
330 – 391

Additions and alterations to original design

Muhammad al-Idrisi
1099 – 1165

What materials were used

Benjamin of Tudela
1130 – 1173

Description of the Mirror.

Shams al-Din al-Ansari al-Dimashqi
1256 – 1327

Describes the ramp and interior

Abu'l-Fida
1273 – 1331

General Description of Size

Ibn Batuta
1304 – 1369

Describes the lighthouse in runs

Muhammad ibn Iyas
1448 – 1522

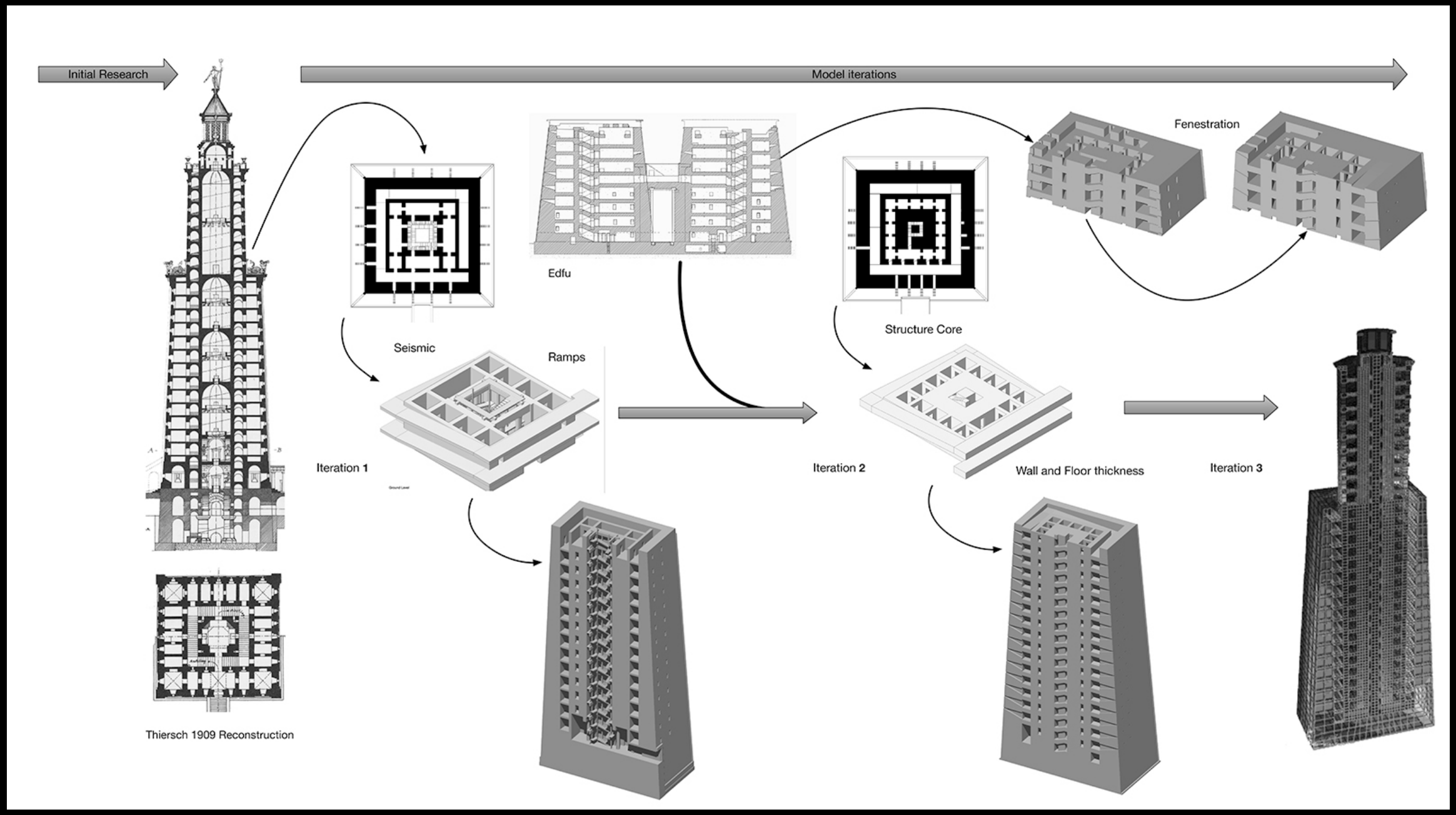
Records that Qait Bey ordered a fort to be built on the foundations of Pharos

1 AD | 250 AD | 500 AD | 1250 AD | 1500 AD

Initial data

Image Source: UCLA Experiential Technologies Center

Pharos Lighthouse



Iteration Diagram

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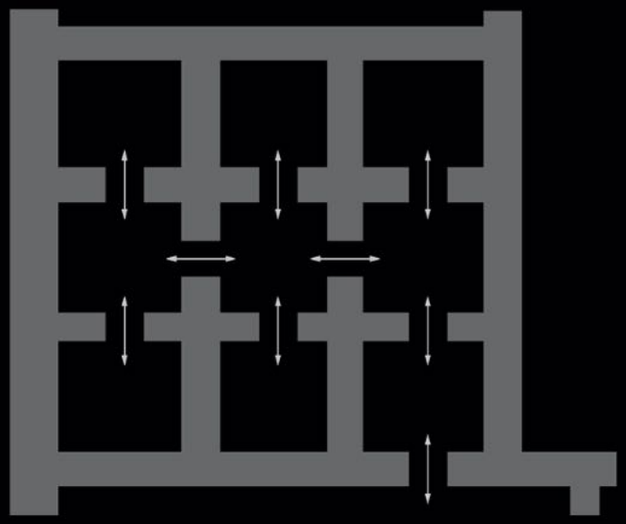
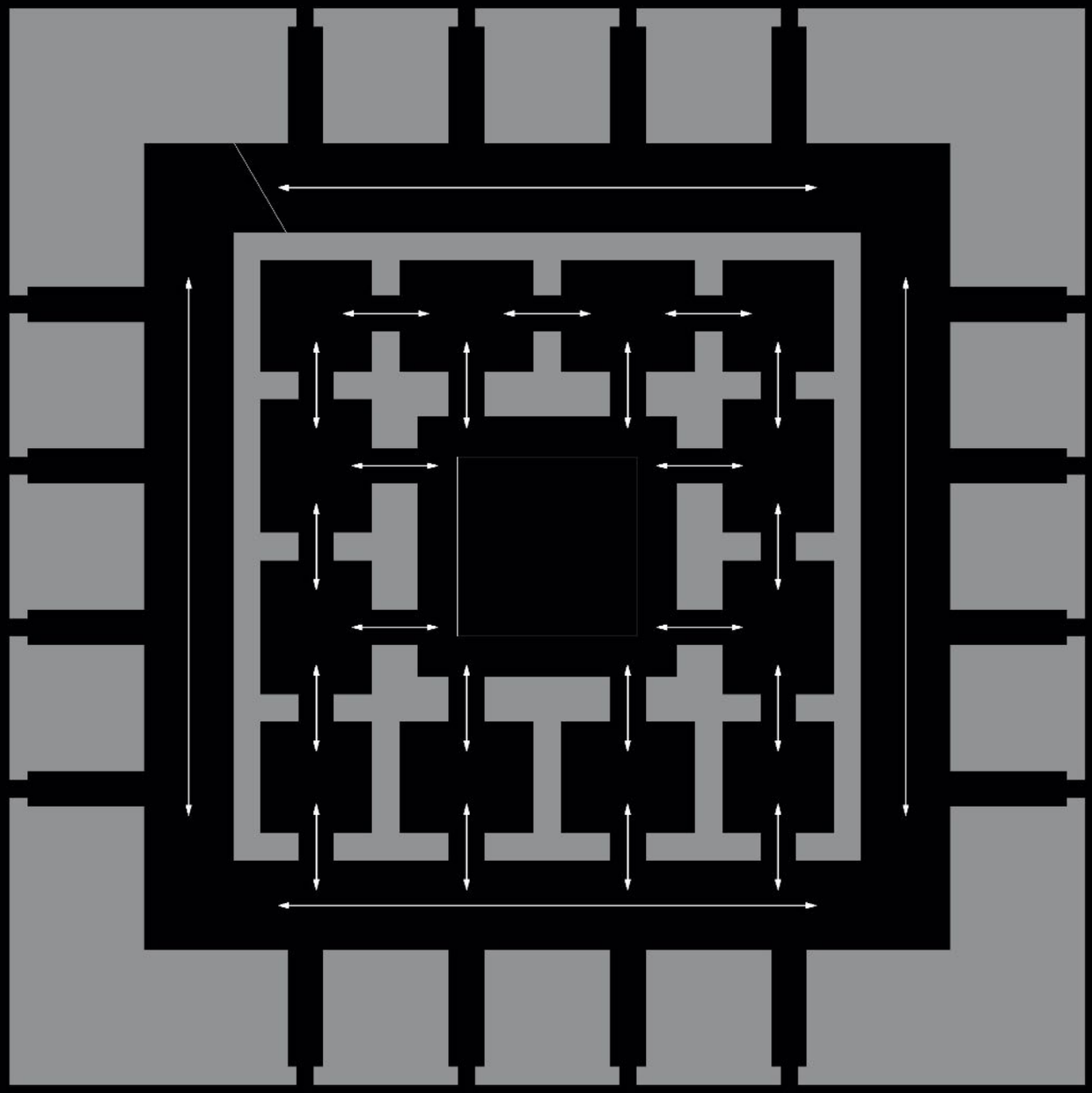
Image Source: UCLA Experiential Technologies Center

UCLA

Pharos Lighthouse



New Kingdom grain store



Reconstructed plan of the Lighthouse

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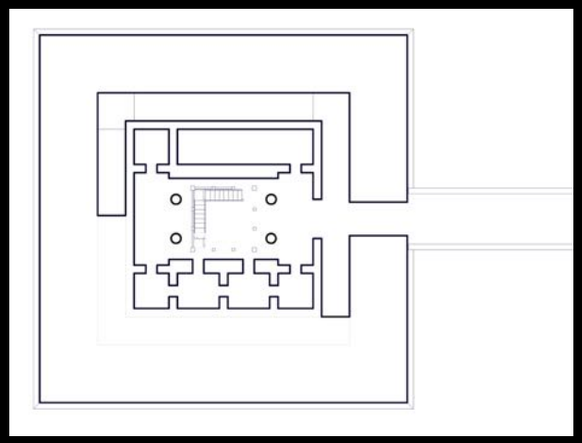
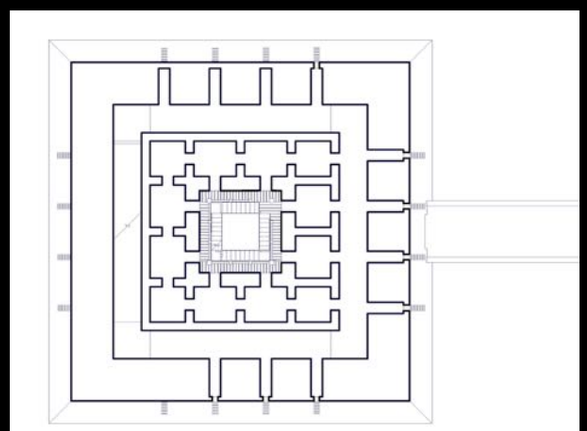
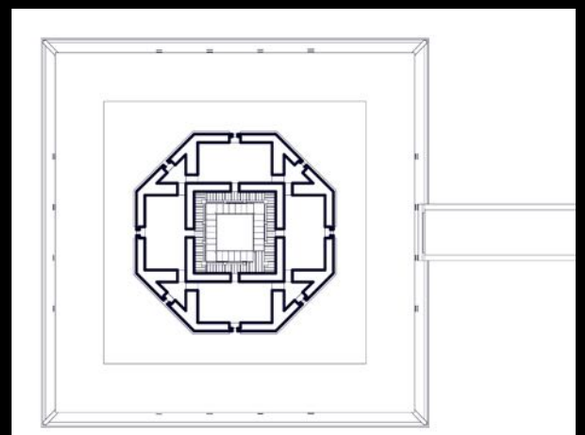
Image Source: UCLA Experiential Technologies Center

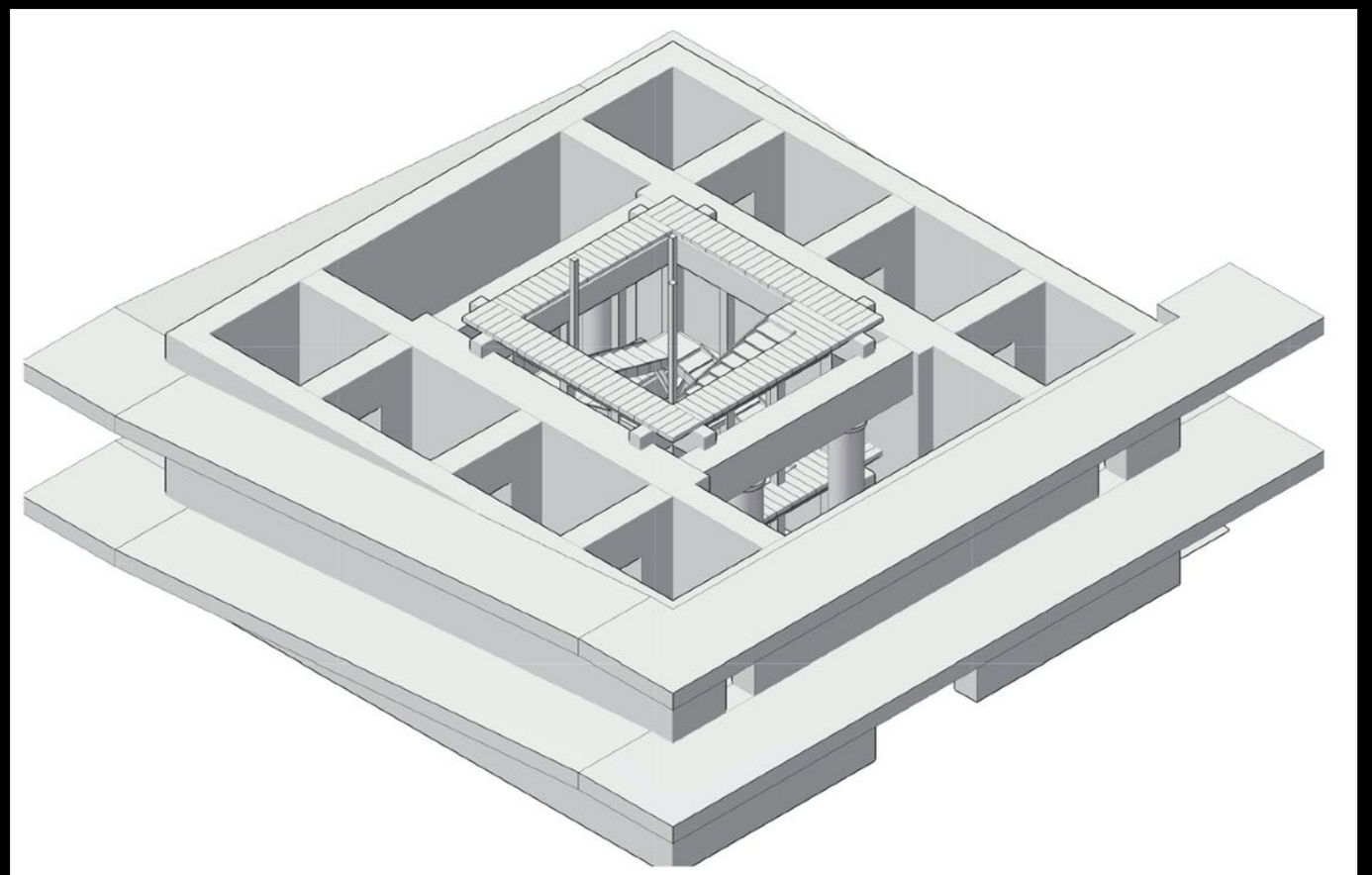
UCLA

Pharos Lighthouse









First Iteration of the lower section of the lighthouse

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Image Source: UCLA Experiential Technologies Center

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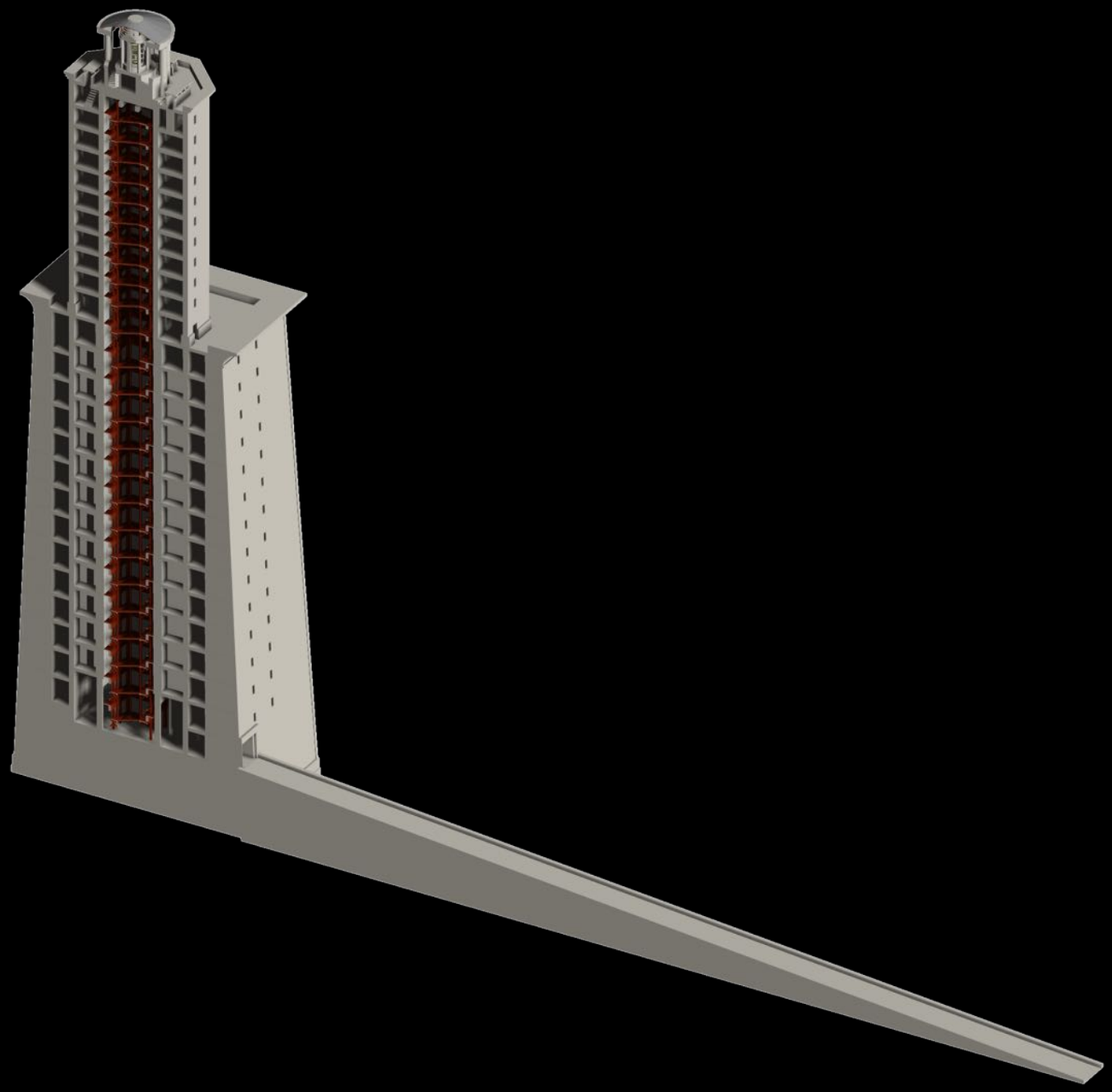
Pharos Lighthouse



Version 1

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Image Source: UCLA Experiential Technologies Center

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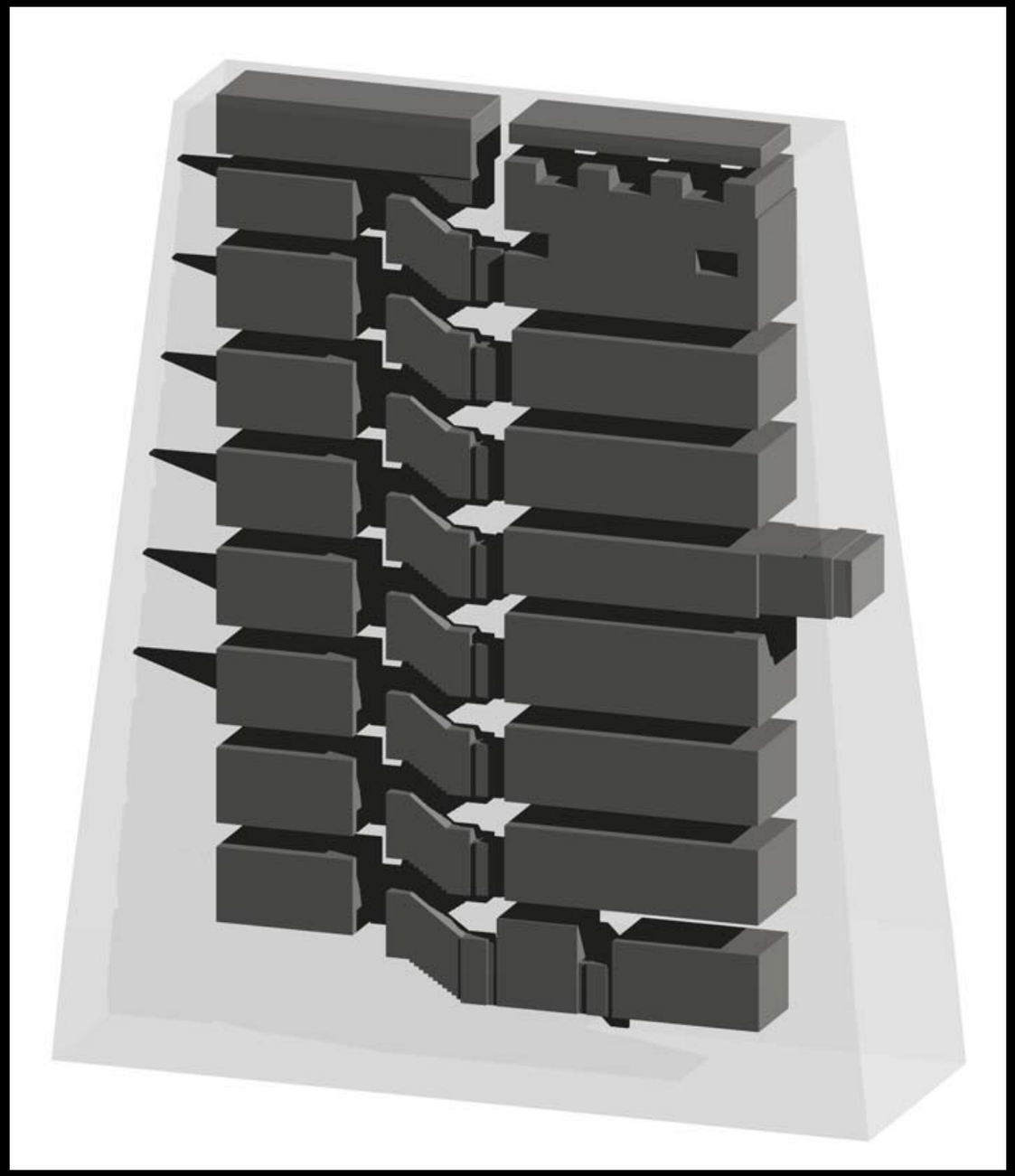
Pharos Lighthouse

Edfu temple pylons

Image Source: UCLA Experiential Technologies Center

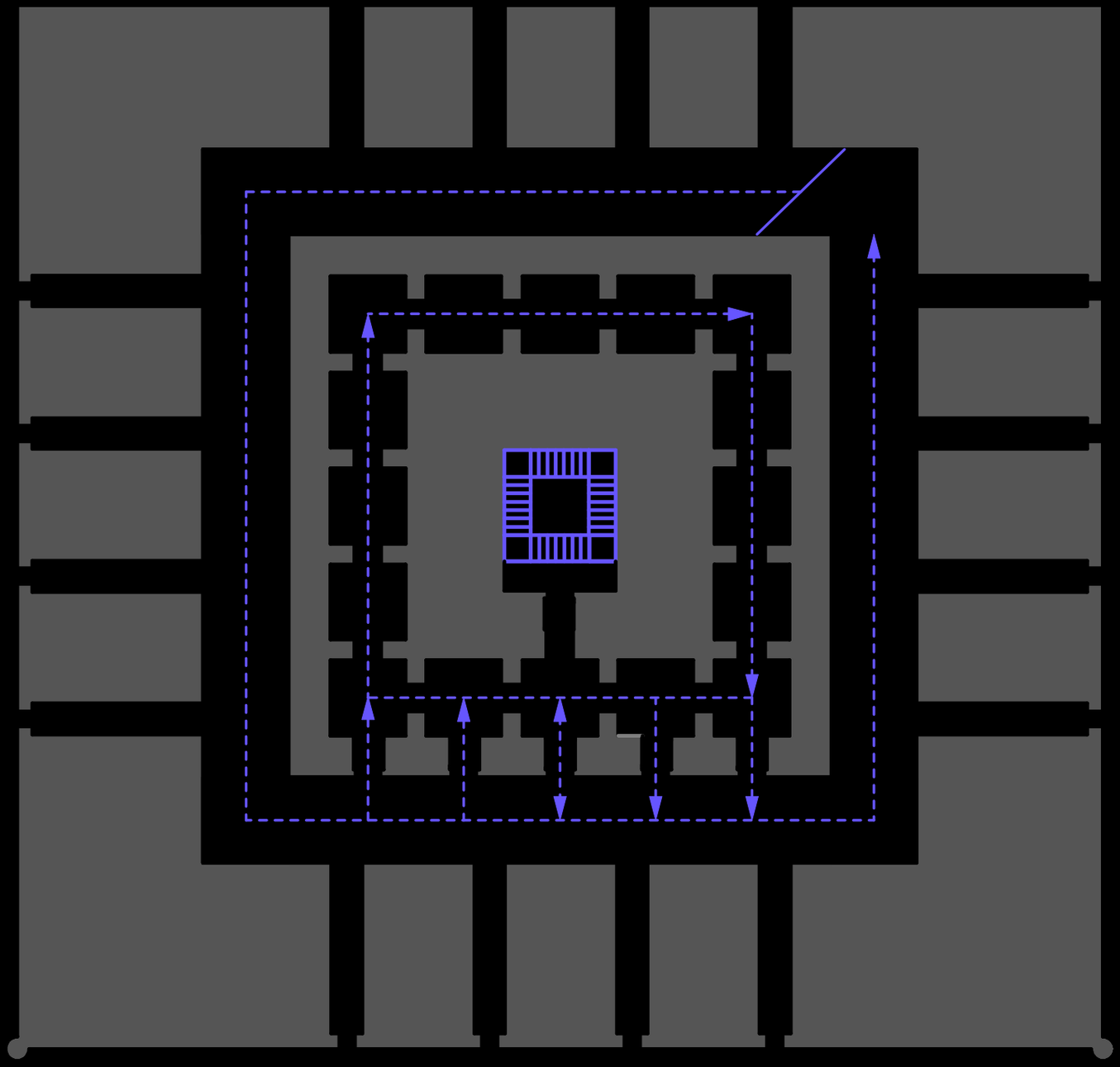
Pharos Lighthouse



Negative space model

Image Source: UCLA Experiential Technologies Center

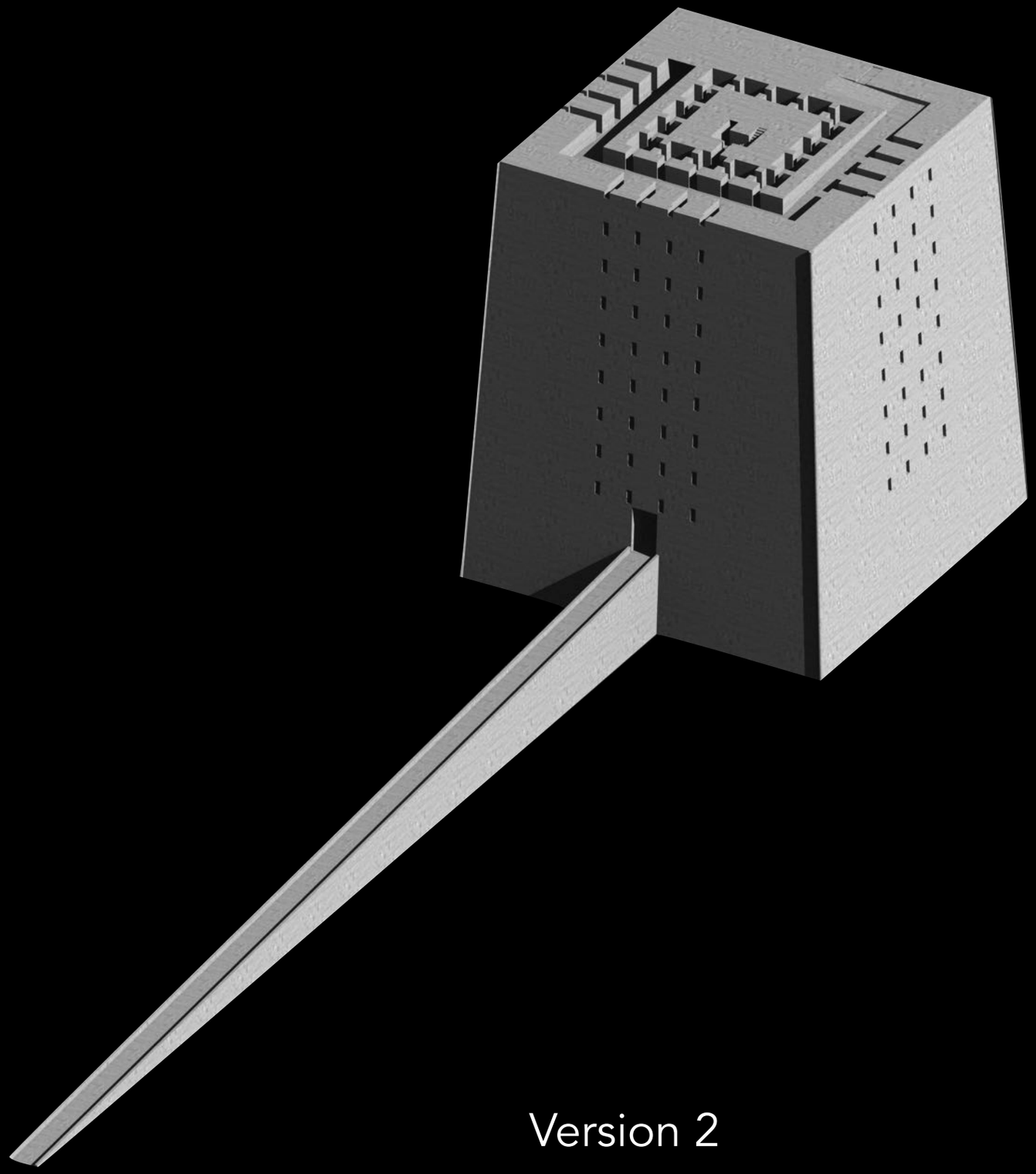
Pharos Lighthouse



Adjusted plan

Image Source: UCLA Experiential Technologies Center

Pharos Lighthouse



Version 2

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Image Source: UCLA Experiential Technologies Center

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Approaches to cultural heritage modeling

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Cultural heritage modeling does not necessarily mean digital

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2d drawings and illustrations

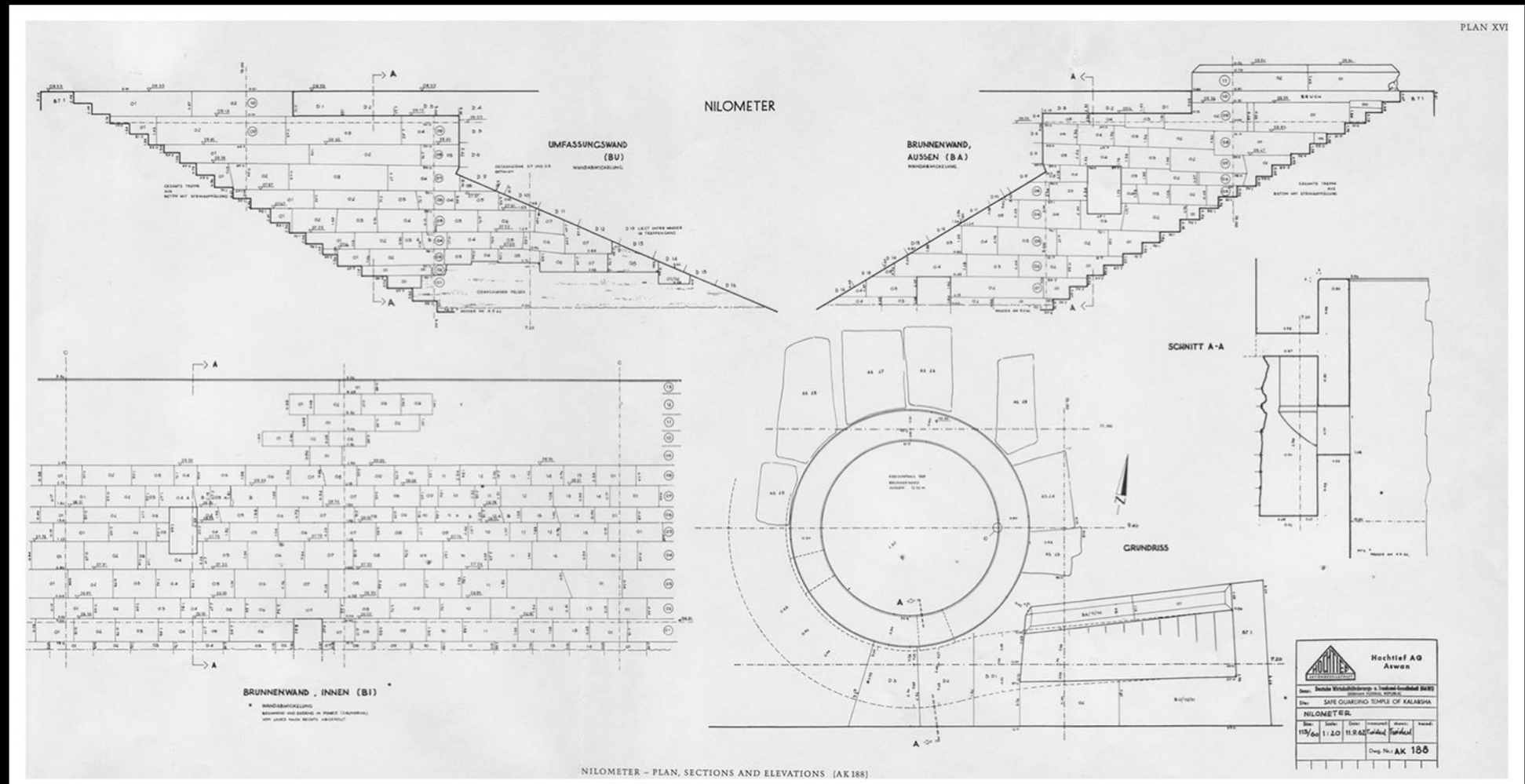

Image Source: Wright, G. R. H. (1972). Kalabsha : the preserving of the temple. Berlin, Mann.

