Introduction

The ancient Maya built their temples as nested dolls–new architecture encapsulating old within its foundations. Many of the best-preserved artworks, including mural paintings and stucco sculptures on architectural facades, lie beneath tons of stone masonry, rock and fill, and are physically accessible only through narrow excavation tunnels. While this effectively controls access and thus protects these fragile artworks, it poses an obstacle to documentation and visualization. Today, one can never “see” the entirety of these ancient architectural spaces and artworks, which in turn limits archaeological capacities for site interpretation, data dissemination, and education. Drawing upon ongoing research in a remote region of the Maya Biosphere Reserve, in what is today Guatemala, this white paper presents our ongoing efforts to meet these challenges, as we seek to bring two remarkable Indigenous Maya artworks from the sites of San Bartolo and Xultun to a broader public. It details the historical background, project rationale as well as the initial stages in creating an interactive online platform to present 3D models of these Maya artworks that document the spread of cultural and scholarly knowledge across the region in the distant past. From data capture to the creation of targeted physical replicas alongside interactive 3D virtual models, our collaborative project engages with variously positioned descendant and local communities and other relevant stakeholders to consider the ongoing lives of these images, and the question of how to curate them over time.

The Artworks of San Bartolo and Xultun

At San Bartolo, an important program of early murals dated to c. 100 BCE, provides vivid depictions of foundational ideologies and their associated narratives. The San Bartolo Murals (SBM) were discovered 20 years ago thereby initiating an international collaborative effort to excavate, conserve, document, and disseminate these fragile paintings (O’Neill 2002; Kaufmann 2003; Urquizú and Saturno 2002). Two walls of the San Bartolo mural chamber known as Sub-1A remain in situ, buried within the Las Pinturas ritual complex; the other two walls were broken into fragments in antiquity and deposited within the footprint of Structure Sub-1A as the chamber was enveloped within the foundation of the new temple (Saturno et al. 2005). The San Bartolo chamber is an outstanding example of the rarely preserved Late Preclassic period Maya mural tradition. Five separate contexts of mural painting are preserved
within the Las Pinturas construction sequence, yet the Sub-1A chamber was interred partially intact with sections of its exterior walls (also painted) and the sculpted bichrome cornice conserved providing unparalleled integrity of the murals within their original architectural space.

The Sub-1A murals depict a dynamic origin story populated by divine protagonists known from later periods of Maya religious repertoires including the Maize God, Chahk, the Principal Bird Deity, Itzamna, the Turtle Earth, and supernaturals associated with wind, water, and death. Across the intricately painted images, these beings interact with human couples (men and women), young men making sacrifice, and with a seated figure titled AJAW – divine ruler (Saturno et al. 2005; Taube et al. 2010). In addition to relating foundational beliefs about cosmologies, nature, and community practice, the murals feature a narrative of kingship during the very development of this institution in the Late Preclassic period, a point in history when the Maya lowlands were undergoing major social and political transformations (Saturno et al. 2006). In addition to the painted imagery, their archaeological context and the results of a twenty-year conservation effort provide insight into the function of public temples, termination rituals, the use of color in the wall paintings, the identification of artists hands, the epigraphic development of the early texts, technological development of pigments and plaster, and conservation methodology, among other topics (Hurst 2009; Hurst and O’Grady 2015; O’Grady and Hurst 2011).

