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An intersection of digital historical preservation and heritage tourism: Prince Frederik's Battery, Virgin Islands National Park

Prince Frederik's Battery was identified as significant to interpretation and preservation. In light of this, the St. Thomas Historical Trust was the recipient of an American Battlefield Protection Program Grant to assist with the documentation and preservation of this 18th century fortification. This paper focuses on the virtual restoration of Prince Frederick's Battery. Researchers recorded extant ruins using a laser scanner and registration of the point clouds, then reverse-engineered the scan data to create two-dimensional drawings. These were used to create a three-dimensional model of the site and a rendered animation. This project generated digital documentation for posterity and narratives that play an actual and virtual role for heritage tourism and a valuable connection to the local population—one that aligns with the unique heritage of the Virgin Islands.

Key words: digital preservation, heritage, tourism, Virgin Islands

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Chad Keller is the Director of the Heritage Preservation Program at Georgia State University. His research and teaching focuses on the integration of newer digital technologies into the investigative and documentation process of cultural heritage sites and objects. Keller has conducted numerous 3D visualization projects involving historic reconstructions, including several interactive 3D models of historic sites and 3D scanning campaigns at notable organizations such as George Washington's Mount Vernon, USVI National Park, Dresden State Museum, and Vatican Museums.

Sarah Dylla's research explores modes of access to history, art, and culture. Through exhibition development, site interpretation, and digital projects, she aims to shed light on lesser known narratives and activate historical records. During the time of the research reported in this paper, she served as a Cultural Landscape Planner for Virgin Islands National Park. Sarah holds degrees in Art and Architectural History from the University of Virginia (B.A., '09) and Public Humanities (M.A., '16) from Brown University.

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Introduction

This research focuses on the process and potential impacts of digital preservation efforts undertaken on an 18th-century fortification known as Prince Frederik's Battery on Hassel Island in the US Virgin Islands. Hassel Island—acquired by the National Park Service in 1978—is a site of growing recognition as a prominent part of the Virgin Islands' history with aims to become a unique option for tourists' itineraries. In light of this, the St. Thomas Historical Trust was the recipient of an American Battlefield Protection Program Grant to assist with the documentation and preservation of the Prince Frederik site and to attempt to elevate awareness of its significance.

Work at Prince Frederik's Battery combined digital preservation initiatives with physical preservation and site interpretation to both gather and document data about the cultural landscape and built environment for posterity, and to help develop a more robust cultural tourism destination. This paper focuses on the virtual restoration of Prince Frederik's Battery, a multi-phase project of digital reconstruction that should serve as a case study for the process and importance of digital preservation of remote and at-risk historic sites. The work accomplished through this project exemplifies the benefits of digital methods for preservation and tourism. This paper describes how this digital reconstruction complements physical site stabilization to create a digital historic record with future uses in reconstruction, monitoring, and research efforts, while also developing products for visitor readiness and historic site interpretation.

Theory and literature review

As a 3D digital preservation effort that considers a full contextual site – historic building and its surrounding landscape, this project is inherently connected to the theories of phenomenology, as used in the field of archaeology. Phenomenology in the archaeological context has often been set in opposition to methodologies that utilize digital tools. Scholars

who align with the experiential tenets of phenomenology are often opposed to the widespread use of representations, as well as the techniques used for capturing representative data in the field, arguing that representations and data gathering technologies create a “mediated” experience with the produced knowledge (Tilley, 2016).

The shift to 3D technologies and resulting interactive, virtual experiences brings a new dimension to representation and enables new types of experiential possibilities to exist, even through the lens of mediation. Three-dimensional representations align with the phenomenological goals of direct, immersive, and “hands-on” experience of sites and objects, while also making this type of approach to research more accessible to those who might not be able to travel to a specific site (or directly handle objects). This shift from 2D to 3D “technologies of representation” calls for a reassessment of the previous divergence between technology and phenomenology (Tilley, 2004).

Digital preservation is one way that Virgin Islands tourism agencies and cultural resource activists can try to balance the demands of the cruise tourism industry with efforts to promote and preserve local heritage. Digital historic preservation work can not only help document at-risk sites for the future but also result in flexible content that can be repurposed in different ways and in different physical locations to raise awareness to important histories and sites (Xiao et al., 2018).