Photographs

Image Source: https://allevents.in/los%20angeles/ucla-graduate-student-association-of-archaeology-conference-2018/126672057998353

Physical modeling

Image Source: https://www.jonathanburden.com/blog/architectural-masterpieces-in-cork/

Digital

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3D Modeling

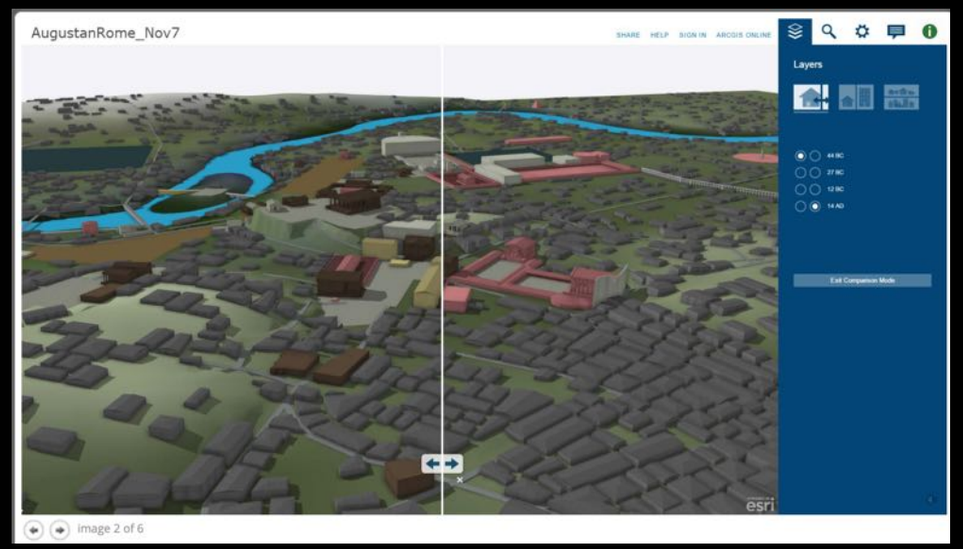

Image Source: UCLA Scholarly Innovation Lab

Digital terrain modeling (DTM)

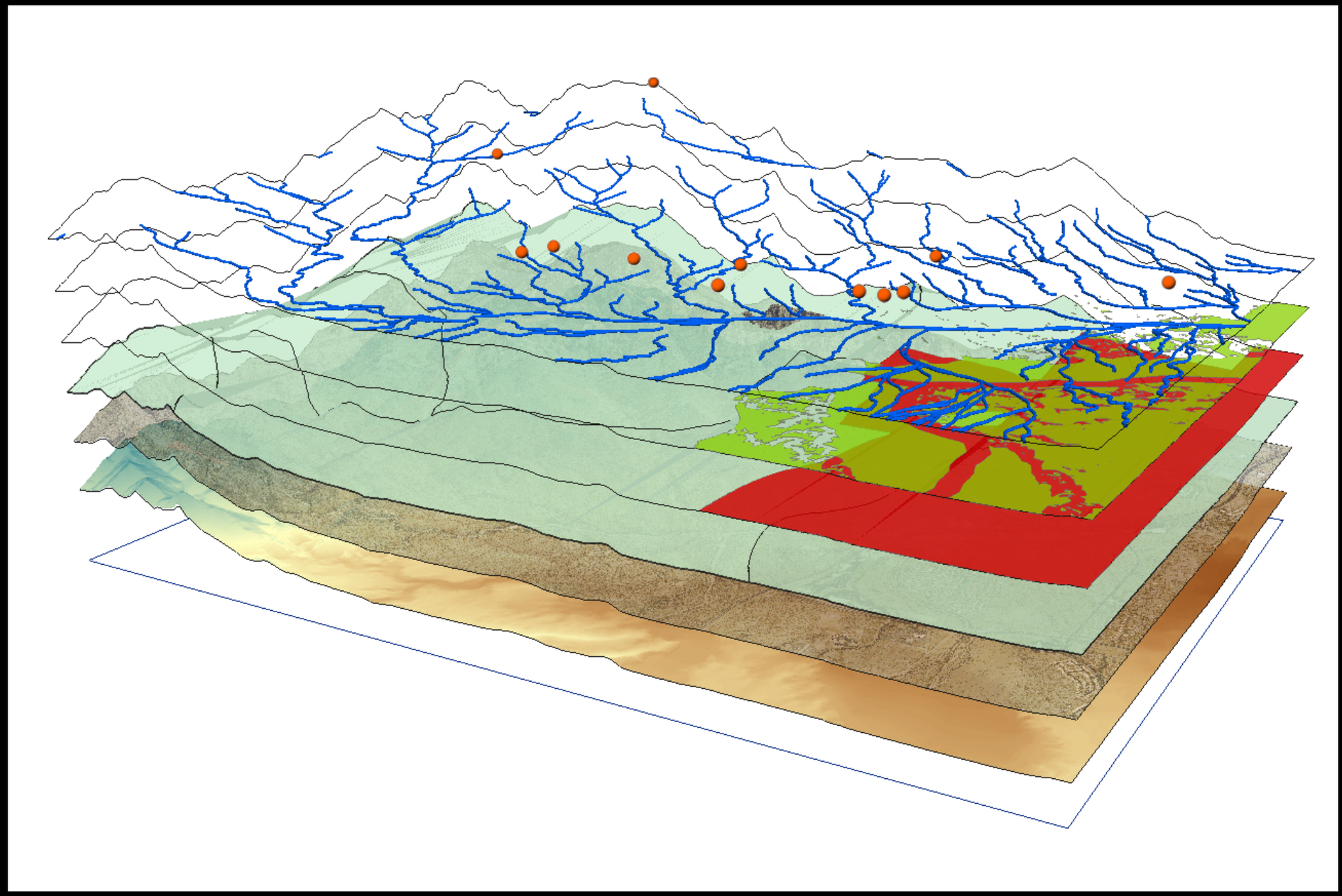

Image Source: https://library.ucsd.edu/news-events/events/gis-for-health-human-services/

Spatio-temporal models (4D)

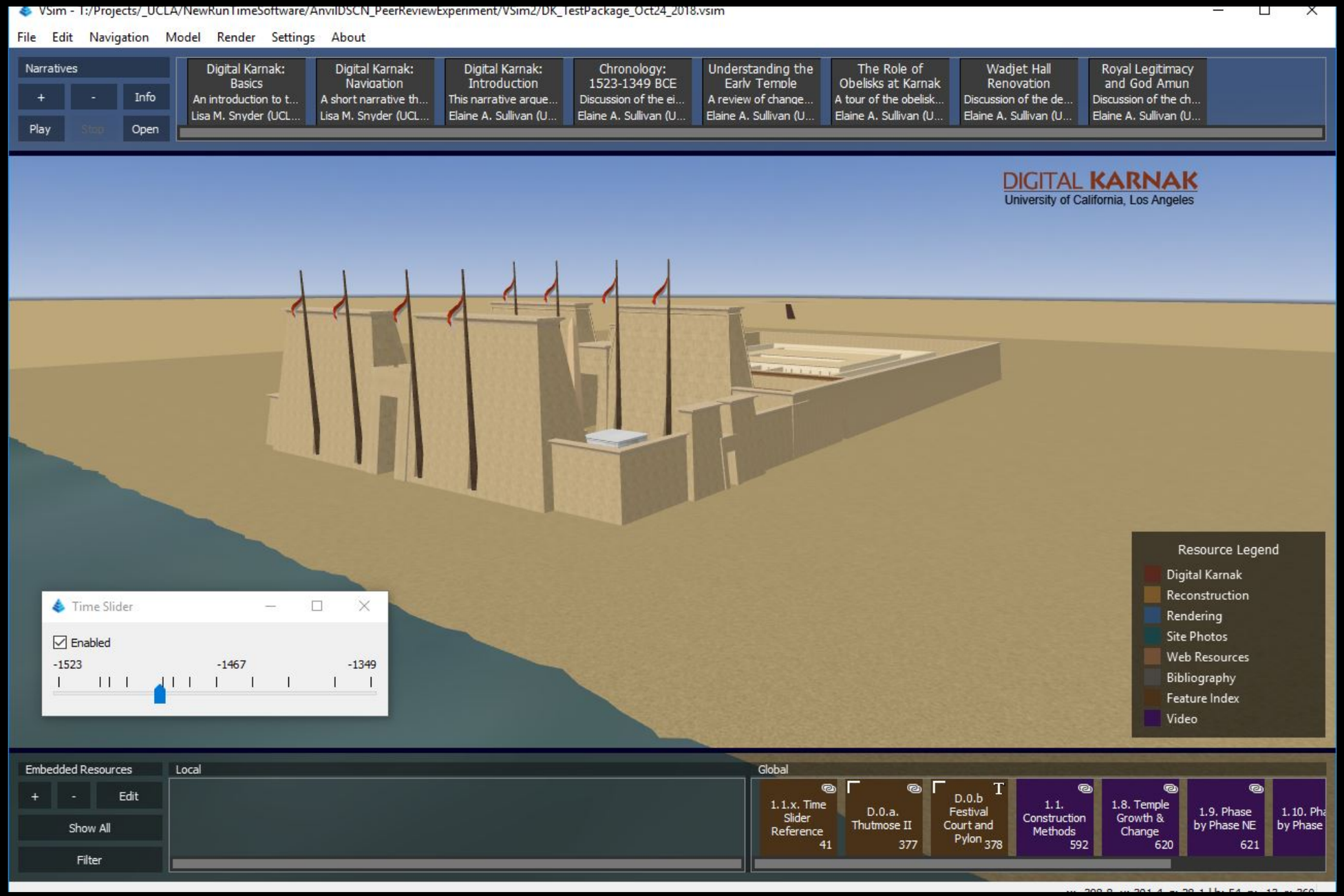

Image Source: UCLA Experiential Technologies Center

Capturing data

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Traditional methods - Notes, Photos

Image Source: Arts at Oxford Journal of Archaeology

Optical - total station

Image Source: https://www.sccssurvey.co.uk

Large scale - Laser Scanner

Image Source: https://www.industry-plaza.com

Large scale - Laser Scanner

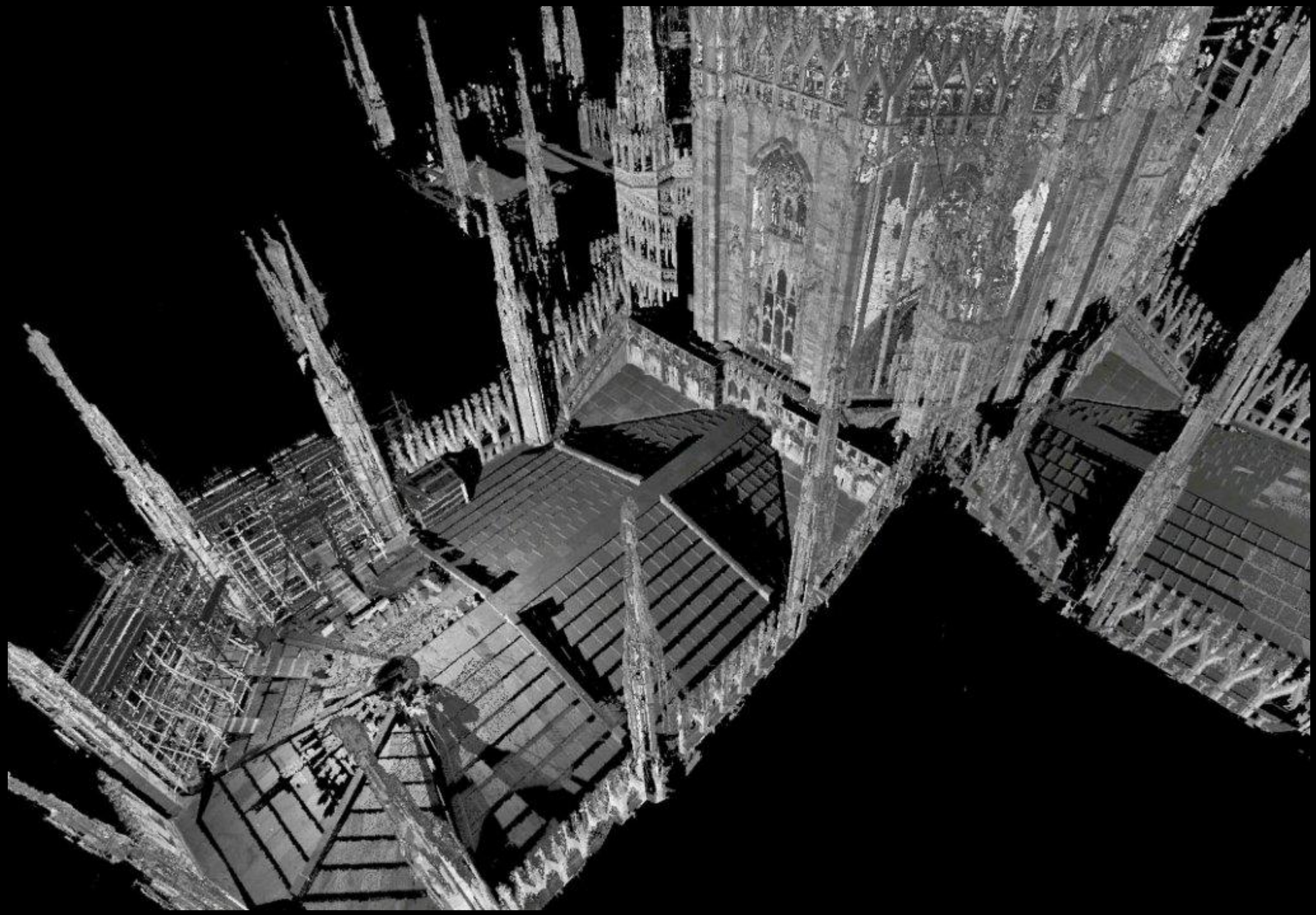

Image Source: The Lidar News Blog

Terrain LIDAR

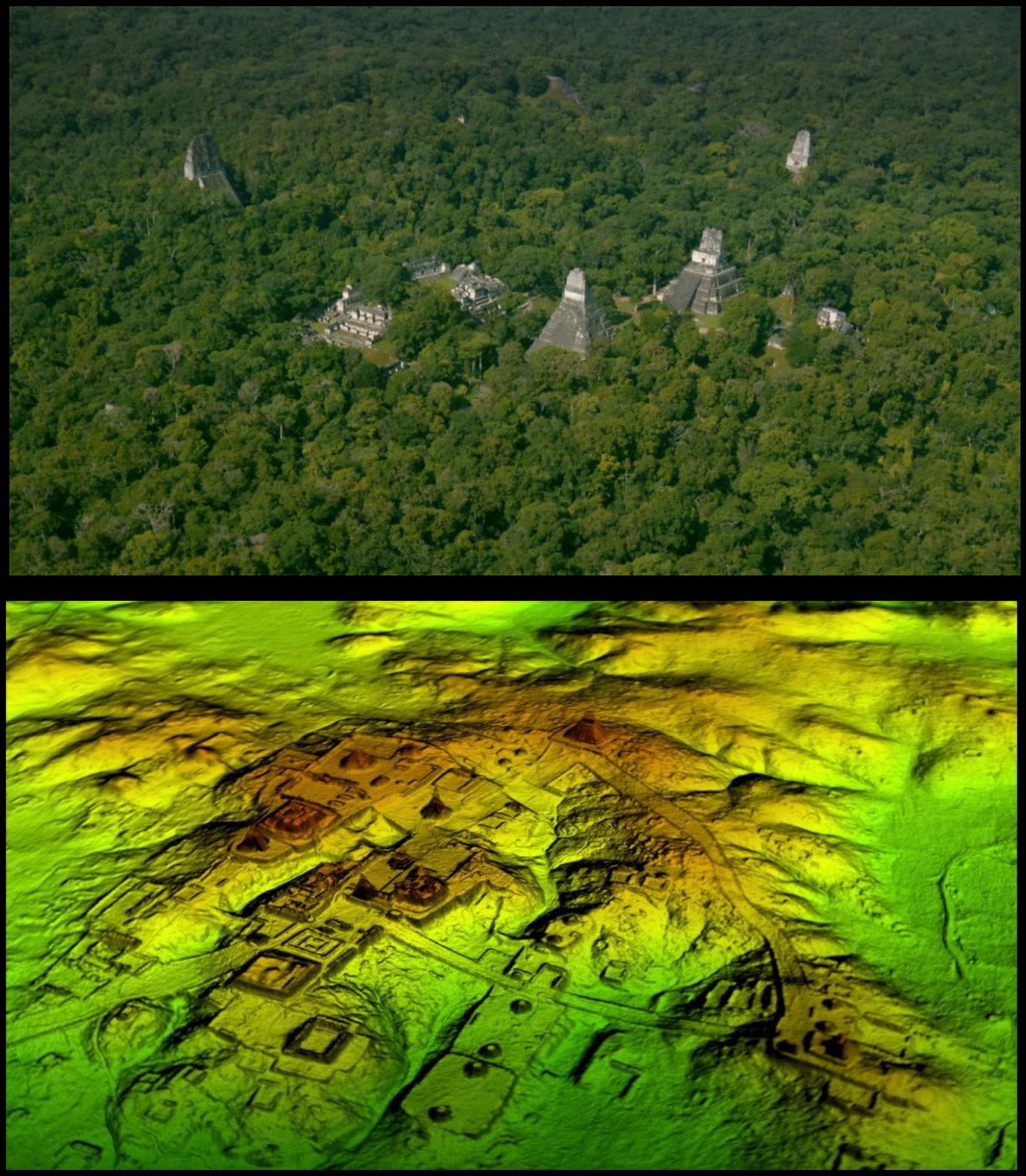

Image Source: https://www.nationalgeographic.com/news/2018/02/maya-laser-lidar-guatemala-pacunam/

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Drones

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Image Source: Center for Digital Archaeology

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Drones - Photogrammetry

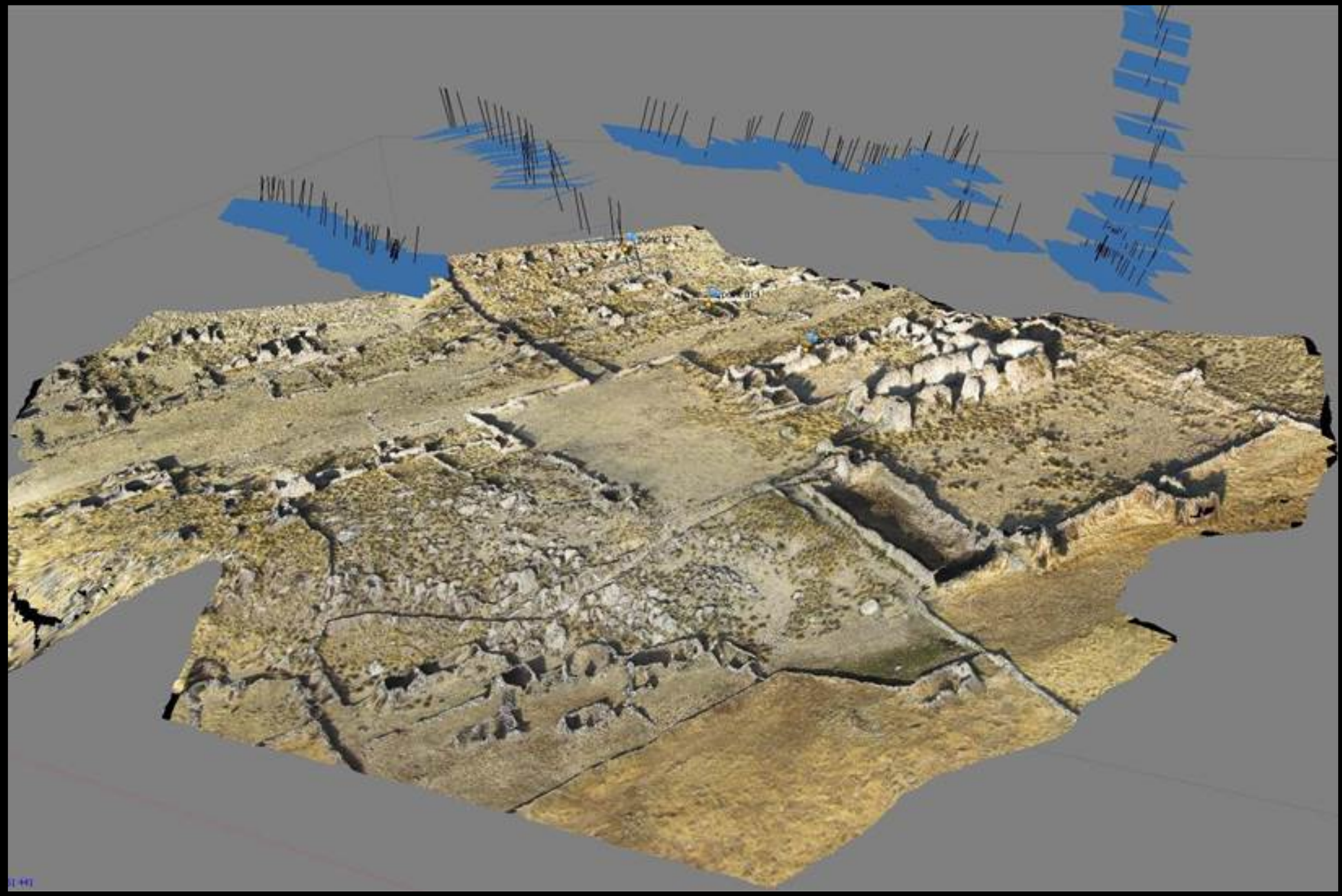

Image Source: Steve Wernke, Vanderbilt University

Drones - aerial reconnaissance

Image Source: Archaeological Conservancy

Drones - equipped with LiDAR

Image Source: RMUS UAV Solutions

Structured light 3D scanner

Image Source: UCLA Library LUX Lab

Photogrammetry or structure from motion

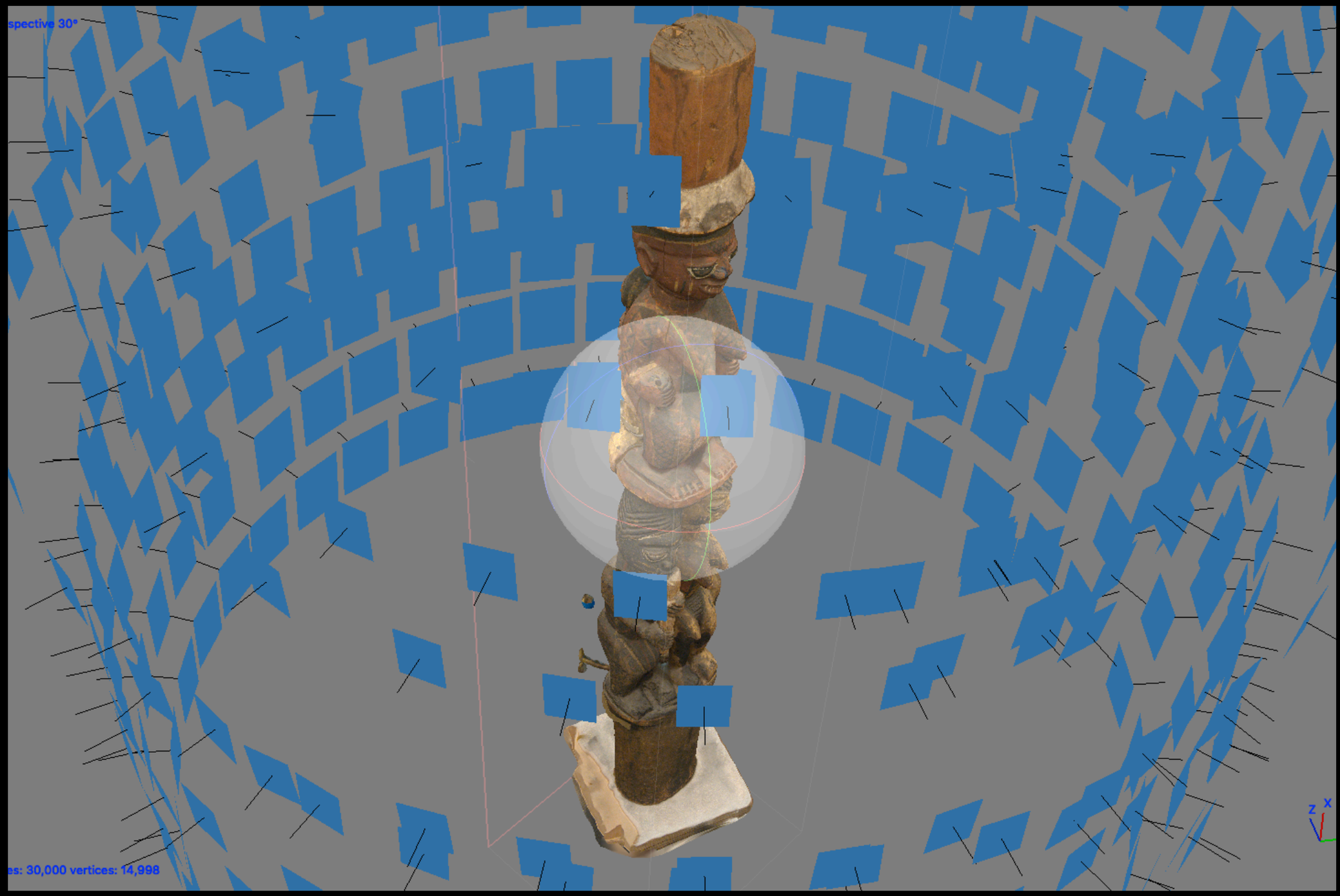

Image Source: UCLA Scholarly Innovation Lab

Photogrammetry or structure from motion

Image Source: https://hackaday.io/project/29530/gallery#beb8e0e39d4064817ba656c712ca04a1

