The 12th International Symposium on Virtual Reality, Archaeology and Cultural Heritage VAST (2011)
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Visualizing Williamsburg: Modeling an Early American City in 2D and 3D

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Abstract

Williamsburg, the capital of Virginia from 1699 to 1780, has been the subject of extensive research for more than eighty years. However this research has never been assimilated to look at the development of this planned city, not at a site level but at a town level. Two digital projects, eWilliamsburg and Virtual Williamsburg, are now seeking to visualize this data in new ways. In 2010, Colonial Williamsburg launched the temporal eWilliamsburg map, an interactive tool for depicting the town's layout for any year in the eighteenth century and for querying information about the structures and residents. Building upon eWilliamsburg, the ongoing Virtual Williamsburg project is using 3D modeling to virtually reconstruct the town as it looked in 1776. Not only are these projects providing novel insights into Williamsburg's eighteenth-century history but, perhaps even more importantly, they are resulting in new online tools for educating and engaging the public.

Categories and Subject Descriptors (according to ACM CCS): I.3.6 Methodology and Techniques

1. Introduction

Williamsburg, Virginia—arguably the most studied early American town—has undergone extensive archaeological, architectural, and historical research since the 1920s. More than 700 research projects on town properties, including over 200 archaeological excavations, have been undertaken and work is still ongoing today. Despite this vast body of scholarship, researchers had never tried to visualize the town's growth over time in any systematic way. The "Frenchman's Map," a c.1782 French billeting map often referred to as the "Bible of the Restoration," is presented as the principal overview of the town, but it was drawn after the capital moved. A majority of the lots have been investigated in some way but these discrete studies had never been assimilated to examine Williamsburg at the town level. Through two digital projects, eWilliamsburg and Virtual Williamsburg, we are now working to integrate all of these datasets, to visualize the town in new ways for research purposes and for developing interactive educational media for the public.

2. Williamsburg

Today Colonial Williamsburg is the United States' largest outdoor living history museum and is dedicated to interpreting life in Virginia's capital at the time of the American Revolution. The Historic Area consists of 88 original buildings and about 500 more reconstructed ones.

Williamsburg served as the capital of Virginia from 1699 to 1780. After the statehouse at Jamestown burned again, the assembly voted to move the capital to Williamsburg, then known as Middle Plantation. The town planners chose the site, which was little more than a church and a college, on the high point of the peninsula formed by the James and York Rivers. Governor Francis Nicholson, who also designed Annapolis, laid out the one-mile long city around public spaces and gridded the remainder of the town into regular rectangular lots. For the first decade, the population remained under 200, but slowly the town lots were purchased and developed [Fis04]. The town continued to grow reaching a population of nearly 1000 residents by about 1750 [Hel89]. By the 1760s the population of the bustling town had grown to nearly 2000 inhabitants, half of whom were enslaved.

Williamsburg was also the site of important events related to the American Revolution. In the Capitol, Patrick Henry presented his "Resolves Against the Stamp Act" to the House of Burgesses in 1765. Perceived by some as treasonous, Henry's resolutions urged the colonists to resist Britain's efforts to tax the American colonies and marked the beginning of the colonial struggle for independence. The House of Burgesses continued to oppose new measures and pushed for independence even after being dissolved. During the war, the town was occupied, first by British troops and then by American and

DOI: 10.2312/PE/VAST/VAST11S/077-080

French forces during the siege of nearby Yorktown, which would effectively end the fighting when Cornwallis surrendered in October 1781.

A year prior to Yorktown, the assembly had moved Virginia's capital to Richmond, so once the War was over the town returned to being a sleepy hamlet. Williamsburg's population decreased by 25% from the pre-war period and would continue to wane [KEL00]. However, this relative decline also helped to preserve the town's eighteenth-century character. Eighty-eight original buildings remained and the relatively undisturbed archaeological record held clues to hundreds more that once dotted the landscape. In the 1920s Williamsburg resident Reverend Dr. W.A.R. Goodwin convinced John D. Rockefeller, Jr., of the potential to return the town to its colonial glory and with Rockefeller's purchase of the Ludwell-Paradise House, the process of researching, restoring, and rebuilding began.

3. eWilliamsburg

The eWilliamsburg time map was launched in 2010 (Figure 1). Funded by a grant from the National Endowment for the Humanities (NEH) and built using ESRI's suite of ArcGIS products, this map tool allows users to visualize in 2D the town's layout for any year between 1699 and 1800; to select properties to access information about owners and tenants; and to query building and parcel attributes. One of the primary goals of creating the temporal map was as an interactive learning tool for educating the public about how dynamic the city was during the eighteenth century, something which is far more difficult to convey within the setting of the living history museum. Being able to visualize the town also permits researchers to ask questions about Williamsburg's spatial development; the nature of neighborhoods; and the organization of the urban landscape.

