

Batten Down the Hatches! Digitizing and Displaying Finds from the Spanish Plate Fleet Wrecks

Charlie Harper

Kelvin Smith Library, Case
Western Reserve University

Abstract

Artefacts from the Spanish Plate Fleet Wrecks of 1715 and 1733 provide an unmatched archaeological window into 18th century life. To publicize these important finds that are often overshadowed by the wrecks' alluring gold and silver treasures, the Florida Bureau of Archaeological Research Collections and Conservation section created an online 3D museum of selected artefacts. This presents our experiences as we plunged headfirst into the world of 3D photogrammetry and online museum development. We highlight our successes and failures with photogrammetry techniques, model creation, general workflow, and 3D web design for education and public outreach.

Keywords: photogrammetry, public outreach, web development

Out of Port: Starting an Online 3D Museum

The Florida Bureau of Archaeological Research (FLBAR) Collections and Conservation section is responsible for curating and conserving artefacts recovered from Florida state-owned and state-managed lands and waterways. FLBAR's facilities are located in Tallahassee, where they currently house millions of artefacts that have been collected since the 1970s. These artefacts are held for the benefit of the people; therefore, the facilities are made accessible for researchers and loans of objects are regularly granted to museums, institutions, and historical societies across the country. Given the volume of materials, the limited staffing, and the facility's inherently fixed location, increasing public access to and awareness of the collection is, nonetheless, challenging. As one way to address this challenge, in 2016, FLBAR Collections and Conservation staff decided to experiment with the creation of a limited, online 3D museum, which could be expanded upon in the future.

The 3D modelling and dissemination of cultural heritage materials has a rich history (Forte and Siliotti 1997; Niccolucci 2007; Pescarin et al. 2012;

Reilly 1990, 1992), and researchers have employed various techniques to produce their models, including laser scanning, structured light scanning, and photographic techniques (Hindmarch 2015: 35–59). Over the last decade, successful outcomes of these approaches have included the Virtual Museum of Iraq¹ (Chiodi 2007), Smithsonian X 3D² (Terdiman 2012), and the 3D Petrie Museum³ (Hess and Robson 2015). Certainly, in our attempts to build a 3D presence online, we were not the first, but nonetheless, as newcomers to the process, we had difficulty finding a ready-made method for our objects, although general information on establishing workflows exists (e.g., Pfarr-Harfst 2016: 43).

Following current museum and cultural trends (Milroy and Rozefelds 2015), the FLBAR's major goals in designing an online 3D museum were to improve public outreach; to display fragile, rare, or understudied objects; to increase awareness of the

1 <http://www.virtualmuseumiraq.cnr.it/homeENG.htm>, accessed 26 February 2018.

2 <https://3d.si.edu>, accessed 26 February 2018.

3 <http://www.ucl.ac.uk/3dpetriemuseum>, accessed 26 February 2018.

Bureau of Archaeological Research's role in archaeological curation and conservation; and to counter the mistaken perception that we hide artefacts. To reach these goals, we decided to employ photogrammetry to model small- to medium-sized objects and to build a custom, scalable website, with which to display these models in a manner accessible to both mobile and desktop users. The Bureau's millions of artefacts offered a cornucopia from which to choose an exhibit theme. Ultimately, we elected to digitize and display a select group of objects from the Spanish Plate Fleet Wrecks.

Favourable Winds: Choosing Artefacts from the Spanish Plate Fleet Wrecks

The Spanish Plate Fleet, so named after the Spanish *plata* ("silver"), which it carried in abundance (Craig 2000), was a convoy system that existed between the 16th and 18th centuries. In order to carry the vast resources extracted from the New World, a formalized arrangement of armed ships and cargo ships travelled along fixed routes. In actuality, there was not one, but two fleets, each of which was tasked with collecting goods from a particular area in the New World; the *Flota* collected goods from Mexico and the *Tierra Firme* collected goods from South America. After rendezvousing in Havana, the two fleets sailed as one to Spain, where they would unload their cargo. The Plate Fleet's return to Spain was fraught with dangers precipitated by the limitations of contemporary sea maps and marauding pirates. During the summer sailing season, their route, too, was treacherous. After leaving Havana harbour and before turning to cross the Atlantic, the convoy sailed along the Florida Keys and then hugged the east coast of Florida's mainland, that is to say, its voyage led it directly through Hurricane Alley.

