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LESSONS FROM 3-D SURFACE SCANNING OF 19TH CENTURY COFFIN PLATES FROM ST. THOMAS ANGLICAN CHURCHYARD, BELLEVILLE, ONTARIO, CANADA

by

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Undergraduate honors thesis under the direction of

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the Upper Division Honors Program.

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Louisiana State University
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ABSTRACT

Coffin plates scanned using 3-D laser technology were examined for new information that could not be seen previous to the scanning process by the naked eye. The purpose of this research was to determine if the 3-D laser scanning could be used as a way to preserve the information on the fragile plates as well as to gain new information. Coffin plates were scanned using NextEngine 3-D laser scanning technology. The resulting scans were compiled and compared to the actual plates to discern if the legibility of the plates had improved during the process. Previously unknown information was able to be detected through the use of the 3-D laser scanners. New information was ascertained from a few of the scans. Painted plates produced more new information than etched or engraved plates. Furthermore, the process has yielded important information about 3-D imaging techniques on thin or flat artifacts as well as artifacts with reflective metallic surfaces.

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INTRODUCTION

Coffin plates often have been used in anthropological studies as means of identifying human remains with the assistance of historical and burial records. Due to the fact that most coffin plates are composed of soft pliable metals such as lead, silver, copper, or tin, they are susceptible to damage and corrosion after extensive periods of time. Furthermore, when dealing with historical sites documentation of burials has either not been kept or has been lost or damaged.

My honors thesis study includes 3-D imaging of a sample of coffin plates from graves excavated under the direction of Dr. Heather McKillop (1995) from St. Thomas Anglican Churchyard, Belleville, Ontario, Canada. The purpose of my project is to provide a digital record of the fragile objects and to see if name, age at death, and/or year of death information can be better read by 3-D images than by observation with the naked eye.

How can some of the basic information about the people who were buried in these historic cemeteries be regained when the coffin plates are not clearly legible? The Digital Imaging and Visualization in Archaeology (DIVA) Lab, directed by Heather McKillop, at Louisiana State University includes 3-D scanning and printing equipment and software to study, record, and display

fragile artifacts discovered off the coast of Belize in conjunction with the Underwater Maya Project (McKillop 2005; McKillop and Sills, 2013). This technology allows archaeologists the ability to create exact replicas of artifacts out of plastic. The 3-D replicas can not only be kept and studied without fear of damaging the original artifact. In addition, the scanners allow those who work in the DIVA Lab to enlarge objects as well as to create whole artifacts from fragmented pieces (McKillop and Sills, 2013).

This last ability is an exciting development in archaeology and 3-D digital imaging because archaeologists can create a complete artifact where one does not exist or is damaged beyond repair. The idea behind my project builds off of this accomplishment; that we can not only complete artifacts but we can actually learn new information about artifacts that would not be possible without this technology. The coffin plates excavated from St. Thomas Anglican Churchyard are delicately engraved, etched, or painted, making many of them difficult to read.

The 3-D laser scanning and assessment of coffin nameplates discovered in the archaeological excavation of the St. Thomas Anglican Churchyard creates a blueprint for the successful 3-D scanning of extremely thin or metallic artifacts. This thesis project also has implications for the gleaning of

new information on highly detailed and delicate artifacts as well as for the preservation of said artifacts. I gained experience in 3-D imaging as a student worker in the LSU DIVA Lab, where I had imaged a variety of pottery and other artifacts. The coffin plates had not been scanned. They presented a new challenge to me due to their fragile condition and their thin and reflective surfaces. Despite my experience scanning in the lab the coffin plates did not prove easy to scan and required certain techniques to obtain an image which I discovered during the scanning process. Because of the difficulty in scanning the thin plates imaging one plate successfully took about two weeks. After an effective procedure for scanning the plates was discovered scanning became much easier and quicker with one plate being scanned per day.

LITERATURE REVIEW

History of St. Thomas Anglican Churchyard

In 1818 the congregation of the St. Thomas Anglican Church was formed and construction of the wood and brick church began. St. Thomas Anglican Church is located in Belleville, a town in southern Ontario, Canada (Figure 1).

