Visualizing the Unknown in Historical Vernacular Architecture

Making Speculation from Archaeological Fragments Explicit

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Abstract. *Computer based visualization tools have the capacity to create convincing reconstructions of historical structures that appear to be authentic and complete but where inferences have been drawn from relatively limited evidence. The challenge is how to make the exciting process of discovery, argument and reasoning more self-evident in the model and also make known the alternative constructions that were plausible but less likely. This paper refers to two computer visualizations developed by the author for world heritage building sites. In both cases, a similar geometrical modeling technique was used. However, in the second case, the 3D modeling approach is developed for juxtaposition with captured dialogs, the evidence used, and the process followed so as to make level of speculation more explicit.*
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ACCOUNTING FOR UNCERTAINTY

The evidence and logic used to build a three-dimensional digital model of a historic structure can be stored as attributes on CAD entities. Yet, unless queried by an expert, the CAD model may visually appear to present a more exact view of the structure than may be warranted by the amount archaeological information found (Dumbill, 2004). At the same time, one of the more compelling reasons for undertaking a three-dimensional digital reconstruction is to provide a team of archaeologist, architectural historians, architects, period historians, and other experts with a means to visually work out how to interpret the evidence. Recording their discussion helps to create an audit trail that can be linked to the geometrical model. Change the logic in the set of assumptions and the original three-dimensional model should be modified accordingly. Testing the assumptions over time may help the next generation of researchers to either more completely validate or to challenge the logic with which the three-dimensional computer model was made. Furthermore, methods of archeological analysis in the future may allow for more accurate assessments of the underlying data.

Two case studies in visualizing historic architecture had similar background conditions. In both cases, the buildings no longer exist. The primary evidence is in the form of written documents that are several hundred years old and in archeological finds that are not fully conclusive about construction methods. Archaeologists used post-holes and other evidence found underground to establish building footprints. No original photographs or architectural drawings exist to directly support a three-dimensional interpretation. Apart from evidence excavated from the site that may establish what existed below ground, the assumptions are more speculative about the structures above ground. There is the added complication that archeological digs in the past or the construction of later structures on the same building site have left a physical imprint that may obscure key data. Moreover, both of the case studies are about highly publicized places. They draw much tourist interest and popular media attention, and so separating fact from popular myth can be one of the challenges.

The first of the two case studies is based on the reconstruction of the Statehouse and a Barracks building at the first permanent English settlement in North America; Jamestown, Virginia. The reconstruction was developed for a permanent exhibit on the original site. In the second case study, a project titled "Mulberry Row The Landscape Of Slavery", two exhibitions are planned for an audience interested in understanding the slave dwellings and workshops on the main street at Monticello, the historic plantation home of Thomas Jefferson (1743 – 1826), the third President of the United States. At Mulberry Row, a landscape partially erased by time, the research is intended to gain some insight into how its occupants lived and worked. While the computer modeling effort derives from a detailed analysis of its subject in both case studies, the fleeting nature of that understanding is made more self-evident in how the interpretive digital reconstructions are being prepared for Monticello.

On the one hand, in the case of Jamestown, the arguments and reasoning are not explicit within the completed three-dimensional models. Rather, the full analysis is described in a book written by the lead archaeologist William Kelso (Kelso, 2006). The book reveals how studies of the site were used to help establish the speculative reconstruction. On the other hand, at Thomas Jefferson's Monticello, the three-dimensional model and underlying database is developed with an eye towards establishing on-line a more explicit decision making trail of the notes, arguments and preliminary sketches that led to its construction. At Monticello participating in the discourse over some plausible interpretation may bring the viewer closer to the processes of discovery. That is, the actual evidence used, the speculation and reasoning are made more explicit within the digital work and disseminated through a variety of linked media. Having access to this primary information, researchers or more casual visitors in the future may be able to better judge the validity of the assumptions made, retrace the thinking that led to them and add their own perspectives.

Figure 1
Computer reconstruction of Statehouse on known site.

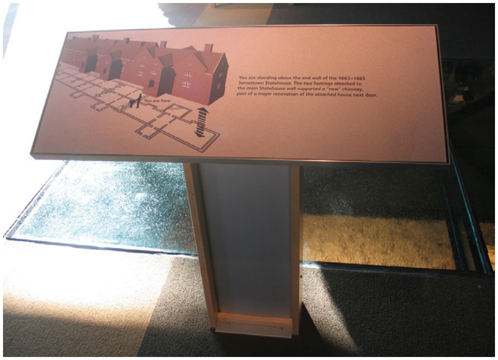


Figure 2
Statehouse digital reconstruction superimposed on foundation wall.

