UCLA LIBRARY'S 3D CUNEIFORM COLLECTION

A DIGITAL PRESERVATION NEEDS ASSESSMENT

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Introduction

UCLA Library Special Collections (LSC) houses three collections of cuneiform tablets. The Lloyd E. Cotsen Cuneiform Tablets Collection (Collection 1883)[1], the Cumberland Clark Cuneiform Tablet Collection (Collection 1826)[2], and the Edward A. Dickson Cuneiform Tablet Collection (Collection 1813)[3]. These cuneiform tablet collections provided the UCLA Library a manageable pilot project to develop 3D models of cultural heritage materials. More and more cultural institutions are taking advantage of 3D technology and working to create 3D scans of their collections as an alternative to access and preservation.[4] These digital collections provide great opportunities for research, creative remixing, hands-on learning and more. Not only can 3D models be viewed and manipulated online, they can be downloaded and used to print replicas. As we move into the future of this rapidly emerging technology, an urgent need to properly preserve 3D models and associated data has become evident. There are many pieces to the puzzle to preservation of these models, including: authenticity, ethics and copyright, storage and file management, access and use, and associated metadata. The following report will assess all digital preservation needs for cuneiform 3D models, make recommendations for future practices, and provide a framework that can be implemented to like collections at the UCLA Library Special Collections.

Status of the Collections and Current Infrastructure

1 "Finding Aid for the Lloyd E. Cotsen Cuneiform Tablets Collection (Collection 1883). UCLA Library Special Collections, Charles E. Young Research Library, University of California, Los Angeles.," accessed March 8, 2020, https://oac.cdlib.org/findaid/ark:/13030/kt0t1nf169/entire_text/?query=Clark%20(Cumberland)%20Cuneiform%20Tablet%20collection;

2 "Finding Aid for the Cumberland Clark Cuneiform Tablet Collection (Collection 1826). UCLA Library Special Collections, Charles E. Young Research Library.," accessed March 8, 2020, https://oac.cdlib.org/findaid/ark:/13030/kt438nf4h2/entire_text/?query=Clark%20(Cumberland)%20Cuneiform%20Tablet%20collection.

3 "Finding Aid for the Edward A. Dickson Cuneiform Tablet Collection (Collection 1813). Library Special Collections, Charles E. Young Research Library, UCLA.," accessed March 8, 2020, https://oac.cdlib.org/findaid/ark:/13030/kt9m3nf3ng/entire_text/?query=Clark%20(Cumberland)%20Cuneiform%20Tablet%20collection;

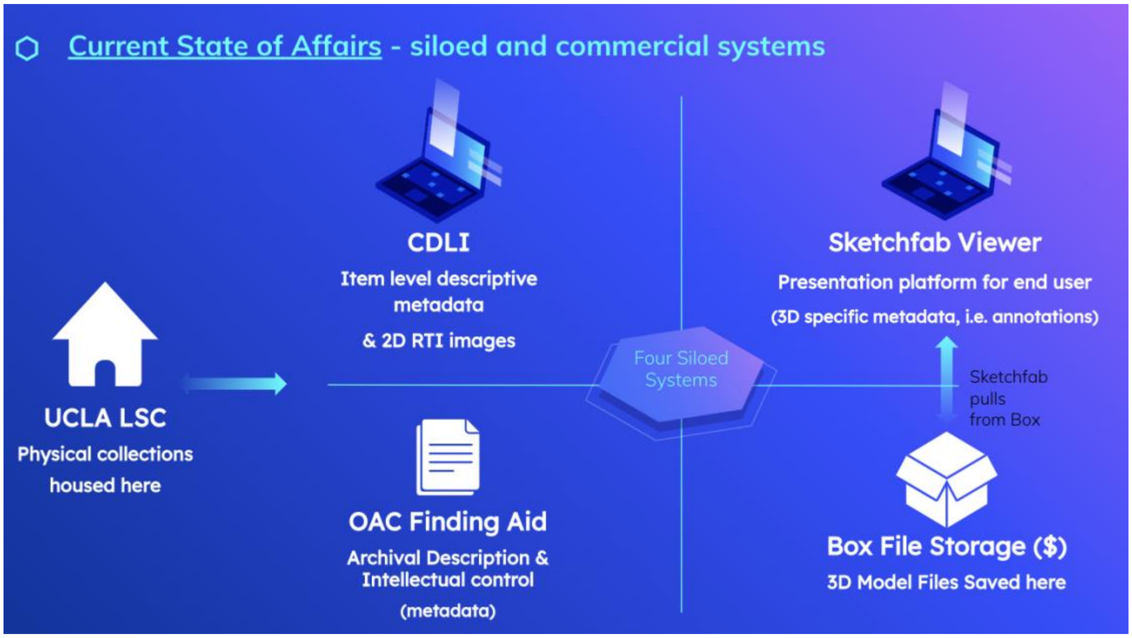
4 "The British Museum Creates 3D Models of the Rosetta Stone & 200+ Other Historic Artifacts: Download or View in Virtual Reality," Open Culture, July 25, 2017, http://www.openculture.com/2017/07/the-first-3d-scan-of-the-rosetta-stone-now-online.html; Eileen Jakeway, "Library's Collections Come to Life as 3D Models | The Signal," Library of Congress, January 9, 2020, https://blogs.loc.gov/thesignal/2020/01/librarys-collections-come-to-life-as-3d-models/; "3D Scanning, Hacking, and Printing in Art Museums, for the Masses | The Metropolitan Museum of Art," accessed February 21, 2020, https://www.metmuseum.org/blogs/digital-underground/posts/2013/3d-printing; "3D Scanning at the Smithsonian," Smithsonian Digitization 3D, accessed February 21, 2020, https://3d.si.edu/content/3d-scanning-smithsonian.

