INTEGRATING 2-D AND 3-D MODELS:
Documenting a Third Intermediate Period Egyptian (White Type) Coffin

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INTRODUCTION

The Yale Computer Graphics Group developed the CHER-Ob program with the needs of art conservators and cultural heritage professionals in mind for the explicit purpose of efficiently carrying out large scale research projects. This program and its analysis tools are used in a case study project focused on integrating 2D and 3D visualizations for condition mapping of one fragment of twenty fragments from a Third Intermediate White Type Egyptian coffin lid dating from the 25th Dynasty (8th-7th century BCE). Combined with the results from previous analytical studies of the coffin lid fragments, this study offers a template for a new form of fully integrated condition mapping for conservation and treatment reports. The hierarchal system following the conceptual creation of a Cultural Heritage Entity (CHE) was tested using the raw data of AA2190.A.1 – Head Fragment of the Third Intermediate White Type Egyptian coffin lid to assess project and file management system, project merging and development, as well as sharing capabilities of the CHER-Ob software.

EGYPTIAN COFFIN LID

- 25th Dynasty inner Egyptian coffin lid.
- Fragment AA2190.A.1's visualizations used for this project.
- 'White' Type coffin is distinguished from other coffins with a layered surface topography lacking varnish, but including: pigment, gesso, linen, daub, wood.
- Condition: each fragment has varying degrees of loss, cracking, delamination of decorative layer, soiling and staining.

Figure 1: AA2190.A.1, Head Fragment, Normal Illumination.

CHER-OB

Open source program developed to fit the needs of art conservators sharing work with collaborators on large scale cultural heritage projects intended for publication.

Key features investigated:

- Cultural Heritage Entity (CHE) depository for all tangible and intangible information about cultural heritage objects.
- Annotation system and analysis tools with built-in application program interfaces (APIs) for the various formats of data. Includes searchable bookmarks, screenshots and pre-programmed color coded categories.
- Integrated visualizations of 2D and 3D digital assets for analysis and condition mapping

DATA SETS

- Digital Photogrammetry: digital processing of multiple overlapping images with calibrated scale bars to produce dense 3D meshes and textured models scaled to real world measurements.

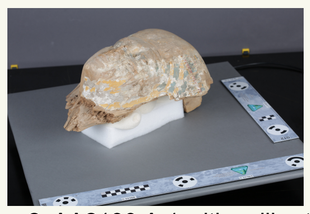


Figure 2: AA2190.A.1 with calibrated scale bars for photogrammetry data acquisition.

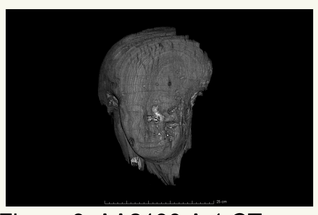


Figure 3: AA2190.A.1 CT scan in volume rendering mode in open source program 3D Slicer.

- Computed Tomography (CT) Scans: Cross sectional series of x-ray images from multiple angles (Right: Visualization in 3D Slicer). Bone algorithm scans at 120kV, slice thickness of 0.625 mm. Standard algorithms at 120 and 80 kV at 340 mA, slice thickness of 0.625 mm.

RESULTS

CULTURAL HERITAGE ENTITY

Phase 1: Cultural Heritage Entity Creation
- CHE created "Third-Intermediate Period Egyptian Coffin AA2190.A".
- All information available regarding all fragments of the Third Intermediate "White" Type Coffin documented and metadata created following the Getty Categories for the description of Works of Art.
- All raw 2D and 3D data visualizations imported.

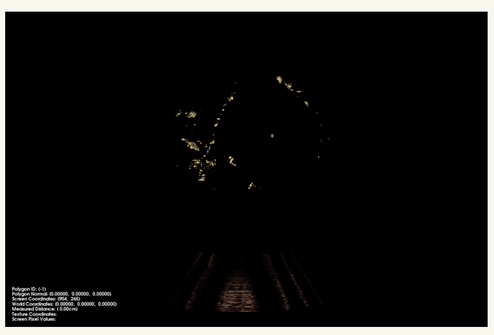
Phase 2: Defining Project focus
- Condition mapping of areas of loss, soiling, staining, cracking, and delamination identified.
- All areas where previous samples extracted for scientific analysis annotated and results are documented.
- Attempt integration of CT scans and photogrammetric models.

Phase 3: "Project" Creation
- Project "Condition Map of AA2190.A.1 – Head Fragment" created.
- All raw data imported (2D and 3D visualizations).