Figure 1: *eWilliamsburg interface set to 1776.* http://research.history.org/eWilliamsburg2/index.html

The eWilliamsburg time map is focused on two primary feature types for visualizing the town: structures and parcels. The map also includes reference layers for streets, topography, and hydrologic features to provide context, but these features are static because of the lack of evidence to show them over time. Rather than mapping complete foundations as single polygons, "building units" were drawn to be able to show how complex structures developed. A building unit was defined as a portion of a structure's footprint built/destroyed during a single construction/demolition episode. Thus a building unit might be the initial structure, an ell addition, or a new porch. While the majority of structures consisted of a single unit, some buildings evolved significantly over time, with Wetherburn's Tavern having the most building units at sixteen. Altogether the map includes 1033 building units representing 742 different structures. The other feature type, the parcel, was defined as the largest contiguous piece of property owned at one time. Surviving early nineteenth-century plats provide the town's general lot structure and numbering system, but fail to convey the complex nature of lot transfers, sub-divisions, and mergers that is evident in the deeds. Thus the information in the deeds was mapped against the plats to create the parcels, which are represented by 448 distinct polygons.

One of the challenges of developing a temporal GIS based on archaeological and historical data is that the dating evidence can often be imprecise or uncertain, or dates, when known, are more often relative than absolute. Computer mapping and databases must be "adapted" to capture the shades of gray inherent in archaeological data. For example, a *Terminus Post Quem* (TPQ) date for a structure's builder's trench may indicate the date after which it was constructed, but without other evidence determining whether it was built one or ten years later may be difficult. Or an historic deed may mention a building, but without other information it may be impossible to know how long it stood. Therefore confronting this uncertainty was critical in an effort to convey what we know is reliable; what is possible within the lines of evidence; and what we simply do not know.

Uncertainty is managed using qualitative attributes—definite, probable, possible, and questionable—to quantify date reliability for buildings and parcels. Thus every date period associated with a building or parcel consists of three attributes: the start year (and month/day if known), end year, and a certainty rating. The start and end dates for a building unit, for example, do not necessarily represent its construction and destruction but rather the start and end of the period associated with that certainty level. For instance, if a building was definitively standing from 1763-1774 but probably was not torn down until 1781, then one associated date period would be 1763-1774 with an attribute of definite and a second would be 1775-1781 with an attribute of probable. [Note that 1781 is included as probable since the building was likely standing for at least part of that year before being destroyed.] Specific guidelines for determining the certainty level were created to ensure consistency in how they were applied to all dates.

The date certainty attributes form the basis for visualization in eWilliamsburg. When the map is dynamically generated for a given year, the darker the building or parcel is shown the more certain the evidence is to suggest it existed in that year. The Douglass Theater provides a relatively simple example of how this is applied. The playhouse was conclusively constructed in

1760, so beginning with that year the reliability can be considered definite. However its destruction date is less clear: an historical reference indicates the building was still standing in 1775, but the property was sold in 1780 and the deed describes the parcel as "whereon the old playhouse lately stood." Archaeology was unable to pinpoint the destruction date any further. Thus for 1760-1775 the playhouse is shown in the darkest brown, associated with the definite attribute. As the user steps through 1776 to 1780, it becomes lighter in color before completely disappearing from the map in 1781.

eWilliamsburg can also be queried to examine building usage and property ownership through other related attribute data. In addition to the polygons and related dating information, the relational geodatabase includes other descriptive attribute data for both buildings and parcels. For buildings, this information includes its modern name, if it has one (for searching); building type; and use. The parcels are linked to owners and tenants as well as transactional information, such as sales and inheritances for generating chains of title. Additional information about the associated people, such as birth and death dates, gender, race, occupation(s), and literacy status, can be learned through the linkage to a pre-existing database of the town's residents, originally compiled during the Department of Historical Research's York County Project.

4. Virtual Williamsburg

The eWilliamsburg time map is an important educational and research tool, but it is also laying the groundwork for the Virtual Williamsburg project. Virtual Williamsburg will be an interactive 3D model of Williamsburg as it looked in 1776. The eWilliamsburg research and data are providing the essential foundation for determining what buildings need to be modeled for an accurate representation of Williamsburg on the eve of the American Revolution. Users will be able to access information about the sites, buildings, objects, and 18th-century people associated with the properties through the 3D interface, and the data structure developed for eWilliamsburg will serve as the basis for managing the digital materials linked to the 3D model.

To model Williamsburg in 1776, over 500 buildings, along with the terrain and landscape features, will be virtually reconstructed. To make the process manageable, the town has been divided into neighborhoods. The first neighborhood being modeled is referred to as "Revolutionary City," or the east end of town (Figure 2). In December 2008, this phase of the project began with the receipt of National Leadership Grant from the Institute of Museum and Library Services (IMLS) and is being done in collaboration with the University of Virginia's Institute for Advanced Technology in the Humanities (IATH). Five principal sites—the Capitol, Dickson Store, Douglass Theater, Public Records Office, and Raleigh Tavern—are being be modeled inside and out, and the thirty other buildings in the project area are having their exteriors modeled within a virtual landscape. This phase of the project will be completed in 2012.

