USING GIS TO PROVIDE SPATIAL ANALYSIS OF ARTEFACTS ON BOARD THE SWEDISH WARSHIP, VASA

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PURPOSE
To support the Vasa Museum's mission of preserving and developing the maritime cultural heritage of Sweden. This project focuses on the museum's conservation efforts by providing a visual representation and spatial analysis of where artefacts were found in and around the Vasa at time of excavation, as well as to investigate spatial relationships among the artefacts.

INTRODUCTION
In 1627, King Gustav II Adolf of Sweden ordered the building of the Vasa. She takes her place in history, not as the first double gundeck warship of her day, but rather for the maritime disaster that followed on her maiden voyage. The Vasa sank barely 1500 meters, one nautical mile, from port. The cause of the disaster was in a faulty ship design; the ship lacked stability. The underwater part of the hull was too small and the ballast insufficient in relation to the rig and cannons. For 333 years, the Vasa would lay 32 meters below the surface in the Lake of Mälaren. Her discovery, excavation, conservation, reconstruction, and preservation would become the primary example for all maritime archaeology efforts leading into the twenty-first century. These efforts are shown in the Vasa Museum and focus not only on the ship but also her artefacts.

BACKGROUND
On August 25, 1956 historic shipwreck researcher Anders Franzén and diver Per Edvin Fältling located the Vasa and immediately began recovery efforts. The Vasa was lifted in eighteen stages to a shallower water. The first lift occurred in August of 1959 and the Vasa returned to the surface at 9:03 am on April 24, 1961. For the next five years, researchers and divers continued to collect and catalogue over 45,000 loose artefacts, which included six sails and the remains of fifteen individuals. Objects came to be logged using a unique find number. This number was inputted into a database that recorded the type and location of each object. With this database and the help of GIS, a visual representation of where the artefacts were found at the time of excavation was created. The MICRODEM program was used to create this visual representation as well as a 3D interpretation of the Vasa.

MATERIALS AND METHODS
This project is a continuation of work from previous midshipmen. It involved using directions from both the MICRODEM Help File and MIDN E.J. Hoerner (Class of 2014), the analysis of the lower gundeck provided by MIDN E.A. Ziel (Class of 2010) and MIDN R.H. Howell (Class of 2011), the analysis of the subsample provided by MIDN Hoerner, and the complete Vasa artefact database provided by the Vasa Museum. In order to create a visual representation of the artefacts, we had to create bins based on the find locations revealed in the Vasa artefact database. We did this by digitizing the natural divisions of the ship, the beams and decks, and connecting each with a standardized side function. Once these bins were created we were able to place the artefacts into them. After manipulating the find information in the Vasa artefact database, we were able to create a Bin_Name column which matched the Bin_Name file created while the digitizing the ship and surrounding area. This information was combined and each artefact was assigned a random X-Y-Z coordinate based on the bin in which they were placed. Once the new location database was created we were able to apply filters using the MICRODEM software.

RESULTS
Figures 1 through 6 depict the data that was created using the database and MICRODEM program. We are able to plot most of the 31,330 artefacts currently logged in the Vasa artefact database and are working to resolve the small number of anomalies. Many of these artefacts are shown in figures 2, 4, and 5. These figures display the distribution of artefacts in the X-Z, X-Y, and Y-Z plane centered at amidships and depth equal to 0. This database provides spatial analysis of the Vasa. We were able to set filters to the system and draw out specific items such as coins, barrels, or weapons. Figure 7 displays the locations of round coins found at the time of excavation. From these figures, we can determine that the majority of coins were found in and around the lower gundeck.

DISCUSSION
Since receiving the entire Vasa artefact database, we were able to see all artefacts, both within, outside and under the warship. The figures produced by GIS allowed us to analyze the relationships and patterns of life on board the Vasa. The overview of the data allowed us to distinguish which areas of the ship were used for what. For example, the majority of coins were found in the lower gundeck. This suggests that the sailors kept their personal possessions on this deck. We were also able to identify similar patterns with artefacts that fell under the “weapons” and “human remains” categories. Weapons were found scattered throughout the warship but the majority of military arms were located on the upper gundeck. Human remains were found in various locations throughout the ship and were identified as fifteen different individuals. The locations of these remains have proved useful in trying to determine why these individuals were unable to safely make it off the ship.

CONCLUSION
The original artefact locations did not allow researchers to see the spatial relationships amongst the artefacts. Our randomized locations in the bins allow for these patterns to be displayed. Being able to visualize the locations of artefacts provides a much clearer and more accurate description of life on board the Vasa than the simple database filled with records and incomplete descriptions. In order to enhance these results, there is some work that still needs to be accomplished. A complete translation of the Vasa artefact database from Swedish into English would prove useful as we are unsure of what many of the objects and locations are. More bins also need to be made. A frequency table provides insight into where objects are and of the 527 locations we only have bins for 483. Many objects also lack location information. If this information could be provided, it would enhance and contribute to the Vasa Museum’s mission through conservation, research, and data management.

REFERENCES