Over the centuries, hurricanes took their toll, with major disasters striking the Plate Fleet in 1622, 1715, and 1733 (Fine 2006). Perhaps the most famous wreck from these disasters is the 1622 *Nuestra Señora de Atocha*, salvaged by Mel Fisher. It is, however, only from the wrecks of the 1715 and 1733 Plate Fleets that the Florida Bureau of Archaeological Research holds large archaeological collections. The choice to build a digital exhibit around these wrecks to the exclusion of the many other well-rounded ar-

chaeological collections that are held by FLBAR was made largely because this collection and its history of recovery accorded so well with the project's overarching goals.

Unlike most of the artefacts held by FLBAR, which originate from professional, documented archaeological projects that follow a rigorous permitting process, the artefacts from the 1715 and 1733 wrecks have been and continue to be acquired via an arrangement between treasure salvors and the State of Florida⁴. Of the artefacts torn from the wrecks by these salvors, 20 percent are required to enter FLBAR's collection for the benefit of the people and the preservation of Florida's history. This 80/20 division inevitably results in yearly legal wrangling, in which the salvors attempt to maximize profits while FLBAR attempts to preserve the wrecks' unique archaeological history. As one might also expect, the salvors do not document their finds in any archaeologically meaningful way so that those objects accessioned into FLBAR's collection lack provenience other than the general shipwreck from which they may have been recovered. In effect, the collection of the Plate Fleet Wrecks has arisen from an ill-formed partnership between treasure hunters and archaeologists that presently exists only because of past historical and legal arrangements.

Treasure hunting, the destruction of archaeological sites, and the detrimental loss of our shared human past is now an increasingly visible problem in Florida (James 2017, Springer 2013). The depth of this problem and the ongoing fight between scholarly archaeologists and looters has even touched the Florida Legislature, where proposals were made in 2016 to institute a citizen's archaeology permit; for the meagre fee of \$100, any citizen would be allowed to dig up riverine sites for artefacts (Brotemarkle 2016). On the other hand, an archaeologist would still need to follow the rigorous permitting process. To date, this legislation has not been successful thanks to the dedicated efforts of many professional archaeologists and citizen activists, but the future of similar proposals is unknown.

Objects from the 1715 and 1733 Plate Fleets were, therefore, an ideal group for digitization and display. With artefacts from the Plate Fleets, FLBAR

⁴ This arrangement is governed by Florida Administrative Code 1A-31.



Figure 1. The route of the Spanish Plate Fleet, including the separate routes of the *Flota* and *Tierra Firme*, in the New World. The two fleets met in Havana before returning together to Spain.

would expose a set of understudied objects that are frequently overshadowed by the salvors' quest for gold and silver cargo (Burgess and Clausen 1976); would increase awareness of FLBAR's role in preserving Florida history rather than commercializing it. This project would also show that proper curation of these objects is a benefit to the people and would expand the public's awareness that even mundane artefacts provide rich historical information and that such information derives strongly from an object's documented archaeological context, which can be destroyed when sites are overly commercialized, whether legally or illegally.

Of the thousands of possible artefacts from the wrecks, we chose ones that would speak to 18th century human experiences and that would purposefully move the dominant narrative of the Plate Fleet Wrecks away from their gold and silver cargoes and into a more archaeologically meaningful domain⁵. From an initially large set of viable choices, 18 artefacts were selected for final modelling and display online⁶. This number was thought to provide a manageable starting point and the chosen 18 fell neatly

into three exhibit groups: weaponry, trade, and daily life. In addition, the artefacts offered a plethora of sizes, shapes, colours, textures, and reflectivity, upon which to hone our photogrammetry skills. For example, the selected grenade was a matte, cracked, lumpy sphere; one of the sanctus bells was shiny, holed, and concave; and the majolica plate was thin, brightly coloured, and had highly detailed paint texture (Figure 2). The immediate challenge was to develop a streamlined photogrammetry process that would generally produce high-quality models in rapid time while also permitting procedural variations to account for the disparate physical characteristics of each object.

