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3D Scan Data for Caddo Ceramic Vessels from the George C. Davis Site (41CE19)

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3D Scan Data for Caddo Ceramic Vessels from the George C. Davis Site (41CE19)

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Abstract
On June 8, 2015, the intact and reconstructed vessels from the George C. Davis site (41CE19) were scanned (3D) in advance of an analysis of 3D geometric morphometrics. These data were collected using a Creaform GoSCAN50 running VXElements via the scanner direct control function in Geomagic Design X. All data associated with this project are available in Zenodo under a Creative Commons Attribution license, where they can be downloaded for use in additional projects. These data have the capacity to augment numerous research designs in the digital humanities and ceramic studies, as well as a wide range of comparative research topics throughout the American Southeast. The reuse potential for these data is significant.

Keywords
American Southeast — Caddo — 3D

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1. Overview

Research from the George C. Davis site (41NA49), or Caddo Mounds State Historic Site, has served as the foundation for much of Caddo archaeology [1, 2], and the site represents one of the best-studied in East Texas. It is a civic-ceremonial center with three earthen mounds, is estimated to encompass over 110 acres, and includes over 100 known–or suspected–structures [3]. Influential studies from this site come from a variety of analytical domains including ceramics [4, 5, 6, 7, 8, 9, 10, 11], lithics [12, 13, 14, 15], plant remains [16, 17, 18], architecture [19, 20] and remote sensing [21, 22, 23, 24, 25, 26, 27]. The site is located near the southwestern border of the Southern Caddo Area (Figure 1), and remains among the earliest of the known Caddo mound sites.

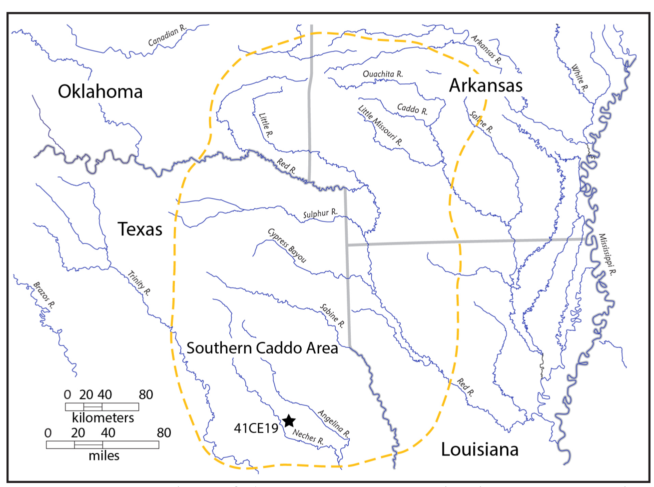

Figure 1. Location of the George C. Davis site (41CE19) in the Southern Caddo Area.

Additional cultural resource management (CRM) undertakings at the site [28, 29, 30, 31, 32, 33, 34, 11, 35, 36, 37, 38, 39] represent the substantial record of investigations that are ongoing. We continue to learn more about the archaeology of the George C. Davis site; however, we should do more with our projects to advance the evolution of archaeological praxis and theory [40].

The addition of analytical approaches that employ 3D meshes (Figure 2) helps, in this case, to advance discussions of shape variations that occur among ceramic artifacts [41, 42], many components of which are difficult–if not impossible–to characterize using traditional orthogonal approaches [43, 44]. These attributes can be couched within a variety of theoretical frameworks [45, 46, 47]. While the production of 3D data are labor and time-intensive (although see [48]), the benefits can be seen in their contribution to conservation [49], participatory digital archaeology [50], and dynamic illustrations [51, 52].