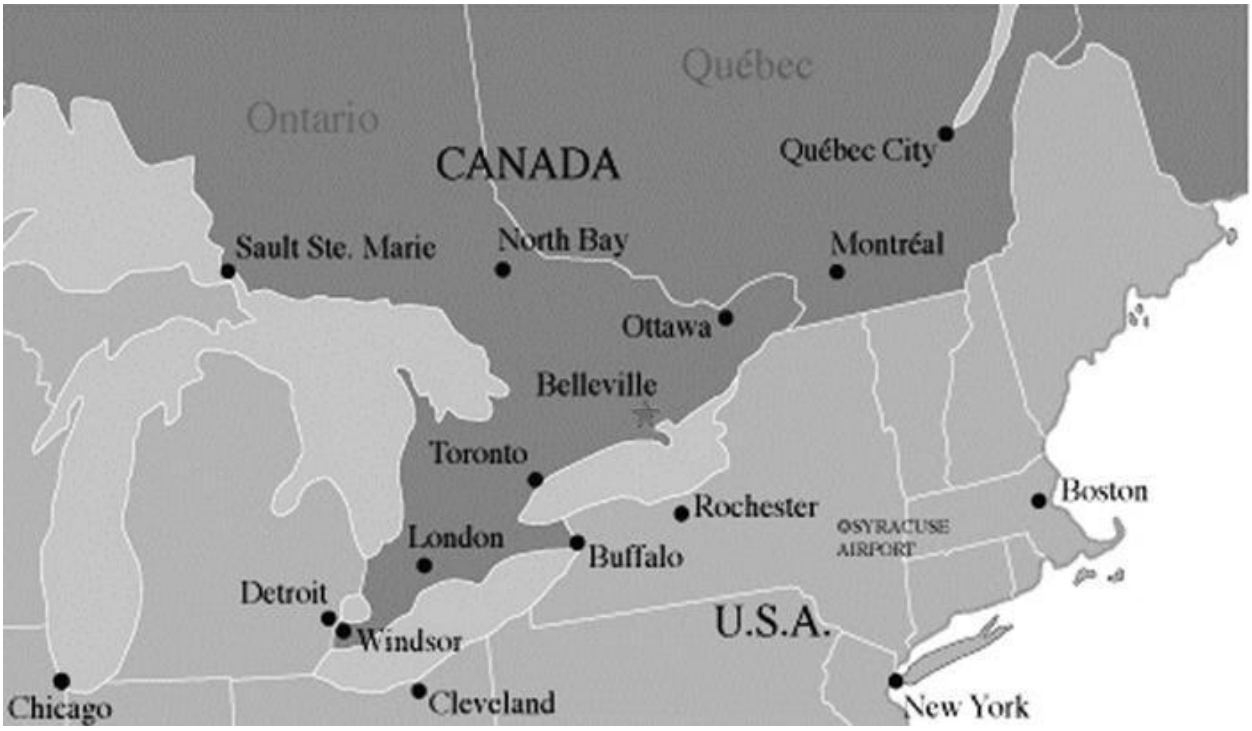

Figure 1: Map Showing Location of Belleville, Ontario, Canada. Photo via http://www.albertcollege.ca/ContactUs.aspx.

In 1858, the original structure was replaced by a limestone one to accommodate the growing congregation. St. Thomas' Anglican Church was damaged by devastating fires in 1876 and 1975 which destroyed the records inside of the church. In 1989 the church called on archaeologists to excavate a

portion of the church yard in order to build a parish hall. The excavation took place between May and August of 1989 during which time the St. Thomas Church register of burials was discovered (McKillop, 1995). The records revealed that over 1,500 individuals had been buried in the churchyard between the first interment in 1821 and the last in 1874, with the greatest period of cemetery use falling between 1850 and 1874 (McKillop, 1995). The area that was excavated had originally been thought to hold sixty to eighty burials based on the remaining grave markers. In actuality, the area consisted of 579 coffin burials (McKillop, 1995). Coffin plates were among the artifacts recovered from the St. Thomas' Churchyard excavation that were used to help personally identify remains.

History of Coffin Plates

Coffin plates are decorative plaques that are usually attached to the outside of a coffin and bear the basic information of the deceased. Some of the most common information that is transcribed on coffin plates is age at time of death, the descendant's name, and the year of death. This information is either painted or etched on the face of the nameplate (Woodley, 1992). In some cases a dedication to the deceased such as, "Our Darling" or "At Rest" is also included on the coffin plates (Hacker-Norton, 1984a). Coffin plates were

usually placed on the center of the top lid in the thoracic or pelvic region (Hacker-Norton, 1984b). As the popularity of coffin plates rose so did the custom of removing them before burial as reminders of the deceased.