Photogrammetry or structure from motion

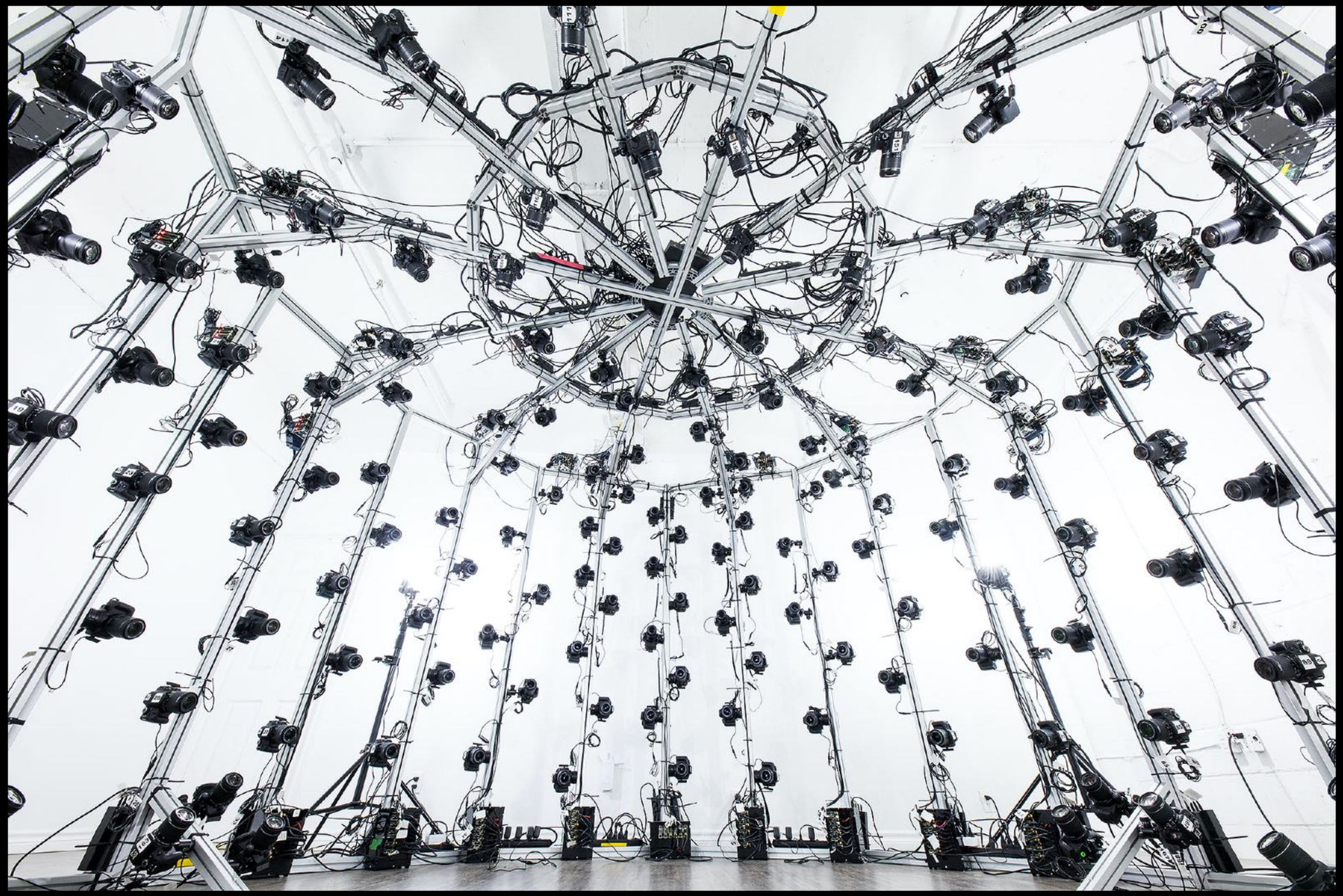

Image Source: Eric Paré ericpare.com

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Document scanning

Image Source: https://www.smithsonianmag.com

Book scanners

Image Source: https://www.aliexpress.com

Do-it yourself book scanners

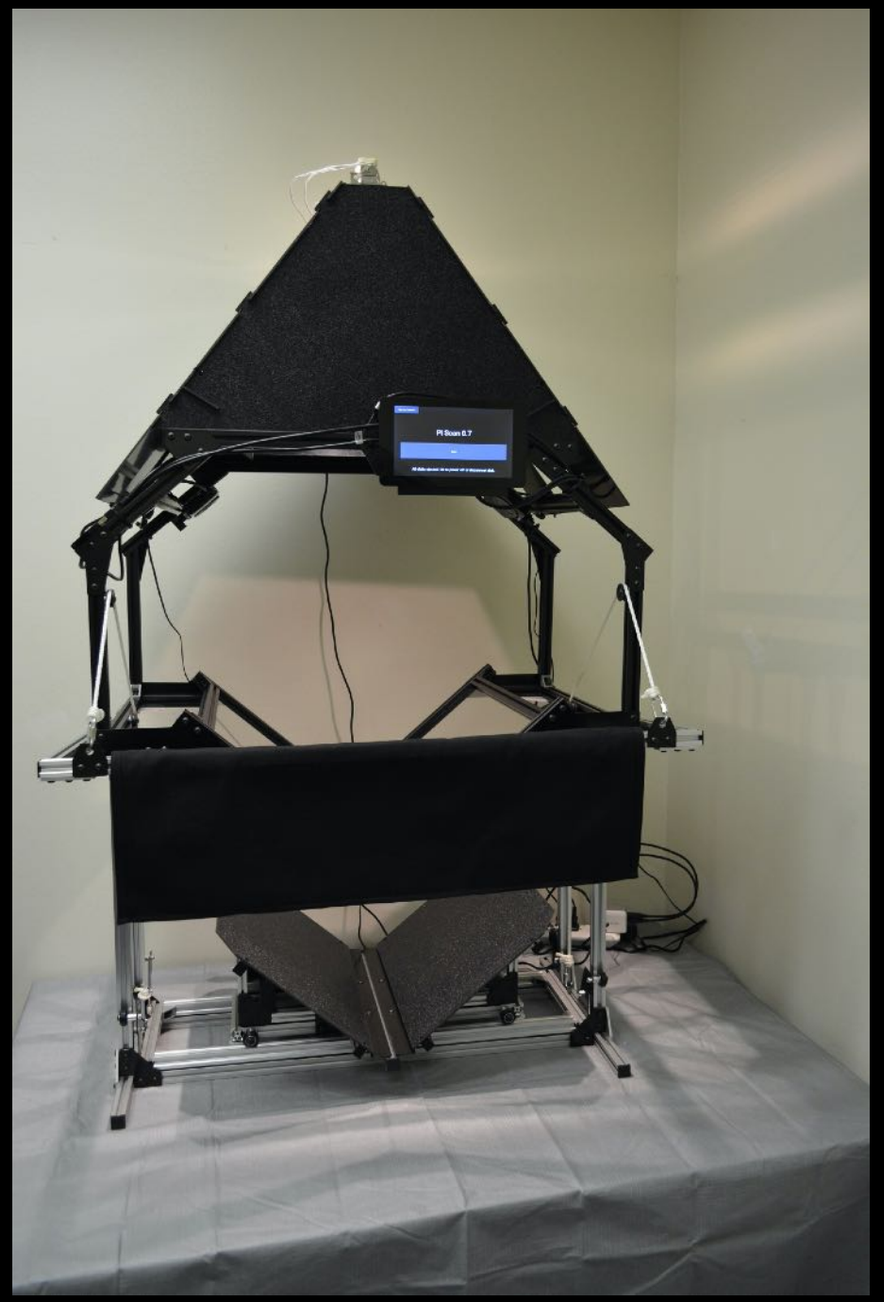
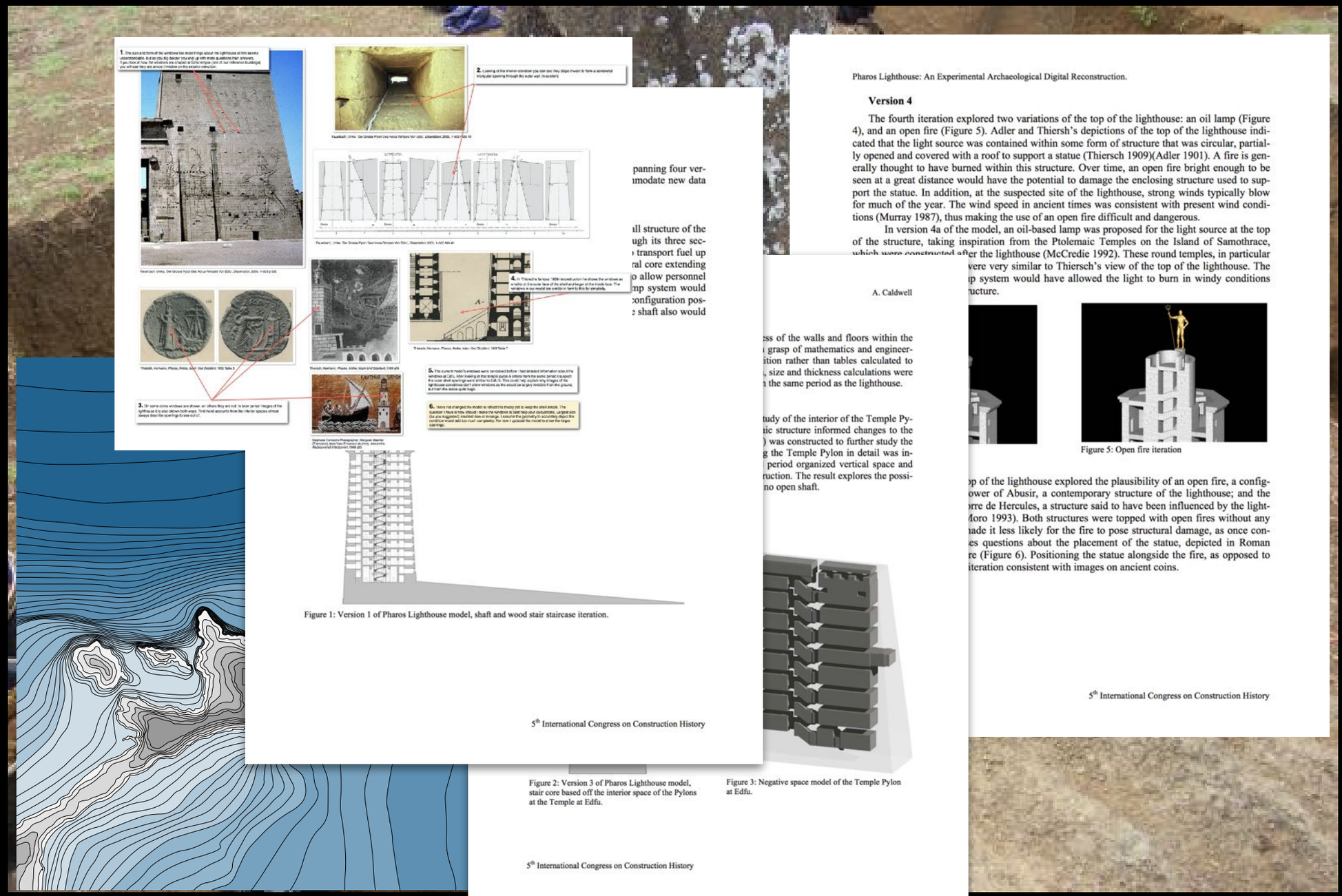


Image Source: https://www.diybookscanner.org

Output

Traditional-Powerpoint presentations, printed drawings and illustrations, published papers



panning four ver-
modate new data

all structure of the
ugh its three sec-
transport fuel up
al core extending
allow personnel
mp system would
configuration pos-
shaft also would

Figure 1: Version 1 of Pharos Lighthouse model, shaft and wood stair staircase iteration.

5th International Congress on Construction History

A. Caldwell

ss of the walls and floors within the
grasp of mathematics and engineer-
ition rather than tables calculated to
, size and thickness calculations were
the same period as the lighthouse.

tudy of the interior of the Temple Py-
ic structure informed changes to the
) was constructed to further study the
g the Temple Pylon in detail was in-
period organized vertical space and
ruction. The result explores the possi-
no open shaft.

Figure 2: Version 3 of Pharos Lighthouse model, stair core based off the interior space of the Pylons at the Temple at Edfu.

Figure 3: Negative space model of the Temple Pylon at Edfu.

5th International Congress on Construction History

Pharos Lighthouse: An Experimental Archaeological Digital Reconstruction.

Version 4

The fourth iteration explored two variations of the top of the lighthouse: an oil lamp (Figure 4), and an open fire (Figure 5). Adler and Thiersh's depictions of the top of the lighthouse indicated that the light source was contained within some form of structure that was circular, partially opened and covered with a roof to support a statue (Thiersch 1909)(Adler 1901). A fire is generally thought to have burned within this structure. Over time, an open fire bright enough to be seen at a great distance would have the potential to damage the enclosing structure used to support the statue. In addition, at the suspected site of the lighthouse, strong winds typically blow for much of the year. The wind speed in ancient times was consistent with present wind conditions (Murray 1987), thus making the use of an open fire difficult and dangerous.

In version 4a of the model, an oil-based lamp was proposed for the light source at the top of the structure, taking inspiration from the Ptolemaic Temples on the Island of Samothrace, which were constructed after the lighthouse (McCredie 1992). These round temples, in particular were very similar to Thiersch's view of the top of the lighthouse. The p system would have allowed the light to burn in windy conditions ucture.

Figure 5: Open fire iteration

op of the lighthouse explored the plausibility of an open fire, a config-ower of Abusir, a contemporary structure of the lighthouse; and the rre de Hercules, a structure said to have been influenced by the light-Moro 1993). Both structures were topped with open fires without any ade it less likely for the fire to pose structural damage, as once con-es questions about the placement of the statue, depicted in Roman re (Figure 6). Positioning the statue alongside the fire, as opposed to iteration consistent with images on ancient coins.

5th International Congress on Construction History

Image Source: UCLA Scholarly Innovation Lab

3D Viewers

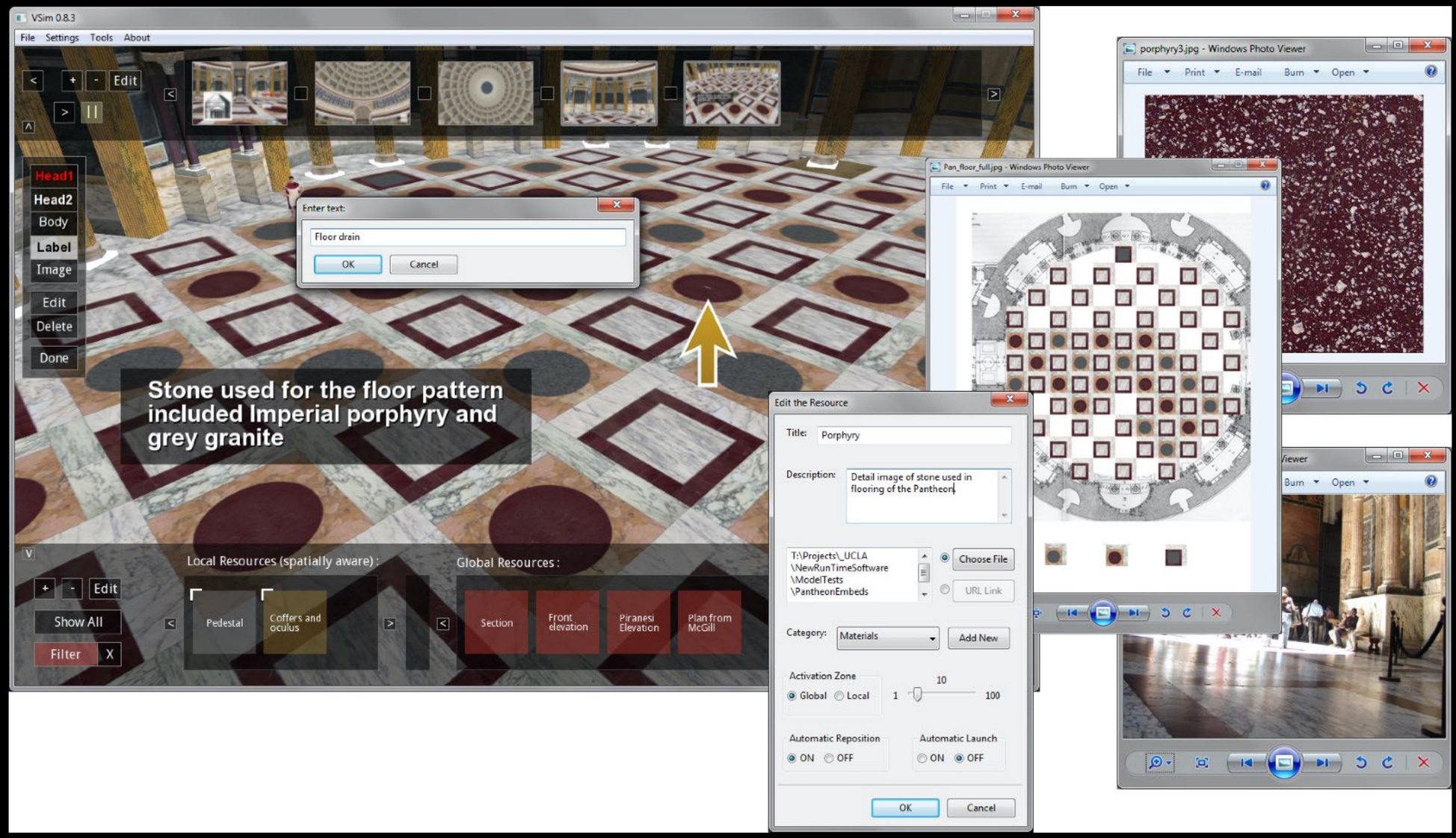


Image Source: UCLA Institute for Digital Research and Education

VSIM

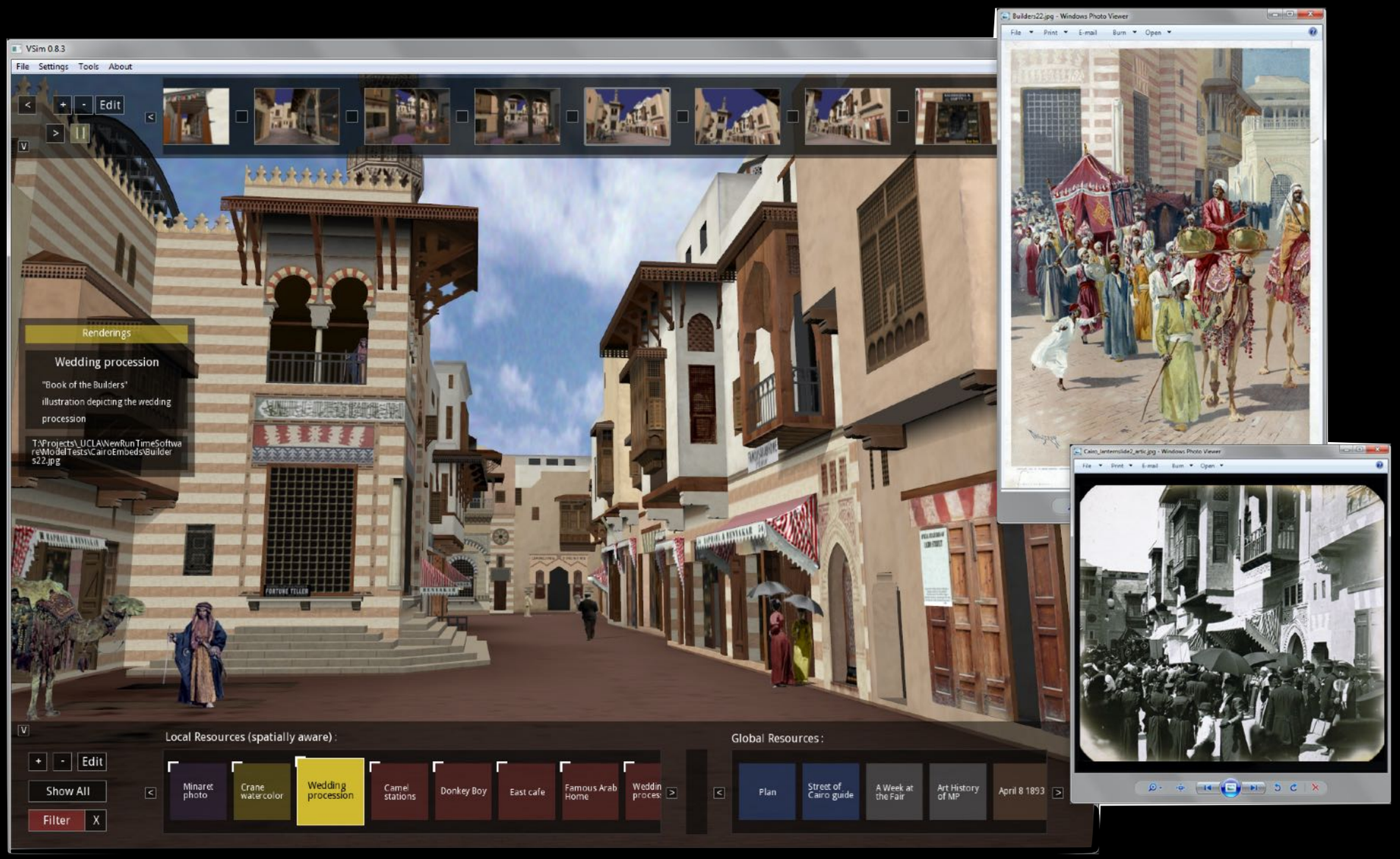


Image Source: UCLA Institute for Digital Research and Education

Sketchfab

Image Source: sketchfab.com, Full León cathedral cloister photogrammetry scan by Miguel Bandera

3D Printing

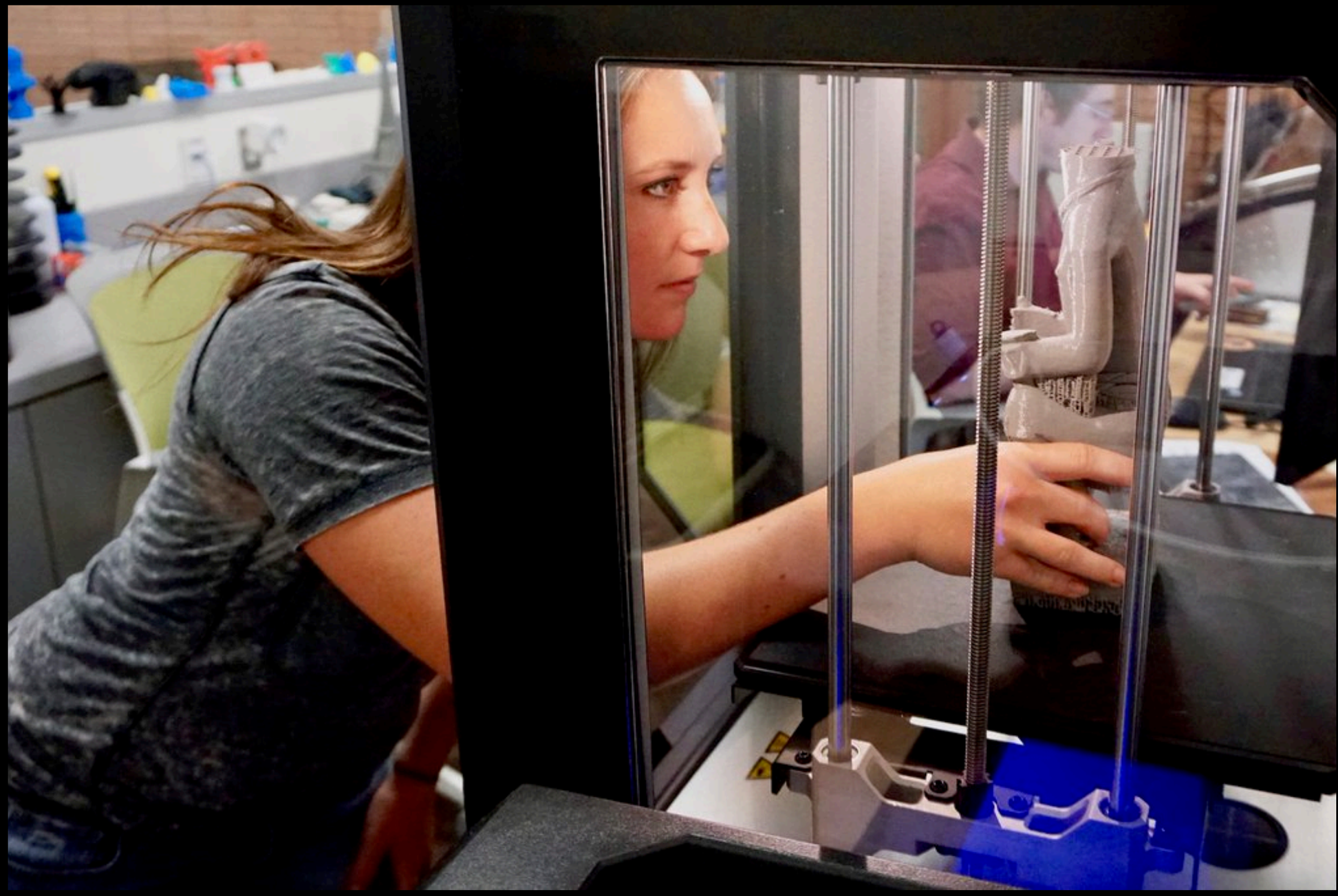


Image Source: UCLA Library LUX Lab

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The web

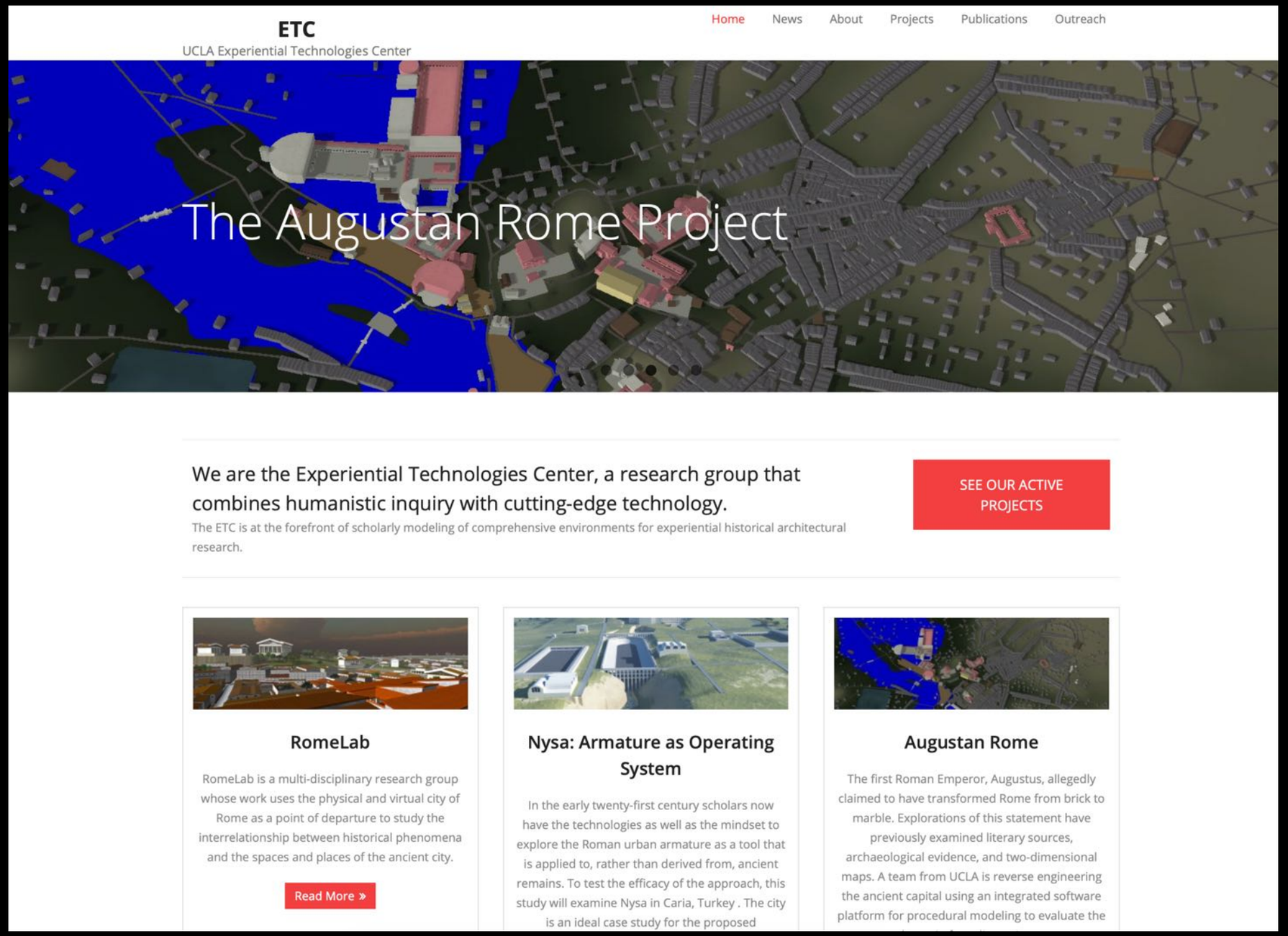

Image Source: UCLA Experiential Technologies Center

Cultural heritage modeling in practice

Examples from UCLA

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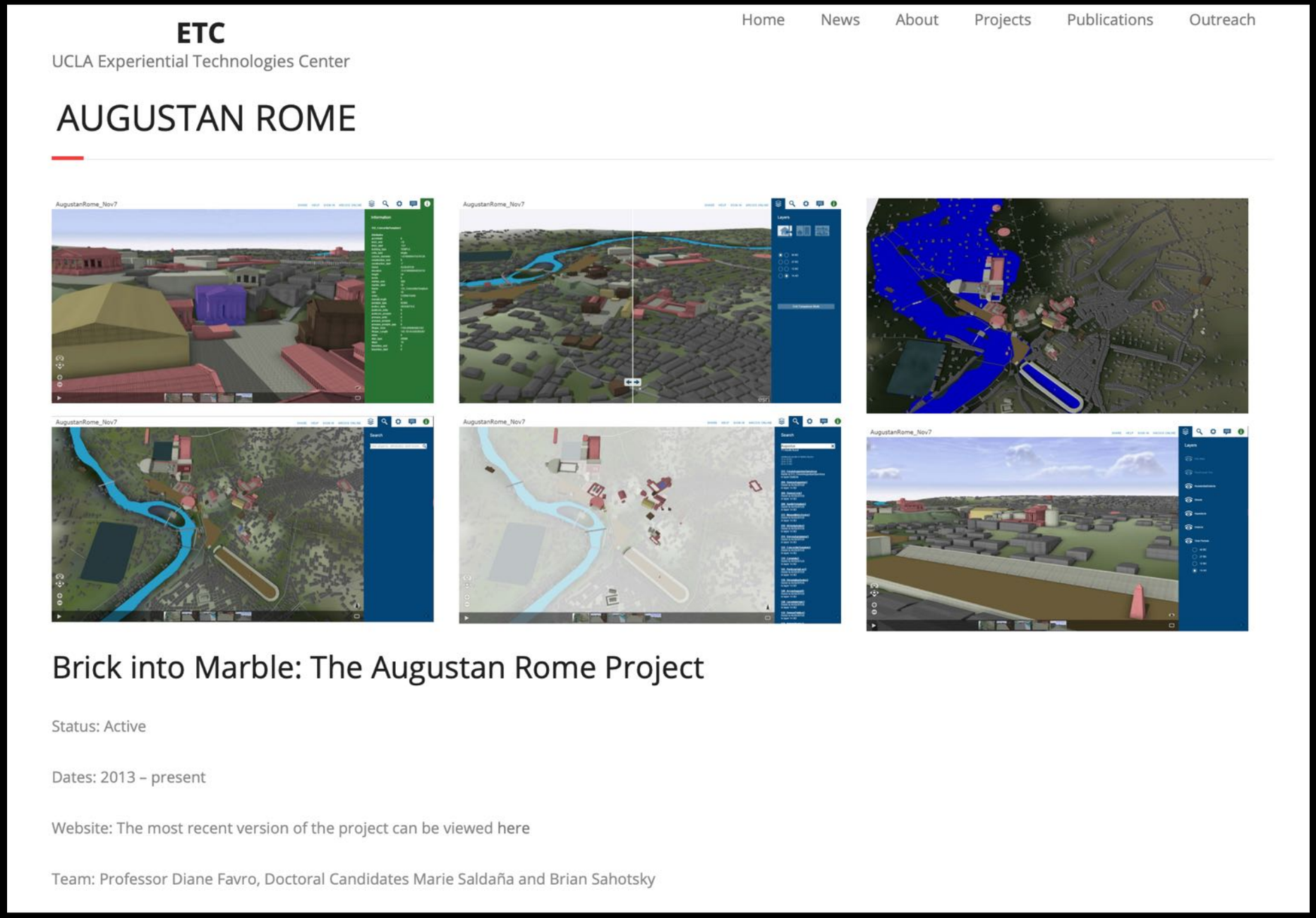
Augustan Rome



Team: Professor Diane Favro, Doctoral Candidates Marie Saldaña and Brian Sahotsky

Image Source: UCLA Experiential Technologies Center

Augustan Rome

Image Source: UCLA Experiential Technologies Center

Augustan Rome

Image Source: UCLA Experiential Technologies Center

Augustan Rome

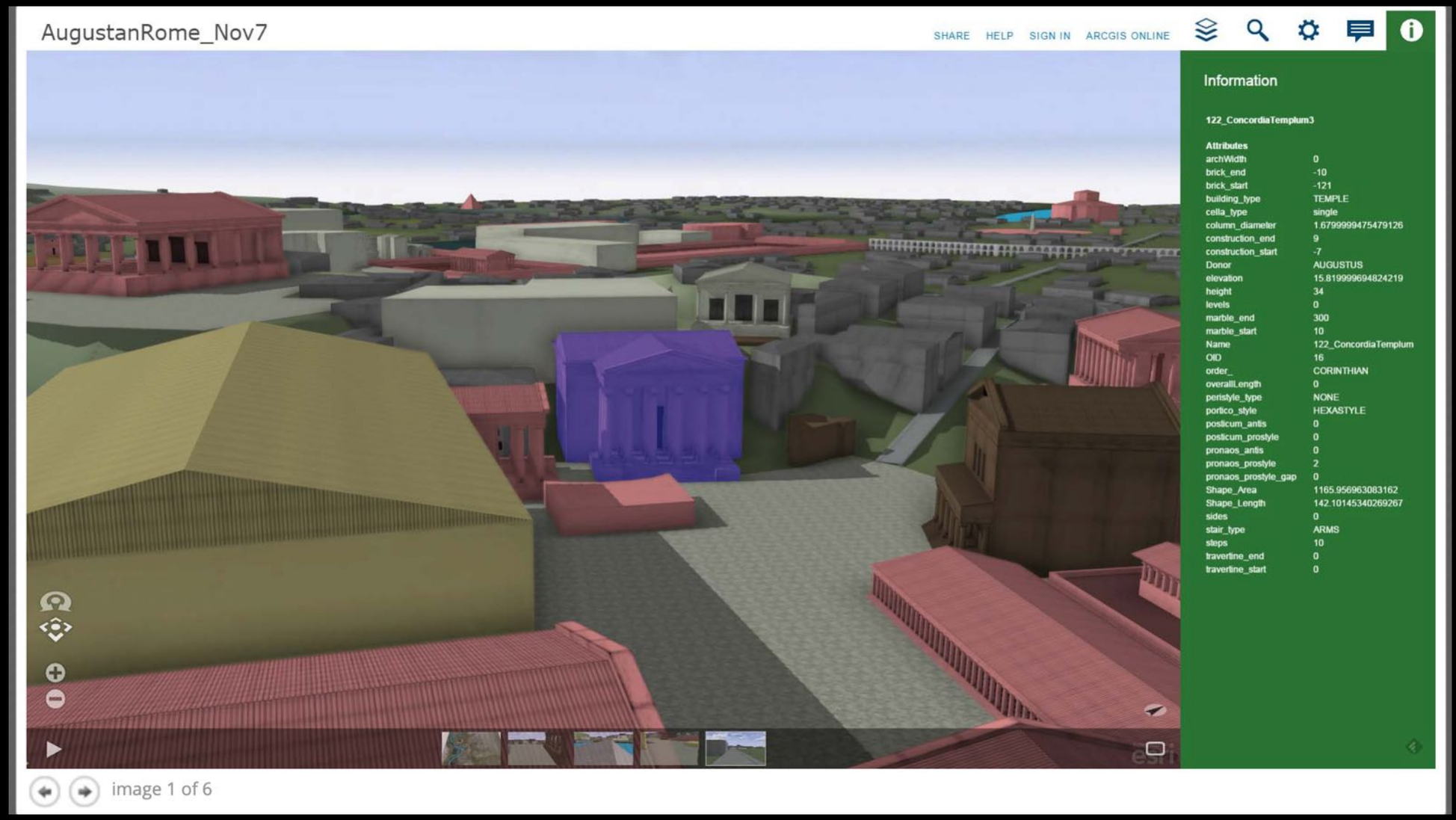


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Image Source: UCLA Experiential Technologies Center