Jamestown Statehouse and Barracks

At Jamestown, the original foundation for the Statehouse partially is visible above ground. Although the building's foundation still exists, its physical appearance had been impacted by a preservation effort in the mid 20th century. A three-dimensional digital model is depicted in figure 1. It is the final iteration on a series of studies that resulted from back and forth speculations between members of an interdisciplinary team. The scope of this dialog is evident in the book by Kelso that distributed at an on-site Museum, but not directly integrated with the final three-dimensional computer model.

At Jamestown, the three-dimensional model was debated, revised several times and continuously scrutinized by the researchers involved. Kelso's archaeological publication explains the complexity of arguments and evidence related to the project. For example, one part of the original Statehouse design would have constituted non-standard government architecture, such as the modest main entrance on the right-hand side of figure 1 above. The untypically small entranceway isn't well established in similar institutional buildings and therefore demonstrates a situation where significant speculation was needed.

At Jamestown, a number of renderings of the three-dimensional computer model are reproduced in panels erected on the site. They are within the museum interior as shown in figure 1 and outdoors as shown in figure 2. All the panels sit directly above and are keyed to a specific location at the foundation walls of the original building. Although the renderings contain a full depiction of the Statehouse, they represent only one of several alternative computer models. The other models were considered to be less likely though still plausible. In addition, the foundation wall was covered in the mid-20th century by an archaeological team in order to preserve it following their own fieldwork. Thus, the existing appearance of the foundation wall and the juxtaposed computer model do not reveal the scholarly uncertainties as addressed by the lead archeologist and his team.

Archaeological speculation at Jamestown also included the reconstruction of a barracks lodge. There are quite a number of popular reconstructions of this building type. It has been reconstructed at a nearby theme park "Jamestown Settlement" which includes a physical reproduction of the original village. Set designers of the 2005 film "The New World" starring Colin Farrell as Captain John Smith attempted another version. The 1995 Disney Animation "Pocahontas" also speculates on its construction (not badly according to lead Archaeologist Bill Kelso).

The archaeological team at Jamestown contacted this author and his graduate students to help reproduce a similar structure based upon the evidence of post-holes and the precedent of wattle and daub construction in the UK. Wattle and daub is a process of making walls from a woven stick structure filled with clay and other materials. Depicted in figure 4 is the exposed structure of purlins that are needed to support a thatched roof.

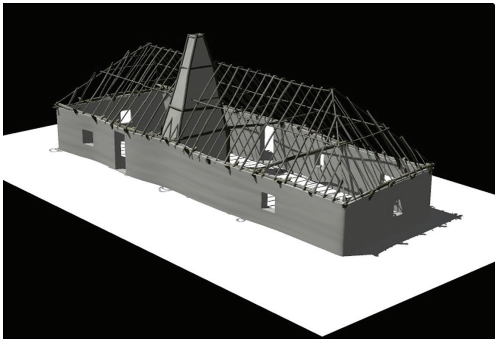


Figure 3
Marker at Jamestown over foundation walls.

Figure 4
Computer model rendering of wattle and daub structure over post-hole plan.

Once the digital model was completed, its construction details were further examined. The archaeological team referenced it in order to build a full three-dimensional mockup on the original site. They tested how the lattice could be woven relative to what could be visualized in the computer model. A few minor discrepancies in the lattice structure were easier to spot through physical construction. Though the three-dimensional model helped to advance the research, it isn't the definitive representation in every detail.

Monticello

At Monticello, a vernacular type of construction that existed on Mulberry Row is no longer very common. One reason may be that the use of logs and other wood members were not adequately protected from rot and terminates. Scholarship has been focused on the configuration of this vernacular building type that has disappeared from the region over time (Chappell, 1997). Several alternative building configurations are plausible for such a vernacular type that was occupied by slaves. Jefferson labeled three of these buildings as "R", "S" and "T" for an insurance report. Research on the vernacular type was the basis for an interpretive set of drawings of "S" by a leading expert (see acknowledgement to James Chappell). A follow-up three-dimensional computer based reconstruction by this author is juxtaposed with the archaeological sketch in an exhibition panel near the actual site on Mulberry Row and depicted in figures 6 and 7.