Storms on the Horizon: Perfecting the Photogrammetry Process

The process of photogrammetry is simple on paper, but difficult in practice. Despite a long history of use in archaeology and cultural heritage, there is no single standard for how one should employ photogrammetry to model artefacts. As Santos et al. (2014: 1–2) point out, the important institutional factors governing the photogrammetric process are often reducing time and cost, increasing ease-of-application, and establishing a workflow that suits the material being modelled. The final use of the models and their intended method of distribution impact the process,

⁵ This is not to say that gold and silver coinage are not archaeologically meaningful, only that the wrecks should not be viewed solely as a source for private gain, but also as a fount of archaeological data.

⁶ A selection of the Plate Fleet models created by the author are available on <https://sketchfab.com/charper> for viewing or downloading.

Year	Wreck of Origin	Artifact Type	FLBAR #
1715	Cabin Wreck	Metate	93.671.176.1
1715	Cabin Wreck	Nuestra Señora Sanctus Bell	95.50.15870.1
1715	Corrigan's Wreck	Cannister Shot	93.641.166.1
1715	Corrigan's Wreck	Clay Roundel with Lion	94.22.8914.1
1715	Corrigan's Wreck	Jangxi Jar Neck	93.641.163.1
1715	Corrigan's Wreck	San Joseph Sanctus Bell	16.3.77228.1
1715	Douglass Beach Wreck	Abó Polychrome Majolica Plate	93.673.105.1
1715	Douglass Beach Wreck	Gunner's Bar	93.673.89.1
1715	Douglass Beach Wreck	Pewter Goblet	82.170.8359.1
1715	Douglass Beach Wreck	Sword Hilt Cast and Concretion	93.674.35.1
1715	Rio Mar Wreck	Olive Jar	72.18.326.2
1715	Unknown	Silver Sword Hilt	94.36.808.1
1733	Capitana Wreck	Barshot	93.616.54.2
1733	El Lerri Wreck	Adorned Storage Jar	75.8.390.2
1733	El Lerri Wreck	Grenade with Fuse	75.8.472.2 / 75.8.361.1
1733	San José Wreck	Helmsman's Slate	93.605.22.1
1733	San José Wreck	Majolica Escudilla	93.605.265.1
1733	San José Wreck	Spyglass	93.605.1751.1

Table 1. The 18 artefacts from the 1715 and 1733 Spanish Plate Fleet Wrecks that were digitized and included for display on the web.



Figure 2. Objects with varying physical characteristics were selected for modelling, including this brass sanctus bell (FLBAR #95.50.15870.1), iron grenade with wooden fuse plug (FLBAR #75.8.472.2 and #75.8.361.1), and polychrome earthenware plate (FLBAR #93.673.105.1).

too. Models meant for direct research cannot follow the same procedures used to create general educational models (Pfarr-Harfst 2016: 43); whereas the former must provide accurate measurements, the latter must only represent the object holistically without the need to be so exacting in their level of detail.

Since our primary goal was outreach and public awareness, we were spared the issues of producing research-quality models; however, the development of our process was not without problems. Particularly, the diversity of materials, their varying conditions of preservation, and their different scales created many headaches, nor are these issues unique to our

collection. These are recurrent problems that one must overcome when modelling an archaeological or cultural collection (Santos et al. 2014: 4–5). It was only over time and through experimentation that we developed a general procedure that permitted the modelling of artefacts of many different materials, sizes, and conditions. At first, though, our failures were many.

Objects that had clear, crisp photographs produced oddly shaped meshes or poor textures. Reflective artefacts especially caused difficulty, and there was a struggle to arrange our lighting in a manner that would make such models work. One particular-



Figure 3. One attempt at a porcelain cup produced a pockmarked, interior-free model due to the impact of surface reflection on the modelling process.

ly egregious failure was a porcelain cup, the surface of which came out pockmarked and the interior of which never materialized due to light reflection (Figure 3). Effectively, modelling artefacts that are reflective or transparent is a major problem in the field, and one that equally impacts laser and structured light scanning (Barsanti and Guidi 2013: 151; Hindmarch 2015: 60–67). Occasionally, the early stages of modelling worked, but in later stages, separately modelled portions of an artefact did not match together correctly and odd pieces were left jutting out into space or overlapping one another (Figure 4). This was typical of monotone artefacts, where Agisoft was unable to determine overlap between photos, and very small objects, where lens distortion may have played a role.