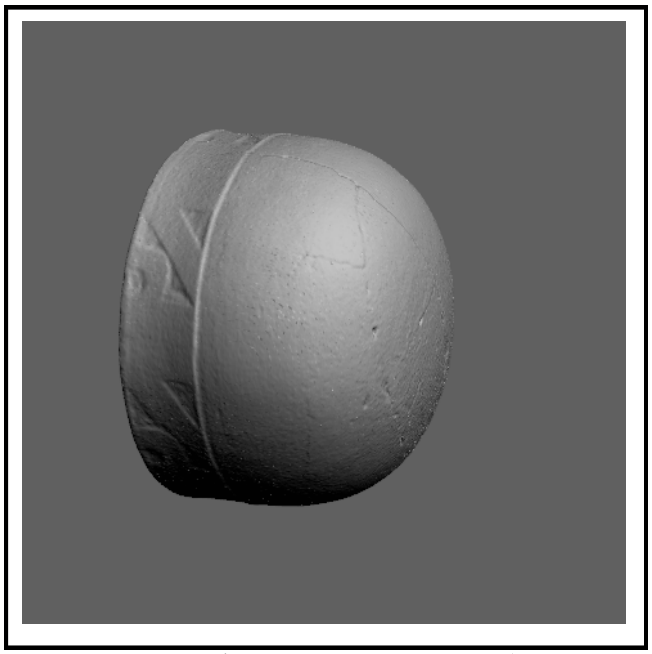

Figure 2. 3D scan of TARL 41CE19 424-21. *This is a 3D figure that can be rotated, measured and otherwise quantified. To activate the figure, this article must be downloaded to your computer. Activate the figure by clicking on the image, then click/drag to rotate.*

A preliminary synthesis of the vessels can be accomplished through the analysis of networks extrapolated from qualitative attributes associated with vessel form and type [3], where the various nodes can be scaled proportional to the number of samples associated with each (Figure 3). While additional network-based analyses are currently underway, this graph illustrates the contributions of the various Caddo vessel forms and types present at the George C. Davis site.

1.1 Context

While the context of the vessels is discussed in detail elsewhere [3], an abbreviated listing is included in Table 1.

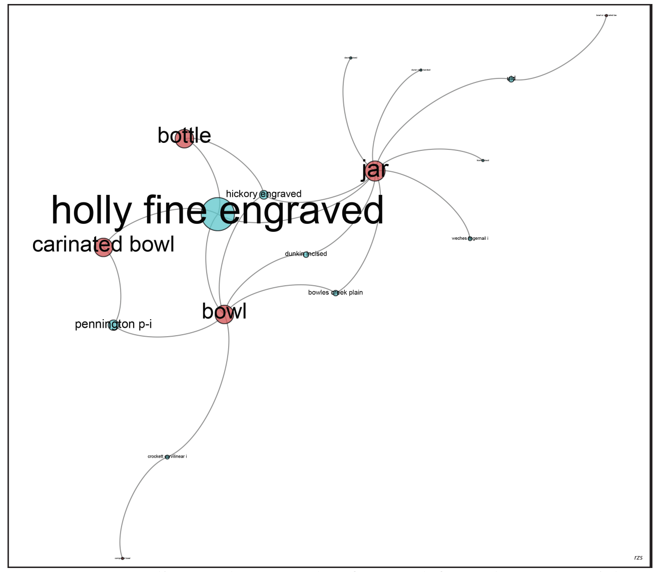

Figure 3. Undirected network of vessel form by type with nodes (vessel forms in red; types in blue) and text scaled proportional to the number of samples from each. All vessels (even those not intact or reconstructed [3]) were used to generate this graph.

1.2 Spatial Coverage

Cherokee County, Texas

1.3 Temporal Coverage

There are a total of 115 radiocarbon dates available for the George C. Davis site that have been reported [53], compiled [54], and recalibrated [55] (Figure 4). The site most regularly articulates with Formative and Early Caddo (ca. A.D. 900-1200) periods in East Texas. Those dates that articulate with the mounds and other known contexts for those vessels discussed herein will be used to augment additional analyses.

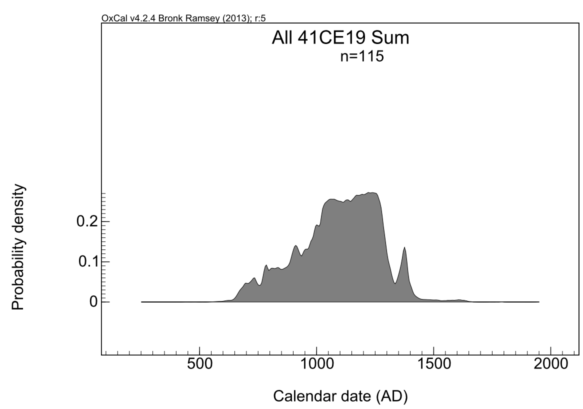

Figure 4. Summed probability distribution for radiocarbon dates from the George C. Davis site.