Currently, the physical objects from all three collections - the Clark, Dickson, and Cotsen collections - are housed with UCLA LSC and are archivally described and controlled using a finding aid that is posted on the Online Archive of California (OAC).[5] Concurrently, a collection aggregator website stores digitized copies of individual cuneiform and catalogs each artifact at the item level. This site is called The Cuneiform Digital Library Initiative (CDLI)[6] and it presents 2D images of each tablet as well as detailed descriptive metadata.[7]

Recently, one of the authors and the team from UCLA Libraries Digital Initiatives and Information Technology department worked to create 3D models of all cuneiforms using a structured light 3D scanner, namely the Artec Space Spider. Currently these models are stored using Box. Box is a commercial proprietary storage solution which has potential negative long term effects concerning the digital preservation of these collections. The Box folder system houses file types specific to 3D models. These file types include the proprietary Artec Studio scanning project associated with each cuneiform, STL files, and OBJ files with their associated texture files, which we will discuss in greater detail below.

The files from Box were then uploaded and connected to a platform called Sketchfab to provide viewer access. Sketchfab is a proprietary 3D viewer software system. 3D viewers are the tools cultural institutions utilize to present their objects to the public. Unfortunately, Sketchfab implements a file size limit and does not allow for robst metadata. Below is a diagram of the current infrastructure that supports the 3D models and metadata of the Clark, Dickson, and Cotsen cuneiform collections:

5 "UCLA, Online Archive of California," accessed March 8, 2020, https://oac.cdlib.org/institutions/UCLA.
6 "CDLI - Cuneiform Digital Library Initiative," accessed March 8, 2020, https://cdli.ucla.edu/.
7 "CDLI-Archival View of P387614," accessed March 8, 2020, https://cdli.ucla.edu/search/archival_view.php?ObjectID=P387614.



As you can see from the above diagram, the 3D files are stored on a server that does not interoperate with the metadata stored in OAC or CDLI. The models can be viewed through Sketchfab which is similarly siloed from the collections' metadata, and Sketchfab adds a layer of complexity in that it creates its own annotated metadata. The goal of this project is to create an interoperable ecosystem that connects the 3D scans of cuneiforms with the existing metadata, and preserves the 3D models and their associated metadata into the future for long term access and authenticity. To do this we will provide a more effective framework below that the library can implement.

In terms of the file formats, the preservation quality scans are critically important. These scans are exported into an OBJ file, with associated texture files. In 3D model parlance, texture refers to the surface color of the object. To create texture, the OBJ files include an image file (in the case of this collection, PNG files) and an MTL file. The MTL file tells the 3D modeling software how the image file is to be applied to the 3D model. STL files are 3D models without any texture information and are used most commonly with 3D printers.

There are currently no standards defining what file types are best for 3D models to be stored and preserved. However, the UK's Archaeology Data Service considers the OBJ format to be preservation quality.[8] Other popular file types being used by cultural institutions include

[8] "Guides to Good Practice: 3d_2-3," Archaeology Data Service / Digital Antiquity, accessed March 16, 2020, https://guides.archaeologydataservice.ac.uk/g2gp/3d_2-3.

X3D, DAE, and PLY. The functionality of these projects is wholly dependent on the resources of archives and their ability to access software. Nevertheless, these projects were saved in either OBJ or STL file formats to prevent obsolescence. This uncertainty regarding appropriate file formats highlights a major challenge facing digital preservationists working with 3D data. Although there are a set of emerging standards for 3D model file formats,[9] the lack of an agreed upon file format combined with the number of different emerging candidate formats can lead to much confusion. Such a variety in file formats will also impede future accessibility. Not only will future software need to be compatible with a variety of formats, but as formats emerge as the industry standard, other formats will increasingly lose a support structure, leaving older models in formats that are no longer supported.