Over time, a general procedure was developed that eased the production of models and in many cases, produced strong results. Still, aspects of the procedure, particularly the intensity and position of lighting, were not based on any fixed method, but were derived ad-hoc from past experience and a familiarity with each object's nuances and peculiarities. The particular rig that we used was built with equipment that FLBAR already owned and was supplemented when necessary with small purchases that fit within the Bureau's limited budget. The rig consisted of a:

- 1) Canon Rebel T3i 18.0 MP DSLR,
- 2) EF 50 mm f/2.5 compact-macro lens
- 3) Altura external flash with diffuser
- 4) Two compact fluorescent lights
- 5) Square light tent

We found that the 18.0 MP canon created excellent models, although a lower resolution camera, or even a phone-camera, are sufficient for creating basic educational models. If possible, though, the cam-



Figure 4. An early try at modelling a gunner's bar resulted in two mismatched halves.

era should at least allow manual setting of parameters such as focal length and exposure time (Linder 2016: 5–6). The use of the 50 mm lens, which offers minimal distortion, was ideal for photographing the objects in our facility, but the context of shooting does impact lens choice, and researchers have found success with other lenses (Barsanti and Guidi 2013: 152; Guidi et al. 2015: 341; Kaufmann et al. 2015: 224; Marziali and Dionisio 2017). The choice of flash, lighting, and light tent, on the other hand, was dictated by availability and cost. We found that the diffuser and tent were affordable and especially important components since they allowed us to vary lighting for different material types (Kaufmann et al. 2015: 225).

The software package that we employed was Agisoft PhotoScan 1.3. The PhotoScan Standard Edition provided the majority of requisite functionality, but added features in the Professional Edition were occasionally necessary to tame the most obstinate models (Agisoft 2017a, 2017b). Although a more complex and expensive rig and software package⁷ may have produced even higher quality results, the total cost for purchasing these did not exceed \$1,000 (USD), making this rig and software an attractive option for small museums and archaeological projects. In addition, a cheaper camera and free

⁷ As of February 2018, the cost of an Agisoft 1.3.2 Standard Edition license ranges from \$59–\$179 (USD).

software (see, for example, Falkingham 2012) now places basic photogrammetry within the hands of many low-to-no budget museums and cultural heritage agency.

To produce models with this rig and software, artefacts were first photographed in multiple chunks (Agisoft 2017a, 36–39). An Abó Polychrome Majolica sherd, a type of pottery made predominantly in Mexico between AD 1650–1750 (Lister and Lister 1974), will be used to illustrate our process throughout the rest of the paper (Figure 5). Typically, this meant vertically rotating the object once or twice so that two to three separate sets of photographs, or chunks, were produced. For each chunk, the general procedure was to photograph one horizontal object rotation straight on ($\sim 0^\circ$ – 20°) and one horizontal object rotation from a raised angle ($\sim 45^\circ$). The size of the object necessarily impacted the placement of the camera. Our objects ranged in size from approximately 7 to 50 cm. We did not have success with anything smaller, which is likely to require a different approach (Marziali and Dionisio 2017).

With a manual turntable, we attempted to take a photograph every 10° of rotation so that an ideal chunk would result in 36 images straight on and 36 images from a raised angle. Others have experimented with fewer photographs per object rotation (Falkingham 2012; Kaufmann, Rennie & Clement 2015), but as a rule of thumb, 36 photographs worked best in our experience. More than 36 meant more time was devoted to photographing, masking, and model processing without any clear gains for our educational and outreach purposes. Fewer than 36 photographs reduced initial time investment, but frequently left one or two underdeveloped portions in our models that ultimately required reshooting anyway.