Table 1. Context of Vessels and Vessel Type

Vessel	Context	Type
101	Mound C, F106	UID Fine Ware
361	Mound C, F107	Holly Fine Eng
424-21	Mound C, F119	Holly Fine Eng
427B	Mound B	Davis Incised
790	Inner Village A	Weches Fing-Imp
2006-04-107	Inner Village, F5	Pennington Punct-Inc
2006-04-108	Mound A	Bowles Creek Pl
2015-1	Mound C, F154	Hickory Eng
2097-1	Mound C, F155	Holly Fine Eng
2097-14	Mound C, F155	Holly Fine Eng
2210	Inner Village A	Bowles Creek Plain
3070-1	Mound C, F152	Hickory Eng
3959	Inner Village A	Pennington Punct-Inc
4020	Mound C, F156	Holly Fine Eng
2006-4-84	Unknown	Hickory Eng
5897	Below Mound A	Holly Fine Eng
5915	Below Mound A	Holly Fine Eng
30342	Mound A	Pennington Punct-Inc
ET221	Surface	Holly Fine Eng

Figure 5. Aligned 3D mesh for TARL 41CE19 2097-1 illustrating the reference geometry (reference vector, point and plane–in green) used to align the mesh.

2. Methods

All whole or reconstructed vessels were scanned with a Creaform GoSCAN50 running VXElements 4.1 via the scanner direct control function in Geomagic Design X 2015.2.0. Upon completion of scanning each vessel, the texture (color) layer was removed pursuant to guidance by the Caddo Nation of Oklahoma that no texture data be made publicly accessible without the express written permission of the Tribe. The uniform color scan data were saved as ASCII.ply files prior to post-processing [56, 57].

2.1 Steps

To align each scan, a reference vector (revolving axis) was inserted, followed by a reference point at the confluence of the vector and the mesh (using a projection) at the central base. Region groups were then used to define the basal plane. All three elements (vector, point and plane) of reference geometry were then utilized in an interactive alignment, with the reference plane as the moving plane, the reference vector as the moving vector, and the reference point as the moving point (Figure 5). Alignment has proven to be an important factor in downstream analyses, particularly when making the transition from Design X and Control to SolidWorks or other CAD-based platform [58].

Post-processing of each 3D mesh began with the healing wizard function in Design X, which corrects problematic issues with non-manifold poly-vertices, folded poly-faces, dangling poly-faces, small clusters, small poly-faces, non-manifold poly-faces, crossing poly-faces, and small tunnels. After these issues were corrected, the global remesh function was used to render the final mesh. When post-processing was complete, each mesh was decimated by 50 percent prior to saving then exporting each as an ASCII.ply. Decimation of the mesh decreases file size while increasing ease of use on standard computers.

A digital photograph of each vessel was taken with a Sony RX1R camera, then saved as a .jpg, which appears alongside each 3D mesh. Since dissemination of the texture file for the 3D mesh is prohibited by the Caddo Nation of Oklahoma, the digital photography provides a color proxy.

2.2 3D Cardboard Puzzles

In addition to the 3D models, two 3D cardboard puzzles were created (for TARL 41CE19 2006-4-84 [59] and TARL 41CE19 424-21 [60]) to augment the on-site efforts of the interpretive staff by providing a physical model through which visitors can interact with the digital proxy. These cardboard puzzles were generated using Autodesk 123D Make [61], and the plans for the cardboard puzzles (Figure 6) accompanied the uploads to Zenodo. Those plans can be downloaded, cut, glued to cardboard, then cut out to create a tangible model of a Caddo vessel. These files were uploaded to Zenodo in .pdf format, and are compatible with most laser cutters where they can be cut out using variety of mediums in addition to cardboard.