Challenges in 3D Models

Mapping the current infrastructure of the 3D models and associated metadata is important to propose current roadblocks. Below, we outline the challenges that exist surrounding preserving the collections' data.

a. Metadata Challenges

To begin, metadata standards for 3D models are still being developed. In particular, metadata that is specific to 3D data has yet to be defined. For example, Annotations are a functionality specific to 3D models. Annotations allow you to tag a specific part of the 3D model and add metadata unique to that part of the model (such as, selecting one side of a cuneiform to access a translation). Annotations on a 3D model will require geospatial data to ensure that the annotation is consistently placed in the correct area, regardless of the end users' mode of viewing the model. Scale is also an issue. 3D objects must adopt a standard metadata schema for conveying the size of the object. In this way, objects from different collections or institutions will be accurately scaled to one another, so that a cuneiform tablet is not as large as a building or vice versa, for example.

At the September 2014 ICAM (International Confederation of Architectural Museums) Conference, the absence of a digital 3D preservation standard and best practices were paramount: The overall impression from across the presentations was that the complex problems inherent in preserving digital design data are multilayered and comprise many general challenges. Each

9 "Guides to Good Practice: 3d_2-3"

institution was developing its own processes and methodologies, and many were not working across allied domains, such as digital preservation, from which they could adapt solutions and standards. The presentations made it clear that the problems would be better worked on collaboratively across institutions and across domains to take advantage of expertise at both the national and the international levels.[10]

Three years later, the Future Landscape: Digital Architecture, Design and Engineering Assets summit hosted by the Library of Congress, the Architect of the Capitol, and the National Gallery of Art in November 2017 brought together leaders from a range of digital design communities.[11] This event reemphasized the pressing need for preservation strategies and uniform standards for metadata, especially with the advancement and availability of preservation tools such as BitCurator and Archivematica.[12] Research undertaken in 2003 on the best practices, strategies, and standards for the preservation of digital 3D architecture and design files is finally yielding results.[13] Three projects began in 2017 supported by the Institute of Museum and Library Services (IMLS): Building for Tomorrow, Community Standards for 3D Preservation (CS3DP), and Developing Library Strategy for 3D Virtual Reality Collection Development and Reuse (LIB3DVR).[14] The CS3DP project has made great progress in developing a uniform community 3D digital preservation standard; researchers collected survey data from a variety of experts regarding their standard preservations practices,[15] and presented their findings at the Library of Congress on November 18, 2018.[16] A representative of CS3DP said the group would be publishing a book detailing best practices and standards in the next year.

b. The Challenge of Automation

The second major challenge facing curators of 3D data is the difficulty in automation, making scalability difficult. In the case of the cuneiform collections, for example, annotations containing translations of the writings must be placed next to the appropriate writing. Many models are cylindrical, containing writings all over the artifact, whereas others often contain

10 "3D/VR in the Academic Library: Emerging Practices and Trends" (Arlington, VA: Council on LIbrary and Information Resources, February 2019)., 95.

11 "3D/VR in the Academic Library," 96.

12 Ibid.

13 Ibid.

14 "3D/VR in the Academic Library," 97.

15 "CS3DP (Community Standards for 3D Data Preservation)," January 9, 2017, https://osf.io/ewt2h/wiki/home/.

16 Library of Congress, "Born To Be 3D," web page, Born to Be 3D: Digital Stewardship of Intrinsic 3D Data*, November 2, 2018, https://www.loc.gov/preservation/digital/meetings/b2b3d/b2b3d2018.html.

writings on the front and back. Such work not only must be done manually, but must be done by subject experts that can read each tablet, thus placing 3D annotations in their appropriate geospatial locations. The format(s) for this type of metadata have not been decided upon. Among the functionalities that must be considered is making these annotations queryable, so that users can easily search for relevant artifacts within the 3D collections just as easily as can be done in the CDLI collection. Because these annotations "live" in 3D space alongside their respective objects, they must also adhere to the same scaling convention, so that annotations retain their appropriate size if objects from different collections are used in conjunction with one another.

c. Platform Usability Challenges

A third challenge regarding preservation is giving a user concurrent access to the 3D object and associate metadata. Currently there is no software nor platform that offers users a straightforward one-stop viewer that incorporates an effective 3D rendering and structured metadata. Users should have the ability to effortlessly view 3D models and metadata, requiring special software a user must install or a powerful computer to view high-resolution models add a layer of complexity that could prevent access. In much the same way a user can currently view 2D images of a given collection by scrolling through a set of thumbnails, 3D models viewers should provide the same capabilities and convenience to users. Users should similarly be able to click on a 3D thumbnail that they wish to inspect more closely. All of this requires a 3D viewer that works with Internet browsers like Firefox, Chrome, Internet Explorer, and Safari. Such viewers are available, the most notable example being the commercial platform Sketchfab, which we are currently using to present the 3D models of UCLA's cuneiforms. Sketchfab is used by dozens of cultural heritage institutions to display their 3D collections.[17]