To aid the software's photographic alignment of each chunk and to protect the artefacts, a patterned foam block was used to support each object. Upon each side of the block, an outlined X in a distinct colour was drawn and the top of the block could then be cut to cradle each object (Figure 5). This block acted as an extra visual feature with which Agisoft could match the overlap between photographs; therefore, its presence was especially necessary for monotone and uniformly shaped objects that provided fewer distinct visual markers. Although our blocks were handmade out of convenience and frugality, patterns can also be printed and more formal, permanent,

and aesthetically pleasing blocks can be created. In many ways, the use of this block serves a function equivalent to the coded targets used in modelling archaeological excavations and architecture (Sapirstein 2016).

The background of each photograph was next masked out so that only the artefact and patterned block remained. The background colour was typically either white or black, depending on which colour provided the best contrast with the object (Guidi et al. 2015: 343). An attempt was made at using a green background and programmatically removing it, but it was ineffective; the green was found to reflect off of objects, giving the final model texture a strange tint, and the programmatic removal of the background blurred object boundaries, resulting in low-quality models. The worst result of a green-screening experiment was a model of an oxidized pewter goblet, which likely belong to one of the Plate Fleet's wealthy passengers. The green reflection on the object's tarnished surface resulted in a model with fuzzy edges and with a colour similar to green, oxidized copper rather than black and purple oxidized pewter. Changing to a white background and manually masking each photograph produced a better result (cf. Guidi et al. 2013: 879–881). Still, it is worth further exploring the conditions under which a green-screen will work as green backgrounds have been successfully employed by others, such as Kaufmann, Rennie, and Clement (2015). Reducing the amount of manual masking is one major avenue for speeding up the creation of models and for making the process more accessible to understaffed institutions and museums.

Once masking was completed, we aligned each chunk's photographs in Agisoft PhotoScan with settings of High Accuracy, Pair Preselection, and Constrain Features by Mask (Agisoft 2017a: 9–11). If alignment was successful, which was immediately apparent, a sparse point cloud existed that mimicked the general form and colour of the object and the patterned block (Figure 6). In the case of unsuccessful alignment, we checked for low-quality photographs, incorrect masks, or took additional photographs before trying to realign. Points in the sparse cloud with high reprojection error were removed using the Gradual Selection Tool (Agisoft 2017a: 29–30) and camera alignment was then optimized (Agisoft 2017a: 24). Each chunk was then processed into a

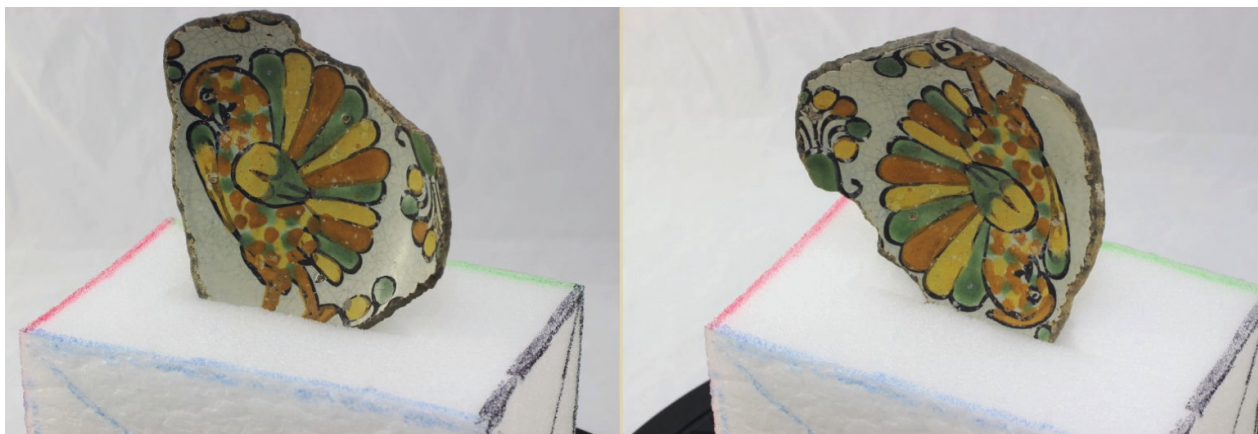


Figure 5. Each object was photographed in chunks. The patterned foam block aided the software's in detecting overlap between rotations within a chunk and thereby aligning photographs in three dimensions. This shows the two chunks used to build a model of the Abó Polychrome Majolica Plate.