Phase 4: Data Modification
- Annotation and condition mapping of AA2190.A.1 – Head Fragment.

Phase 5: Share and Merge 'Project' with CHE
- Merge all modified data relating to AA2190.A.1 – Head Fragment back to the CHE "Third-Intermediate Period Egyptian Coffin AA2190.A".

ANNOTATION & ANALYSIS OF MODEL OF FRAGMENT AA2190.A.1



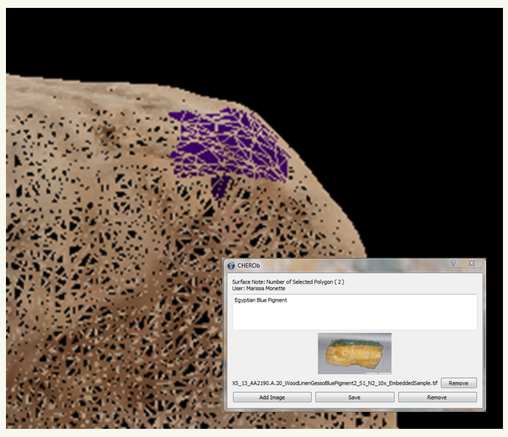


Figure 4 (above left): application of measuring tools for surface characterization.

Figure 5 (above right): CT scan slice visualization in CHER-Ob.

Figure 6: (left): Frustum (volume selection) annotation tool demarking sample extraction of blue pigment on wire frame rendering of photogrammetric model.

INTEGRATION

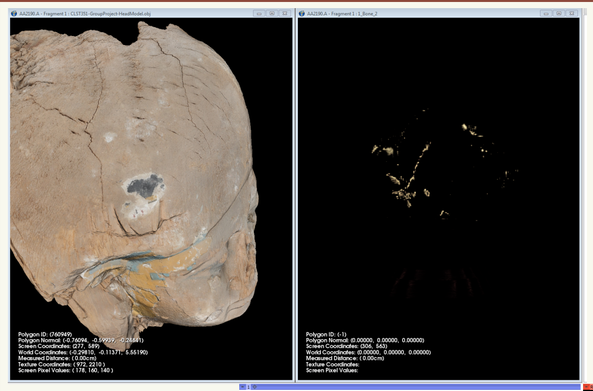
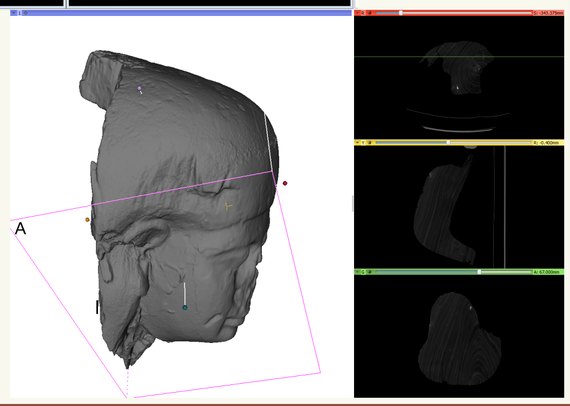


Figure 7 (left): CHER-Ob's simultaneous tile view of 2D CT scan slice (cranial) and 3D model. Closest option for viewing multiple integrated data sets within the same window.

Figure 8 (right): 3D Slicer's integration of textured 3D model with corresponding intersections for scrolling through axial (red), coronal (blue-green), and sagittal (yellow-orange) angle series.



CONCLUSION

- CHER-Ob successfully merged raw data under hierarchal system using the digitally born concept, CHE. Integration of information with automatic report generation for project AA2190.A.1 – Head Fragment under CHE was efficient and practical.
- Successful use of comprehensive built-in APIs for annotation systems and measuring tools for use on various raw data types, however "light weight" design resulted in delayed manipulation of the 3D models.
- CHER-Ob failed to demonstrate capabilities of single window, multi-media integrated visualization of 3D and 2D data for a successful analysis of both the external texture and internal structure (CT scan).
- Failure to manipulate and annotate condition notes on CT scans. CHER-Ob viewer had underdeveloped contrast, resolution, processing speed, and single angle series view with limited slice navigator resulting in inability to annotate or analyze visualization successfully.
- Competitive open source programs, including 3D Slicer (version 4.8) for CT scans and QGIS (version 3.0.1) for annotation and analysis of photogrammetry, have more advanced and developed versions used by professionals in their respective fields. However, these programs lack the multi visualization capabilities of CHER-Ob (version 1.2) and are not purpose built for analysis cultural heritage digital assets.

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