As compelling as Sketchfab's system is, there are drawbacks. Educational institutions, such as UCLA Library, are able to obtain a free account with Sketchfab. Sketchfab's free educational account is equivalent to their Pro plan,[18] which places limits on the number of annotations per model as well as the number of views per month, among other limitations.[19]

[17]"Sketchfab Launches Public Domain Dedication for 3D Cultural Heritage," Sketchfab Community Blog, February 25, 2020, https://sketchfab.com/blogs/community/sketchfab-launches-public-domain-dedication-for-3d-cultural-heritage/; Thomas Flynn, "What Happens When You Share 3D Models Online (In 3D)?," *3D/VR in the Academic Library: Emerging Practices and Trends: Council on LIbrary and Information Resources*, February 2019.

[18] "Sketchfab for Education – Sketchfab Help Center," accessed March 16, 2020, https://help.sketchfab.com/hc/en-us/articles/210213633-Sketchfab-for-Education.

[19] "Plans & Pricing," Sketchfab, accessed March 16, 2020, https://sketchfab.com/plans.

Most notably, however, are the limits placed upon the file size of the individual models. The file size of a 3D model usually corresponds directly to the resolution, or quality, of the digital model.[20] In the case of such high resolution models, displaying them on an end-user's machine using Sketchfab's free educational account means decimating[21] the model. Ideally, such limits would not exist, allowing end users to experience preservation quality models for any given 3D object. The end result is that the 3D models in these collections are hosted on two commercial platforms: Box is used for accessing and downloading the preservation quality models, and Sketchfab as a means to present the objects in 3D for end users to engage with. Discoverability and accessibility of the collection is limited to just OAC and CDLI, however each individual model on Sketchfab has links to both OAC and CDLI, as well as the corresponding Box folder that contains the models. Instead of becoming reliant on these commercial platforms, cultural heritage institutions should be striving to create an open source framework that mirrors the functionality of Sketchfab, with a trusted repository for hosting preservation quality models as the underlying infrastructure. Fortunately, the pieces for such a framework already exist, and we believe that these collections of 3D models make for a great sample set with which to test the viability and robustness of the framework proposed below.

d. Challenges Associated with Current Community Preservation Best Practices

Developments in digital 3D modeling and the corresponding metadata allows communities, educators, and researchers to access culturally and historically important materials. Institutions such as libraries employ 3D modeling software to share heritage materials, but the reliance on proprietary software has left scholars, archivists, and librarians scrambling for definitive standards to preserve and display 3D imagery and associated metadata. Though, currently, a uniform guideline to practice 3D preservation is absent. In a 2013 report, the Digital Preservation Coalition addressed the importance of preserving CAD (computer-aided design) models. This report highlighted several strategies that can be utilized for preservation, including

[20] The resolution of a 3D model refers to the number of its polygons. 3D models are a collection of thousands or even millions of points in 3D space, collectively known as a point cloud. Each point within this point cloud is connected to its neighboring points, forming triangles, or polygons. This collection of polygons forms the 3D model. The higher the polygon count, the more seamless and detailed the model; however, higher polygon counts also correspond directly to the model's file size.

[21] Decimation is the process of algorithmically reducing the number of polygons in a model. In the case of this collection, this process can be done using the Artec software.

STEP, the Standard for the Exchange of Product Model Data (ISO 10303),[22] the IFC and NBIMS-US Standard, VDA the Recommendation 4958 (VDA, 2005–2007), the LOTAR standard, and the FACADE project standards.[23] In pointing out the variety of strategies, this report evidenced the lack of a uniform international standard for 3D preservation best practices.

Proposing a Sustainable Framework

The major components of the current framework that need to be replaced are Box and Sketchfab. Replacing these tools would allow UCLA Library to regain control over the digital objects. In total, the new proposed framework contains four major components: a new, trusted, preservation-minded repository to replace Box; a platform that interfaces with this new repository, making objects within the repository more discoverable and accessible; a seamless method for displaying 3D models in a 3D environment that includes any associated annotations and metadata; a virtual machine on which all of these pieces come together, thus removing the need for high-resolution models to be decimated.