Roughly eight kilometers to the south of San Bartolo is the Maya city of Xultun, an urban kingdom that was a major geopolitical center during the Classic period (250 to 900 CE). Dominating the northern sector of Xultun is another well preserved, buried artwork: the modeled stucco friezes of the Los Árboles acropolis (Structure 12F19). The Los Árboles Friezes (LAF) were created between the fourth to early-fifth centuries CE, as Xultun rose to regional power following nearby San Bartolo’s decline. Similar to the SBM, the Los Árboles acropolis was built over time with later construction enveloping earlier versions of this multi-room elevated temple-palace complex; the richly adorned penultimate phase of the acropolis was entombed nearly intact. The Los Árboles acropolis is among these greatest examples of the Early Classic sculpted stucco tradition: extensive ornate modeled stucco masks and friezes celebrate lineage and rulership within a sacred landscape articulated on the platform façade. The 4.5 meters high platform is adorned with a massive tree emerging from the skeletal head of the Jaguar God of the Underworld, an aspect of the sun. The great tree is marked with hieroglyphs and framed by celestial bands and the rain god, Chahk. Above this mythical landscape, the palace galleries each have a sculpted frieze, including an 18-meter long façade of six ancestor portraits flanking a central ruler depicted as the Maize God on the central building. The interconnected lime plaster facades contain highly codified, visually stunning imagery and iconography that fuse themes of rulership, sustenance, and sacrifice across the various structures and platform constituting the Los Árboles acropolis.
San Bartolo and Xultun are extremely remote archaeological sites positioned 30 km (as the crow flies) beyond the last maintained road within a dense tropical rainforest; during the rainy season the sites become isolated by vast seasonally flooded lowlands (bajos). San Bartolo and Xultun are located within the protected lands of the UNESCO recognized Maya Biosphere Reserve (or MBR), which includes 1,614,260 hectares of multi-use protected lands and national parks. The Maya Biosphere Reserve (MBR) is part of the Selva Maya, one of the largest intact tropical forests in the Americas outside of the Amazon (Primack et al. 1998). The MBR, under jurisdiction of the government agency the National Council for Protected Areas (CONAP), was created by Guatemala in 1990 as part of an international effort to conserve and protect this biodiversity hotspot and directly involves local communities in the stewardship of these ecologically rich forests through 25-years concessions for management organizations with the objective to balance sustainable-use and profitable extraction (Gretzinger 1998; Taylor 2010; Radachowsky et al. 2012).

The MBR is also the ancient heartland of the lowland Maya culture from 400 BCE to CE 900. This region was a dense network of cities and villages until the late 9th century CE when social upheaval ended dynastic rule at the majority of city-states and people migrated north and west, abandoning cities that have now been reclaimed by the forest. Within the MBR, archaeological sites fall under the jurisdiction of the office of the Directorate-General for Cultural and Natural Heritage (DGPCYN), within the Ministry of Culture and Sports. Two government agencies, the Institute of Archaeology and History (IDEAH) and the Department of Prehispanic Monuments (DEMOPRE), are charged with the protection of cultural heritage and oversight of archaeological investigative projects. However, these institutions are severely under resourced with shortages in staff, vehicles, and funds. At present, only a limited number of sites are developed for regular tourism, including Tikal (UNESCO World Heritage Site), Yaxha, and Tayasal being among the most accessible.

Questions about potential tourism, particularly for archaeological sites, remain ever present with diverse interests held among local, regional, national, supranational, cultural, and scholarly stakeholders. The registered archaeological site of San Bartolo (400 hectares) straddles two forest concession areas within the public lands of the MBR, the Las Ventanas Management Unit and the San Bartolo Management Unit, ceded to the Sociedad Civil Árbol Verde and the Sociedad Civil Amigos del Bosque respectively. For twenty-two years, the San Bartolo-Xultun Archaeological Project has maintained the road for site access, provided year-round site guards, monitored and protected the mural paintings (and the protective shelter at the Las Pinturas mound), and sustained a small research camp. The SBX Project employs 30-100 individuals from small communities across the Petén during its annual 2- or 3-month investigative season. Building a network of stewardship for cultural resources among the local stakeholders is
centrally important to the SBX Archaeological Project given the distance and lack of resources at the national level. Typically, tourism is seen as the source for generating both public interest and funds for ongoing maintenance of cultural heritage sites. However, tourism is a particularly delicate issue when considering opening archaeological spaces like the San Bartolo mural chamber or Los Arboles Friezes to the public. Biological growth and vandalism pose dangers to artworks in sealed chambers, such as at Lascaux, Altamira, or as witnessed at the caves of Naj Tunich in Guatemala (Bastian et al. 2010; Schabereiter-Gurtner et al. 2002; Stone 1995). The San Bartolo murals and Los Árboles friezes are currently well-preserved but are extremely fragile and vulnerable artworks; unmanaged (or poorly managed) tourism poses the greatest threat to their preservation. In addition, the impact of tourism on the natural resources of the MBR must also be considered, as well as the extremely high financial investment needed to develop access at these sites.