Coffin plates were used before the 19th century. However, the Industrial Revolution brought about a period of coffin embellishment due to the ease and cheap cost of mass production (Bell, 1990). Coffin plates were mass-manufactured and then engraved by a local business. In fact, between the mid-19th and mid-20th centuries the average cost of a coffin plate was about 34 cents as most coffin hardware was manufactured from inexpensive stamped tin (Woodley, 1992)(Hacker-Norton, 1984a). A large quantity of coffin hardware does not necessarily lend any insight into a person's wealth or social status, as by the mid-19th century most people could afford to adorn a coffin (Hacker-Norton, 1984a).

There are many varieties of coffin hardware, such as thumbscrews, coffin handles, and escutchions. There is, however, evidence that coffin plates were the first kind of hardware available. Larger elaborate painted coffin plates tend to predate smaller etched coffin plates (Woodley, 1992). Although the coffin plates used in this project were from Belleville, Ontario, nameplates have been found all over the United States; from Louisiana, to New York, to

California (Hacker-Norton, 1984b). According to Woodley, southern Ontario, which includes the St. Thomas Anglican Churchyard in Belleville, Ontario, first began using coffin hardware around 1850 (Woodley, 1992). However, the collection of coffin plates from St. Thomas Anglican Churchyard includes coffin plates from as early as 1821, proving that coffin plates were in use in southern Ontario at least 30 years earlier than previously thought.

3-D Scanning Technology

3-D laser scanning represents an exciting new area of research and expansion in anthropology and archaeology. This technology has obvious benefits in the preservation of artifacts because once 3-D scans have been taken, the object can be worked within a "virtual workroom" where examination can occur with no effect whatsoever on the actual physical artifact (Wachowiak, 2009). When used in conjunction with 3-D printing, 3-D laser scanning also allows archaeologists the opportunity to bring archeological artifacts to places that would otherwise not have access to them, due to remote location or limited access to internet (McKillop and Sills, 2013). Furthermore, 3-D scanning can be used in the restoration of archaeological artifacts. Archaeologists can scan a piece of an artifact and utilize 3-D modeling software to recreate the whole artifact (McKillop and Sills, 2013).

Although 3-D laser scanning is a cutting edge technique in archaeology, the technology was not originally developed for these purposes. Primarily, 3-D scanning was developed for use in the field of engineering and used initially in the surveying of industrial facilities (Hughes, 2005). At the onset 3-D laser scanning equipment was expensive, large, and scarce. Cost and availability was and remains a large part of why 3-D scanning technology is not widely spread in the fields of anthropology, archaeology, history, and art. However, as advances have been made in recent years the cost and size of these machines have diminished tremendously. In fact, some varieties of commercial 3-D laser scanners are presently being tailored and marketed specifically for "heritage applications" (Wachowiak, 2009). Art is another area that has been exploring the practical uses of 3-D laser scanning. It has been found to be valuable in monitoring the deformation and state of conservation of certain types of panel paintings, such as the "Adoration of the Magi" by Leonardo da Vinci (Guidi, 2004). Furthermore, the famous Tate Modern in London has utilized this technology to scan cellulose nitrate sculptures by Naum Gabo as means of documentation before the sculptures being to disintegrate (Wachowiak, 2009).

3-D scanners are useful in many different areas because they produce a high quality record of an objects surface topography. This high resolution 3-D map can be accurate to the sub-millimeter level depending on the machine used (Wachowiak, 2009). Laser scanners have the ability to be accurate because they can take thousands of point measurements per minute. To create the 3-dimensional image, the scanners capture the shape of the object and transform the spatial geometry from an x-y to an x-y-z coordinate points system relative to the scanner itself (Hughes, 2005). The technique used is known as triangulation, where the scanner emits a laser line onto the object and records the reflection sent back to the scanner. This process causes problems when scanning highly reflective surfaces and sharp objects because of the appearance of extraneous reflections and stray light which interferes with scanning (Wachowiak, 2009).