The foundation of our proposed framework is Merritt. Merritt is “an open-source digital preservation repository maintained by the University of California Curation Center (UC3) at the California Digital Library (CDL).”[24] Although not TRAC certified,[25] Merritt is a CoreTrustSeal-certified digital repository.[26] Utilization of this repository comes at a cost to the UCLA Library. However, paying for Merritt’s service ensures this collection, as well as future collections, will be stored on a reliable, preservation-oriented, open source repository. Merritt’s service makes copies of any ingested data, ensuring that data is stored in more than one location. Additionally, fixity checks of the collections are also handled by Merritt. The alternative to a system like Merritt is for UCLA Library to build and maintain data centers that can mirror these functionalities; a prohibitively costly scenario. Once an agreement between UCLA Library and Merritt has been reached, the 3D model files will need to be migrated from Box to Merritt. Use

22Alex Ball, “Preserving Computer-Aided Design (CAD),” 1st ed., DPC Technology Watch Report (Digital Preservation Coalition, April 2013), https://doi.org/10.7207/twr13-02.

23 Ball, “Preserving Computer-Aided Design (CAD),” 9.

24 “Merritt: A Trusted, Cost-Effective Digital Preservation Repository,” University of California Merritt, accessed March 16, 2020, https://merritt.cdlib.org/.

25 “TRAC Metrics,” Center for Research Libraries: Global Resources Network, accessed March 16, 2020, https://www.crl.edu/archiving-preservation/digital-archives/metrics-assessing-and-certifying/trac.

26 Core Trust Seal, “Core Trust Seal Assessment Report - UC3 Merritt,” August 7, 2018, https://www.coretrustseal.org/wp-content/uploads/2018/08/UC3-Merritt.pdf.

of API's to automate the process would be ideal, however technical documentation from Merritt indicates that this may be difficult with the current file structure on Box.[27]

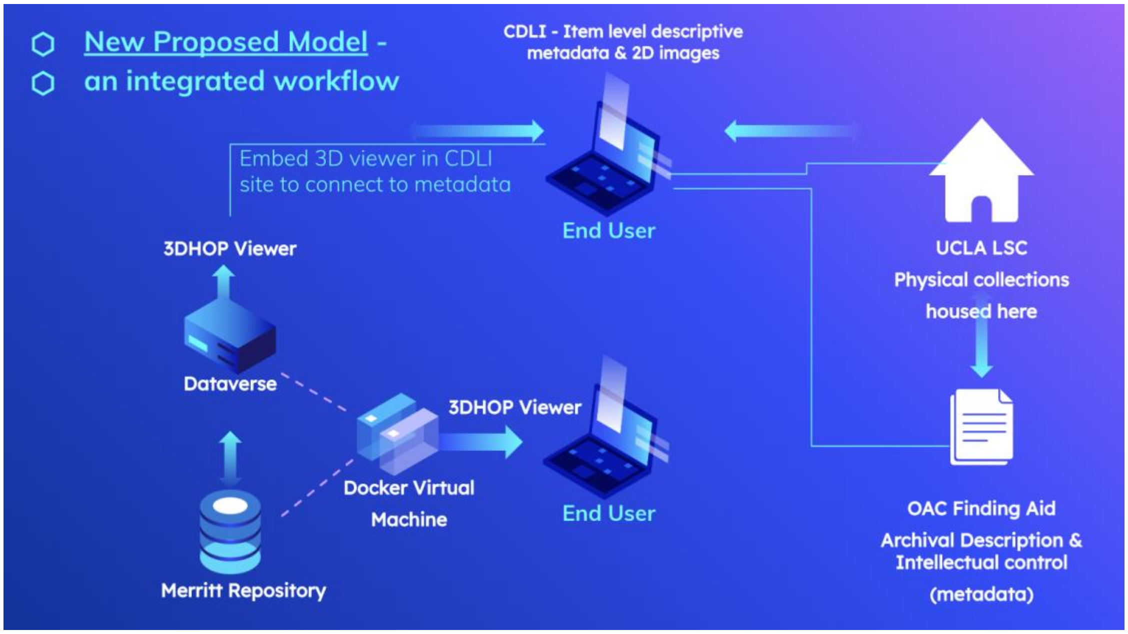
In conjunction with ingestion into Merritt, the collection -- particularly its associated metadata -- needs to simultaneously be ingested into Dataverse. Dataverse is an "open source research data repository software"[28] that will interface with collections hosted by Merritt in order to make them accessible and discoverable. UCLA Library already has an instance of Dataverse, however work needs to be done in order to adapt the system to a collection of 3D models. The aforementioned challenges regarding 3D-specific metadata are still a problem. However, such challenges need not prevent institutions from developing collections using these open-source tools. Once standards have been established, it will require less work for institutions to apply these standards to collections that have already been migrated, since the work of migrating collections like this is not reliant upon the establishment of metadata standards. In other words, collections will inevitably need to be migrated, so migration should happen as soon as possible before collections on commercial platforms grow too large and difficult to migrate.