Scholars recognize the benefits of using 3D modeling software to reconstruct historic sites and architecture (Gill 2009). The method of 3D reconstruction involves the capture and reproduction of an object based on color and depth information using tools like laser scanners digital cameras (Gomes et al., 2014). Recent applications include virtual restoration of ancient plank roads (Chen et al., 2016) and wooden architecture (Hu et al., 2016) in China, tombs of historic nobility in the United Kingdom (Frank et al., 2016), as well as a burial monument Hungary (Szabo et al., 2017).

There are a number of different methods for capturing 3D data such as light scanning, photogrammetry, laser scanning and LIDAR (Skates et al., 2017). Early methods of virtual reconstructions depended on generating digital models from hand measured drawings, which reflects the recognized process for documenting historic sites by the National Park Service (Burns, 2004). Early adopters did not integrate the use of laser scanning technology to document a site digitally but relied upon measured drawings that utilized traditional analog documentation methods via a tape measure (Tyler et al., 2009). In the early 2000s, laser scanning technology was introduced as an alternative method for documenting cultural heritage sites and eventually, standards and best practices for capturing data were established (Hughes & Louden, 2005). Since then, many projects have incorporated the use of laser scanning to document a site and using the resulting measurement data as the basis for creating the virtual reconstruction (Guidi et al., 2014; Riley et al., 2011).

Methodology

Study site

Hassel Island is a landmark for military and mercantile history in the Caribbean, populated with historical sites that communicate a variety of stories (Hassel Island, n.d.). The island houses Prince Frederik's Battery (Figure 1), an 18th-century Danish fortification that successfully defended St. Thomas from British warships during a skirmish related to the Battle of Copenhagen in the French Revolutionary War. Shipley's Battery, Cowell's Battery, and the sites constructed under the direction of Lt. Col. Charles Shipley are the only existing Napoleonic War structures on United States soil (Wright, 1976).



Figure 1. Prince Frederik's Battery

Also, dating from as early as the mid-19th century, Hassel Island contains important sites, architecture, and artifacts of steamship coaling stations and shipping depots of prominent companies, such as the Royal Mail Steam Packet Company (RMSPC) and Hamburg American Lines (now Hapag-Lloyd). A significant marine slipway and vessel repair station, Creque Marine Railway, is still present on Hassel Island. The large complex, established in the 1850s as the St. Thomas Marine Railway Company, contains a rare Bolton engine, and is proclaimed to be the last remaining example of a steam-powered marine railway in the Western hemisphere (Rumm, 1985). Sites on Hassel Island include resources from both World Wars, as U.S. naval troops were stationed in the old industrial depots.

In 1976, just before the Park Service acquisition, the island was designated as a historic district on the National Register of Historic Places. In the 1980s, the NPS contracted a HABS documentation of several sites and a HAER report on Creque Marine Railway. With funds lacking for conservation and visitor-use plans, Hassel Island received little attention or

preservation efforts. In the 2000s, there was renewed recognition from the NPS and interested community constituents. By this time, the island was overgrown with tropical vegetation, root systems and extreme weather compromised many structures, and old pathways were impassable, rendering Hassel Island mostly inaccessible to the public. With funding and additional workforce from the St. Thomas Historical Trust and Friends of Virgin Islands National Park, work to preserve, protect, and interpret Hassel Island in line with General Management Plan goals commenced. One of the results of this renewed effort was the receipt of an American Battle Protection Program (USNPS, n.d.) grant to document and preserve the site of Prince Frederik's Battery.

Data collection

To accurately document and restore Prince Frederik's Battery digitally, a multiphase approach was taken. The existing physical ruins were recorded first using three-dimensional laser scanning technology. This was chosen over conventional methods of documentation due to the heightened level of accuracy capable of the laser scanner and the speed with which it can capture dimensional information. Next, the collected measurements were post-processed remotely and used as the basis for the three-dimensional reconstruction. Finally, the virtual restoration was modeled, rendered and animated via three-dimensional modeling software typically used in the game design and movie visual effects industries.

Prince Frederik's Battery is a medium sized site covering an area of under a quarter acre. The site was documented using the Faro LS 120, which is ideal for medium to large projects. This particular scanner is a mid-range, phase-based scanner with a 360° x 320° field of view capable of collecting 976,000 points per second with millimeter accuracy at a distance of up to 120 meters. Each point consists of a precise, three-dimensional x, y and z coordinate. The scanner operates by emitting a laser pulse at a known wavelength. The pulse encounters an object and bounces back to the scanner but at a different wavelength. The

difference between the emitted and returned wavelength is how the distance is calculated. Scanners operate on a line-of-site and are not capable of seeing through objects such as walls in buildings. Therefore, the scanner must be moved around the site to get a complete record of the building being documented. From each location, the scanner generates millions of points and assembles them into a point cloud.