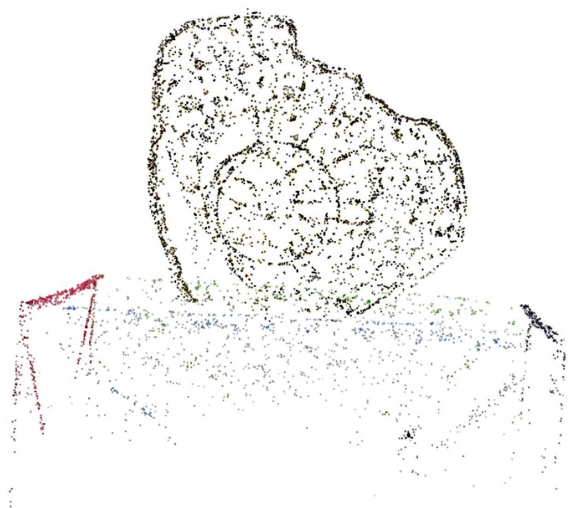


Figure 6. A sparse point cloud after the photo alignment of the first chunk of the Abó Polychrome Majolica Plate.

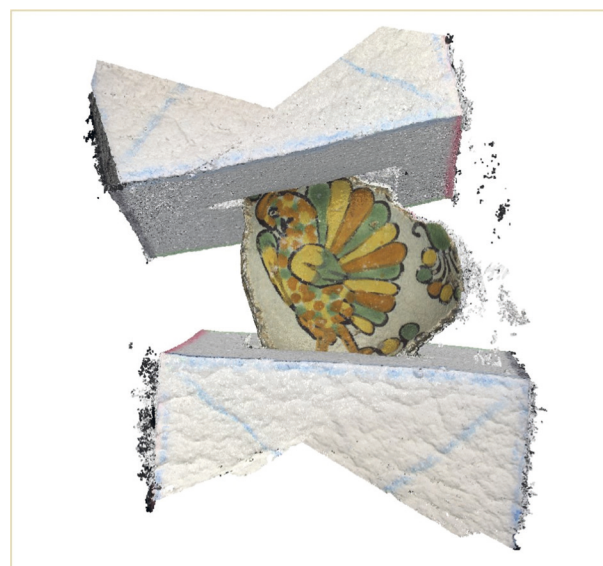


Figure 7. The two dense clouds of the Abó Polychrome Majolica Plate have been aligned, but the patterned blocks have not yet been deleted from the dense clouds. Note that spurious points right of the plate have not been removed in this example for illustrative purposes.

high-quality dense cloud using aggressive or moderate depth filtering (Agisoft 2017a: 12–13). Spurious points were commonly introduced during this stage (Kaufmann, Rennie, & Clement 2015: 226), and each dense point cloud required cleaning, both manually and using the built-in Select Points by Color tool (Agisoft 2017a: 30–31).

Each chunk's photographs were next manually masked a final time to remove the patterned block and any problem areas on the object itself, especially small patches of high reflection, which found would negatively impact texture creature. The dense clouds

of each chunk were then aligned to one another (Agisoft 2017a: 37) based on the fully masked photos (Figure 7). Masking out the patterned block ensured that Agisoft did not attempt to incorrectly align the chunks' dense clouds using this part of the photograph. Once the dense clouds were aligned properly, the patterned block was itself deleted from the dense clouds. The aligned chunks' dense clouds were finally merged into a single point cloud that represented the entire object. On the rare occasion when dense clouds did not align properly, manual alignment was attempted in PhotoScan Professional; however,

	x3dom	SketchFab
Technology	JavaScript Framework	Online Viewer and Model Host
HTML Implementation	<x3d> tag with child tags	<iframe> tag
Customizability	Highly customizable through JavaScript and DOM	Some customization through JavaScript API, but has cross-site scripting limitations
Difficulty of Implementation	Moderately easy to implement basic functionality	Very easy to fully implement
Hosting	Hostable anywhere	Hosted only by SketchFab, but has a RESTful API
Cost	Free and open-source	Free in certain instances

Table 2. A comparison of x3dom and Sketchfab.

we found that failure to align two chunks typically meant that one of the two had been poorly photographed or incorrectly processed.