The third piece of our proposed framework is another open-source tool that will serve as a means of displaying 3D models. This viewer is called 3D Heritage Online Presenter, or 3DHOP, and "is supported and successfully tested on the current versions of Chrome, Firefox, Edge, Opera and Safari."[29] Integrated functionality with a web browser means that the end user will not need to download any kind of software in order to view the 3D models. Instead, a window within the browser will provide an environment in which the user can rotate the 3D model, zoom in and out, change the lighting direction/source, and see any associated annotations or metadata. 3DHOP provides much of the same functionality and seamless presentation that has made Sketchfab so popular. However, integration with a web browser means that the end user's device is responsible for loading the model, and although this doesn't require any additional software, depending on the size of the model this can be problematic. To overcome this problem without the need to decimate the model, the final component of our framework is a virtual Docker instance.[30]

27 "CDLUC3/Mrt-Doc," Merritt Technical Documentation GitHub, accessed March 16, 2020, https://github.com/CDLUC3/mrt-doc.
28 "The Dataverse Project," accessed March 16, 2020, https://dataverse.org/home.
29 "3DHOP: 3D Heritage Online Presenter," accessed March 16, 2020, http://3dhop.net/.
30 "Docker," accessed March 16, 2020, https://www.docker.com/resources/what-container.

In conversations with the director of UCLA Library's Data Science Center (DSC), we've learned that the DSC is exploring Docker as a possible means to alleviate the requirements on end user devices. A Docker instance is a virtual machine, much like an instance of Amazon Web Services (AWS), which can be thought of as a computer that runs in the cloud. In reality, however, a Docker instance is much more powerful than a personal computer, and is capable of easily handling multiple users and multiple connections simultaneously. A Docker instance thereby takes care of the heavy lifting required by high-resolution models, with the end user's web browser essentially serving as just a monitor through which the Docker instance displays the model. It should be noted that the ability to connect to a Docker instance requires a high-speed Internet connection; an accessibility challenge to be sure, but so far the least prohibitive one that we've encountered.

Our research has shown that all of these pieces can, theoretically, work together to provide a comprehensive service that preserves and makes discoverable a collection of 3D models. Merritt is the repository responsible for preservation and storage of the collection. The collection and all associated metadata is also ingested into Dataverse, a service layer that sits on top of Merritt and makes objects in the repository discoverable, accessible, and queryable. 3DHOP is an in-browser viewer that presents 3D models and any associated metadata that are pulled from Dataverse and Merritt, all of which is run on a virtual machine service from Docker. To further preserve the metadata and item-level cataloging from CDLI and the OAC finding aid the 3DHOP viewer has the capacity to be embedded into the CDLI website. This would allow the LSC metadata to be directly associated with the 3D model. Throughout this entire process, the only requirement for end user accessibility is a broadband Internet connection. Below you can see an illustration for the above proposed model that will result in better digital preservation of the 3D models and their metadata:



Ethical Considerations

Above, we discussed the complex technical preservation needs associated with the cuneiform collections, but the ethical implications add an entirely new layer of complexity that must be addressed. The cuneiform tablet collections provided the Digital Library a manageable small scale collection that seemed ideal for the development of the first 3D models of cultural heritage materials, but questions surrounding the collections' provenance have led to ethical and legal quandaries. The tablets from all three of these collections were created roughly 4,000 years ago and originated in the region of Mesopotamia, geographically represented today as Iraq and parts of Iran, Syria, and Turkey.[31] The contents of the collections and their provenance are documented in the finding aids, as follows:

1. The Lloyd E. Cotsen Cuneiform Tablets Collection:
    a. Contents of Collection: 215 cuneiform tablets, the majority of which were written by students in ancient Mesopotamian schools -
    b. Provenance: The collection was created from smaller, private collections, acquired over several decades. In 2011 the Cotsen Institute donated the cuneiform tablet section as a gift to the Children's Library to UCLA Special Collections. The majority of tablets in this collection date to the Old Babylonian period (c. 1900-

31 "Mesopotamia," Ancient History Encyclopedia, accessed March 16, 2020, https://www.ancient.eu/Mesopotamia/.

1600 BCE), which was known for the development and proliferation of individual scribal schools. In addition to the Old Babylonian texts there are tablets from the Uruk III period (c. 3200-3000 BCE), the Early Dynastic III period (c. 2600-2350 BCE), the Old Akkadian period (c. 2340-2200 BCE), and the Third Dynasty of Ur (c. 2100-2000 BCE).[32]

2. Cumberland Clark Cuneiform Tablet collection,
    a. Contents of Collection: Twenty-five cuneiform tablets
    b. Provenance: Tablets are from the Old Babylonian Period (ca. 2000-1600 BCE), specifically from the ancient Mesopotamian school environment called eduba (translated as "house of tablets"). They were anonymously donated in 2007. The donor asked UCLA to name the collection after Cumberland Clark.[33]
3. The Edward A. Dickson Cuneiform Tablet Collection:
    a. Contents of Collection: Eight cuneiform tablets
    b. Provenance: Tablets were circa 2000-1800 BCE and donated to the university by Edward Augustus Dickson, he was one of the cofounders of UCLA.[34]