MATERIALS AND METHODS

In this project I use a sample of 19 coffin plates from the large collection that was excavated at the St. Thomas Anglican Churchyard in 1989 under the direction of Heather McKillop (1995). The coffin plates were examined in the Louisiana State University DIVA Lab in the Department of Geography and Anthropology (McKillop and Sills, 2013). The plates were in varying degrees of preservation. Many were relatively warped and corroded. Some were broken into pieces and or corroded. A few were in good condition with little to no corrosive activity and all of the plate accounted for. Of the nineteen plates in my sample, eight had either no year inscribed on them or the date was not legible. Of the eleven dated coffin plates the years range from 1855 to 1873. All but five nameplates contained legible information about the age of the deceased, which ranged from ten months and ten days to seventy-five years. Only two of the nineteen had illegible names. None of the coffin plates bore epitaph-like inscriptions such as “loving mother”. Both males and females were represented in the sample.

Many of the coffin plates were warped in a very similar wave-like pattern. The reason the warping occurred in this fashion was due to the decay of the wooden coffins. The coffin plates were usually placed over the center of

the coffin in the thoracic region (Hacker-Norton, 1984b). As the wooden coffins decayed over time, the sandy soil of the churchyard collapsed into the space below the coffin lid (McKillop, 1995). The coffin plates were then resting on the vertebral columns of the deceased and overtime the pressure from the soil above warped them into their current wave-like shapes.

The coffin plates included 12 rectangles, 5 ovals, one cross, and one shield. Some of the plates had designs, including nine scalloped edges, one rope, one chain and flower, and two with bead details, whereas others were more simplistic in design. The quality and the style of the etchings and paintings varied in the sample. In my sample, most coffin plates were etched rectangles or oval shapes (Table 1). The painted plates were one cross-shaped, one shield, and two rectangles.

Table 1: Description of Coffin Plates

	Method of Inscription		
	Painted	Etched	Raised
Rectangular	2	10	
Oval		4	1
Cross	1		
Shield	1		

I observed each coffin plate and recorded all legible information. I then compared my observations with records. This comparison was done in order to ensure that any and all visible information was recorded before the scanning took place and to try and alleviate possible human error.

For this project I used the NextEngine 3-D Scanner HD and the software Scan Studio HD (Figure 2). Using gloves, I placed each coffin nameplate onto the turntable and secured it with the gripper arm. The turntable was set up at a distance of seventeen inches from the scanner for each scan.