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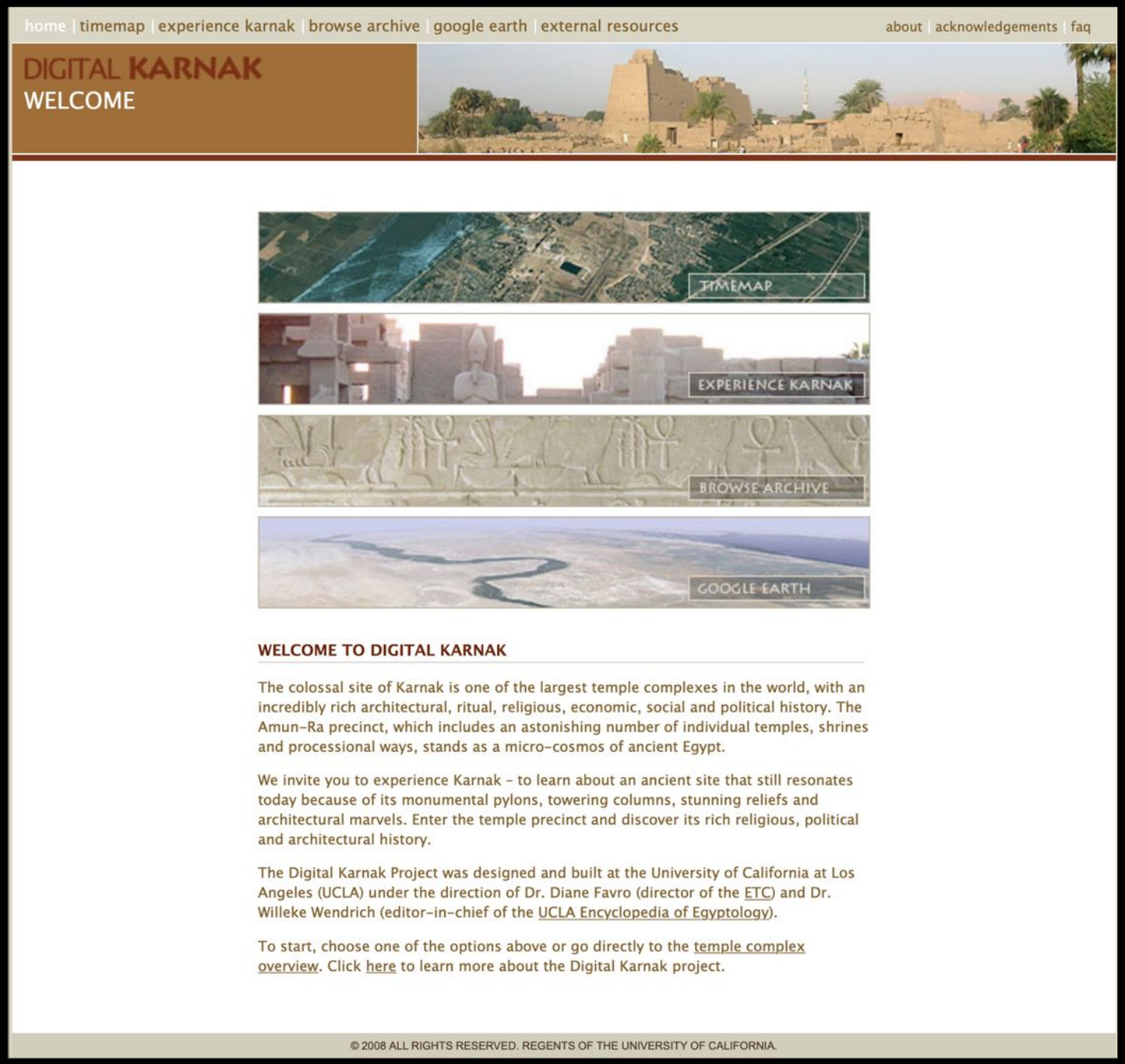
Digital Karnak



Project directors Prof. Diane Favro , Prof. Willeke Wendrich

Project coordinator Dr. Elaine Sullivan

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http://wayback.archive-it.org/7877/20160919152116/http://dlib.etc.ucla.edu/projects/Karnak//

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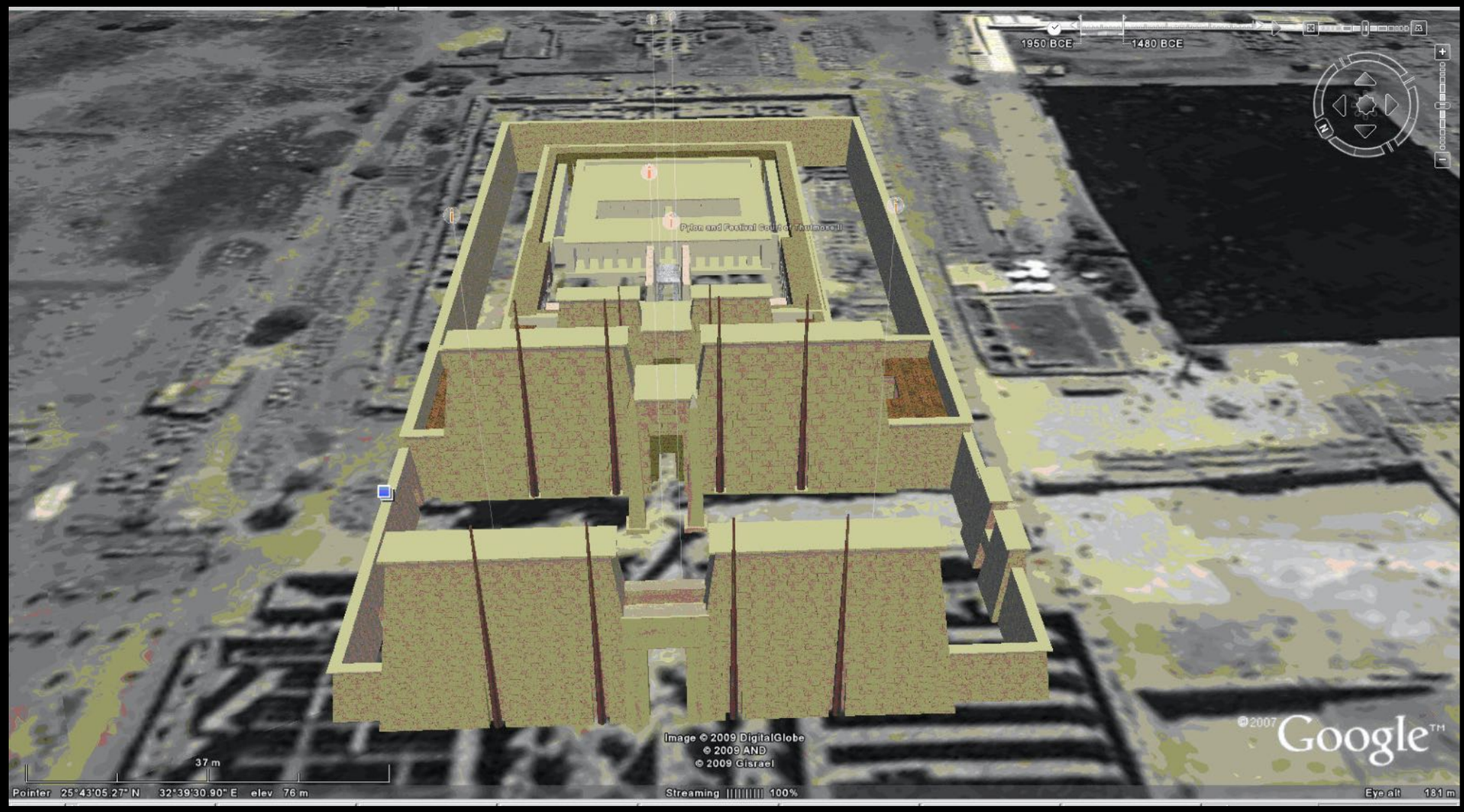
Digital Karnak



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http://wayback.archive-it.org/7877/20160919152116/http://dlib.etc.ucla.edu/projects/Karnak//

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Digital Karnak

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http://wayback.archive-it.org/7877/20160919152116/http://dlib.etc.ucla.edu/projects/Karnak//

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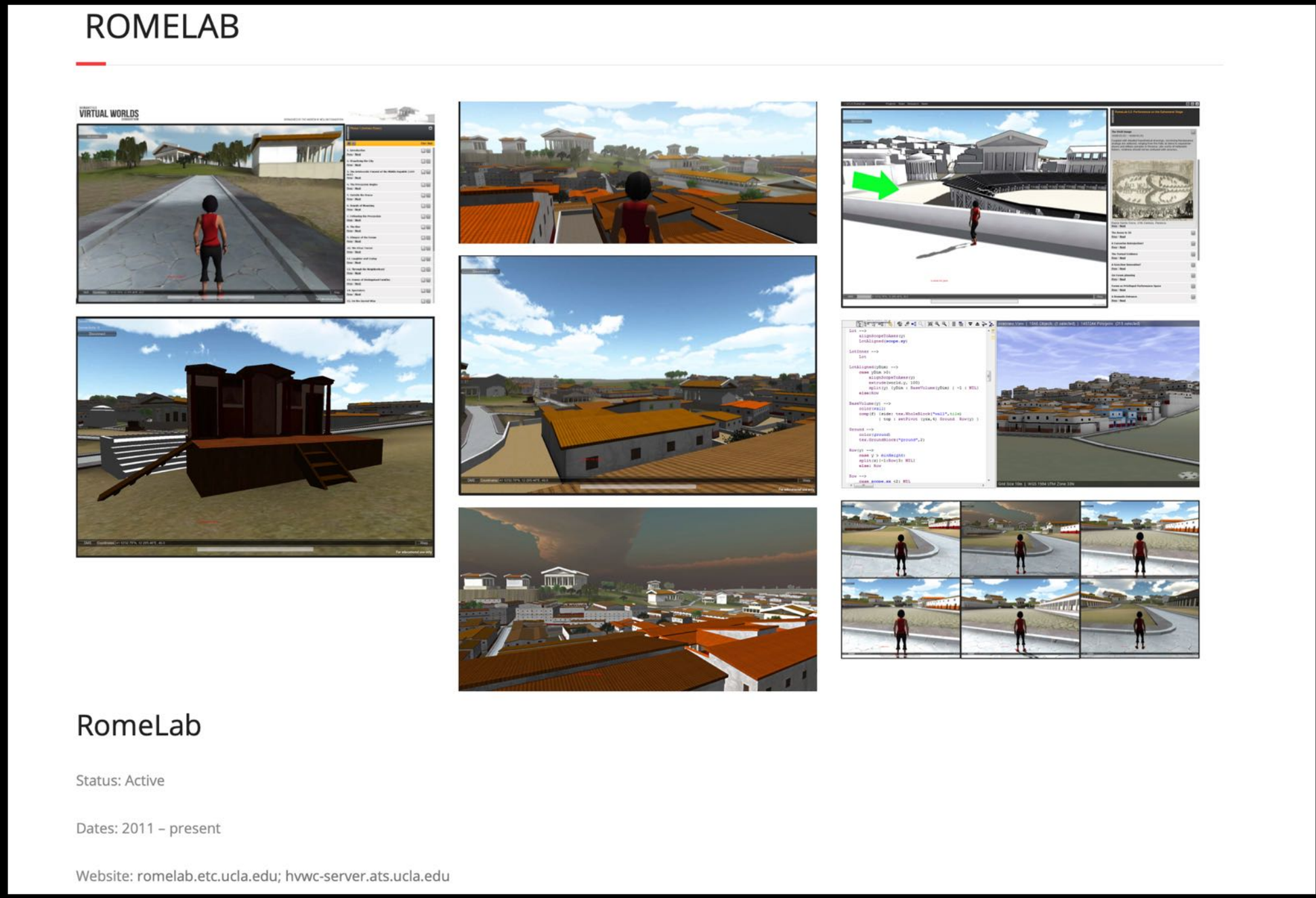
RomeLab



Team: Assistant Professor Chris Johanson, Doctoral candidate Marie Saldaña

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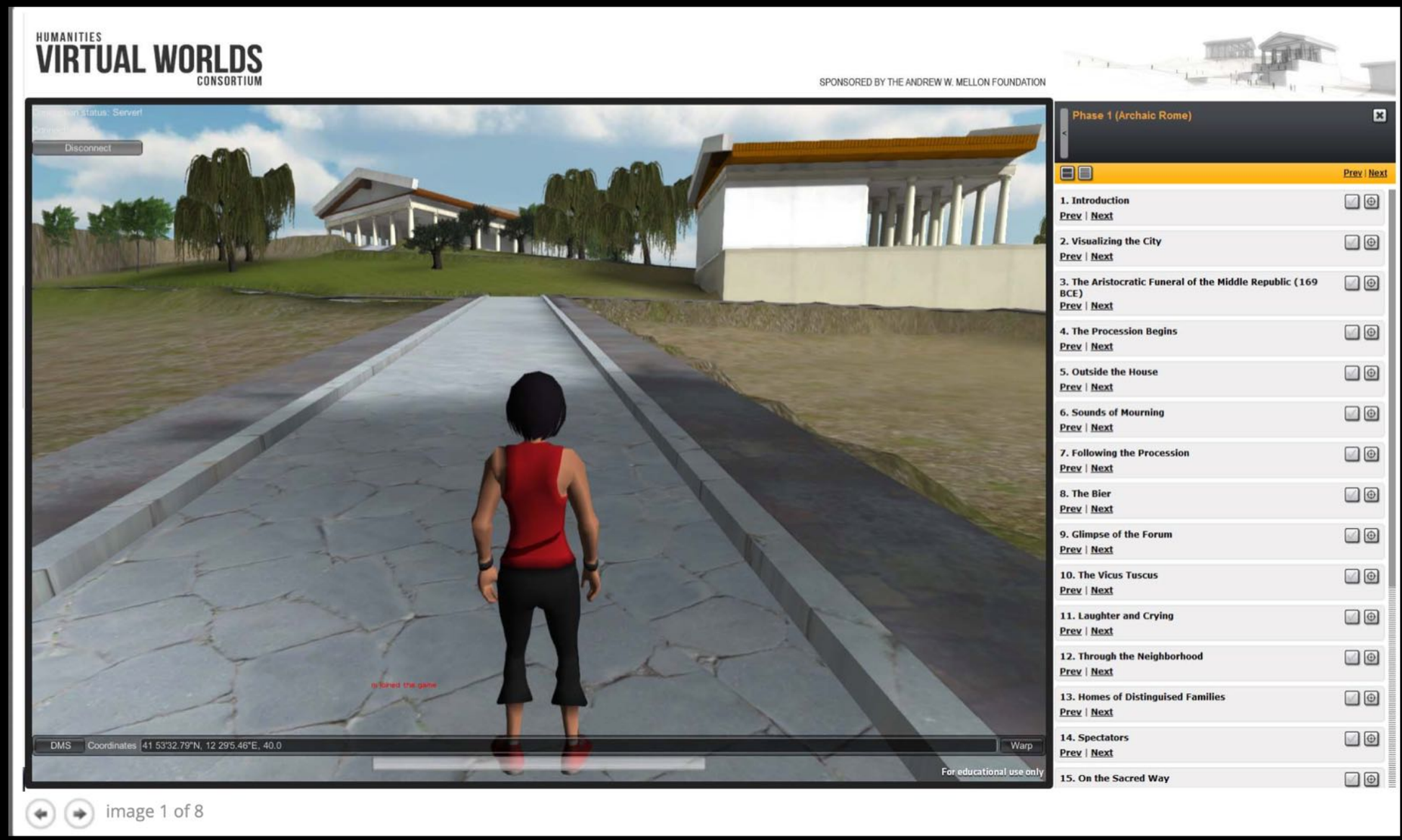
RomeLab



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RomeLab

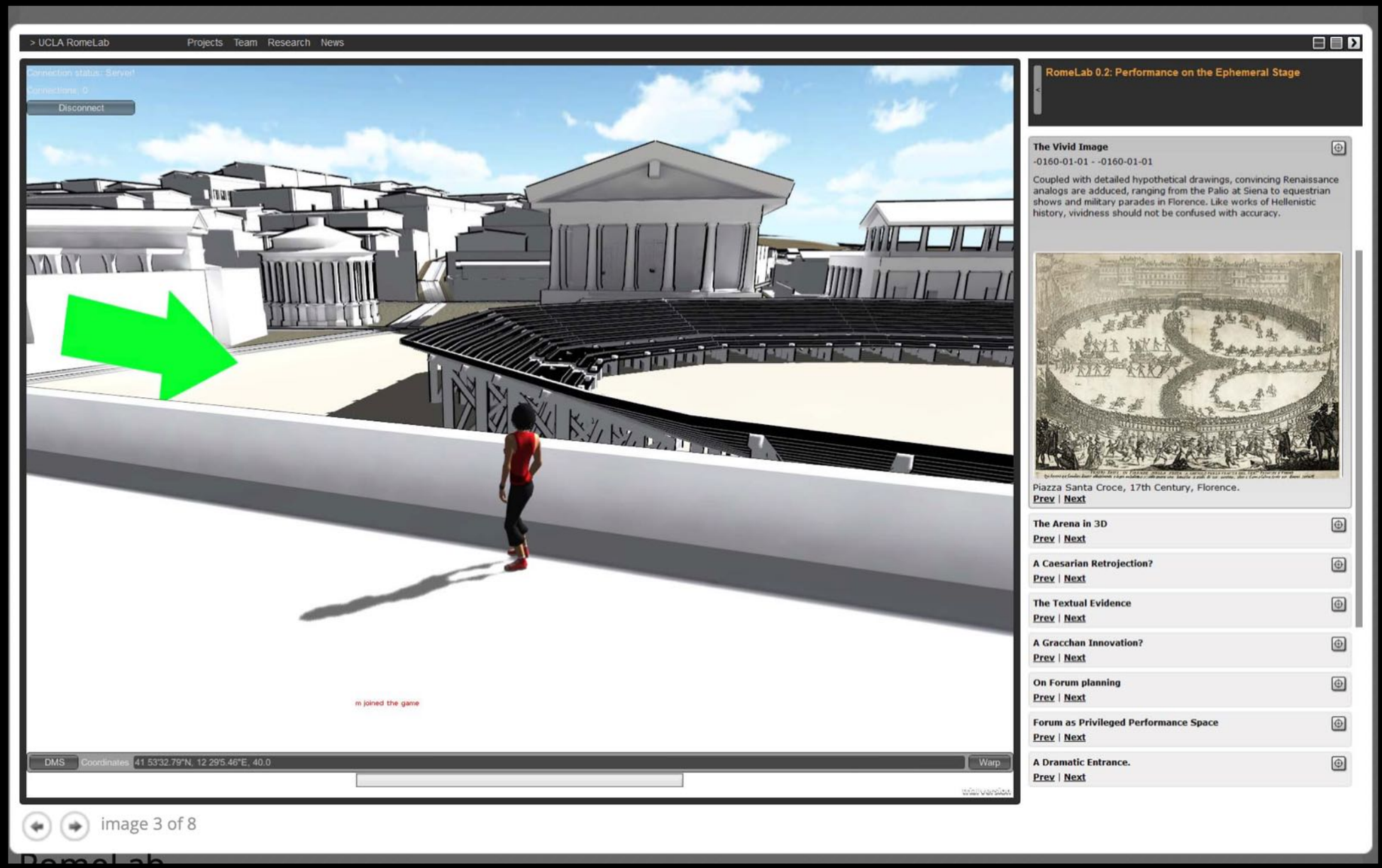

Image Source: UCLA Experiential Technologies Center

RomeLab

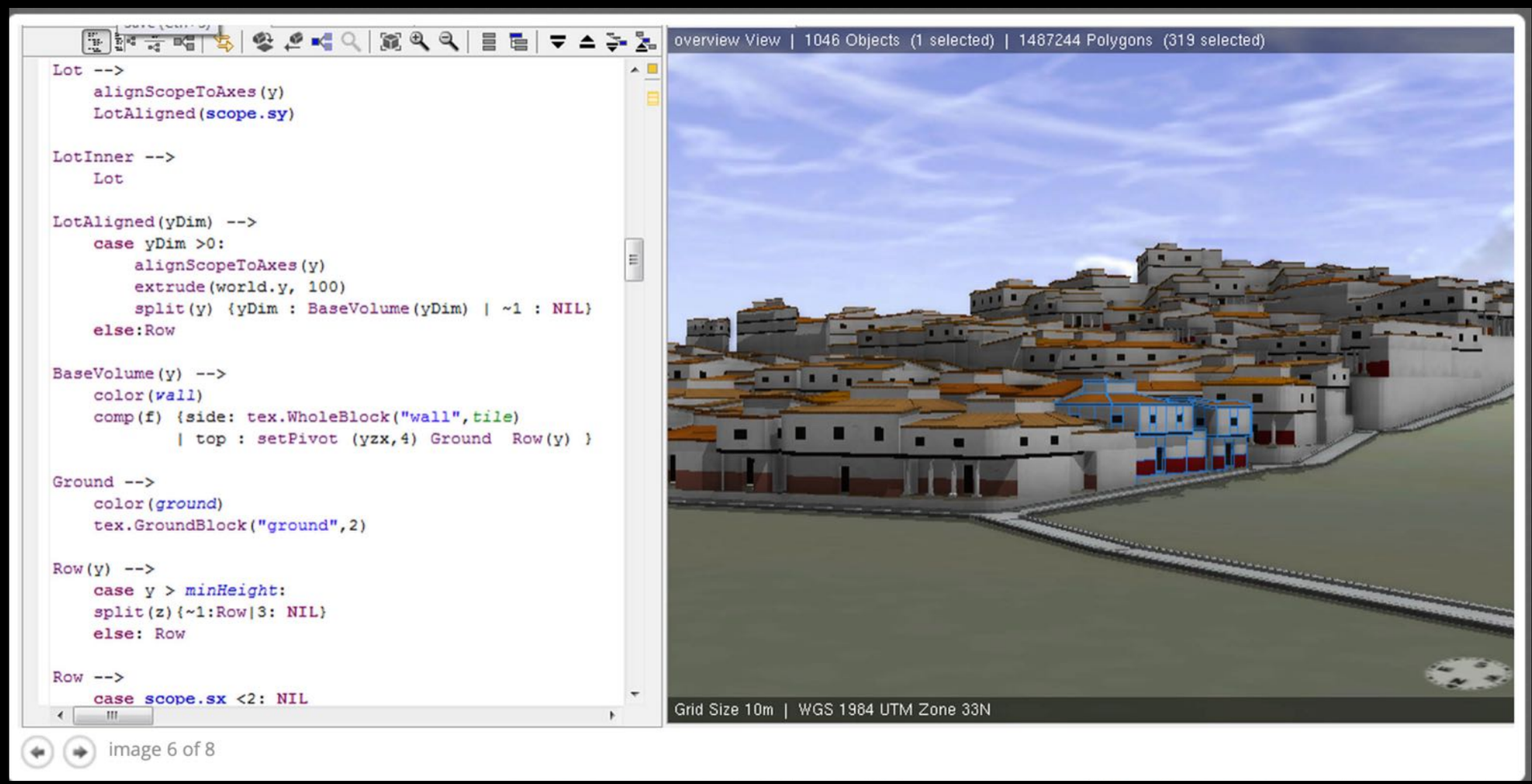

Image Source: UCLA Experiential Technologies Center

Immersive Humanities Viewer

Principal Investigator(s): Dr. Dave Shepard, CDH; Prof. Willeke Wendrich, NELC

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https://humtech.ucla.edu/project/immersive-humanities-viewer/

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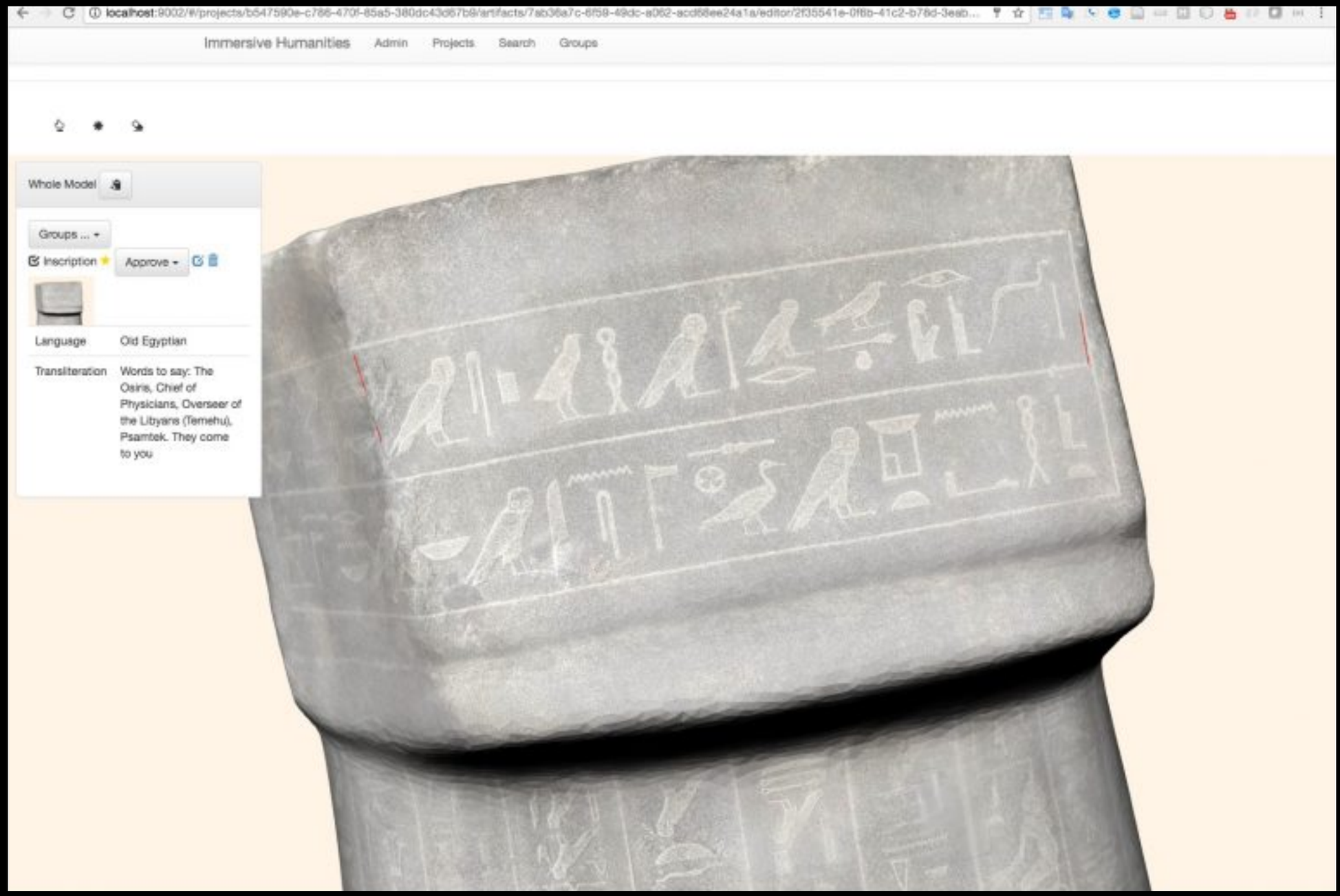
Immersive Humanities Viewer



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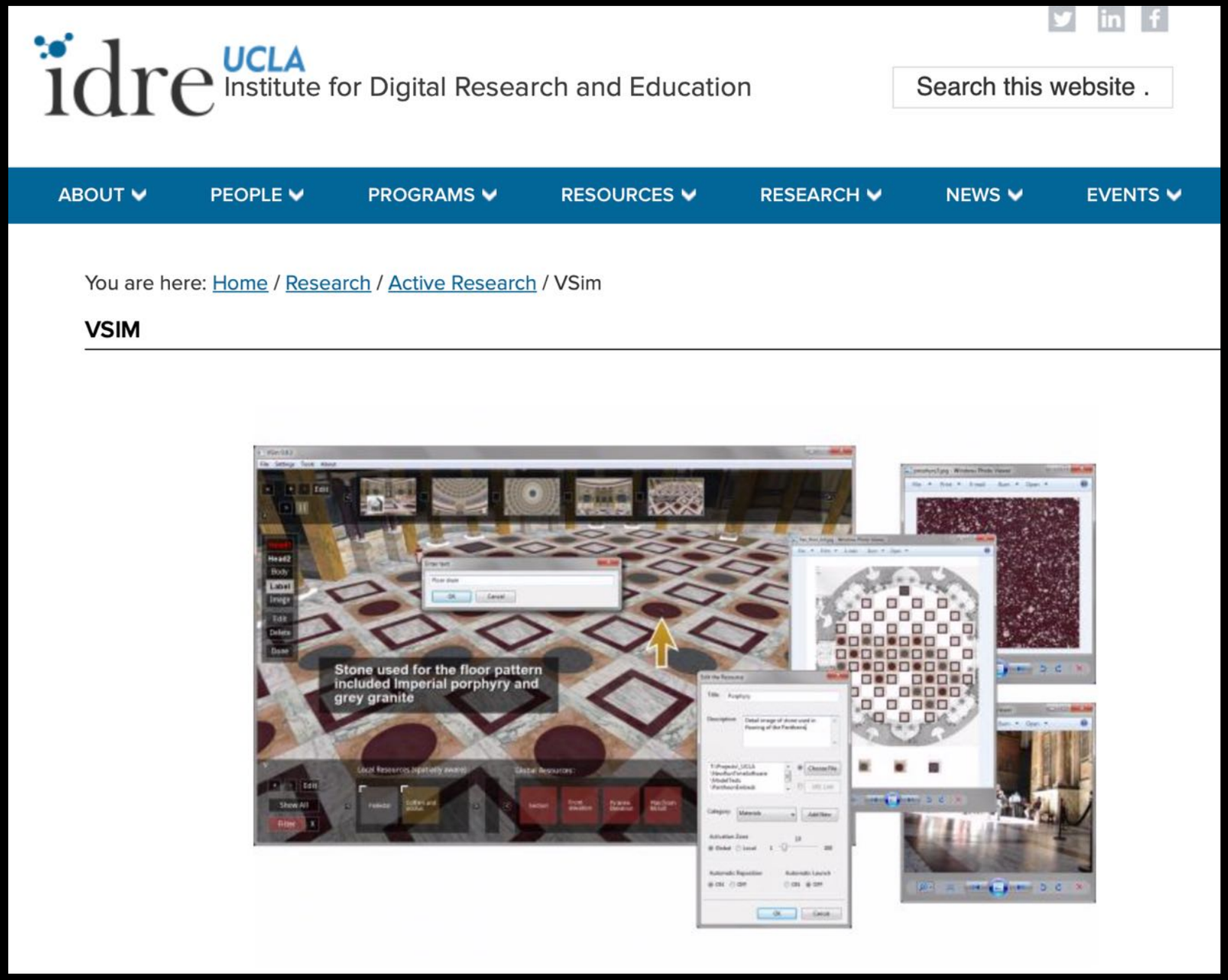
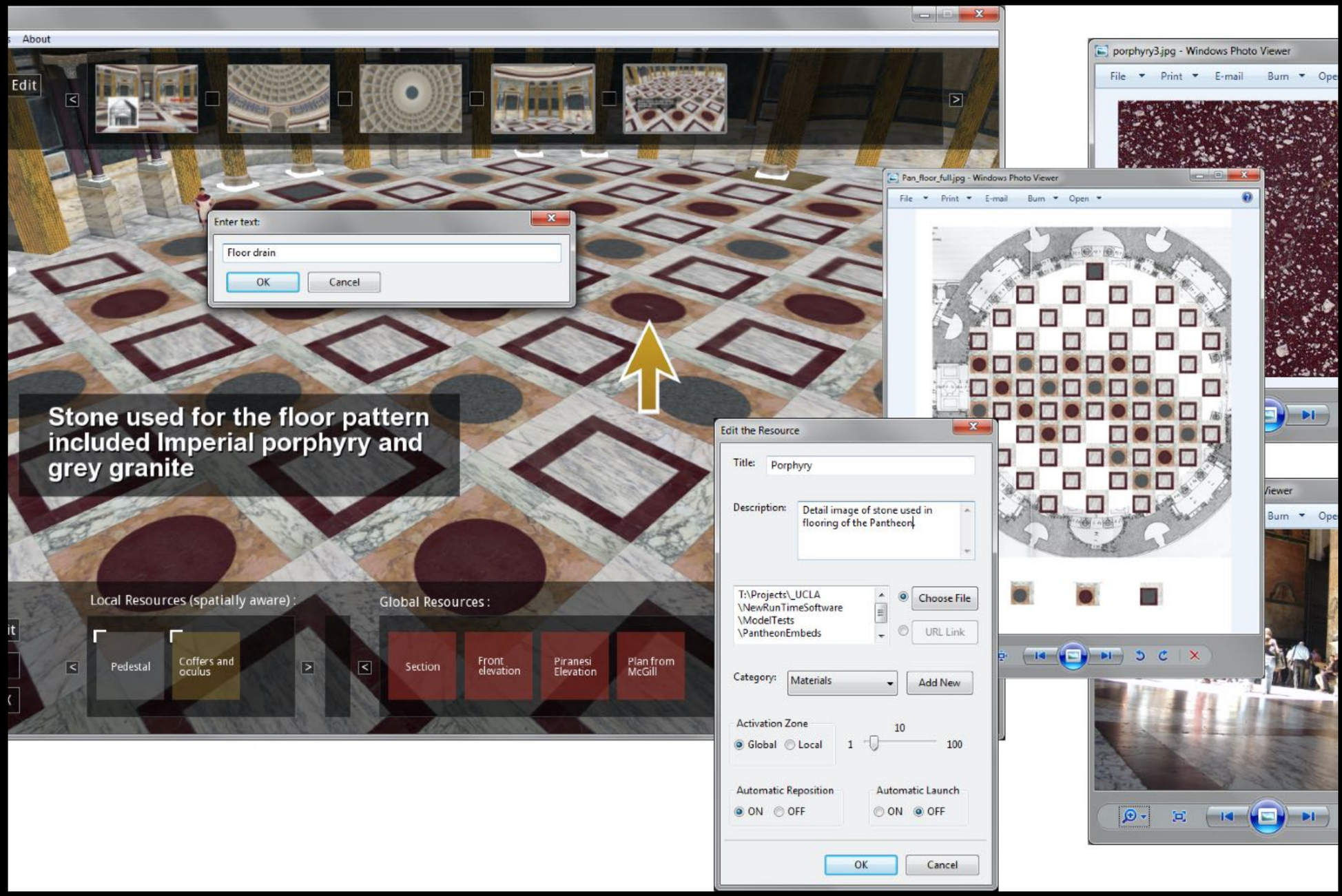
VSIM