The Cotsen Collection and Dickson Collection have known donors, but the finding aid does not detail a comprehensive record of ownership beyond the donation of the materials in the 1900s. Whereas, the Cumberland Clark Collection has an anonymous donor with no detailed provenance beyond the date of donation in 2007 and the origin of the tablets sometime between 2000-1600 BCE. The gaps in provenance paired with the vague geographical origins of these items complicates who has rights to these items and what is the ethical path forward.

32 "Finding Aid for the Lloyd E. Cotsen Cuneiform Tablets Collection (Collection 1883). UCLA Library Special Collections, Charles E. Young Research Library, University of California, Los Angeles.," accessed March 8, 2020, https://oac.cdlib.org/findaid/ark:/13030/kt0t1nf169/entire_text/?query=Clark%20(Cumberland)%20Cuneiform%20Tablet%20collection.

33 "Finding Aid for the Cumberland Clark Cuneiform Tablet Collection (Collection 1826). UCLA Library Special Collections, Charles E. Young Research Library.," accessed March 8, 2020, https://oac.cdlib.org/findaid/ark:/13030/kt438nf4h2/entire_text/?query=Clark%20(Cumberland)%20Cuneiform%20Tablet%20collection.

34 "Finding Aid for the Edward A. Dickson Cuneiform Tablet Collection (Collection 1813). Library Special Collections, Charles E. Young Research Library, UCLA.," accessed March 8, 2020, https://oac.cdlib.org/findaid/ark:/13030/kt9m3nf3ng/entire_text/?query=Clark%20(Cumberland)%20Cuneiform%20Tablet%20collection.

Precedence of the repatriation of Mesopotamiam tablets is sparse, but the University of Pennsylvania Museum recently returned tablets similar to those housed at UCLA to the Iraqi government,[35] evidencing the Iraqi government's capability of preserving these artifacts.

A multidimensional examination of repatriation needs to be considered prior to returning the artifacts. As Stefan Armbruster writes in "Digital Repatriation of Artifacts a 'Thorny Issue,'" the Queensland Museum wanted to repatriate artifacts to the New Ireland clan in Papua New Guinea.[36] In this case of repatriation, the Chief of the New Ireland clan felt the clan could not properly store and preserve the artifacts, and that if they were returned many others would try to claim them bringing disruption and requiring resources beyond that of the clan.[37] Similar to UCLA's collection of tablets, the ever changing geopolitical landscape and fuzzy provenance make this a difficult case for repatriation and could ultimately lead to a fight for control between current countries on land that was once Mesopotamian.[38] Furthermore, as Sam Pack documents in the text "Digital Repatriation in Vietnam: Towards an (Alter)Native Media Tradition, Visual Anthropology," the duty of an institution does not end once the items are repatriated back to their point of origin.[39] UCLA will need to make an ethical decision to prepare sites for preservation ro create digital 3D model renderings, extending the process of reparation beyond giving back materials. UCLA has the means to preserve the cuneiforms, and makes them available to the foremost researchers, but it is not necessarily UCLA's right to keep them. For guidance, UCLA Library should consider the Unesco Charter on the Preservation of Digital Heritage, as they advocate for, "[a] fair balance between the legitimate rights of creators and other rights holders and the interests of the public to access digital heritage materials should be reaffirmed and promoted, in accordance with international norms and agreements."[40] Navigating the rights, ethics, and laws surrounding artifacts like the tablets is complex. The UCLA Library has taken

35 Stephan Salisbury, "Penn Museum Returning Fragments of Tablets Excavated a Century Ago in Iraq," *The Philadelphia Inquirer*, December 3, 2019, Web Edition edition, sec. News, Arts & Culture, Entertainment, History, https://www.inquirer.com/arts/sumerian-tablets-penn-museum-repatriation-iraq-20191203.html.

36 Stefan Armbruster, "Digital Repatriation of Artefacts a 'Thorny Issue,'" SBS News, August 26, 2013, https://www.sbs.com.au/news/digital-repatriation-of-artefacts-a-thorny-issue.

37 Armbruster, "Digital Repatriation of Artefacts"

38 Anne Gilliland, "'Responsibility and Rights Identification: Orphaned Material or Material Where Who Is Responsible or Who Created or Owns It, and Other Important Information, Are Often Unclear.'" Lecture 1 Slide 23.

39 Sam Pack, "Digital Repatriation in Vietnam: Towards an (Alter) Native Media Tradition," *Visual Anthropology* 26, no. 3 (2013): 215–22.