Following this, the images were then converted into usable forms. The images were developed to be used in a variety of interpretive video displays at the USVI National Park visitor center and the St. Thomas Historical Trust museum space. Further, these images could be used in promotional materials sent to cruise ship companies and small tour operators, as well as in future historic research or conservation monitoring work.

Results

The documentation of Prince Frederik's Battery involved a total of 14 different scan locations to record the site in its entirety. This includes both interior and exterior scan locations of a site that consists of a paved path, kitchen, latrine, living quarters, cistern, and rampart wall capped by a terreplein. After capturing the data on site, the information was processed remotely. Processing the data involves point cloud registration, which was done using JRC Reconstructor. During this phase, the individual point clouds are spatially referenced to one another and combined into one cloud. The result is a highly accurate three-dimensional representation of the historic battery and site (Figure 2). The points of the combined cloud are so densely packed that it gives the impression of a solid model; however, this is not the case. The point cloud must be imported to other software and will be used to assist with creating a polygonal model and the virtual reconstruction.

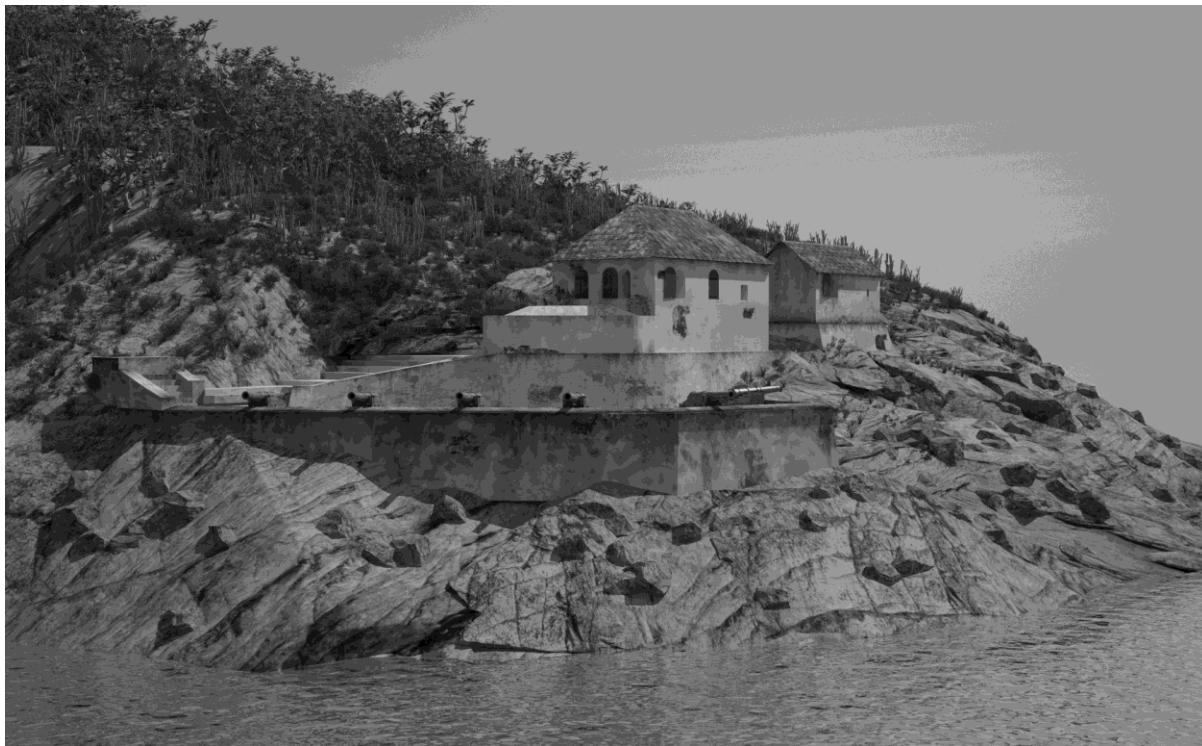


Figure 2. Virtual Reconstruction Prince Frederik's Battery

A combination of AutoCAD and 3ds Max was used to virtually reconstruct Prince Frederik's Battery. Both are Autodesk products and were chosen due to a proven, well-established workflow. First, the combined point cloud was imported into AutoCAD to be reverse engineered. During this stage of the process, the three-dimensional point cloud was cut into sections, and the basic form of the buildings and site were outlined by tracing over the points with two-dimensional lines. Next, the lines were opened in 3ds Max and extruded to generate the three-dimensional model. Once the solid model was created, textures and environmental lighting were added to simulate the different real-world material surfaces and lighting conditions, all of which contributes to the realism of the model. Finally, 2,850 individual high-definition frames were rendered to generate the animation video, which is currently displayed in the former military magazine that is now being used as the Island's visitor center.