Principal Investigator(s)Dr. Scott Friedman and Dr. Lisa M. Snyder. VSim 2.0 Lead programmer David Stephan, additional team members Francesca Albrezzi, Aaron J. Taber, and Sam Amin. Dr. Elaine Sullivan and Joy Guey

Image Source: UCLA Institute for Digital Research and Education

VSIM



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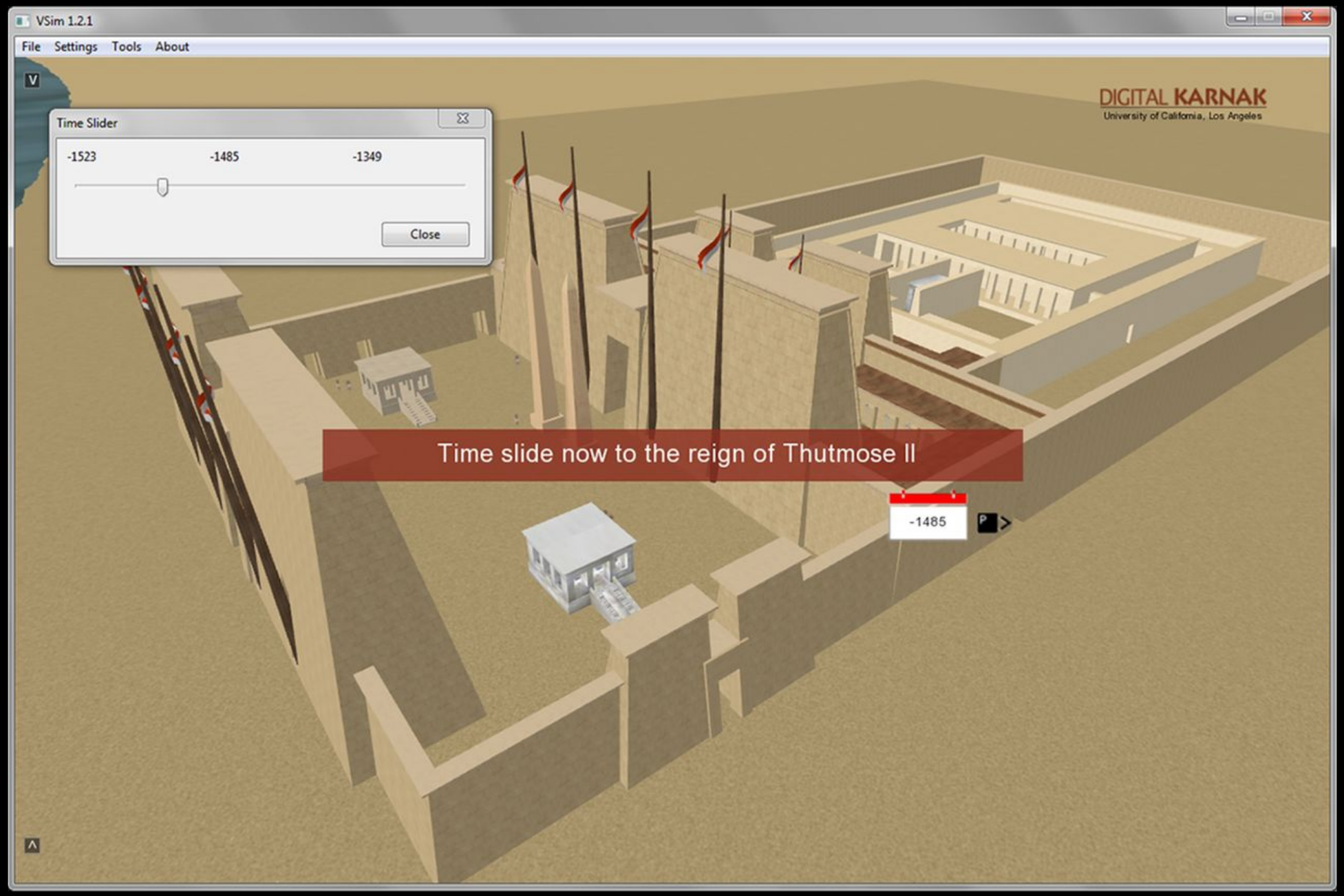
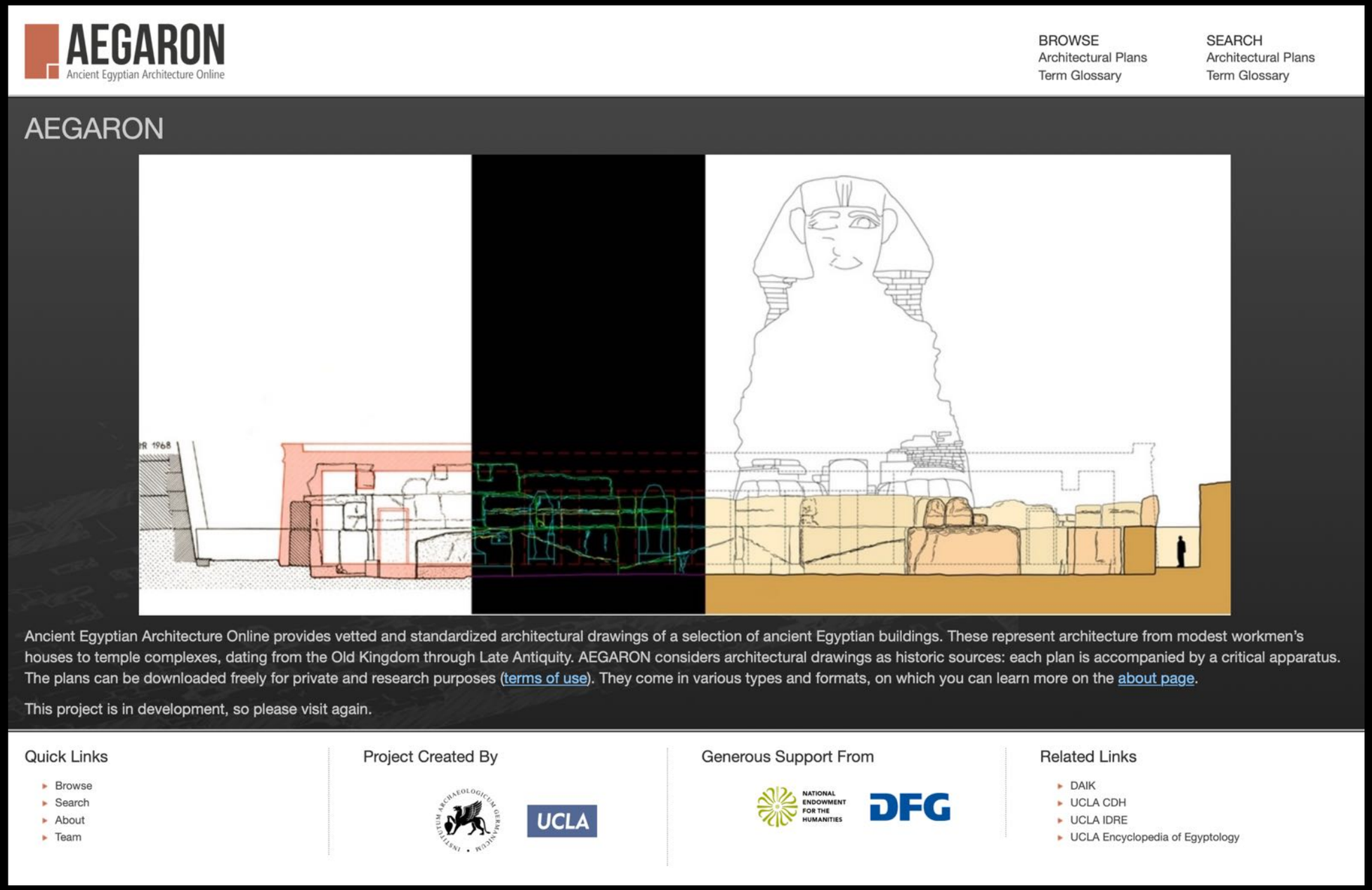


Image Source: UCLA Institute for Digital Research and Education

VSIM

Image Source: UCLA Institute for Digital Research and Education

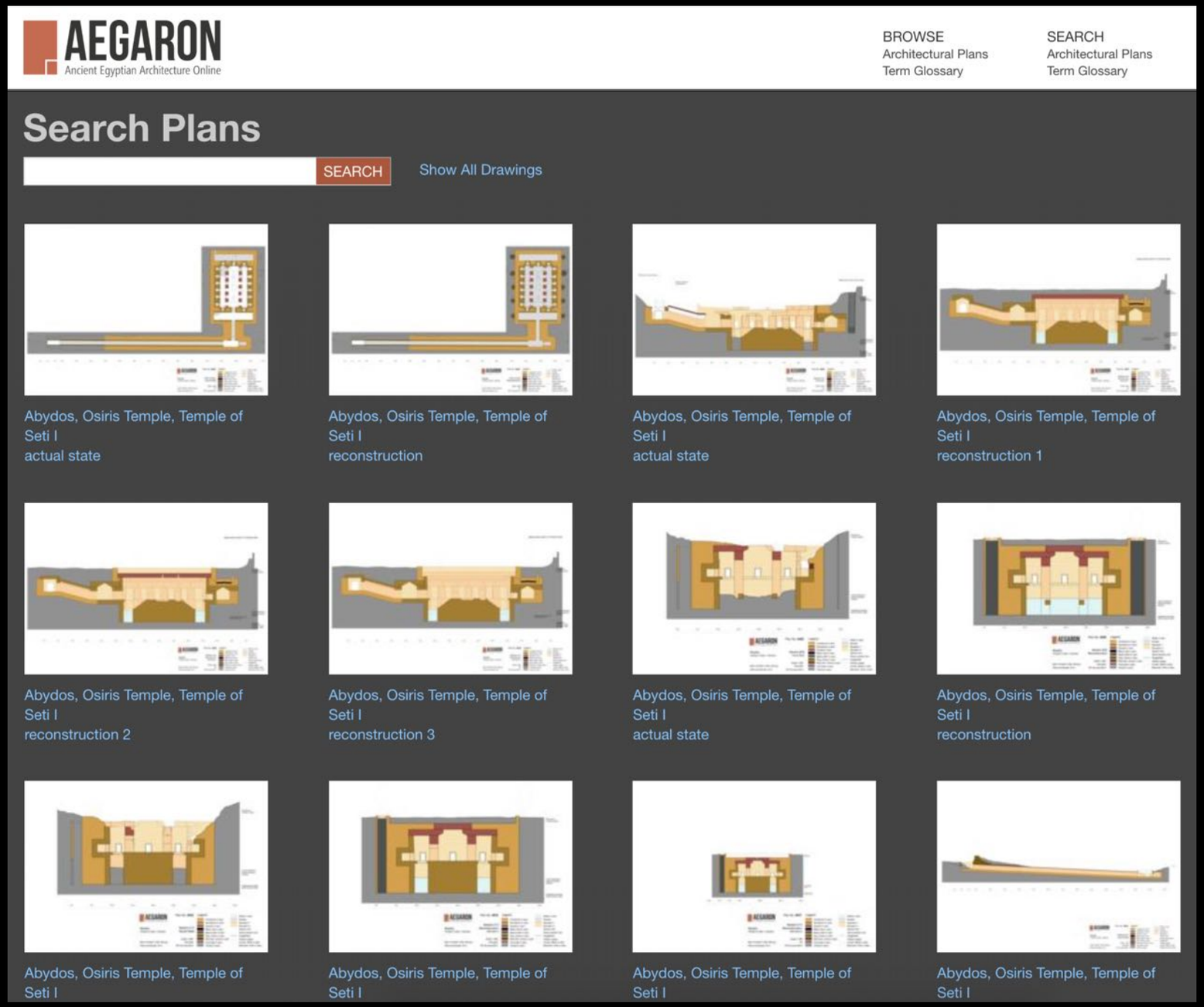
Aegaron



Cairo: Prof. Dr. Stephan J. Seidlmayer, Dr. Ulrike Fauerbach In
Los Angeles: Prof. Dr. Willeke Wendrich, Stephen Davison

Image Source: http://drupaldev.aegaron.ucla.edu

Aegaron



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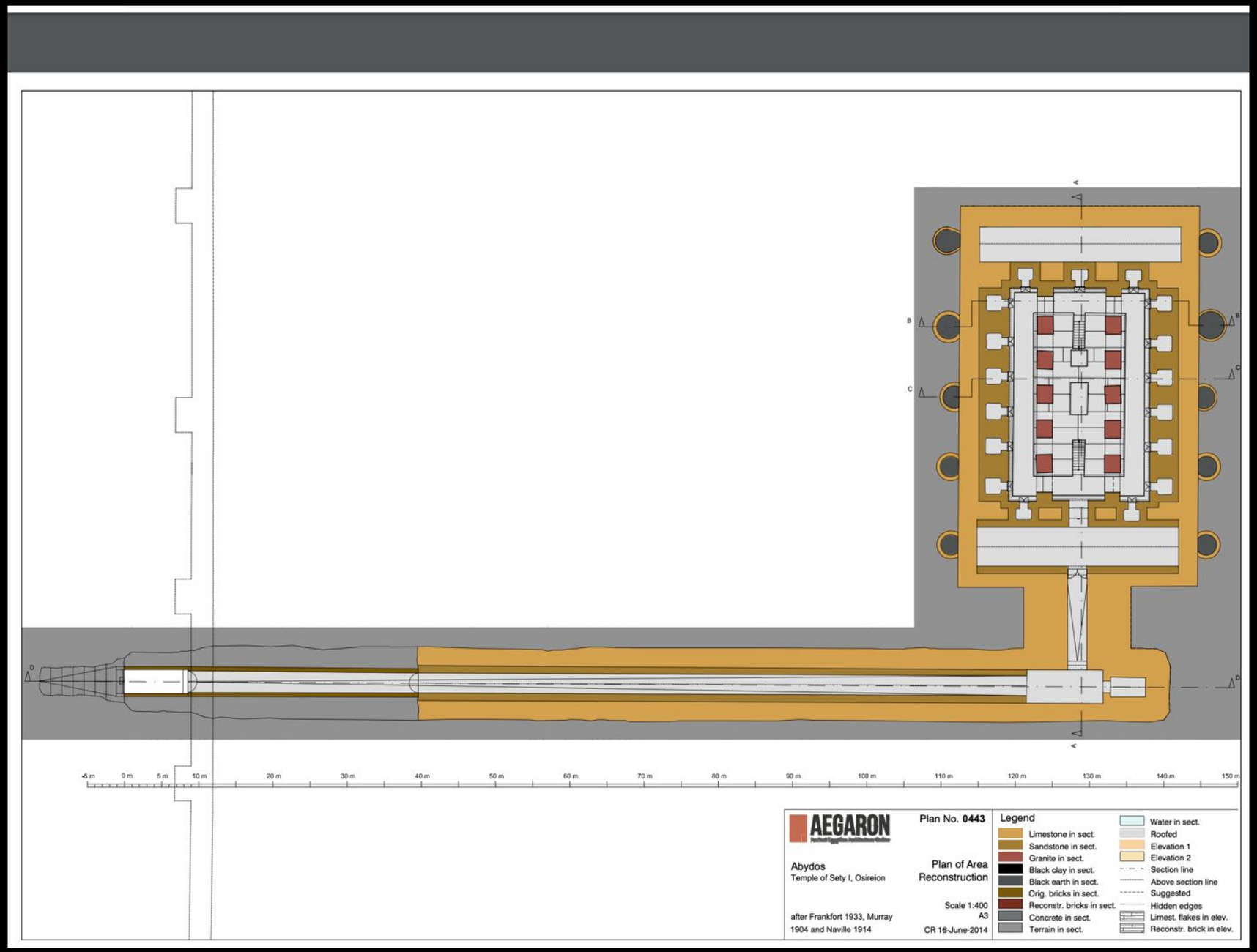

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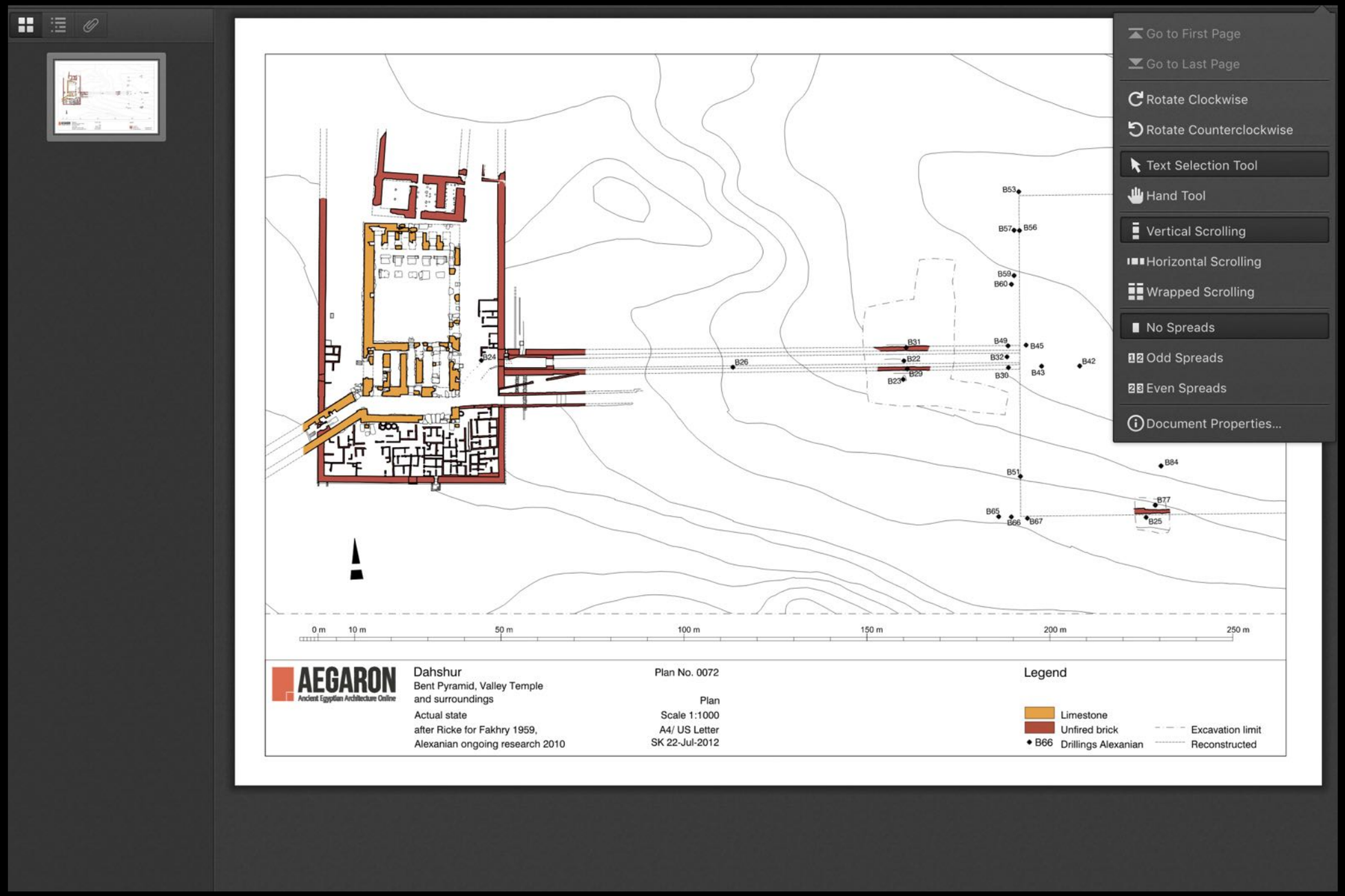

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Outcomes for research

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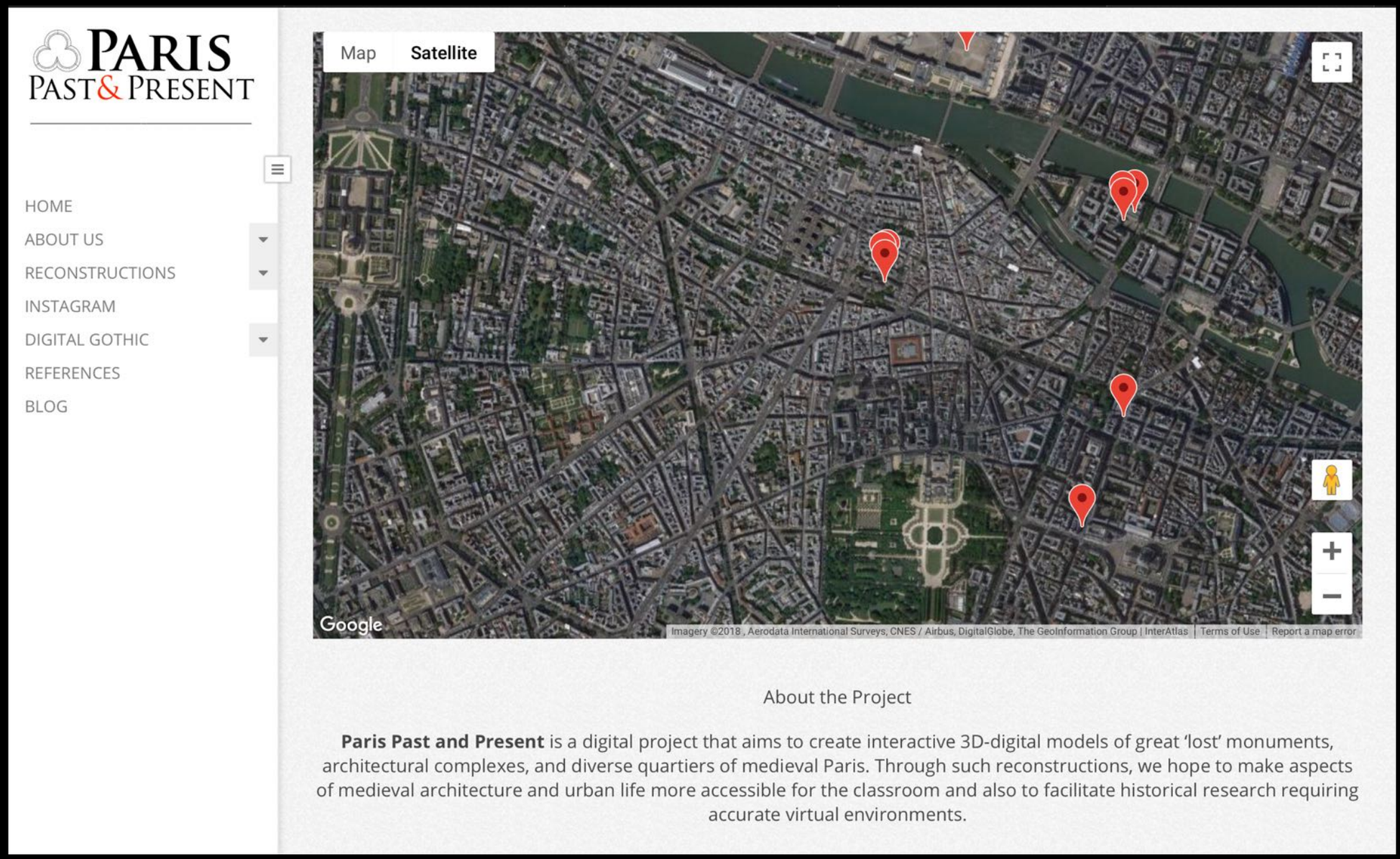
Paris Past & Present



Principal Investigator Dr.Meredith Cohen, Project Manager Dr. Kristine Tanton

PARIS PAST & PRESENT

Image Source: http://paris.cdh.ucla.edu

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Paris Past & Present

Lady Chapel Reconstructed dado arcade in Square Laurent Prache, Paris

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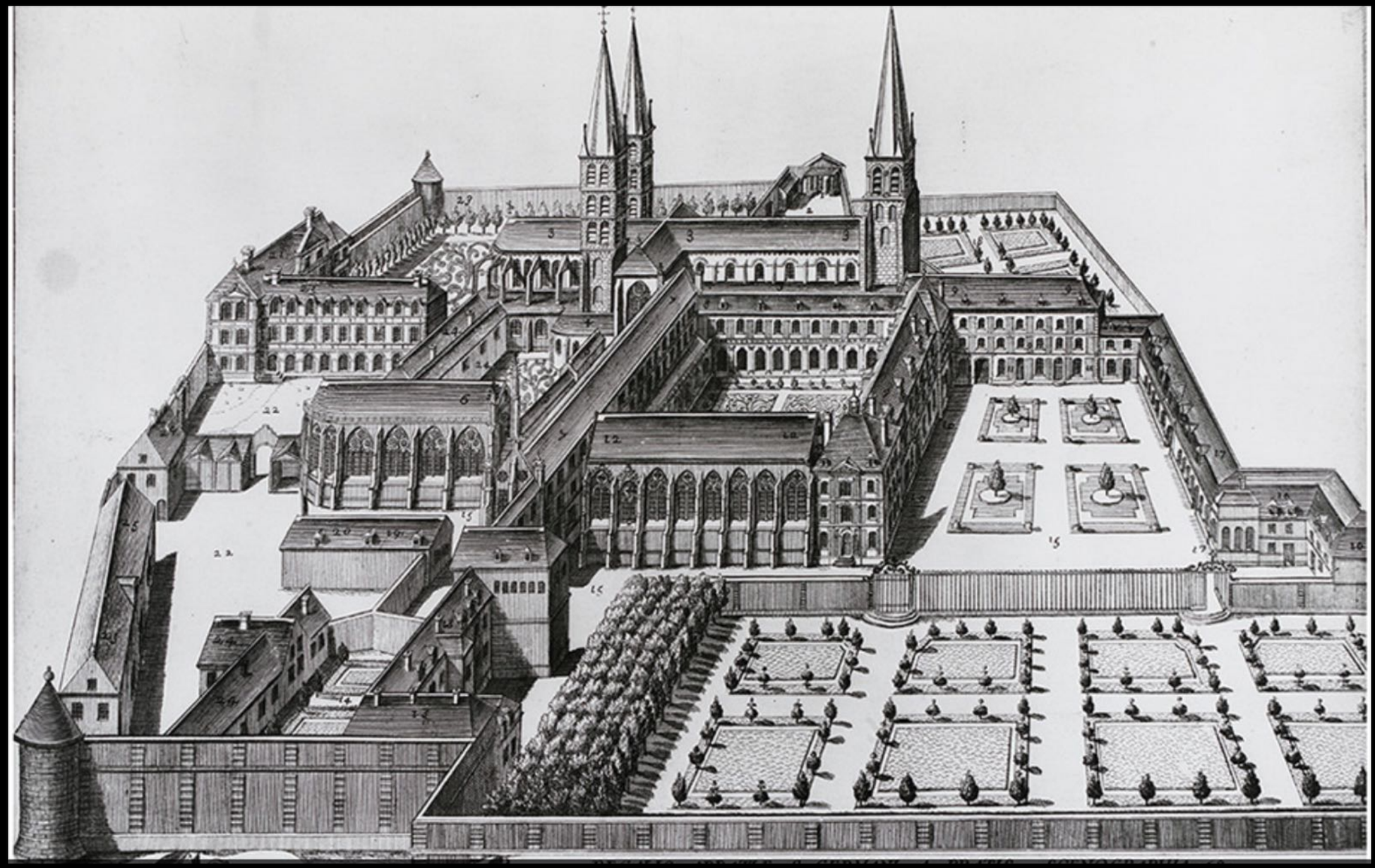
Paris Past & Present