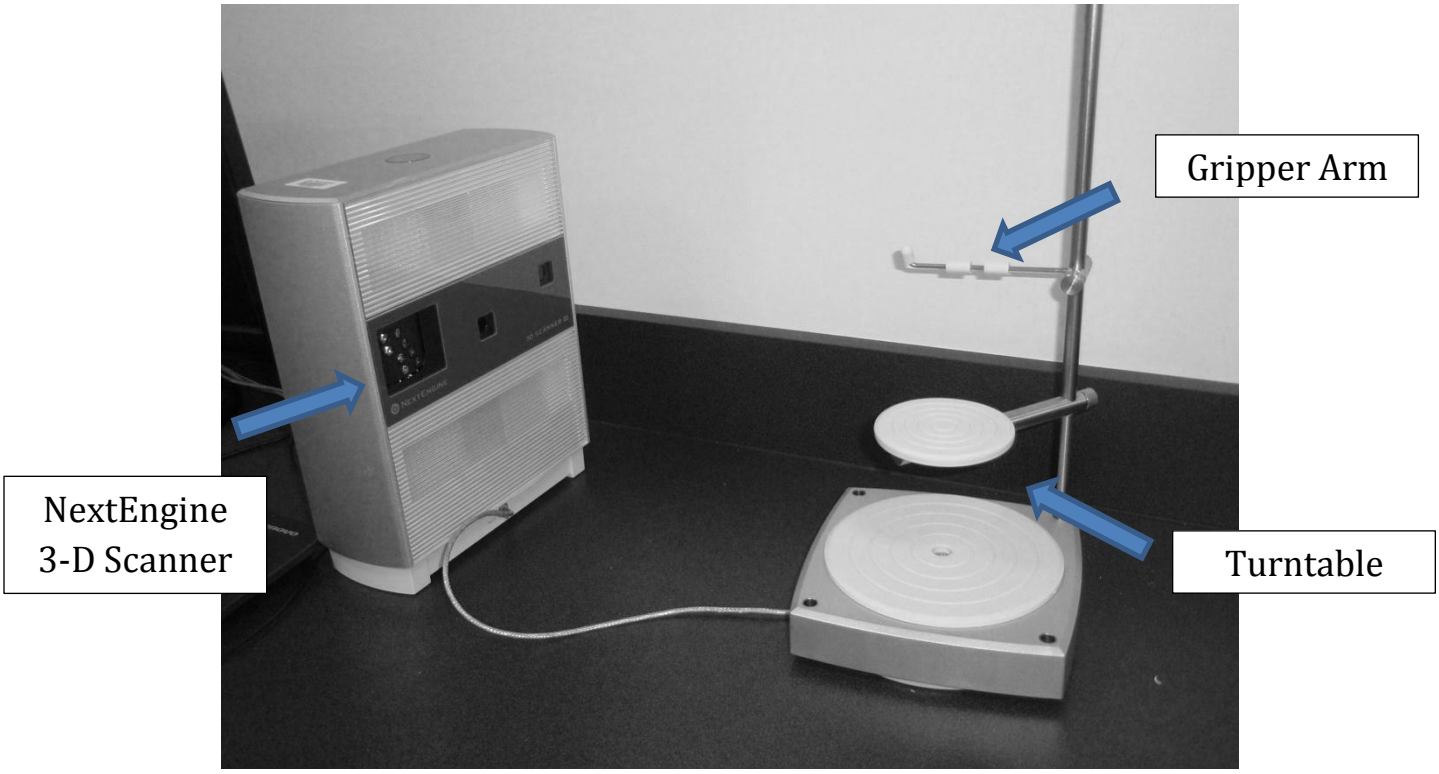

Figure 2: A NextEngine Laser Scanner Set-Up. (Photo by Abby Woltering)

This distance is recommended for the turntable at the wide range. The wide range was necessary to accommodate the larger coffin plates. The target setting was kept at neutral for most of the coffin plates, although the light target setting was used occasionally. The dark target setting was never utilized. Most scans were done with eleven divisions. This means that the 3-D scanner took eleven single scans during the turntable's 360° rotation. In other words, the turntable divided the 360° into eleven rotations of a little less than 33° each. One 360° scan and two single scans (one of the front and one of the back) were the minimum number of scans taken for any given coffin plate.

Figure 3: Me Scanning Coffin Plates in the LSU DIVA Lab. (Photo by Jana Brady)

Once all of the scans had been completed and were uploaded onto the computer via the NextEngine software each one was trimmed to delete the small amounts of the turntable, arm, and other background material that the scanner picked up. Because the scanner cannot differentiate between the artifact and anything that is touching the artifact it picks up portions of the gripper arm and the turntable in each scan. To remove these unwanted portions on the final image I used a trimming tool to manually highlight the extraneous data and the software would then delete all portions that I had highlighted. The final scans were saved. The markings on the scan were

compared to the markings on the actual object. Differences between the two were recorded.

RESULTS

New, previously illegible information was detected using 3-D laser scanning technology on three of the coffin plates excavated in the St. Thomas Anglican Churchyard. Etched or engraved coffin plates tend to yield less new information than painted plates. Two of these three coffin plates were etched whereas one was painted. 3-D scanning revealed full names on the painted plate and only a few letters on the etched plates. Importantly a new 3-D scanning technique, using clay blocks to orient the object, was determined for scanning thin artifacts. Also I discovered that darkening the room and using the light target setting for metallic objects obtained the best possible 3-dimensional replicas of the reflective coffin plates.

DISCUSSION

Three dimensional scans made during the course of this project were compiled and compared with original plates in order to determine any differences or trends in the information that could be gathered from the coffin plates. The results show that 3-D laser scanning does have the ability to provide us with new information about these artifacts. In three different coffin plates, the scans were able to provide us with information on the name that was not observable by the naked eye including one plate with first and last names and two plates with corrections of the spelling of a last name (one letter). Two of these were engraved and one was painted. These results seem to imply that the scanners can detect more information from engraved metal plates than painted. However, because there were only four painted coffin plates in the sample used and the quantity of new information was highest with the painted plate, I would suggest that scanners are actually more able to provide new information on painted plates. There were multiple cases where no new information was found but the scans helped confirm the markings on the coffin plates. The scans were particularly helpful in some hard to read plates where an educated guess had to be made, which could be confirmed by

the scans, or when my observations conflicted with those made in the original records made by other workers in the lab.

For two coffin plates, my visual reading and the 3-D scan image were the same. However, for each of the coffin plates, one letter or name was incorrect in the records. For another coffin plate I was able to read a number on the 3-D scan that was not visible to me before or in the records.