The objective of our project, an “Architectural Walking Tour of Ancient Maya Masterpieces,” was to increase access to the remote artworks of San Bartolo and Xultun. Creating digital viewscapes of archaeological sites is certainly not a new concept, however, it is new for Guatemala. In the case of the SBM and LAF, these visualizations also promote conservation stewardship given that these buried artworks exist in a fragile equilibrium and their preservation depends on highly restricted access. Building on best practices and results from a number of global examples, our goals included streamlining the digital capture process for off-the-grid, remote, and under-resourced applications, and similarly having our deliverables, (virtual models of the SBM and a trial model of the LAF), be equally accessible to low bandwidth cellular users. The digital capture was also designed to serve conservation monitoring, scholarship, and public products through a variety of resolutions. In this manner, our National Endowment for the Humanities - Digital Humanities Advance Grant created a new visualization of the buried artworks, but also created a platform capable of supporting comparative data and integrating a wealth of previous documentation into the 3D model.

**Previous Documentation and the Digital Humanities “Walking Tour” Initiative**

At 100 BCE and CE 450 respectively, the temples housing SBM and LAF each sat on a large open plaza. Over time, these buildings and their artworks were buried by later rulers/actors in order to construct new temples and re-invest the temple complexes with sacred power. Eventually, San Bartolo and Xultun were abandoned and subsequently reclaimed by the jungle. Due to this history, these contexts have outstanding preservation but present specific problems for discovery, research, and dissemination. Narrow excavation tunnels are poor spaces for traditional photography, and in 2001, digital scanning was in its infancy, and by 2010, equipment was bulky, its operation expensive, and the digital products were overly complicated to use in research, and difficult to store and disseminate—hardly a substitute for visiting any such chamber in person.
Moreover, our international team’s early documentation efforts had to occur piecemeal, meter by meter, as the artworks were excavated to ensure they were recorded in case of damage or collapse. For the San Bartolo murals, it took ten years to excavate and conserve the *in situ* paintings and stabilize the access tunnels (during which time additional murals and 7000 mural fragments were found); it took five more years to curate, document, and reassemble the thousands of mural fragments collected during excavations. The Los Árboles Friezes required ten years to uncover the architectural program, and conservation and curation is still a work-in-progress. This enormous collaborative effort resulted in various means of documentation and dissemination, primarily through illustrations, which are widely reproduced and exhibited. Prior to photogrammetry, tiled 2D scans acquired by holding a flat-bed scanner to the wall provided the best native capture of mural surfaces. Visualization of the 3D environments similarly relied upon measured plans and profiles informing perspective renderings, alongside photography. In 2018, Heather Hurst created a full-scale replica of the San Bartolo mural chamber at the Tang Museum of Skidmore College; this was the first time individuals were able to experience the murals within an open chamber and it was particularly successful in showcasing the impact of interactive replicas.

In 2012, San Bartolo was placed on the UNESCO Tentative List of World Heritage sites. During the pandemic (2020-2021), the office of the Ministry of Culture and Sports reviewed its Tentative List and solicited materials from a select group of sites, including San Bartolo, for potential full nomination. With major decisions being considered regarding the future of San Bartolo on a local, national and international scale, the NEH-DHAG award activities bear significant relevance. A key question is how we might increase accessibility to these artworks for a broader public, while maintaining the conditions necessary for the SB and LAF’s long term conservation. With these concerns in mind, digital humanities tools are helping the SBX Project develop previously unavailable channels for dissemination and accessibility.

Support from the National Endowment for the Humanities Digital Humanities Advancement Grant expanded the SBX Project collaborators to add a team of coders specializing in the digital humanities, led by Luke Hollis at the non-profit New Alexandria, and a talented contributor in cultural heritage education and archaeology, Laura Gámez based in Guatemala. In 2021, the research team spent the field season in Guatemala digitally capturing the San Bartolo murals using a Leica BLK 360 LiDAR system as well as the Matterport Pro 2 Infrared 3D scanner—in addition to capturing source photos for photogrammetry with a Canon EOS 6D DSLR camera. This was followed by a collaborative, multilingual effort to create a prototype “architectural walking tour.” This walking tour allows users to digitally experience the mural tunnels and viewings chamber by utilizing Matterport web platform.

The virtual tour was created in two formats: first a guided tour provides information about specific aspects of the archaeology and iconography of Las Pinturas, alongside details
about conservation and the materials used to paint the mural. In the second format, there is a “free explore mode” that permits users to “walk” through the tunnels with 360-degree views; with various interactive points providing interpretations of images, descriptions of the archaeological context and the history of the mural room through additional media including images, videos, and links. For example, the partially exposed architecture (within the limitation of the tunnels), is complimented with reconstruction drawings, and in other places buildings that were partially dismantled in antiquity due to later construction are outlines in space.