The resulting data and images were used in a complementary way three other efforts on the Prince Frederik site. First, the physical site stabilization of Prince Frederik's Battery,

which was completed successfully by local masons (STHS, 2013). The second was infrastructure development for visitor readiness that included trail and site clearing and the development of walking tours (STHS, 2014). Reports indicate that over 350 visitors made a tour in both 2014 and 2015 (STHS, 2014; 2015). Third, historic site interpretation that included signage and a brochure with a trail map (STHS 2014). Finally and ultimately this project generated digital documentation for future generations.

Discussion

Since the UNESCO *Charter on the Preservation of Digital Heritage* (2003) and the *London Charter for the Computer-Base Visualization of Cultural Heritage* (2009), scholars and cultural heritage professionals have been building a framework to support digital preservation and cultural heritage work in many formats. From the work of international coalitions, museums, parks, and academic laboratories, the needs that drive this pursuit have become more formalized and evidenced. Work toward 3D documentation and reconstruction of landscapes and buildings specifically highlights how digital heritage preservation can be used to document at-risk sites in the historic context of their immediate surroundings, provide open access experience of these through shared video and web-based products, and mitigate future impacts to the physical site. All of these benefits come together in the research project at Prince Frederik's Battery, as the phased process of the project created archival digital data and multiple deliverables that hold potential to be purposed for research as well as tourism advancement.

Hassel Island has a wealth of resources that have potential heritage tourism experience for visitors to St. Thomas. Stakeholders must harness new approaches to preserve, promote, and interpret these resources. One approach discussed in this paper is digital preservation. Not only does digital preservation generate the variety of data necessary to conserve an at-risk site, but the process can be used to develop multimedia interpretation and

marketing materials as well (Gomes, 2014). Results have indicated that the digital preservation work on Prince Frederik's Battery has not only created a suite of 3D models but also tangible site interpretation and steadily increasing visitation to Hassel Island and Prince Frederik's Battery.

This research generated digital documentation for posterity and narrative animations that may be used at visitor centers. Prince Frederik's Battery plays both an actual and virtual role for heritage tourism—one that aligns with the unique heritage of the Virgin Islands. Further, the processes and outcomes of the land-based portion of this project (site stabilization, trail development, interpretation) present ways to expand the scope of the digital preservation activities to manage risks and expand visitation to these heritage resources.

Digital devices and platforms are now commonplace objects and means of communication. It is indisputable that such technologies engender different ways of seeing and understanding than direct human perception, but the results of digital 3D experiences could replicate as similar of an experience as possible, while also serving as hermeneutic devices, facilitating experiential learning for broader audiences, and holding the potential to mitigate physical cultural heritage preservation concerns. Through a data collection process based on practices that are at work across the broad cultural heritage field (documents, materials, archives, objects, and architecture), the Prince Frederik's Battery project has generated agile data that has been purposed to encourage more direct, immersive understanding of the site's history, but may also be used in the future for other research or market-driven needs.

Conclusion

Historic sites like Hassel Island's Prince Frederik's Battery need to be part of the fabric of a community to appreciate the value of their cultural heritage and so that visitors are able to participate in authentic experiences. Research on Hassel Island's Prince Frederick's

Battery serves as a case study for ways to employ digital technologies in the service of both preservation and engagement efforts, documenting disappearing sites for posterity while also activating the hidden resources to encourage visitors, researchers, and local knowledge.

The methodology used in this project effectively involved a variety of tools and platforms to gather precise data and manipulate that data into accessible interpretive content. The process and results are extensible, as the data can be revisited and repurposed for scholarly, park operational, or promotional purposes. As just one case, this project presents a potential for expanded implementation across sites on Hassel Island, in Virgin Islands National Park, and at similar destinations, where multimedia digital preservation endeavors can help infuse the tourism industry with more robust and historically complex opportunities.

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