Lastly, a high-quality mesh was built from the merged dense clouds. Typically, this first consisted of one million faces, but the number was often pared down to appropriately balance mesh definition and file size (cf. Guidi 2015: 344–346). To cover the mesh, an averaged or photo-mosaiced texture (Agisoft 2017a: 14–16) was created from the fully masked photos. In a manner similar to the mesh face count, we started with a texture size of 10,000 pixels and repeatedly reduced this number until reaching a subjectively reasonable balance between texture definition and file size, which was an especially important concern for displaying these models on the web. An averaged blending mode was often best for objects with gloss or high sheen, while a photo mosaic blending mode provided higher definition for matte objects. When completed, the model was saved and exported in OBJ format with a JPG texture.

Run Aground: Displaying 3D Models Online

The problem of how we would disseminate these 3D models to a web audience existed concurrently with our unravelling of the photogrammetry process. Our attempts to display models online in a robust, scalable manner hinged on a choice of two technologies: x3dom⁸ and Sketchfab⁹, both of which have been used for displaying cultural items online (Lloyd 2016; Santos et al. 2014: 10–13; Ubik and Kubišta

2016; Unar and Patoli 2016). From a technical perspective, if you are using a modern browser, neither x3dom nor Sketchfab requires the once-obligatory download of a browser plugin to display 3D models, but the two still offer disparate strengths and weakness, which were at first difficult for us to gauge within the scope of our goals (Table 2).

Because of its high customizability, hosting-neutral nature, and open-source codebase, our initial leaning was towards using x3dom. When a diktat was then handed down by the State that we could not use Sketchfab since the company might own and commercialize our models, our settlement on x3dom was fixed. Yet, after building a proof-of-concept site around x3dom's JavaScript library, we found that while it met our basic needs, it would not offer the range of functionality that we envisioned without significant and time-consuming customization, which is not practical for many institutions. After a thorough review of Sketchfab's Terms of Service and a clear demonstration that we retained ownership of our content, we were permitted to move away from x3dom and implement a second proof-of-concept using Sketchfab. While certain elements of low-level customization were lost, in its place we gained a ready-made viewer that displayed high-quality models (Figure 8). Perhaps Sketchfab's most attractive features to us were out of the box lighting, built-in model annotations, and a RESTful API with which we could pull and push model data in JSON to and from Sketchfab's servers (Ubik and Kubišta 2016). Moreover, Sketchfab is built to work across devices, which solves the tricky problem of displaying 3D on mobile devices (di Benedetto 2014). As a result, after FLBAR acquired a free cultural institution license that allowed unlimited hosting, we resolved that our current and any future exhibits would use Sketchfab. Legitimate ques-

⁸ <http://www.x3dom.org> [accessed 27 February 2018]. The name is nonsensically pronounced “x-freedom.”

⁹ <http://www.sketchfab.com> [accessed 27 February 2018].



Figure 8. The completed models loaded in SketchFab of the sanctus bell, grenade and fuse plug, and polychrome plate shown previously (see Figure 2).

tions remain, though, about the long-term viability of this decision. Since Sketchfab is as a third-party host of our models, future issues can always arise if the company is bought out, moves to a paywall, or goes defunct. As with other digitized content, the appropriate, long-term storage and documentation of 3D models is an ongoing issue.

The Swim for Shore: Building the Website

Since the State of Florida uses Microsoft Azure for hosting, we built the structure of the online 3D museum in ASP.NET Core. Instead of designing a static site, which was certainly possible, we used .Net MVC (model-view-controller), mixing in static, purely descriptive content when necessary. Both the gallery and individual model pages relied on Sketchfab's RESTful API to pull names, descriptions, thumbnails, and links, based on unique model IDs. This permitted content and models to be changed on Sketchfab by non-technical users and additionally centralized the storage of all model data.