Yet, this is but one of several interpretations that have been vetted before a group of experts. The current exhibition on the site addresses the speculative nature of the existing reconstruction, points to the ongoing research and identifies the artifacts being used to make sense of the archaeological findings. While the images may appear deceptively photorealistic and thus seem to be factually certain, a QR Code symbol is posted that can be scanned by a smart phone in order to redirect the viewer to a web site where more detailed information is posted. A blog was initiated at http://www.mulberryrow.org to record visitor reactions and creates an opportunity for the project team to respond (see acknowledgements to Dierkshiede and Wollerton below).

In the effort to interpret the disappearing landscape of Mulberry Row, the range of digital resources embodies several alternative lines of reasoning beyond that which can be provided by the three-dimensional model. It provides a representation not only of the structure but also of the archeological evidence, and the assumptions and reasoning used to reconstruct buildings on the site. The approach is in effect cognizant that superior methods may be available in the future, pending new discoveries developed from new analytical technologies or methods. It is explicit about its own limitations in the hope of being relevant to a longer-term research and future rediscovery process.

Figure 5
Mockup Structure at Jamestown developed by Bill Kelso's team.

Figure 6
Panel showing state of the research with computer renderings at right.

Another example of this approach is being undertaken with respect to the Smokehouse and Dairy structure depicted in figures 8 and 9. Jefferson referred to it as building "M" in his insurance report. Here too the research team is stepping through a series of alternative speculations based upon the archaeological evidence and historical precedents. Cut-away views of the roof framing structure show two different interpretations of "M". A less likely system based upon purlins is depicted in figure 8. Within the rendering, the computer 3D model is juxtaposed above a drawing of archeological findings. The purlins would have supported a board and batten roof. A more likely framing system without purlins is depicted in figure 9 and would support a riven clapboard roof.

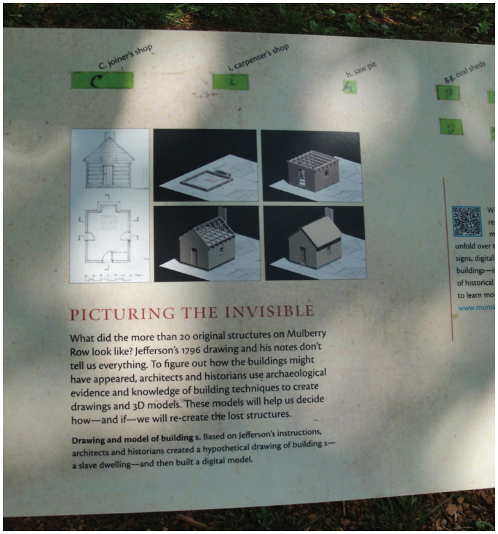
Note the logs and riven clapboard walls of figure 9 were algorithmically generated using random number generators. A parametric script simulates their moderately curved edges and uneven surface. A specialist demonstrated how to make the riven clapboards and thus provided the basis for the script (see figure 10). Parametric variables can be adjusted to speculate about the non-uniformity of the log and riven clapboard geometry. For example, for any given log section the radii are scripted as a part of 17 input variables:

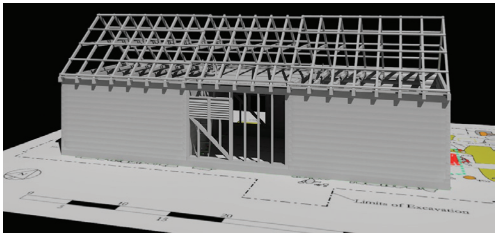
```
logSection = logSectionMaker(RLcurCS, logCenter,
radiusNE + radiusNEt, radiusNW  + radiusNWt, radiusSW
+ radiusSWt, radiusSE + radiusSEt, rAngleNE, rAngleNW,
rAngleSW, rAngleSE, logWidth, logHeight, numLogSides);
```

CONCLUSION

At both Jamestown and Monticello, information technology has been widely used to document the location of the site's artifacts, date materials, scan objects, and is encoded in a relational database and GIS system. By default the three-dimensional architectural model at Jamestown doesn't make explicit the wealth of this data. It is the visual result without all the underlying evidence. At Monticello, there is a more direct link to the supporting material publically accessible form on-line and allows for greater scrutiny