Bouillart image of Saint-Germain des Pres monastic complex

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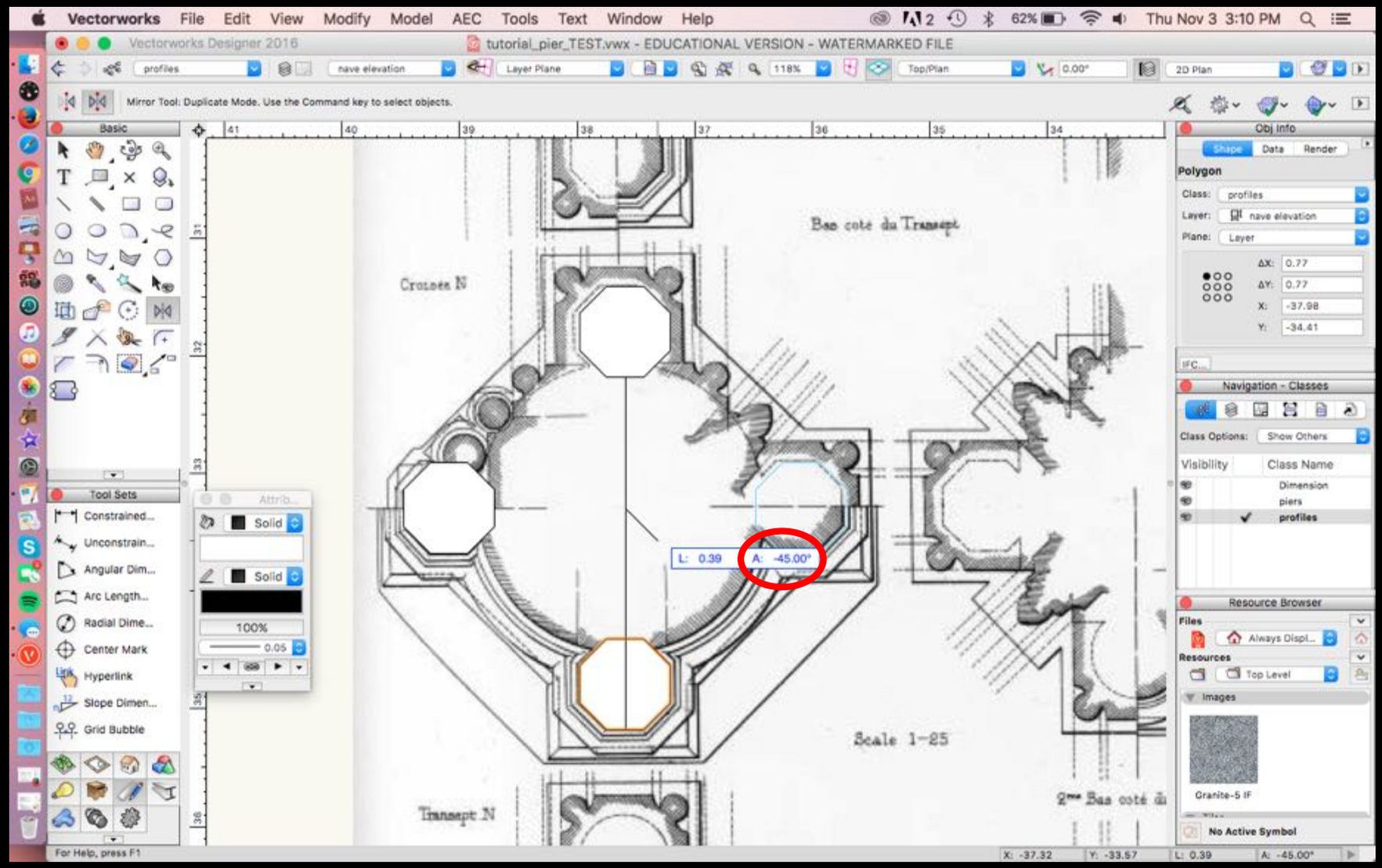
Paris Past & Present



Tutorial: Digital Gothic—AH C117B (Winter 2017)

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Image Source: http://paris.cdh.ucla.edu

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Paris Past & Present

Lady Chapel interior

PARIS PAST & PRESENT

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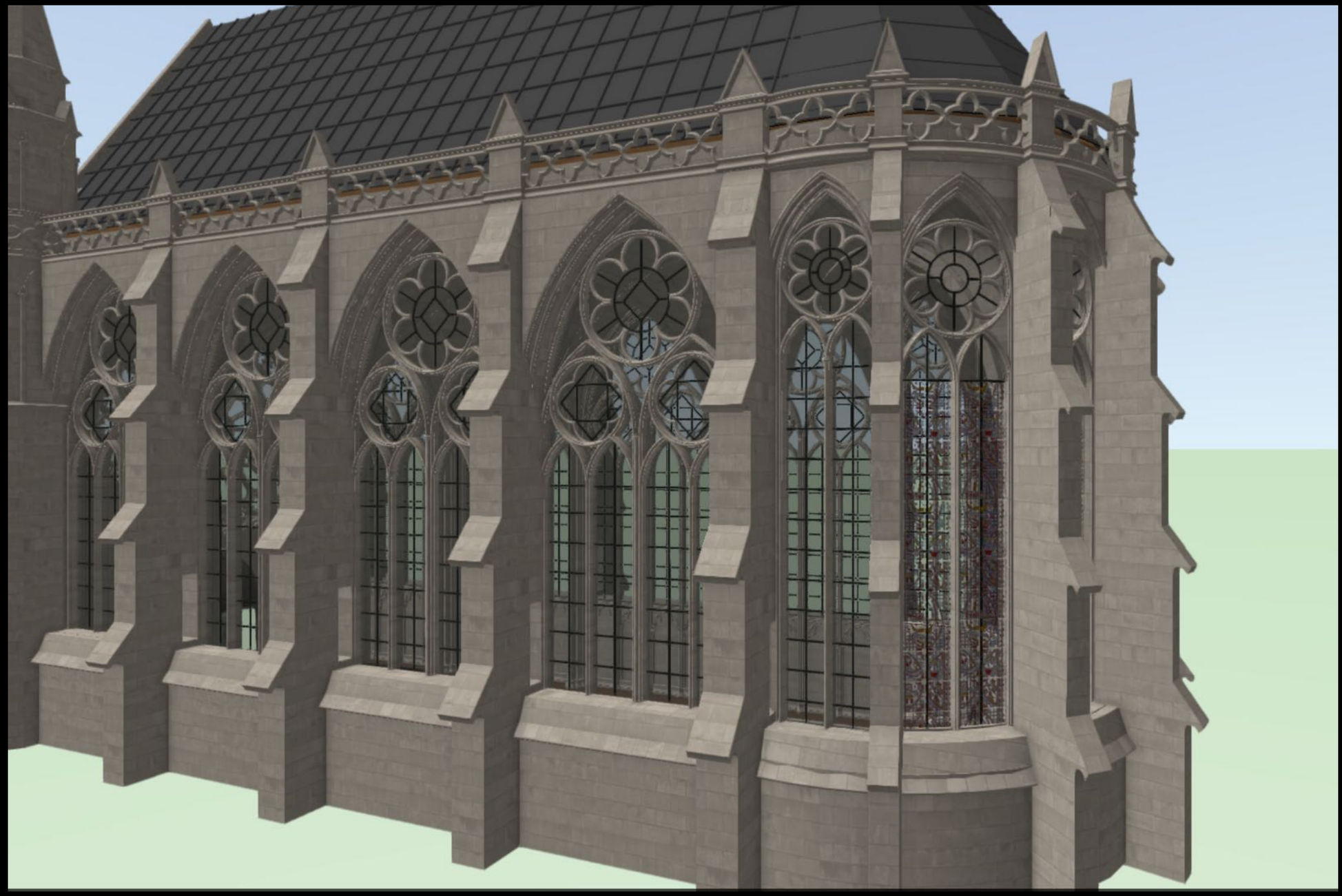
Paris Past & Present



Lady Chapel exterior

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Image Source: http://paris.cdh.ucla.edu

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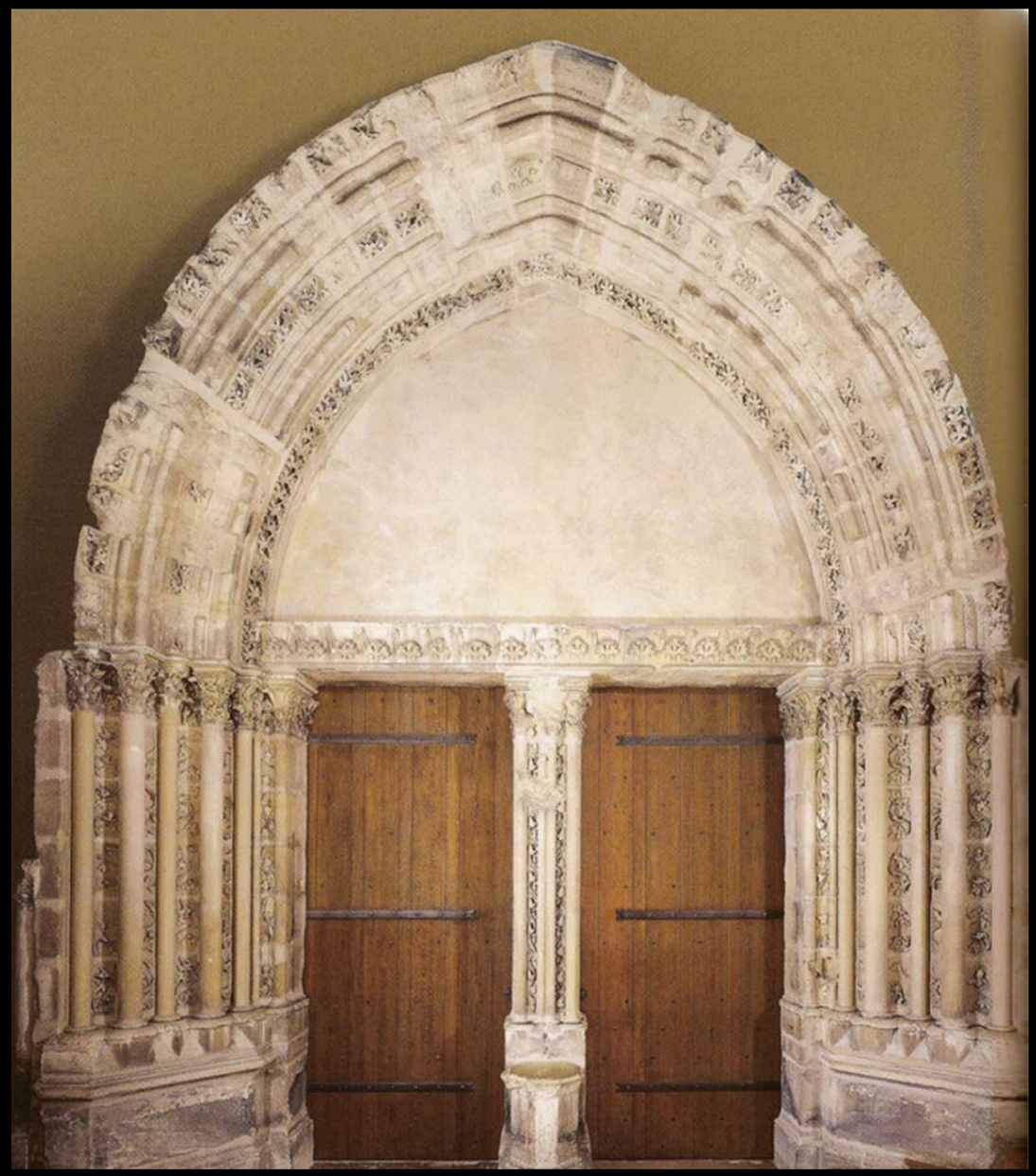
Paris Past & Present



Portal for the Lady Chapel now installed at the Musée de Cluny

PARIS PAST & PRESENT

Image Source: http://paris.cdh.ucla.edu

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Paris Past & Present

Fragment inserted into model

PARIS PAST & PRESENT

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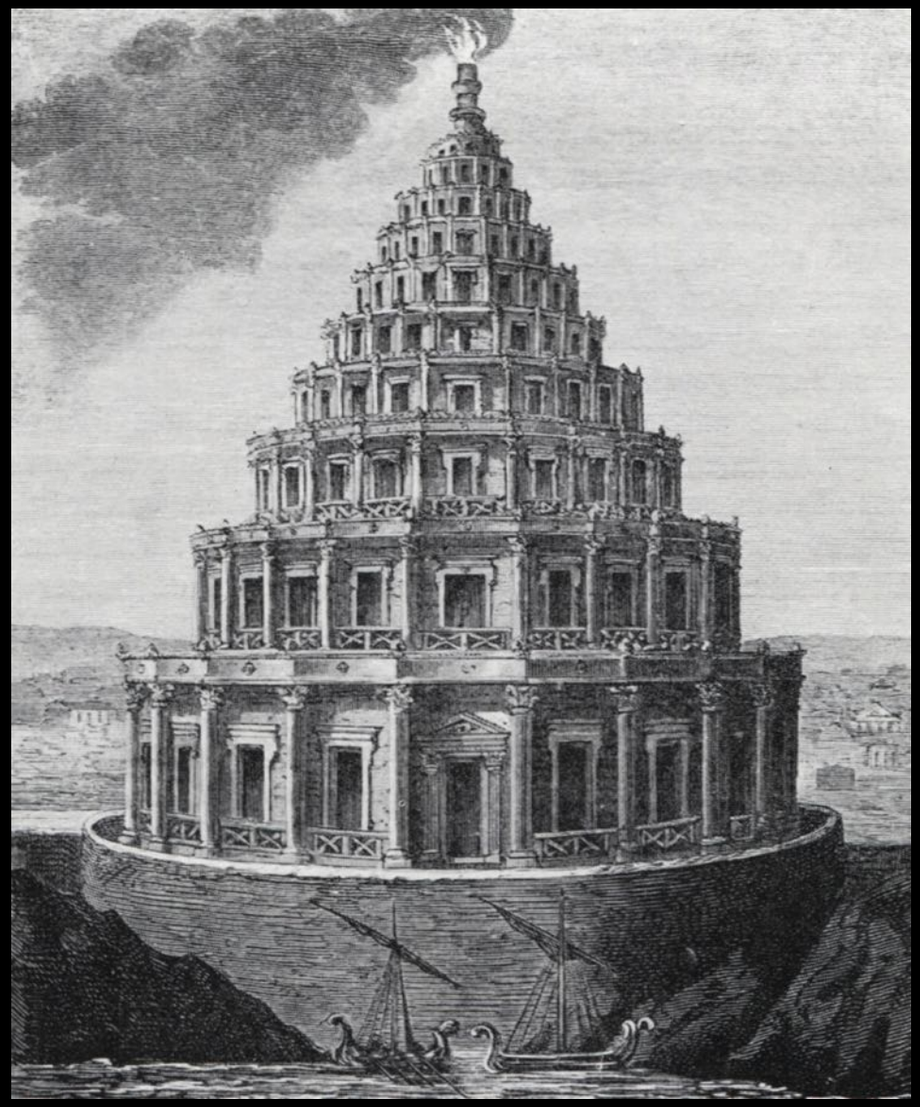
Reconstruction of the

Pharos Lighthouse of Alexandria



Team: Professor Diane Favro, Associate Professor Ertugrul Taciroglu, Anthony Caldwell

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Image Source: UCLA Experiential Technologies Center

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Pharos Lighthouse

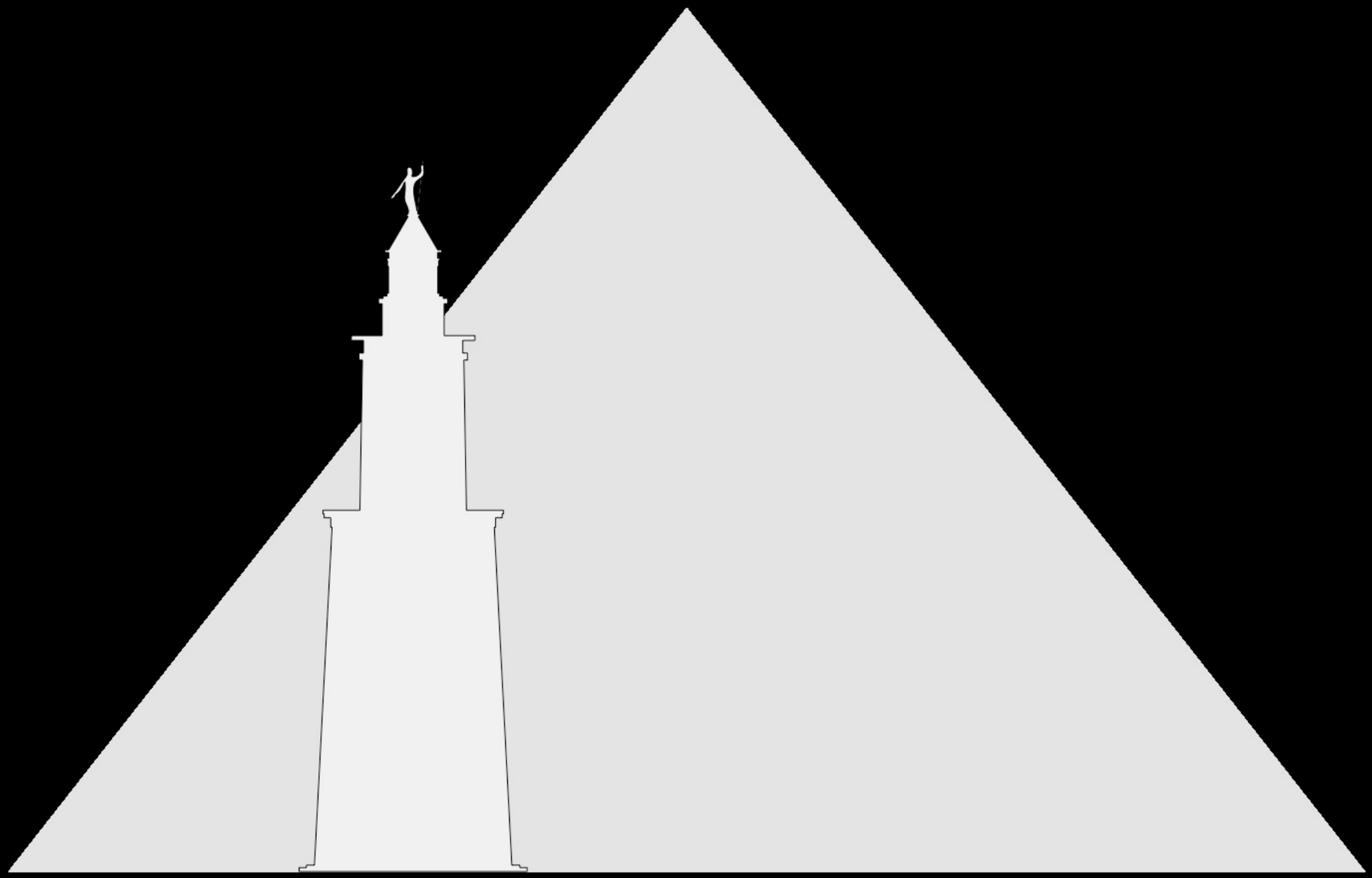

Image Source: UCLA Experiential Technologies Center

Pharos Lighthouse

Pliny the Elder
23–79 AD

Lighthouse Inscription and cost

Lucian of Samosata
125–180 AD

Name
of the Architect

Strabo
63 BC – 24 AD

Color, Material, Size,
and location

Eusebius of Caesarea
263–339 AD

Dates for construction

Titus Flavius Josephus
37–100 AD

How far the light
could be sean

Ammianus Marcellinus
330–391 AD

Additions and alterations
to original design

Benjamin of Tudela
1130–1173 AD

Description of the Mirror.

Shams al-Din al-Ansari al-Dimashqi
1256–1327 AD

Describes the ramp and interior

Abu'l-Fida
1273–1331 AD

General Description of Size

Ibn Batuta
1304–1369 AD

Describes the lighthouse in runs

Muhammad al-Idrisi
1099–1165 AD

What materials were used

Muhammad ibn Iyas
1448–1522 AD

Records that Qait Bey
ordered a fort to
be built on the
foundations of Pharos

Timeline of observers

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Image Source: UCLA Experiential Technologies Center

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Pharos Lighthouse

Architectural program:

Basic assumptions:

The lighthouse existed.

There was a light on top.

The lighthouse was located in one of the two harbors at Alexandria.

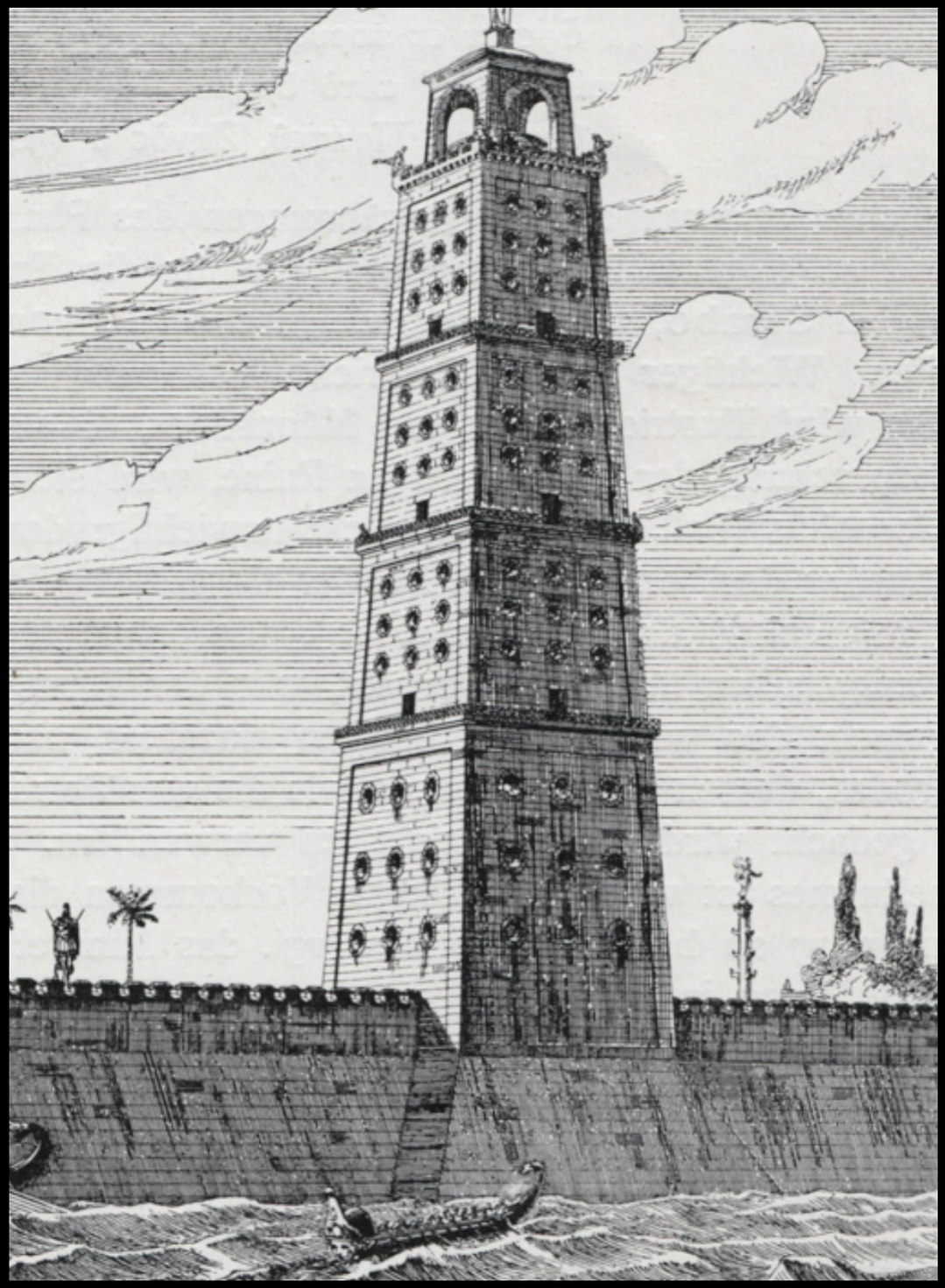
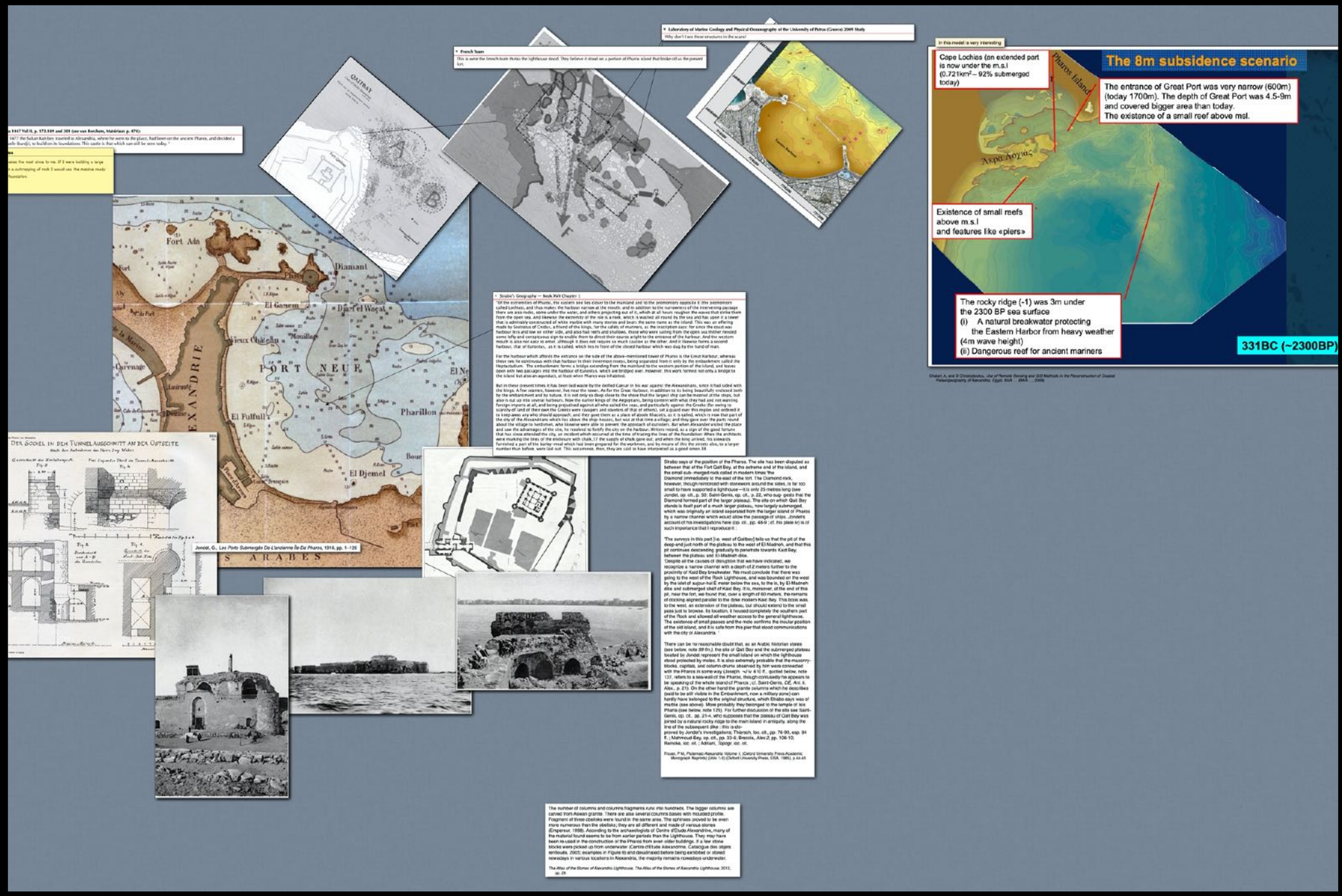


Image Source: Adler, F. (1901). Der Pharos von Alexandria

Pharos Lighthouse



Visual board of the site

Image Source: UCLA Experiential Technologies Center

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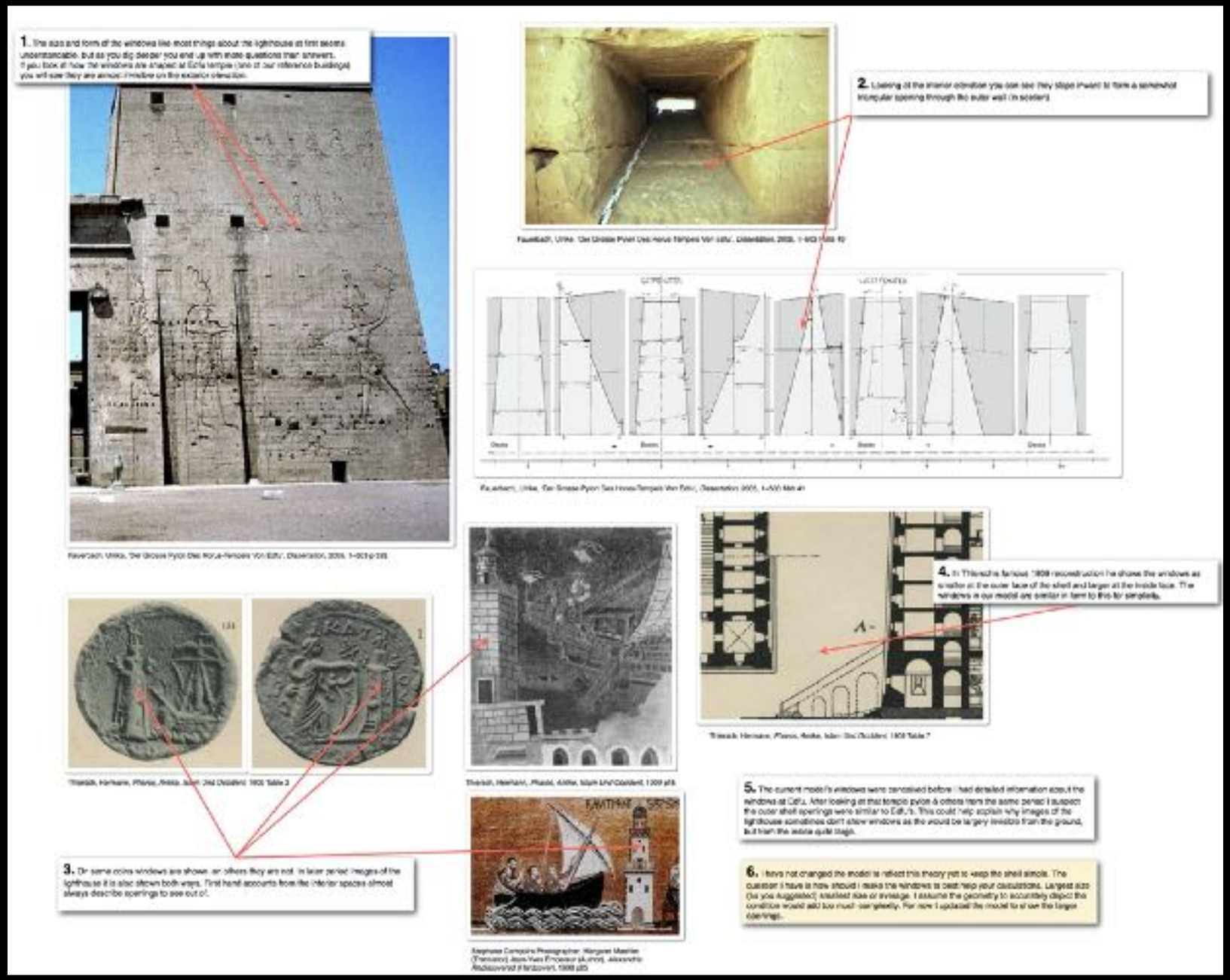
Pharos Lighthouse



Visual board of the structure

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Image Source: UCLA Experiential Technologies Center

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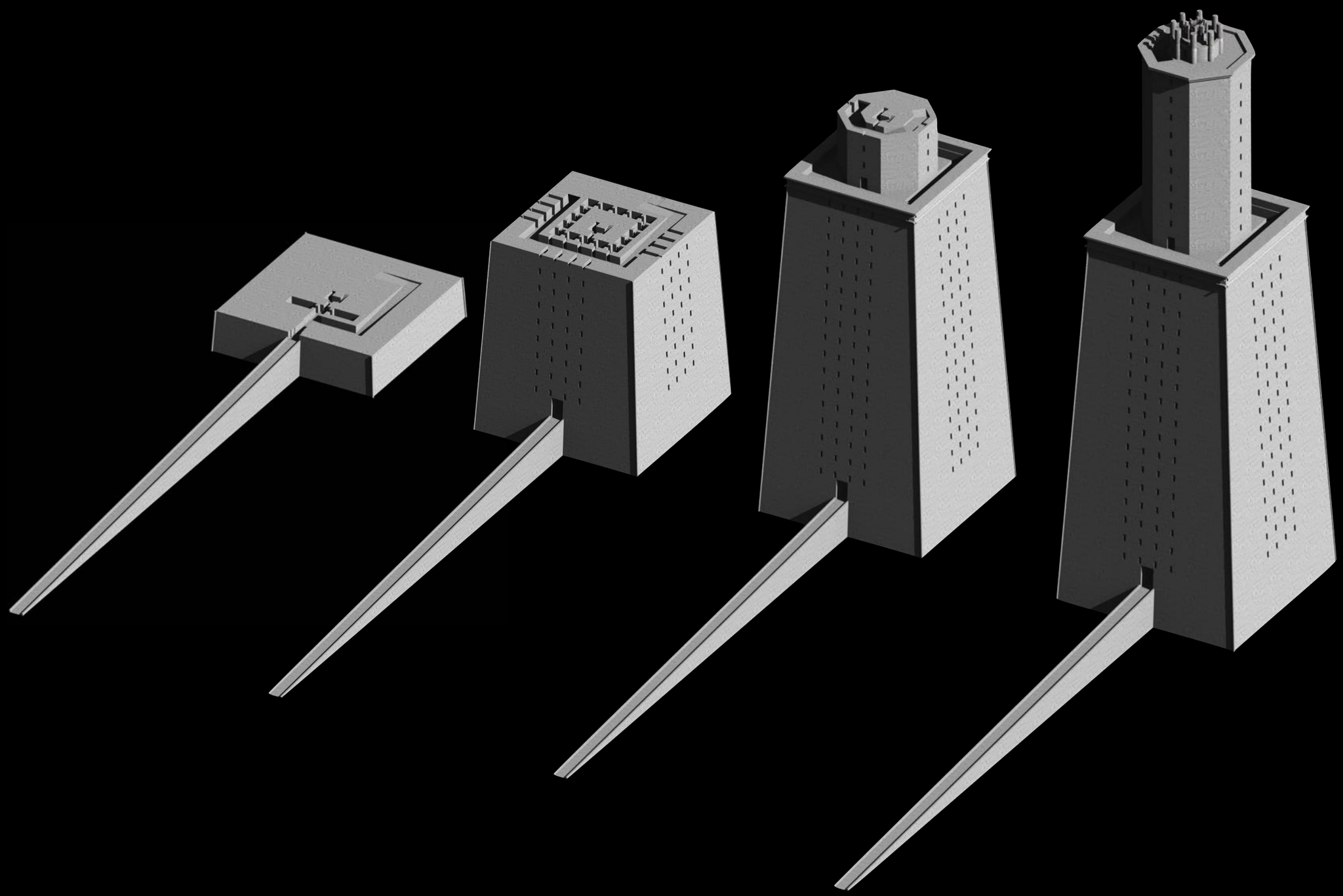