Figure 2: *Basic massed models showing the progress to-date in modeling the "Revolutionary City" neighborhood.*

So why create a virtual model when there is a physical reconstruction? While the experience of visiting the Historic Area can never be replaced, there are things that can be accomplished in a virtual world that cannot be done in the restored one. One of the biggest challenges with the Historic Area is that it does not show a specific moment in time: earlier and later buildings may sit side by side and others have never been reconstructed. Approximately half of the sites in the current project area have different uses and/or owners than are ascribed to their counterparts in the Historic Area today. Simply viewing these buildings according to their 1776 functions alters our perception of the neighborhood. In the virtual world, inaccuracies as well as the concessions to modern living that affect the physical reconstruction can also be corrected.

The project is relying on a two-stage modeling process, one that involves developing a research model that undergoes a thorough review and revision process including archaeologists and other team members before moving into the texturing stage. For the research model, the building is reproduced as accurately as possible in AutoCAD without being concerned about making it look realistic. For example, the research model of the second capitol shows a building different from the currently reconstructed one, a closer approximation of the first capitol that burned in 1747 (Figure 3). Once the massed model is finalized, it is then textured and lit using 3DSMax and other software packages to achieve the photo-realism needed. The review process and modeling decisions are being thoroughly documented to be linked to the final interface. Consequently, users will be able learn about how the final model was reached, hypotheses that were tested, and questions that might still exist.

Modeling furniture and objects for the interior spaces in the five principal structures is also a key aspect of the project. Just adding a few objects can change the look of a room, and more easily indicate a space's function and scale. Artifacts found at a site can be used as the basis for virtual objects; for example fragments of delft tiles were found at the Dickson Store site in coffeehouse period contexts indicating they had been in place during the earlier store period. When the store became a coffeehouse, the fireplace tiles were removed as part of turning the side

room into a dining room (Figure 4). Visualizing change over time across the eighteenth century is probably unrealistic for Virtual Williamsburg, but we can model multiple key periods to show how a site developed.

Figure 3: *The top image shows the reconstructed first capitol. The bottom one is the research model of the second capitol, in which the apisidal ends have been squared off and a portico added on the west end to re-orient the building's main entrance from the south side.*

The end result of the Virtual Williamsburg project will be an interactive 3D model linked to the Foundation's rich documentary resources. One of the primary goals is developing a model that will be flexible enough to use in a range of online and onsite presentation formats. In addition to rendering images and animations for illustrating online and onsite materials, the model will run in Unity 3D allowing for real-time interaction over the internet.

5. Conclusions

While our primary goal in creating these visual tools is the educational value, these approaches are also changing research at the Foundation. By working with the datasets in new ways and making computer-based analysis an integral part of the process, we are able to test and enhance our interpretations. They are also helping us to re-examine long-held assumptions, see new things, and to refine our understanding of the town as we strive to educate the public.

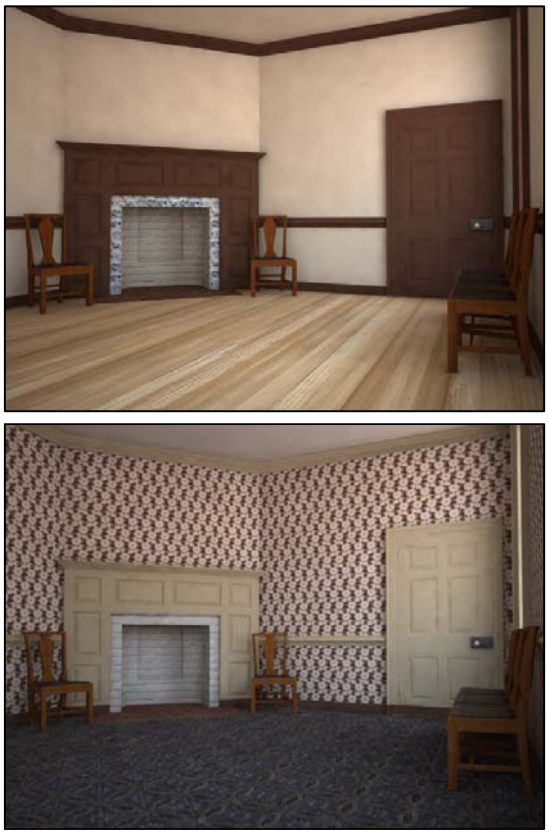

Figure 4: *Textured model of Side Room of the Dickson Store. The top image shows 1750 and the lower one 1765-1776.*

Acknowledgments

The eWilliamsburg project was funded by a grant from the National Endowment for the Humanities (NEH). The Virtual Williamsburg project has received funding from the Institute of Museum and Library Services (IMLS), the NEH, and the Andrew W. Mellon Foundation. We are extremely grateful for this support.

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