40 Gilliland ""'Responsibility and Rights Identification," Lecture 1, Slide 4.

laudable steps to preserve the cuneiform tablets through the production of 3D models, but the university should note guidelines and similar examples to guide decision making.

As it pertains to the ownership of these artifacts, UCLA owns the tablets, and controls the copyright. Though if UCLA repatriates these artifacts, they will have to consider copyright issues of the 3D models, and should consider the security and legality of storing and sharing these 3D objects through proprietary software and the platform to which they are uploaded or linked:

> The very act of preserving some digital items may require violation of some of the copyright owner's rights. For example migration may violate the copyright owner's right to create a derivative work. Making a digitised file widely available may impinge on the copyright owner's distribution, performance and display rights. (MIT Libraries, 2012b). Rights in content and any associated software may belong to different individuals or organisations (Driscoll, 2006) making it a long and complex task to obtain the required permissions for preservation, or to port software to other operating systems or hardware.[41]

Unfortunately, copyright, privacy, and security laws and/or regulations regarding artifacts analogous to these collections are slow to catch up to advancements in technology.[42] In the meantime, uploading 3D models with proprietary software or posting models publically could lead to the creation of digital copies by site visitors or software companies, posing copyright issues in the future. While laws are slow to catch up to technology, the likelihood the original artifacts are legally repatriated is far from implausible. A federal court decided 3,800 Iraqi artifacts must be returned to the Iraqi government after being smuggled into the U.S. and landing in the hands of Hobby Lobby Stores, Inc.[43] If cuneiforms were to be repatriated, 3D models would be important to continue research at the university, and preserving the models securely could protect against future liability.

Conclusion

It is clear from the presented challenges and the proposed framework, that the current state of 3D model preservation is greatly lacking adequate and homogenous metadata, file format, automation, usability, and ethical standards. Below, we will summarize our technical and

41 Bernadette Houghton, "Preservation Challenges in the Digital Age," *D-Lib Magazine* 22, no. 7/8 (August 2016), https://doi.org/10.1045/july2016-houghton.

42 Gilliland ""Responsibility and Rights Identification," Lecture 1, Slide 23.

43 Department of Justice, U.S. Attorney's Office, and Eastern District of New York, "United States Returns Thousands of Ancient Artifacts To Iraq," The United States Attorney's Office Eastern District of New York, May 2, 2018, https://www.justice.gov/usao-edny/pr/united-states-returns-thousands-ancient-artifacts-iraq.

ethical recommendations to promote the preservation of the 3D models and the three cuneiform collections. The recommendations will address the challenges laid out in the report, while considering constructive next steps the university, the library, and special collections can take to further the preservation of these materials. Ultimately, our proposed framework and recommendations aim to fill the gaps found in 3D model preservation.

- Metadata Standard Recommendations:
    - After considering metadata standards such as METS/MODS/PREMIS,[44] we recommend that the UCLA Library stays in contact with CS3DP. Implementing METS/MODS/PREMIS could take additional resources from the library, and may be a waste to implement with CS3DP so close to the release of metadata standards. Throughout our research we found archives, museums, and researchers looking towards CS3DP as the gold standard for metadata of 3D models. While standards are yet to be presented by CS3DP, we contacted a member of the group who stated a book will be published this year.
- Repatriation Recommendations:
    - The university should consider creating a repatriation action plan. If there is a chance some or all of the cuneiforms are to be repatriated in the future, a plan involving preservation protocol and the university's involvement after a change of ownership should be outlined.
    - The university should consider adding a statement to CDLI that gives viewers the ability to contact the library regarding repatriation inquiries.
    - The university should consider adding a statement to CDLI and the finding aid regarding the trustworthiness of the materials. Solidifying the trustworthiness of the tablets is a step towards documenting their provenance.[45]
- File Type Recommendations:
    - Continue to monitor professional working groups like CS3DP, IIF, and the Archaeology Data Service. Check current files to ensure accessibility and prevent file degradation.

44 Angela Dappert and Markus Enders, "Using METS, PREMIS and MODS for Archiving EJournals," *D-Lib Magazine* 14, no. 9/10 (September 2008), https://doi.org/10.1045/september2008-dappert.
45 Gilliland "Responsibility and Rights Identification," Lecture 1, Slide 23.

- File Storage Recommendations:
  - Migrate files to Merritt where multiple copies will be housed and fixity checks performed, considering a LOCKSS approach to preservation.[46]
- 3D Viewer Recommendations:
  - Migrate files to 3DHOP and use Docker Instance to view models on a browser.
- Scalability/Automation Recommendations:
  - Monitor professional working groups like CS3DP for recommendation regarding scalability and automating processes.

[46] LOCKSS |. (n.d.). https://www.lockss.org/

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