At the time of writing this paper, public exhibitions of the Mulberry Row project are being prepared for Monticello and for the Smithsonian Museum of





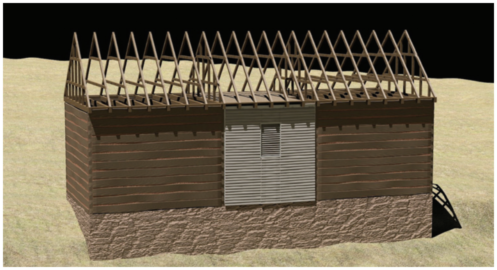


Figure 7 (left)
Detail of panel with QR code symbol embedded at mid-right.

Figure 8 (right up)
First interpretive model with roof purlins and straight-cut logs.

Figure 9 (right down)
Algorithmically interpreted logs, revisited system.

Figure 10 (left)
Hand riven clapboard

Figure 11 (right)
prototype iApp depicting Building "T" mockup, a slave residence.

American History. A combination of information technologies will provide different ways of revisiting the data behind the project. An accompanying web-based exhibition can be linked directly to the QR codes on the site and may provide the most detailed data. Two kiosk computers on Mulberry Row will provide interpretive animations. In addition, an early prototype iApp by this author will allow a user to see the varied structures on Mulberry Row juxtaposed through a kind of augmented reality interface that will link to the same web sites. The test depicted in figure 11 mockups one of the slave quarters "T" on a now vacant part of Mulberry Row. Through a wireless network technique for triangulating locations on site, different images will be programmed to automatically pop into view as the visitor walks towards locations where structures once existed.

The purlins in the Barracks depicted in figure 4 at Jamestown were prepared without exploring an alternative roof structure since they were highly likely to have existed. However, the purlins on the roof depicted in figure 8 for building "M" at Monticello were developed along with a contrasting alternative. This approach may be especially needed where the reconstruction is not based upon artifacts found on the site alone, but rather a kind of detective-like process from circumstantial evidence. As already noted, most of the physical evidence has disappeared from the site. It exists primarily in broken fragments. Therefore, comparisons with other known sites, inference, and peer review all have a key formative role. An integrated knowledge base can potentially transform a relatively inert three-dimensional sketch into one that can expose the systematic base of information more common in contemporary archaeological GIS applications. Making the background information explicit through a variety of media as well as providing a blog may enliven the visitor's experience. It allows them to have more immediate access to and express their opinion on the background arguments. They can vicariously become part of the project team.

ACKNOWLEDGEMENTS

Much credit for the work goes to the team of archaeological staff, curators, historians and other experts involved in the two case studies reported in this paper. The Jamestown project was completed through the Jamestown Rediscovery Project led by Director of Archaeology Bill Kelso. History Professor Randall Shifflett, then Acting Director for the Virginia Center for Digital History, was the lead PI of a Mellon Grant that inaugurated the project. Duncan Morton of Johnson, Craven, and Gibson Architects in Charlottesville, and Meghan Quinn, former graduate research assistant, collaborated on the Statehouse and Barracks visualization. Haley Sharpe Design, Leicester, UK, developed the panels for Jamestown that contain my computer renderings. Mulberry Row is under the auspices of the Thomas Jefferson Foundation. The research is funded by an NEH grant led by Guilder Curator and Vice-President of Museum Programs, Susan Stein. Ed Chappell, Director of Architectural and Archaeological Research at Colonial Williamsburg provided expertise and created drawings essential to the reconstructions. The archeological team reporting to Director of Archaeology Dr. Fraser Nieman at Monticello have done the extensive fieldwork and provided critical assessments. Staff Archaeologist Don Gaylord provided GIS derived drawings, including an archaeological sketch that is in the ground plane of figure 8. Dr. Christa Dierksheide, Assistant Curator at Monticello provided generous guidance and initiated the blog on Mulberry Row with her colleague webmaster Chad Wollerton. The scripting was done with Bentley Systems Generative Components. Staples and Charles Ltd., Alexandria, Virginia, developed the panels for Monticello with my computer renderings. WillowTree Apps of Charlottesville, Virginia, wrote the QR code interface for them.

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