The method of generating the gallery and presenting the models to end-users was built with the creation or addition of future exhibits in mind. When a client request for the model gallery is received by the controller, a server-side JSON array of collection names and model IDs is parsed, and the data for each model, including its thumbnail, is retrieved via a server-side GET request to Sketchfab's RESTful API¹⁰. The controller then builds

these data into a view and returns it to the client. Since all styling is well separated into independent CSS files and a JSON array controls the gallery, exhibits can be changed or new exhibits can be quickly built.

The site's individual model viewer, too, follows the same principle; the controller dynamically builds a view for each model based on the model id passed in the client's request. Additionally, a major advantage to this approach rather than a static HTML approach is that Sketchfab relies on Markdown syntax for text descriptions. This again means that a non-technical user could style a model's description or annotations directly through Sketchfab with no regard for how CSS code or the server is structured. When the Markdown is retrieved, the controller parses it and passes proper HTML to the view.

Surviving the Wreck

The time from conception to completion was not short; it required approximately 12 months of experimentation with a staff of four working only sporadically, as time allowed. Once we had developed our workflow, a new model could be created within a few days, during which most labour was spent cleaning dense point clouds and masking photos. Discovering ways to reduce these two tasks would greatly increase the pace of model creation. Not only did our free dive into photogrammetry present a steep learning curve, but with limited staff, we had to fulfil many other conservation and curation functions as we also worked towards an online 3D museum. The long pro-

¹⁰ In deployment, the model data is actually cached on the server for 7 days to speed the return of content. The final site was intended to be deployed in July 2017; however, the cogs of

Florida State's government move at their own, unpredictable speeds.



Figure 9. The galleries, in this case the one on trade goods, were generated dynamically on the server from a JSON array of model IDs.

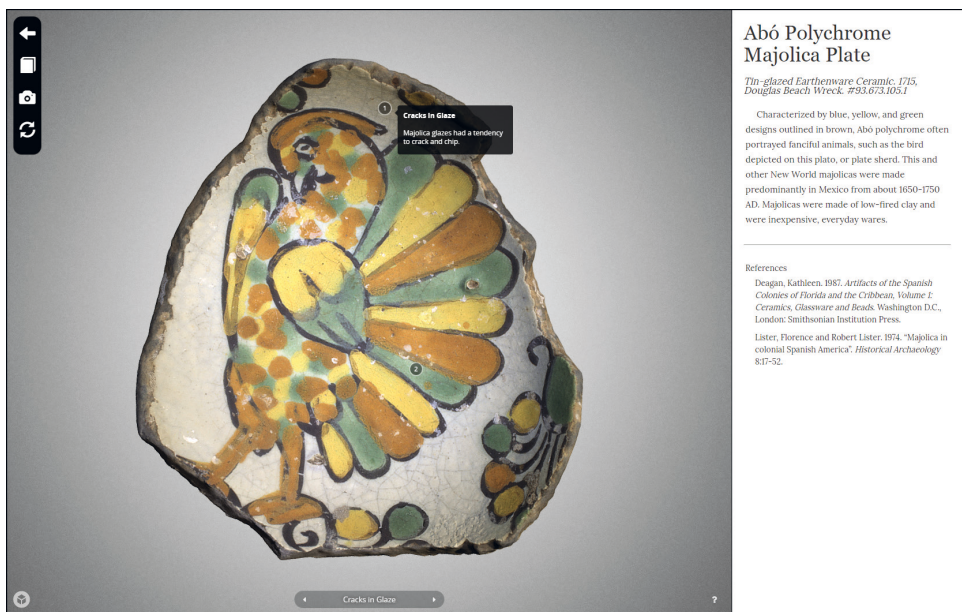


Figure 10. The model viewer was heavily customized and pulled its data directly from Sketchfab through its RESTful API. The final view of the Abó Polychrome Majolica Plate is seen here with its annotations and descriptive sidebar.

cess of mistakes and mishaps, though, led us to develop streamlined and reusable methods, and to design a scalable codebase upon which future exhibits can be built for the people of Florida. The successful completion of this project was ultimately not about expensive equipment or abstruse knowledge, but rather patient experimentation. Many questions and avenues for exploration remain open with the use of photogrammetry with cultural materials (e.g., Agosto and Bornaz 2017), but we hope that our achievement encourages any individual or organization with similar goals and

limited funding to persevere and that this knowledge of our process will prove instructive to them.

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