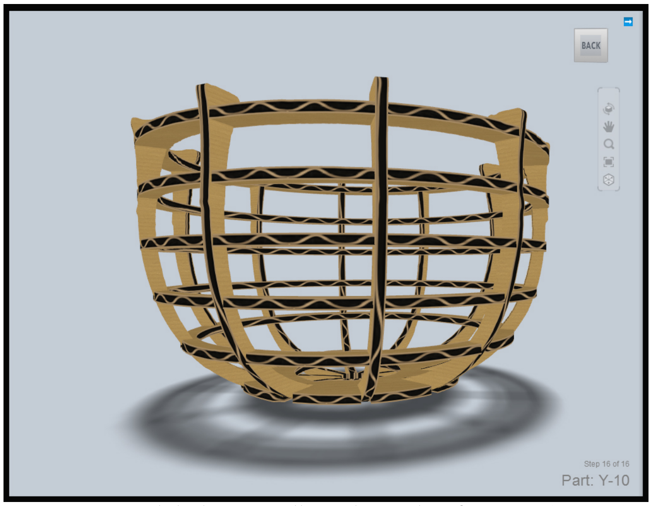

Figure 6. Modeled 3D cardboard puzzle of TARL 41CE19 424-21 created using Autodesk 123D Make.

3. Data Description

3.1 Collection Name
Caddo Burial Vessels 3D

3.2 Data Type
Decimated meshes and digital photographs

3.3 Format Names and Versions
ASCII.ply (mesh) and .jpg (digital photograph)

3.4 Creation Dates
June 8, 2015

3.5 Dataset Creators
Robert Z. Selden Jr.

3.6 Language
English

3.7 License
Creative Commons Attribution

3.8 Repository Location
Caddo Burial Vessels 3D

- TARL 41CE19 101 [62] (http://dx.doi.org/10.5281/zenodo.28085)
- TARL 41CE19 361 [63] (http://dx.doi.org/10.5281/zenodo.28086)
- TARL 41CE19 424-21 [60] (http://dx.doi.org/10.5281/zenodo.28087)
- TARL 41CE19 472B [64] (http://dx.doi.org/10.5281/zenodo.28088)
- TARL 41CE19 790 [65] (http://dx.doi.org/10.5281/zenodo.28090)
- TARL 41CE19 2006-4-107 [66] (http://dx.doi.org/10.5281/zenodo.28092)
- TARL 41CE19 2006-4-108 [67] (http://dx.doi.org/10.5281/zenodo.28093)
- TARL 41CE19 2015-1 [68] (http://dx.doi.org/10.5281/zenodo.28255)
- TARL 41CE19 2097-1 [69] (http://dx.doi.org/10.5281/zenodo.28256)
- TARL 41CE19 2097-14 [70] (http://dx.doi.org/10.5281/zenodo.28264)
- TARL 41CE19 2210 [71] (http://dx.doi.org/10.5281/zenodo.28272)
- TARL 41CE19 3070-1 [72] (http://dx.doi.org/10.5281/zenodo.28274)
- TARL 41CE19 3959 [73] (http://dx.doi.org/10.5281/zenodo.28278)
- TARL 41CE19 4020 [74] (http://dx.doi.org/10.5281/zenodo.28286)
- TARL 41CE19 2006-4-84 [59] (http://dx.doi.org/10.5281/zenodo.28292)
- TARL 41CE19 5897 [75] (http://dx.doi.org/10.5281/zenodo.28298)
- TARL 41CE19 5915 [76] (http://dx.doi.org/10.5281/zenodo.28304)
- TARL 41CE19 30342 [77] (http://dx.doi.org/10.5281/zenodo.28307)
- TARL 41CE19 ET221 [78] (http://dx.doi.org/10.5281/zenodo.28310)

3.9 Publication Date
August 18, 2015

4. Reuse Potential

Those data from this project have long-term and wide-ranging reuse potential, of which many applications may (likely) not yet have been contemplated. While the primary purpose of this endeavor was to document the vessels in advance of a 3D geometric morphometrics study [41, 42, 79], two of these have since been modeled as 3D puzzles that can be cut out using materials that are easily acquired by most (i.e., a cardboard box).

These data have significant reuse potential in the digital humanities where they can augment more qualitative studies of decorative designs and motifs. They also hold promise for clarifying questions of vessel shape and form that can be addressed in analyses of asymmetry and 3D geometric morphometrics.

Acknowledgments

I extend my gratitude to the Caddo Nation of Oklahoma and to the Texas Archeological Research Laboratory (TARL) for providing the requisite permissions and access needed to scan this collection of Caddo burial vessels.

This article was written using an open access LaTeX template [80] in Overleaf, and I wish to thank Dr. John Hammersley and Dr. Lian Tze Lim for their help with scripting questions.

The 3D model used in Figure 2 was generated as a .ply in Design X and converted to a .u3d in MeshLab with the support of the 3D-CoForm project.

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