Version 4 model

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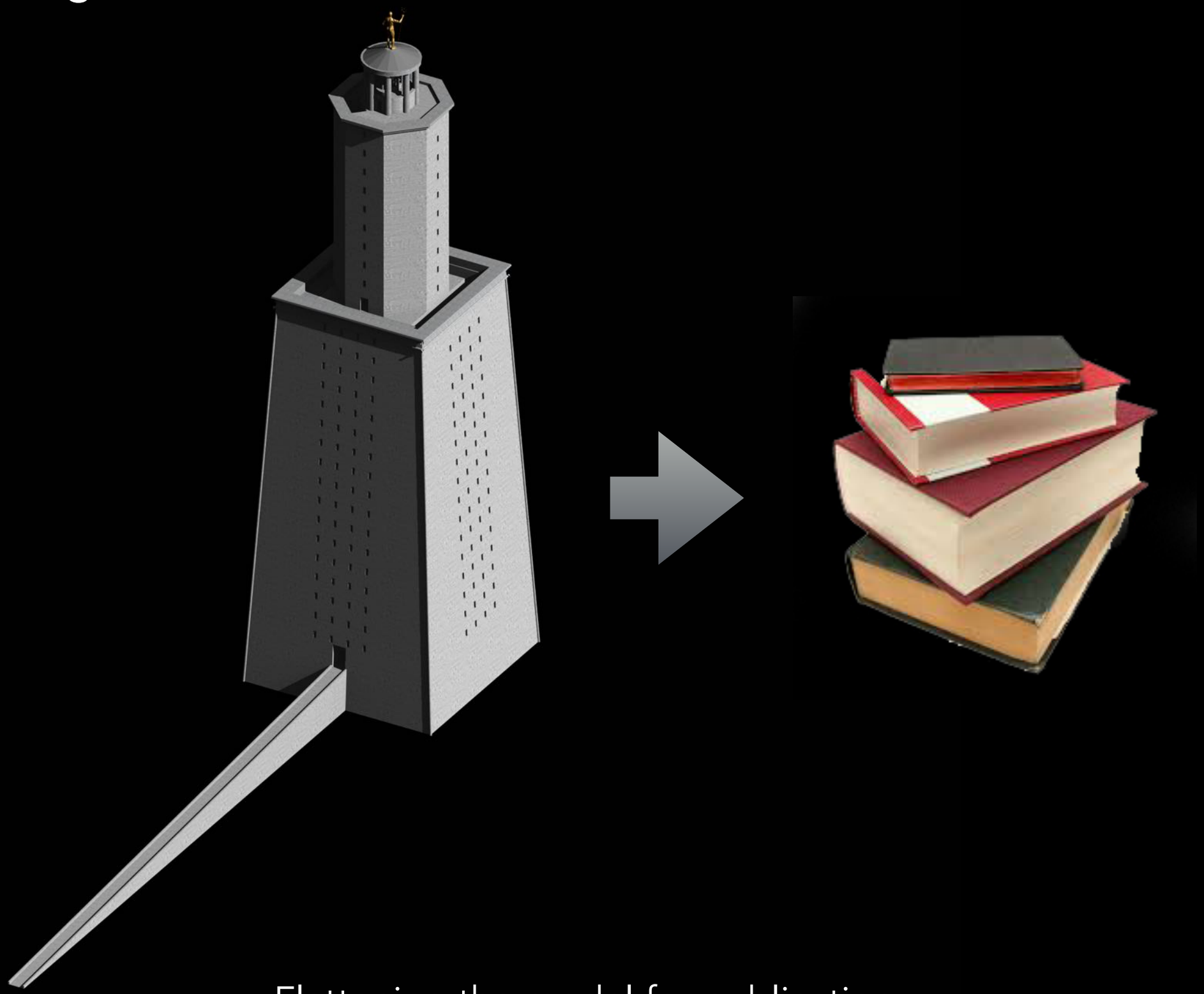

Flattening the model for publication

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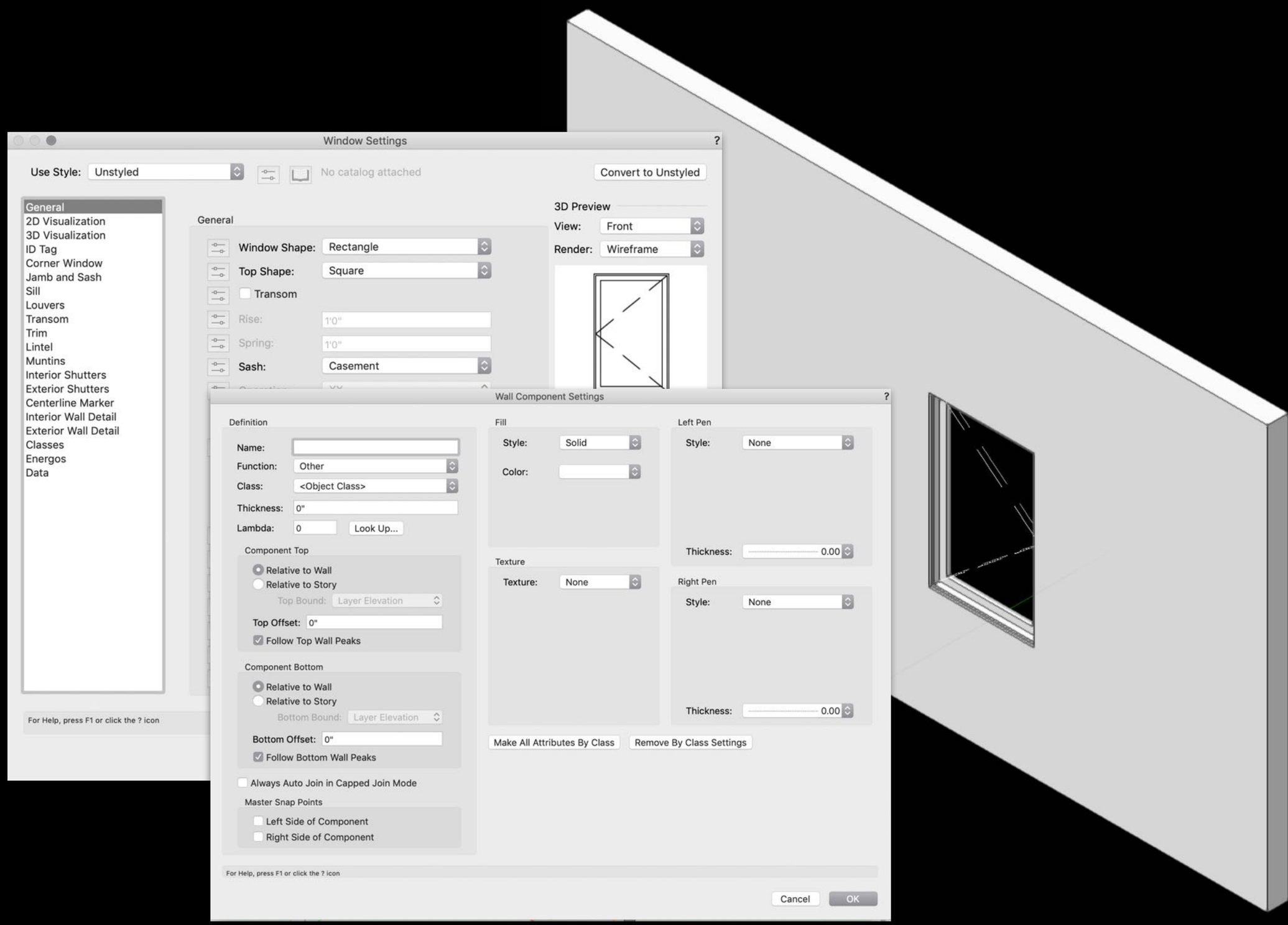

Parametric models and BIM

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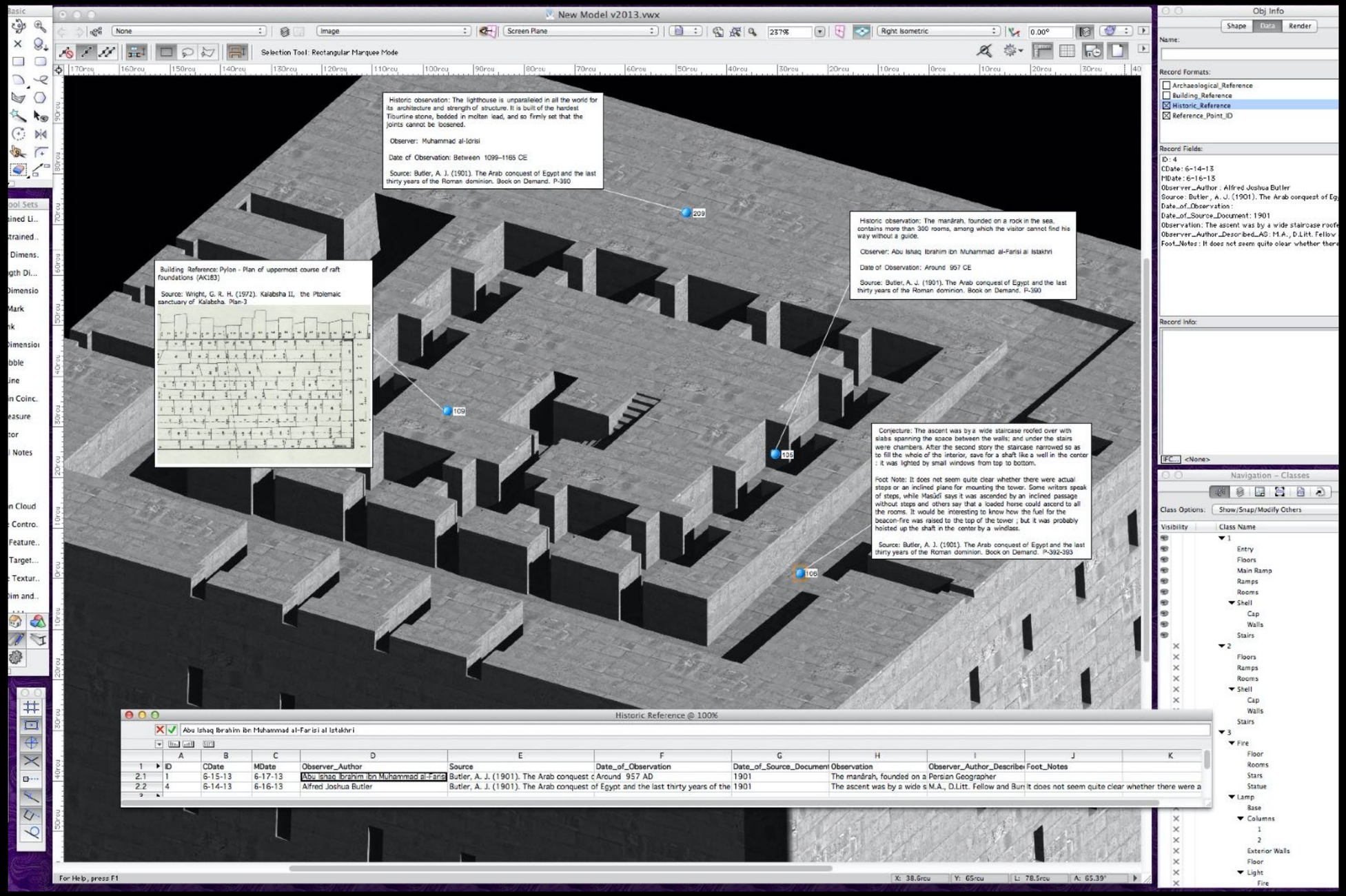
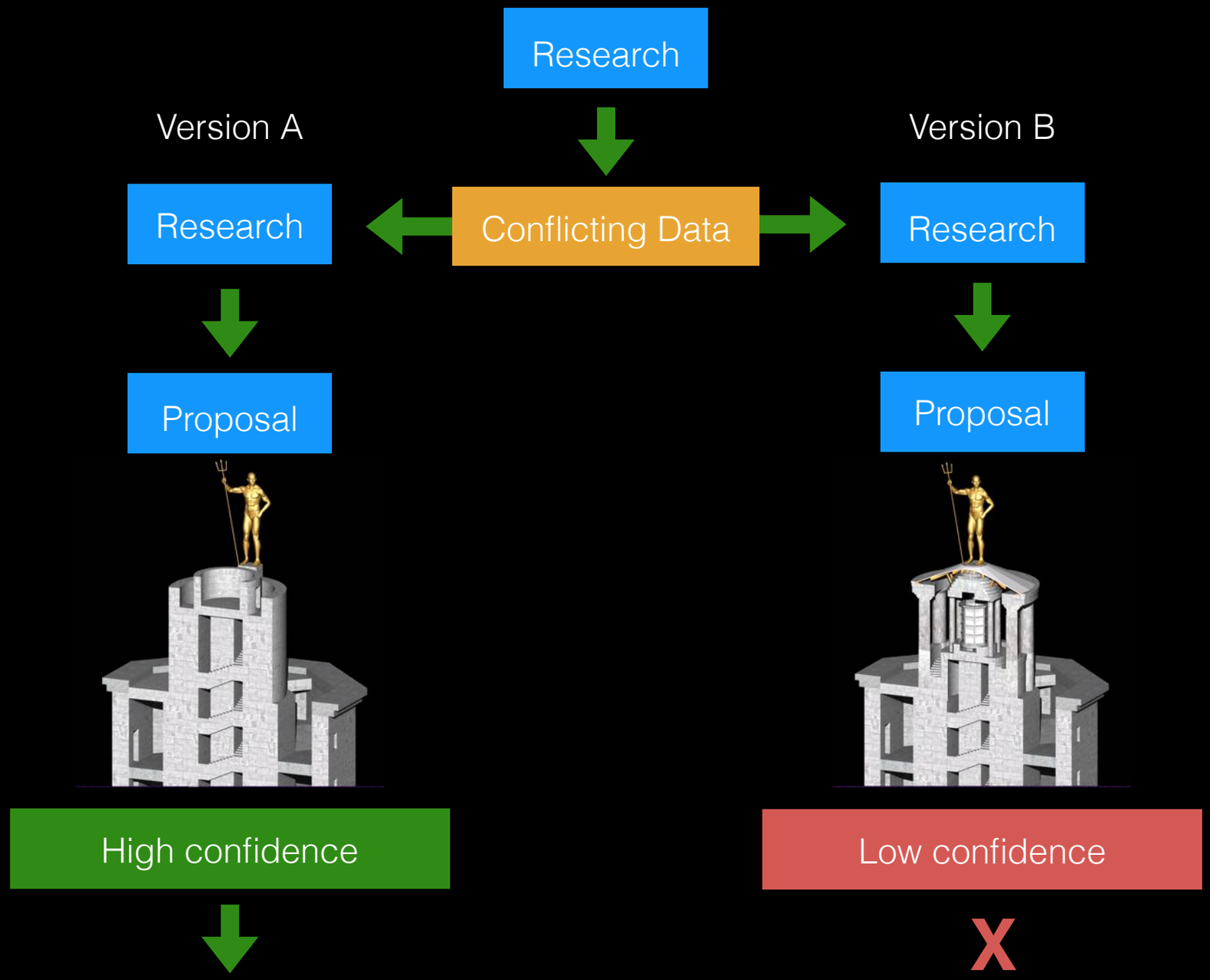


Image Source: UCLA Experiential Technologies Center

Pharos Lighthouse



Decision trees

Image Source: UCLA Experiential Technologies Center

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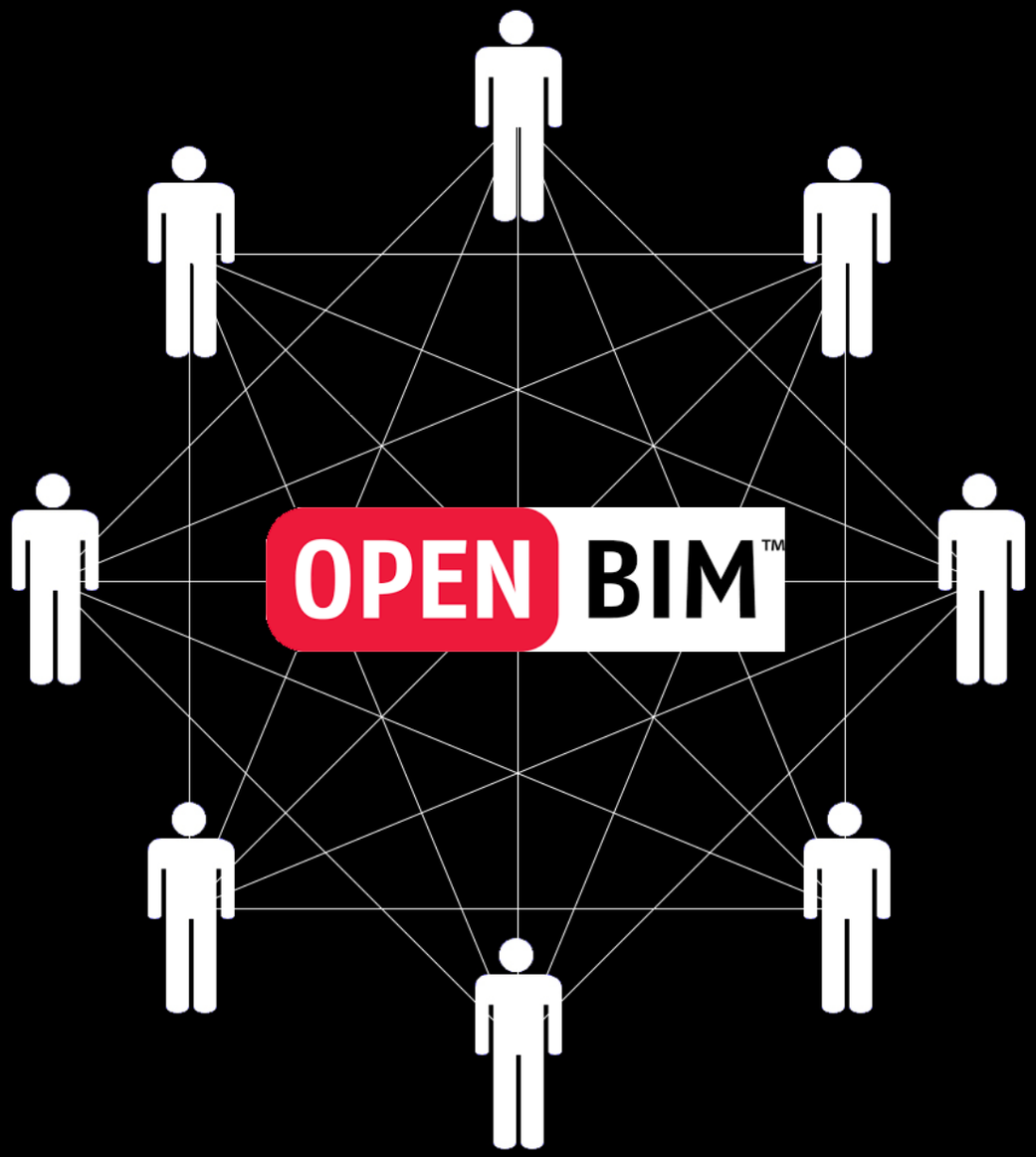
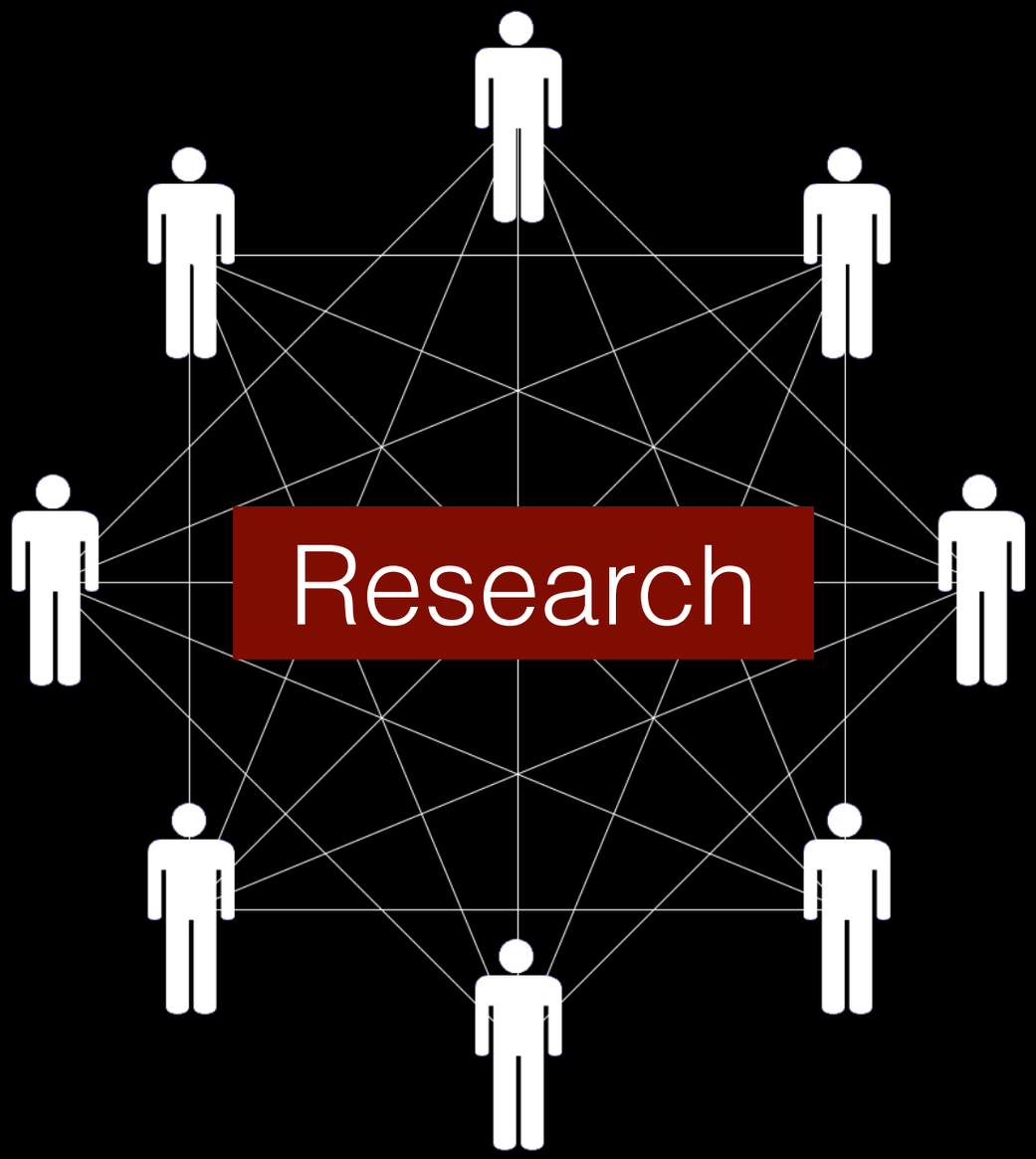


Industry Foundation Classes (IFC)

Image Source: UCLA Experiential Technologies Center

Pharos Lighthouse



Open sharing of research projects

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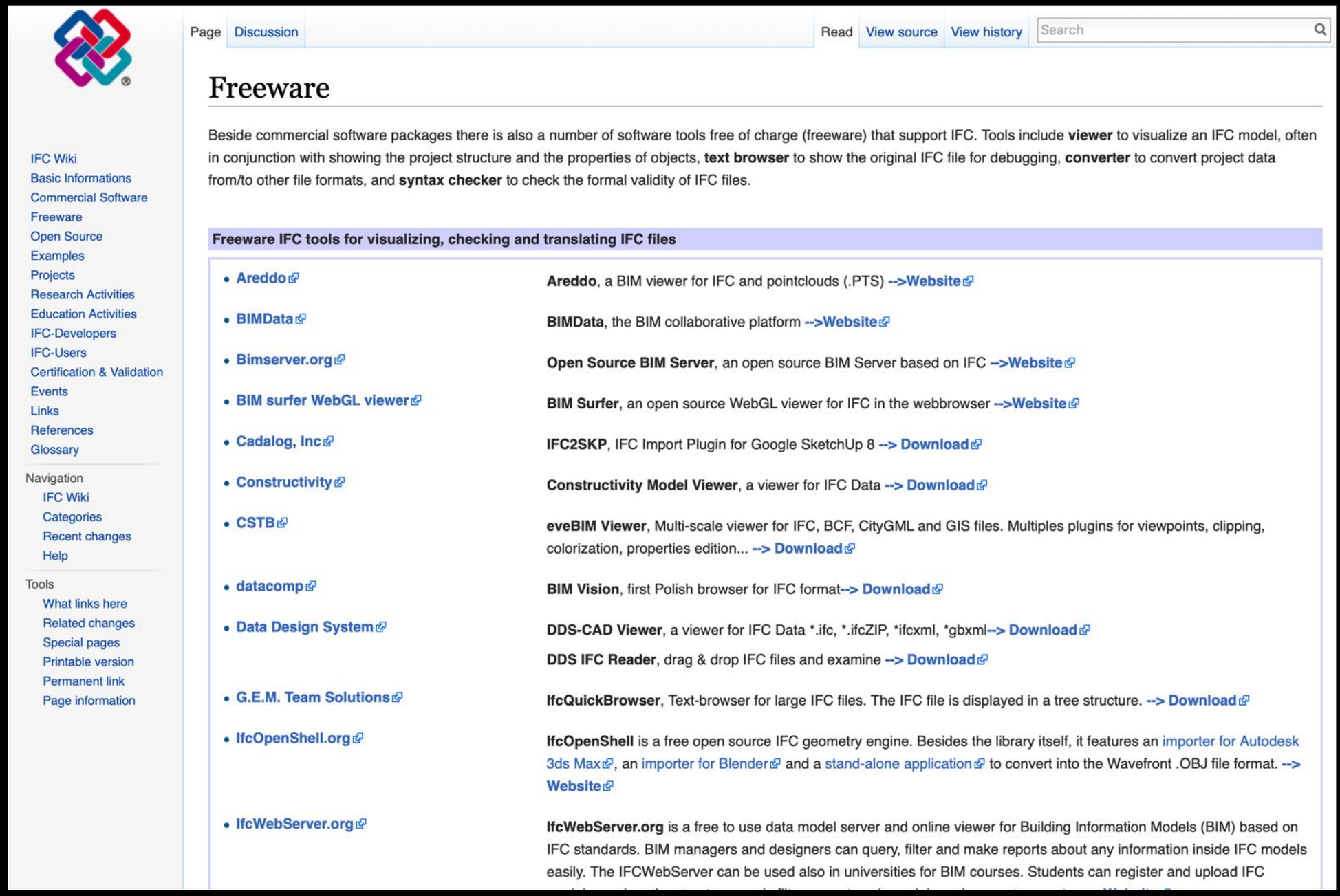
Pharos Lighthouse



Page Discussion Read View source View history Search

Freeware

Beside commercial software packages there is also a number of software tools free of charge (freeware) that support IFC. Tools include **viewer** to visualize an IFC model, often in conjunction with showing the project structure and the properties of objects, **text browser** to show the original IFC file for debugging, **converter** to convert project data from/to other file formats, and **syntax checker** to check the formal validity of IFC files.