The field capture experience required major curation of the tunnel environments to ensure even, quality lighting was maintained for the Matterport scanning, as well as during photogrammetry. Hollis, with years of experience documenting the tombs of Luxor and burial chambers in Greece, among other environments, found the tunnels to be the most extreme capture he had experienced. Most tunnels at San Bartolo and Xultun retain 99% humidity, creating fogging of lenses; elsewhere, the change in levels and narrow crawl spaces required multiple captures in order to complete the 3D mesh. The experimental capture of the LAF was useful in determining the rigging needed to capture 5m tall tunnels exposing the sculpted platform façade with deep relief. Finally, in exterior spaces, we found drone video footage paired with lidar point cloud data provided a potential avenue for generating a “walking tour” experience outside of the tunnel environments.

The curation of the walking tour of the SBM began with a storyboard (Hurst and Rossi), followed by bilingual caption development (Gámez and Hurst), and then supplementary photos / videos / illustrations were provided to Hollis and his team for pop-up integration. Rossi developed a short participant survey to be administered during the user trials, and data tracking was employed to see how long users paused before advancing in the tour, as well as where they had trouble navigating the tunnel spaces within the model. Throughout this process, edits were made responsive to user experiences and unexpected elements, such as the “measure” function within the Matterport interface, were considered for better integration.

Future Goals and Ongoing Challenges

Our project had two opportunities for user trials: first, at National Museum of Archaeology and Ethnology, Guatemala City; and second, at the University of Texas at Austin Llama Lab (Lidar and Landscapes of the Ancient Mediterranean and Americas). We had approximately 90+ users access our models during the trials, with the range of online visitation spanning 10 to 35 minutes in duration. The first user trial used cellular data only, whereas the second trial was within the UT computer lab. An optional survey was made available to participants, resulting in 55 completed surveys that included demographic information, technological performance questions, and an open-ended question regarding the value of virtual models for cultural heritage preservation. These user trials were particularly useful in
understanding difference in functionality of the model across phones, tablets, and computers, as well as highlighting human preferences, such as holding tablets vertically rather than in landscape orientation. Excellent feedback was collected after User Trial 1 and the model was improved for Trial 2. Trial 2 had less demographic range with students, professors, and staff attending, yet this group articulated the interests of an educational curriculum and research applications.

Following these user trials, the SBX Project planned to make the model publicly accessible first in Guatemala. It will be installed on a tablet kiosk at the National Museum of Archaeology and Ethnology, Guatemala City, in association with a permanent San Bartolo exhibition already on display. However, extensive renovations of the museum and the sudden death of Director Daniel Aquino delayed installation of the kiosk (planned for December 2022). This first installation will happen as soon as possible. Yet, this pause in public availability has enabled our project to more thoughtfully consider the launch of the digital tour. Once online, the murals and the site of San Bartolo will be available for scholars, the K-12 educational curriculum, and the general public. When we shared the model with members from the two forest concessions and members of an NGO representing Petén community interests, these stakeholders raised concerns that online access to the model might encourage greater tourism – visitation that the archaeological sites are not ready to support and that the concessions might be held responsible for this impact. This merits a slower launch, local stakeholder participation, and careful messaging at the initial hosting page. We are currently developing these materials now.

The ‘public accessibility’ of this model and the digital tourism (and/or physical tourism) it might bring about raises its own questions about images and their circulation, of course, which our team continues to wrestle with. What might the consequences be of freely circulating a digital experience of these sites? Might this lead to an increase in visitation and/or site looting on the ground? Or the converse, would the digital experience supplant futures for conventional tourism that would benefit local communities? This last point in particular has been raised as a concern for local community organizations who rely on the tourism industry, even as they expressed concern for a rise in tourism that might be at odds with their existing forest management plan. Some local stakeholders have asked, why ‘open access’? —could the new digital experiences hold potential for fairly sustaining these sites of cultural heritage and their future stewards? The “Walking Tour” model was received with great enthusiasm and excitement. Although there are questions to discuss, we believe the digital model will play a key role in maintaining access to the artworks while simultaneously enabling the physical access to the tunnels and buried architecture to be restricted, thereby better supporting protocols for protection. In future work, we will continue to thoughtfully develop digital materials alongside developing a site management plan for the long-term preservation of the San Bartolo murals and Los Árboles Friezes.
References
