Creating Digital Models of Papier-Maché Ceiling Elements in Philipse Manor Hall

Anyone watching the news lately will be aware that historic structures are being destroyed both by humans, such as groups like ISIS, and natural disasters, which can wipe out important pieces of history. Additionally, as artifacts and structures age, they degrade and break down naturally, making them fragile and prone to damage. Historic preservation is important because it allows people to study how their culture has changed over time. Keeping a model of artifacts acts as a safety net so that no matter what happens to the original piece, there is a record which can be used for the same purpose.

While there are common methods used to preserve artifacts, these often require physical contact with the object either for taking measurements or creating a mold. One issue that could arise is the fact that certain objects are so delicate that the act of touching or moving them in an effort to preserve them could result in damage. Creating models of fragile artifacts is a high priority because they are most susceptible to damage in the first place. It is therefore necessary to create a method of preservation which will allow for objects to be modeled without the ability to touch or move them.

My research focused on the 17th century Philipse Manor Hall in Yonkers, NY. While the building itself has historical significance, one of its main features is a ceiling that contains fifty-two Rococo style design elements made of papier-maché. This architectural embellishment was a popular display of wealth at the time. Due to the fact that the ceiling elements are made of papier-maché, it is not possible to use common methods of historic preservation at the risk of damaging the elements in the process. The purpose of my research was to show that 3D laser scanning and photogrammetry are viable techniques of historic preservation, and to discuss which data collection device is best suited for the task of modeling the ceiling at Philipse Manor Hall.

I performed this work by traveling to Philipse Manor Hall with several different 3D laser scanning and photogrammetry tools. The two elements I focused on depicted a dog and a

bust of Isaac Newton. Each tool was used to collect data for both elements, which were compared based on the number of data points defining specific features. I then compared the data collection techniques themselves on the following bases. Cost ranging from $\$3,000$ to over $\$100,000$, time ranging from 5 to 180 minutes, resolution ranging from 0.0001 to 0.005 meters, and ease of use which I discuss having used each device.

The results showed that the Artec Space Spider 3D laser scanner was the best suited tool for the task. This method produced models with a high level of detail and a resolution of approximately 0.0001 meters. While there were tools that produced similar results, one of the key advantages of the Space Spider was its ease of use. The Artec scanners are hand held and collect data as they are moved in front of the object. This cuts scan time down to about 15 minutes, and allows for thorough data collection, which is more difficult when using tools that must be set up on a tripod to collect data. The speed and ease of use allow for lower costs when considering the "cost per day" of a project, even though the device itself was $\$24,800$. If this work were to include scanning the entire ceiling, the Artec software would have more capability to handle this scale of a project, whereas some other software options struggled to handle data from a single ceiling element. While the Space Spider is best suited for this specific task, it does not imply that it is a "better" scanning device, because other tools used are normally intended for different scales of work.

Future work would include gaining a better understanding of how the raw data is stored for each tool, and finding a way to directly export it to compare the models prior to any software processing. This could have the potential to refine the results from my research.