Freeware IFC tools for visualizing, checking and translating IFC files

- **Areddo** — **Areddo**, a BIM viewer for IFC and pointclouds (.PTS) **-->Website**
- **BIMData** — **BIMData**, the BIM collaborative platform **-->Website**
- **Bimserver.org** — **Open Source BIM Server**, an open source BIM Server based on IFC **-->Website**
- **BIM surfer WebGL viewer** — **BIM Surfer**, an open source WebGL viewer for IFC in the webbrowser **-->Website**
- **Cadalog, Inc** — **IFC2SKP**, IFC Import Plugin for Google SketchUp 8 **--> Download**
- **Constructivity** — **Constructivity Model Viewer**, a viewer for IFC Data **--> Download**
- **CSTB** — **eveBIM Viewer**, Multi-scale viewer for IFC, BCF, CityGML and GIS files. Multiples plugins for viewpoints, clipping, colorization, properties edition... **--> Download**
- **datacomp** — **BIM Vision**, first Polish browser for IFC format**--> Download**
- **Data Design System** — **DDS-CAD Viewer**, a viewer for IFC Data *.ifc, *.ifcZIP, *ifcxml, *gbxml**--> Download**
  DDS IFC Reader, drag & drop IFC files and examine **--> Download**
- **G.E.M. Team Solutions** — **IfcQuickBrowser**, Text-browser for large IFC files. The IFC file is displayed in a tree structure. **--> Download**
- **IfcOpenShell.org** — **IfcOpenShell** is a free open source IFC geometry engine. Besides the library itself, it features an importer for Autodesk 3ds Max, an importer for Blender and a stand-alone application to convert into the Wavefront .OBJ file format. **--> Website**
- **IfcWebServer.org** — **IfcWebServer.org** is a free to use data model server and online viewer for Building Information Models (BIM) based on IFC standards. BIM managers and designers can query, filter and make reports about any information inside IFC models easily. The IFCWebServer can be used also in universities for BIM courses. Students can register and upload IFC

IFC Wiki

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Image Source: UCLA Experiential Technologies Center

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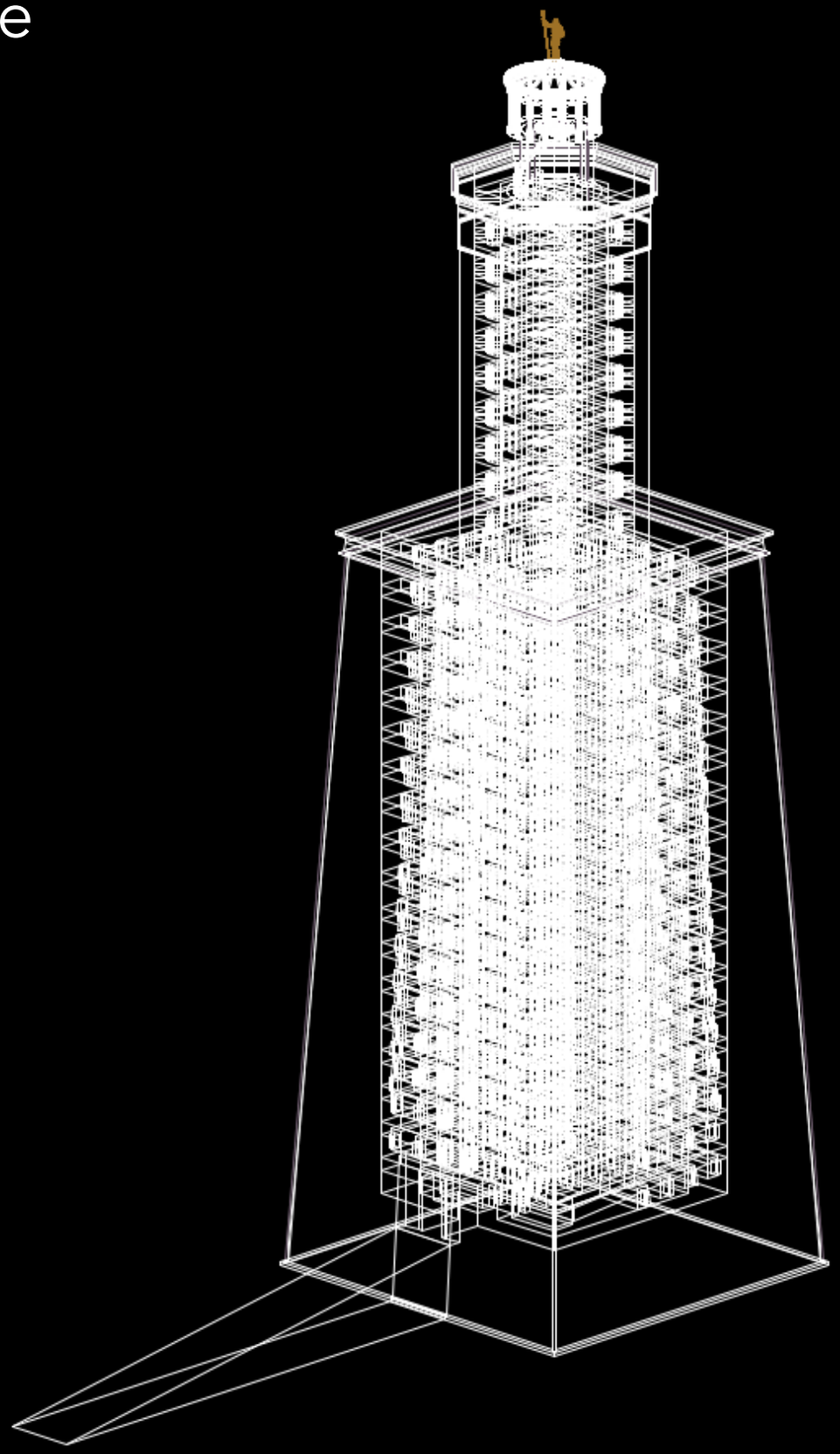
Pharos Lighthouse



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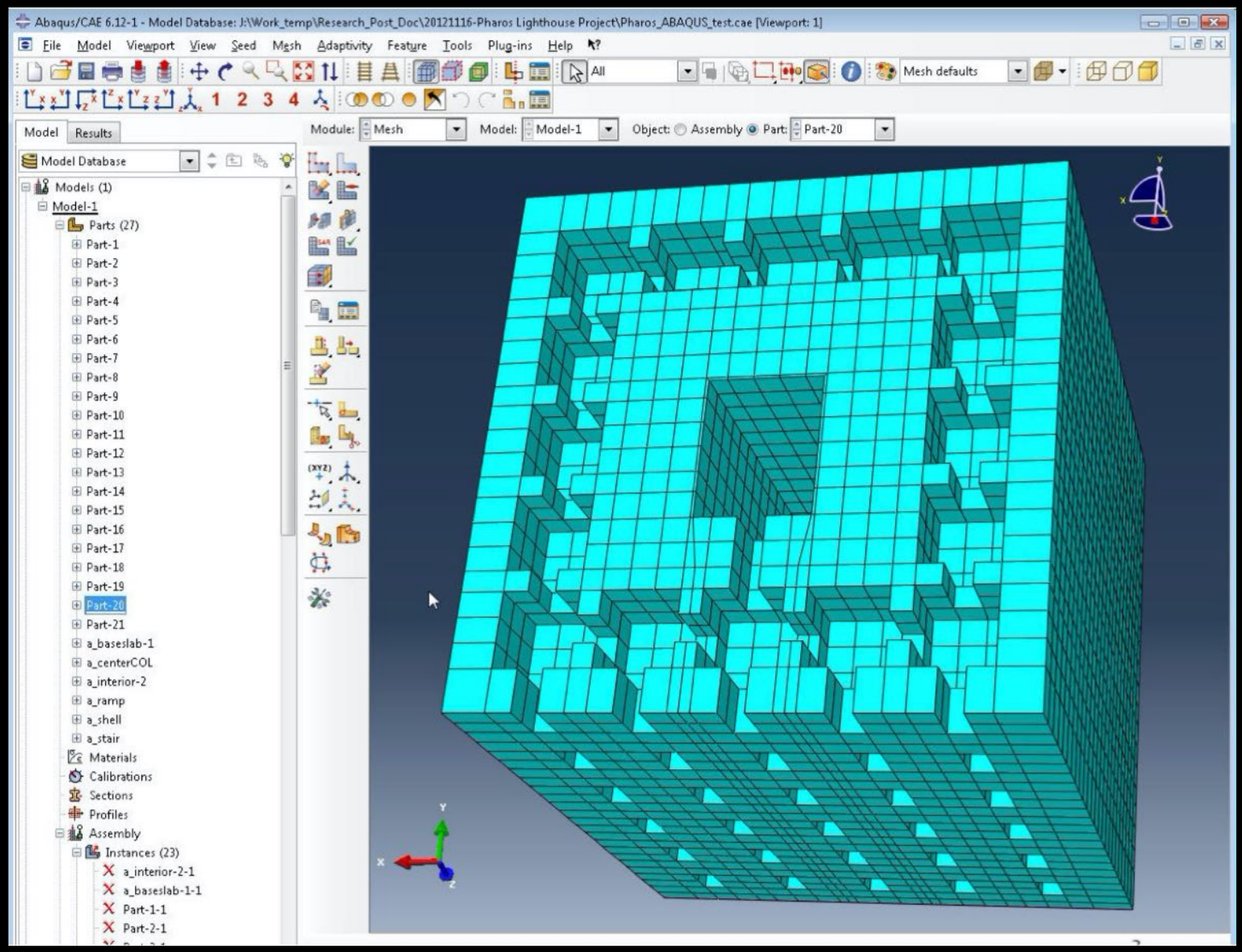

3D Finite Element Model

UCLA Samueli School of Engineering

Image Source: UCLA Samueli School of Engineering

UCLA

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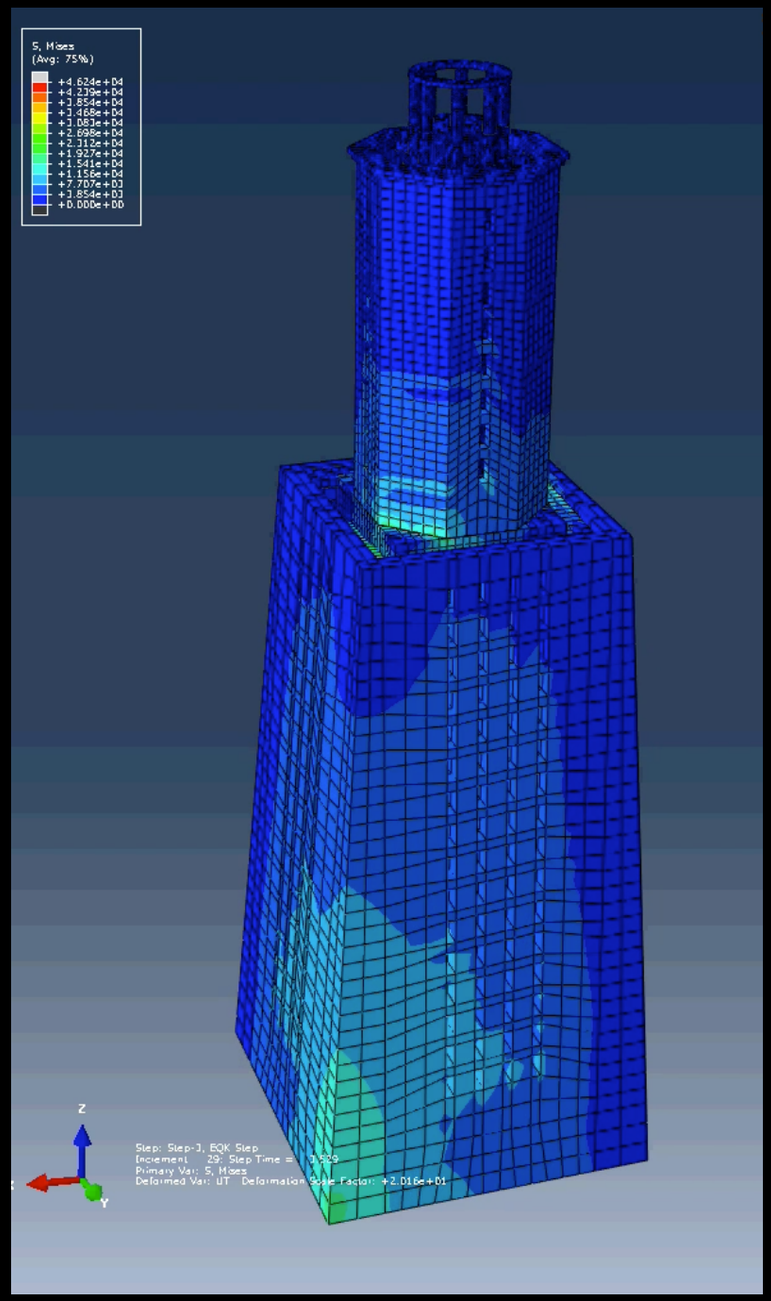

Discrete element simulation

Image Source: UCLA Samueli School of Engineering

What research projects are suited to 3d modeling?

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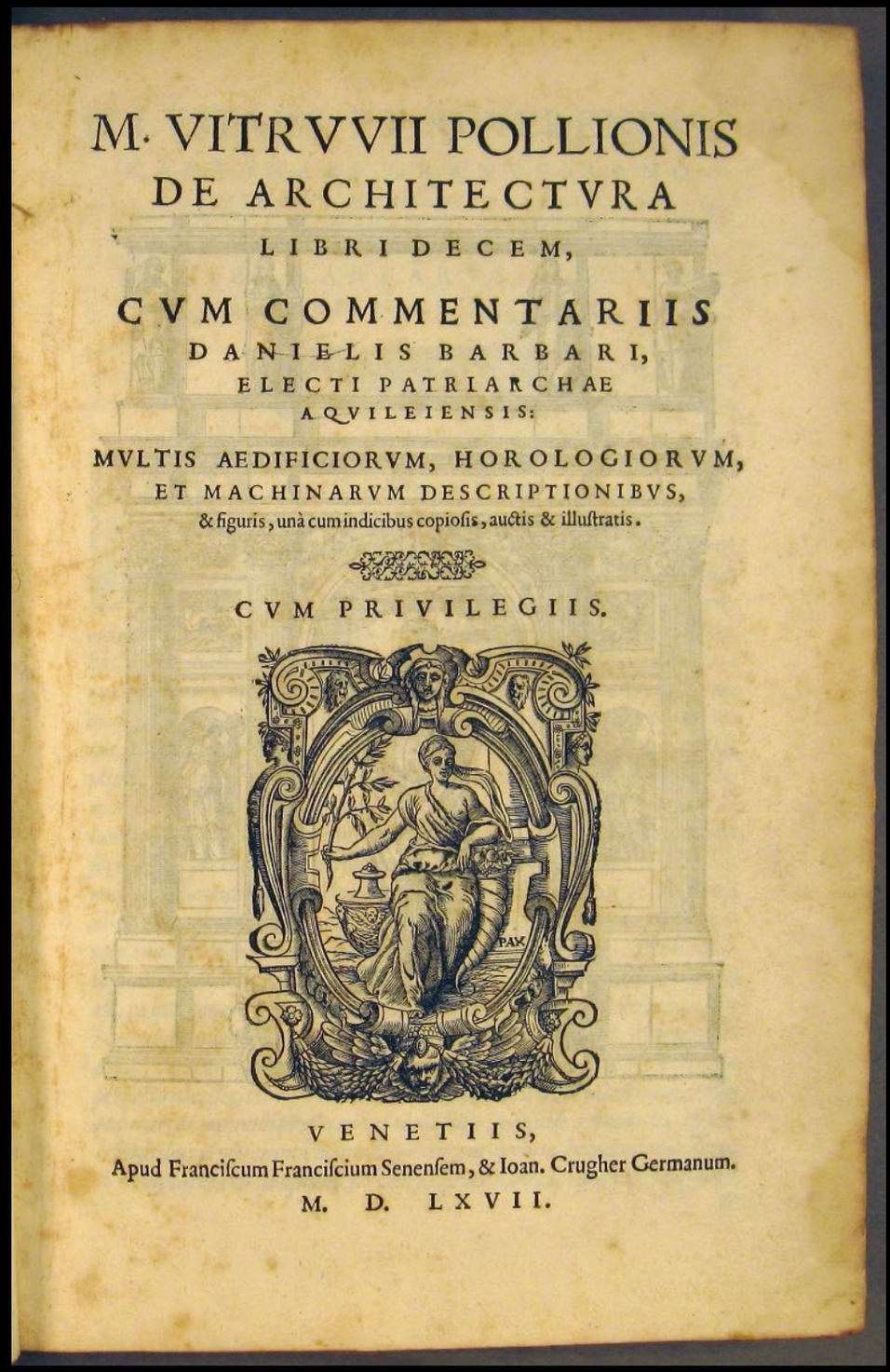
Data

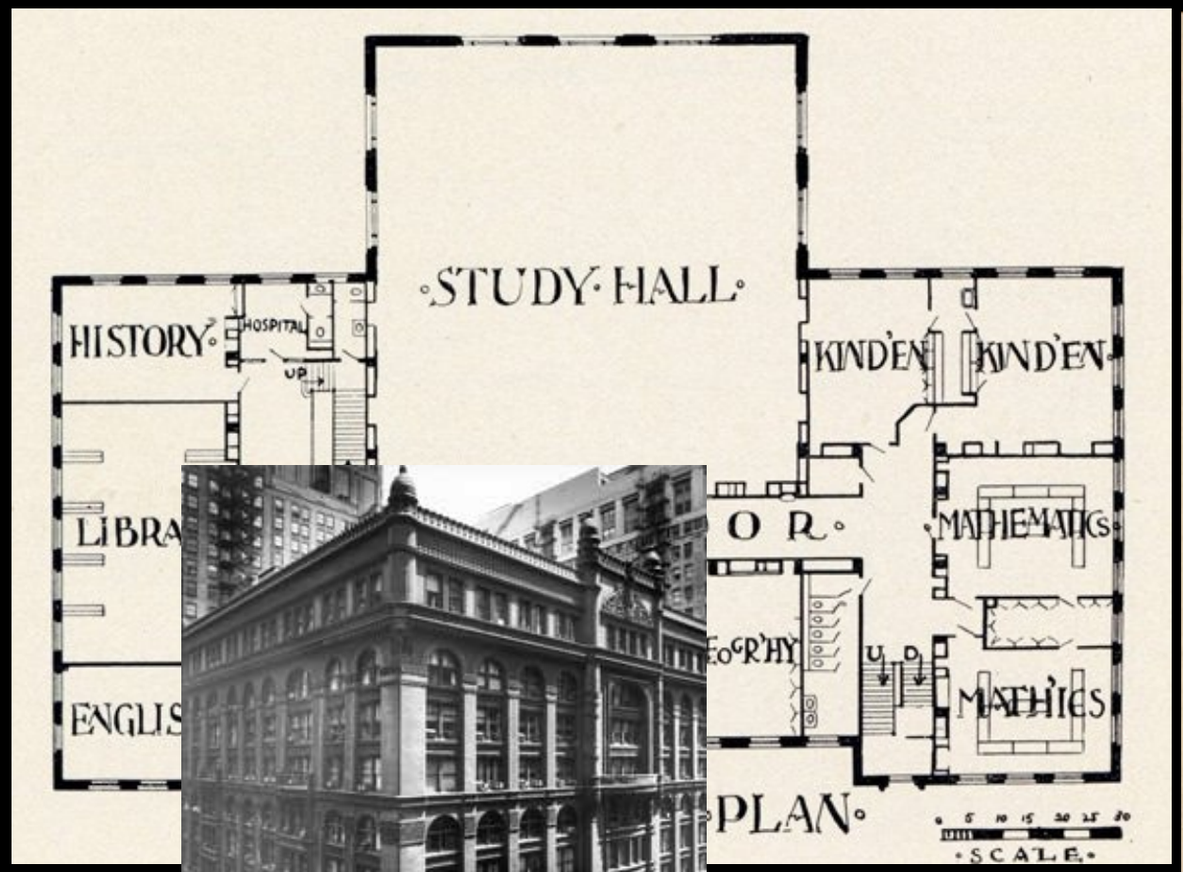


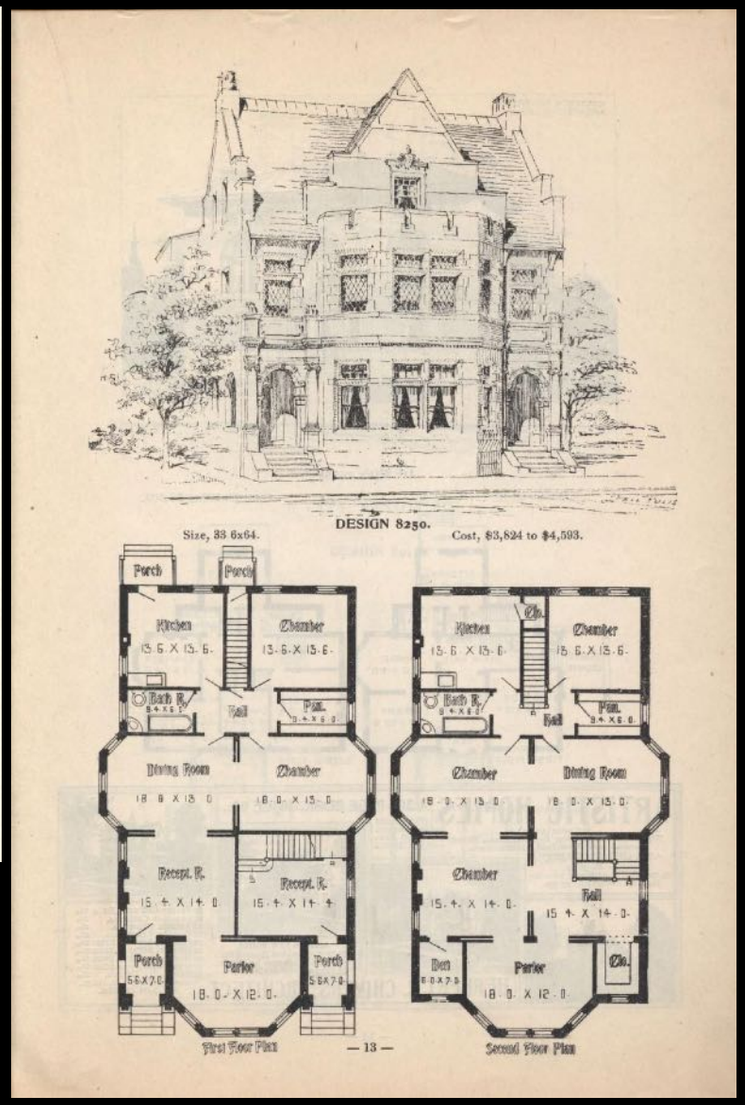
M. VITRVVII POLLIONIS
DE ARCHITECTVRA
LIBRI DECEM,
CVM COMMENTARIIS
DANIELIS BARBARI,
ELECTI PATRIARCHAE
AQVILEIENSIS:
MVLTIS AEDIFICIORVM, HOROLOGIORVM,
ET MACHINARVM DESCRIPTIONIBVS,
& figuris, unà cum indicibus copioſis, auctis & illuſtratis.

CVM PRIVILEGIIS.

VENETIIS,
Apud Franciſcum Franciſcium Senenſem, & Ioan. Crugher Germanum.
M. D. LXVII.

Plans and Photos





Images Source: https://www.universalhub.com, https://www.pinterest.com/pin/559924166146324591/?lp=true, https://www.historians.org

Manageable scale

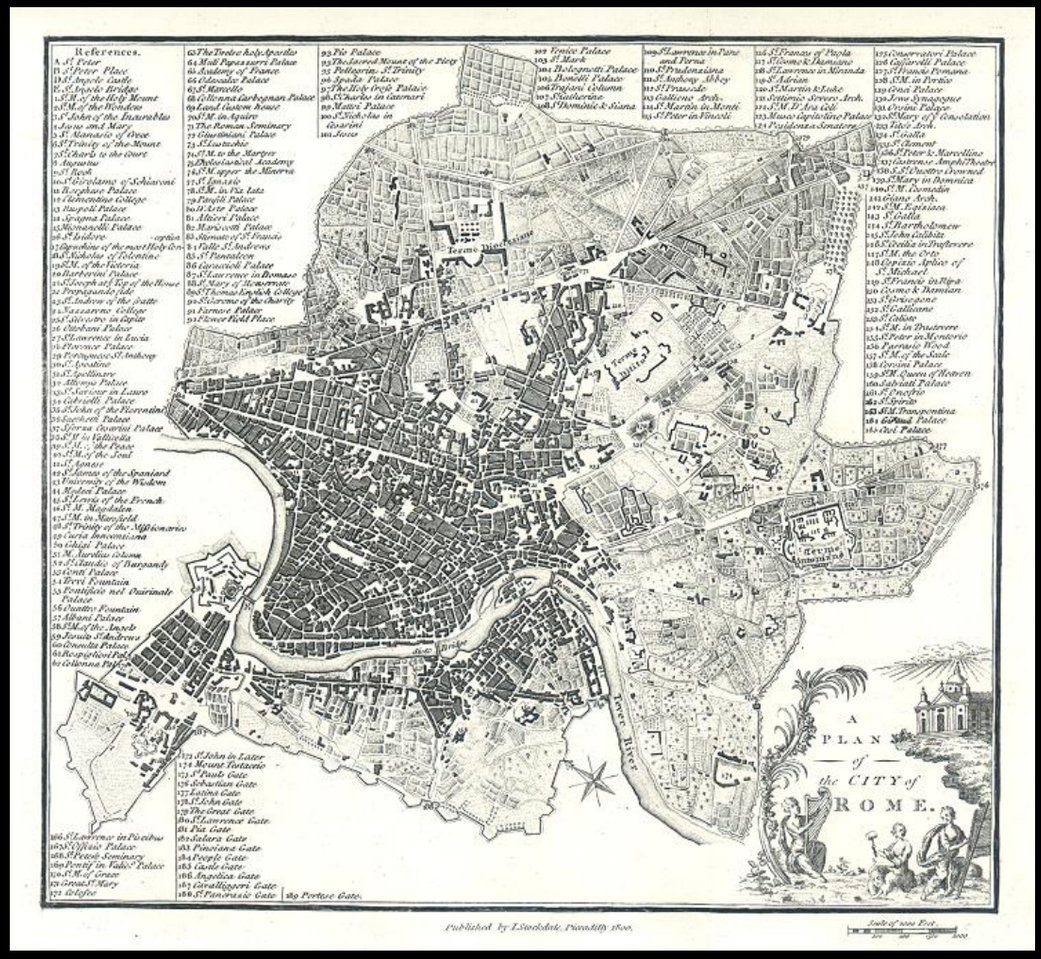


Image Source:s https://www.terrecottecestenoli.it, http://www.ancestryimages.com

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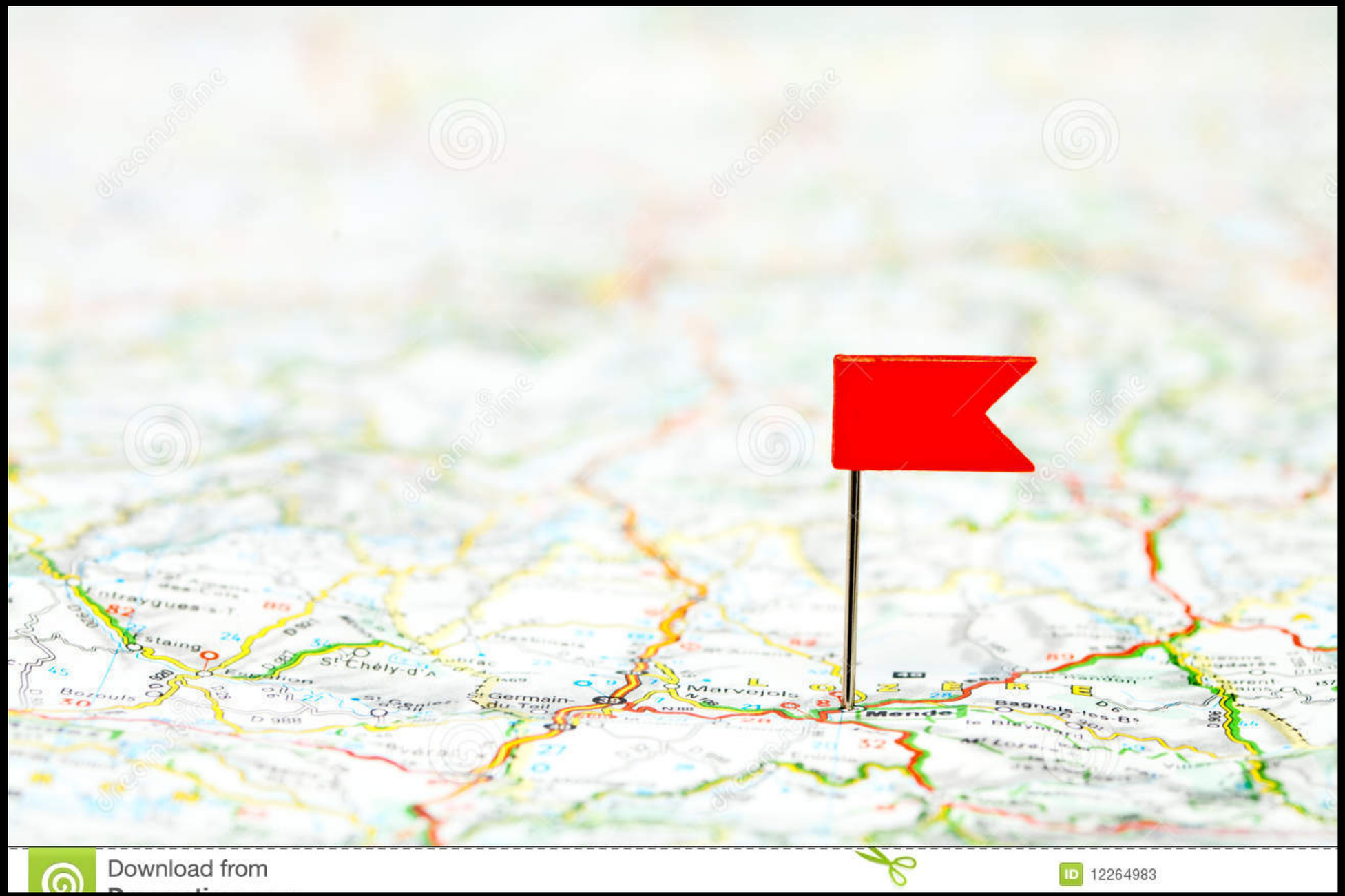

Think about your Destination

Image Source: https://nyforrichardson.blogspot.com/

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Focus on content not platform

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Software & hardware

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Image Source: https://www.elsetge.cat/pngvi/hiJTmw_smartphone-wqhd-wallpaper-facebook-server-room/

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Teams and skills

Image Source: https://infolific.com/technology/project-management/improving-your-team-skills/

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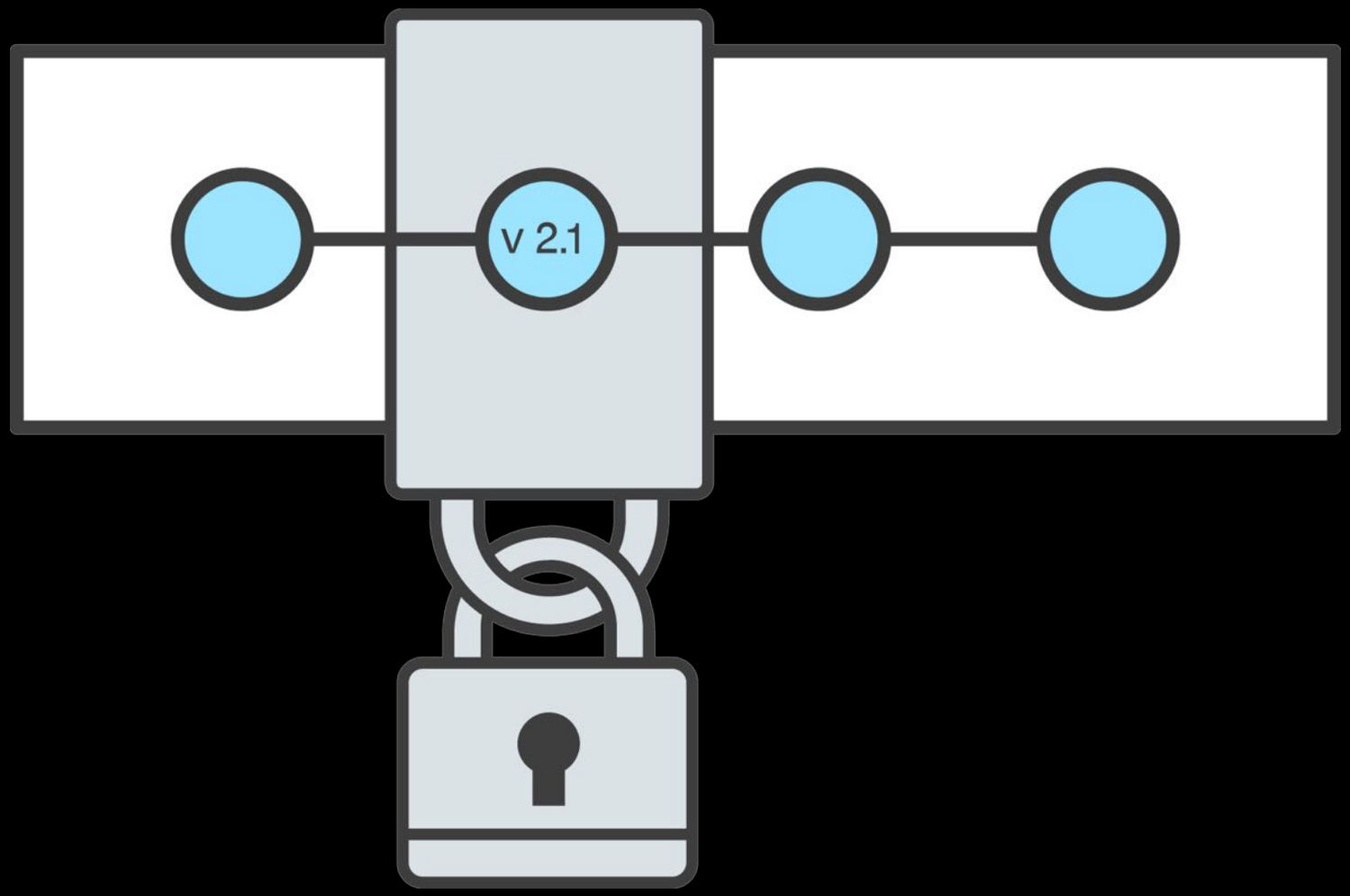

Version control

Image Source: https://www.atlassian.com/git/tutorials/what-is-version-control

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Backup

Image Source: https://www.techcd.com.br/noticias/backup/

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Archiving

Image Source: https://www.docbyte.com/whitepapers/time-to-go-legally-paperless-start-your-digital-archiving-strategy-here

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Project longevity and sustainability

Image Source: https://www.mbacentral.org/sustainability-mba-degrees/

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Modeling Software

Title	Licence	Free Version Available	Uses (Partial List)	BIM Support	URL	Cross-platform
AutoCad	Commercial	Yes	2D/3D Modeling with many specialized toolsets	Yes	https://www.autodesk.com	Yes
Blender	Open Source	Yes	Modeling, rigging, animation, simulation, rendering, compositing, motion tracking, and video editing and game	N/A	https://www.blender.org	Yes
Rhinoceros 3D	Commercial	No*	NURBS based 3D modeling with focus on producing complex curves and freeform surfaces.	Plug-in	https://www.rhino3d.com	Yes
Sketchup	Commercial	Yes	Web-based 3D modeling for architectural, interior design, landscape architecture, civil and mechanical engineering, film	Plug-in	https://www.sketchup.com	Yes
Solidworks	Commercial	No*	Engineering focused 3D solid/parametric modeler	Yes	https://www.solidworks.com	No
Unity	Commercial	Yes	Game engine used to create both three-dimensional and two-dimensional games as well as simulations for its many	N/A	https://unity3d.com	Yes
Vectorworks	Commercial	Yes	2D/3D solid/parametric modeling, digital terrain modeling, GIS, Rendering, and animation	Yes	https://www.vectorworks.net/en	Yes
VSIM	Educational	Yes	Real-time exploration of highly detailed, 3D models in both formal and informal educational settings.	N/A	https://idre.ucla.edu/research/active-research/vsim	Yes

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Questions?

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