One coffin plate was read:

"(Full First Name) (Middle Initial) (Partial Last Name)"

"Aged"

"___ years & ___ months"

at first by the naked eye. Scanning provided the information that it was 6 months. However, the scans were unable to help determine the surname mostly due to corrosion or the years.

One coffin plate was originally found to be illegible by me and in the records. The only information that could be gathered without the 3-D scans was that there were three lines of painted script. After scanning the first line could be clearly read as the first and last names of the deceased, with ten letters legible. The second line of script was still entirely illegible, but portions of letters could be made out and the line ran the length of the plate. The

words aged and years could be made out on the third line. The scans of this coffin plate yielded the most new information through the duration of the project. The coffin plate was unique not only in the quantity of new information that was gathered but also some of the implications of the information. None of the coffin plates in my sample had any inscribed saying or epitaph and most followed the template of:

"Name of Descendent"
"Aged"
"# years, # months, # days"
"Year of Death"

One coffin plate had a name and age of death in the records. Scanning revealed the name was incorrect although still illegible. However, the scans indicated that the age of death was not ten months as in the records but in fact ten years. This particular coffin plate was unique in the fact that it was not etched or painted but rather the markings were raised. Also this coffin plate was among the most highly reflective of all the plates in the study. The plate also had moderate to severe amount of corrosion that was present on the plate. These factors made the reading of this plate difficult.

The reflective surfaces of the plates represented only one of the problems that arose throughout the collection of data. One suggested resolution to this problem was to coat the surface with a matte spray to reduce the reflected light (Wachowiak, 2009). Although this technique may work in an industrial or artistic setting, using a matte spray would be inappropriate in an archaeological setting as the physical integrity of the artifact could be compromised. In order to reduce the effect of the glare by as much as possible, highly reflective plates were scanned in a dark room to reduce the outside light that could interfere with the laser scanning process. However, seeing as the 3-D scanners use laser light to triangulate the spatial limits of the object, there was still some stray light present even in complete darkness. This stray light caused small holes in the resulting scans. In some cases, repositioning the coffin plate so that the hole or holes did not fall on any of the pertinent information was suitable. However, in the most reflective ones the holes could not be diverted enough to collect all of the necessary information. Through trial and error I discovered that changing the target setting of the scanner from neutral to light helped combat the problem enough so that the desired information could be attained.

Although the main focus of this project was information that could be garnered from the markings and engravings on the coffin plates we also wanted to collect information about the size, shape, and style of the coffin plate as a whole. Normally we would take 360° scans of an artifact and be able to achieve both of these goals. However, because of the thin nature of the coffin plates, I had many problems obtaining 360° scans that accurately represented the shape or contained a clear image of the markings.

The first problem with the 360° scan that I ran into was that the scanner would not recognize the coffin plate as a 3-dimensional object due to its thin and flat nature; therefore the scanner could not orient itself around the coffin plate well enough to obtain a 360° 3-dimensional model of the plate. This problem was solved by mounting the plates on a chunk of clay molded into a square (Figure 4).

Figure 4: Coffin Plate Mounted on Block of Clay for Orientation Purposes. (Photo by Abby Woltering)

The scanner was able to orient itself around the block of clay because of its geometric nature. Furthermore, because the coffin plate was mounted on top of the clay and the scanner is unable to determine that these were two separate entities the scanner then was able to spatially place the coffin plate into an x-y-z coordinated plane. Using this technique I was able to get clear 360° scans of all of the nameplates which replicated the size, shape, and style of the plates.

One instance in which problems arose was with a large shield-shaped plate measuring 20.3 cm x 20.8 cm. Due to its large size, the aforementioned

template for scanning thin artifacts did not work. The scan was a perfect 3-D image of the bottom portion of the shield. However, the 3-D scans on the top portion were not oriented correctly. To rectify this problem, the coffin plate was “sandwiched” between two blocks of clay, one on top and one on bottom. This method resolved the problem and allowed us to obtain the desired scans.

The next problem that occurred was that the 360° scans were not capturing the markings like I had hoped; they were only capturing the overall shape, size, and design of the coffin plate. Many techniques were tested to correct for this problem. The reason that the markings became jumbled on the 360° scans were because of the inherent flat nature of the coffin plates and the shallow nature of the etchings.

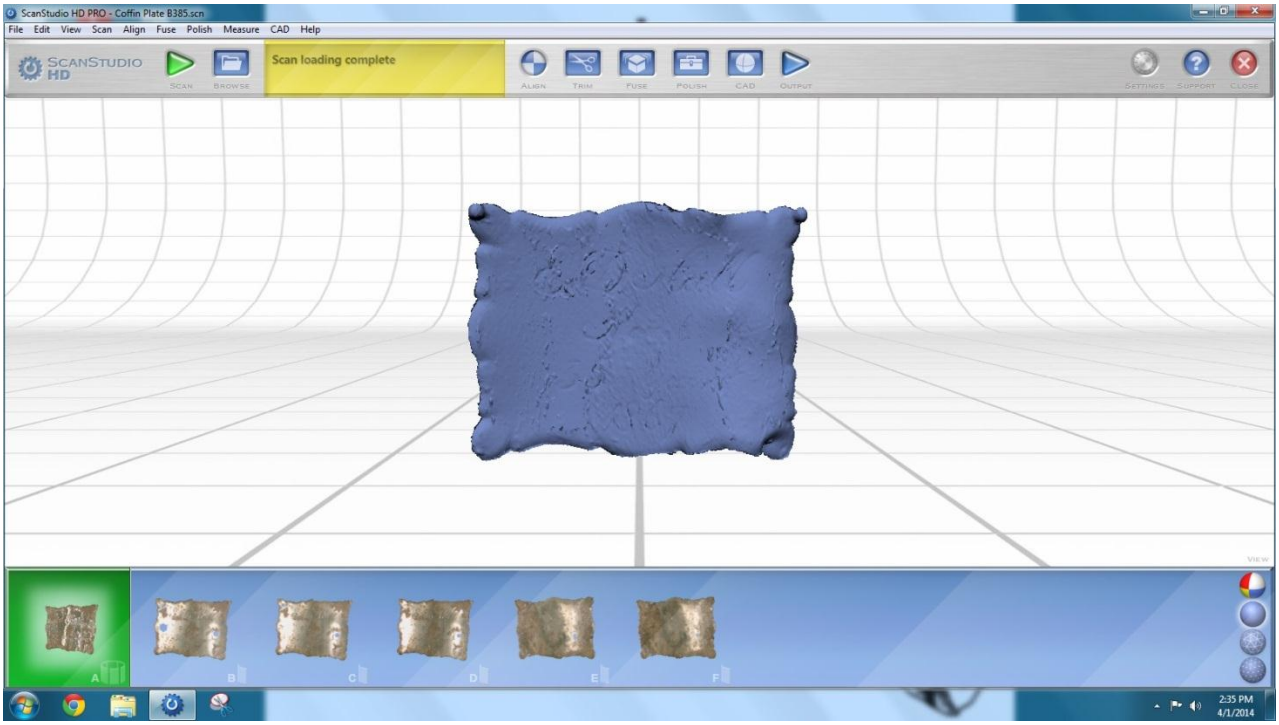

Figure 5: The Finished Scans of a Coffin Plate in the NextEngine Software. (Photo by Abby Woltering)

As the coffin plate turns on the table, the scanner takes scans from all angles. As the angle of the coffin plate to the laser beam is lessened, its access to the shallow engravings is lessened until it reaches a point where the coffin plate is perpendicular to the laser beam and can no longer access the engravings. When the 360° is compiled in the alignment process, the scans which contain less or no information about the engravings get aligned and overlap those that do, making for a jumbled appearance. In order to view the shallow engraving, I made a single scan of the front and the back. Then I did a separate 360° scan to capture the 3-D shape of the coffin plate.

CONCLUSION

This thesis project on coffin plates excavated at the St. Thomas Anglican Churchyard in Belleville, Ontario, Canada has important implications for scanning of thin and/or shiny artifacts as well as the use of 3-D laser scanners reading text on artifacts. The data collected show that new information can be detected with the help of this technology which could be beneficial in the personal identification of human remains. In this way, 3-D scanners give archaeologists an opportunity to learn more about artifacts while actively preserving them. This study offers valuable insight into the exciting possibilities of 3-D technology as well as having historical importance as the new information learned can be added to the historical records. Furthermore, this project helps create a much need blueprint for navigating the difficult scanning of thin, flat, or reflective artifacts.

A larger sample than my case study of 19 coffin plates may reveal additional information on the name, age at death, and date of death. A larger sample of painted and engraved plates would be useful to determine if there is a difference in the amount of new information we can learn using 3-D scanning to image text that is either painted or etched on objects.

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