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ARCHAEOLOGY AND THE COMPUTING AGE

By
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Project submitted in partial fulfillment of the
requirements for the
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INTRODUCTION

From the beginning, computer technology has been based on a mathematical need fueled by the desire to eliminate the possibility of human error in numerical calculations. This need dates to the early 1800's when multiple inconsistencies dominated the scientific community.

During this period, a time of industrial expansion, experts in the fields of science, engineering, and finance commonly utilized mathematical references called tables. These tables contained numerical information such as interest rates, ocean tides, trigonometric, logarithmic, and geometric calculations. Created by mathematicians, tables were frequently laced with several mathematical errors (Sellers, 1996). This aspiration to eliminate the human factor, through mechanized means, was the dawn of the computing age.

Now, the world is filled with countless wonders that would have never existed without the creation of computing technology. Such technology, which is now commonplace, helped us to; win a world war, put a man on the moon, and aided in the creation of weapons of mass destruction (Sellers, 1996).

However, it wasn't until the 1960's when computing technology became recognized as a tool for historical analysis, particularly in the field of Archaeology. When computing technology made its grand debut in archaeological studies, it forever changed the view of computers in scientific analysis. The once magical black mathematical box, was now a powerful data repository or searchable electronic filing cabinet (Chenhall, 1967).

By the 1980's, computers made another evolutionary leap by incorporating the ability to perform sophisticated data collection along with its searchable database capabilities. This started a surge in the manufacture of interfaceable electronic data collection tools. Some of the first compatible measuring devices consisted of digital calipers, scales, video imaging, and measuring devices. As time progressed advancements such as the Electronic Distance Meter (EDM) came into existence. The EDM was used to create precise distance measurements based on a laser system. (Couch, 1991).

As computerized data collection tools evolved into the 21st century, they completely reshaped the scientific world. Now scientist have access to 3-dimensional technology, X-ray Computed Tomography (CT Scan), Light Detection and Ranging scanners (LiDAR), Geographic Information Systems (GIS), image analysis, and Ground Penetrating Radar (GPR) (Bimber & Chang, 2011).

The utilization of computer technology in historical investigation has opened a number of locked doors, despite numerous concerns by critics. Through the application of tools such as: computer modeling, image analysis, and ground penetrating radar both scientist and historians now have the ability to perform in-depth investigations into aspects surrounding questionable historical events.

THE EARLY THEORY AND EVOLUTION OF COMPUTER INTEGRATION INTO FIELDS OF HISTORICAL STUDIES

Early explorers of history, such as Archaeologist, were mainly composed of adventurers. These pioneers in their field, were mainly interested in the acquisition of spectacular objects rather than maintaining a sense of historical preservation. Essentially, they lacked the desire for delicacy and utilized archaic means of excavating historical sites. Most of these early scientists would conduct practices such as random digging and indiscriminate blasting to obtain valuable artifacts. Thus, ignoring important details such as an artifact's proximity to other artifacts or the object's relationship to its surroundings (Couch, 1991).

As early historical investigation methods evolved, members of the scientific community were tasked with bringing a well-defined discipline to their fields of study. The process, gradual in its growth, improved data recording practices and collection techniques (Couch, 1991). However, by the 1960's computer technology began to integrate into the scientific community.

Scientist were now tasked with a new mission, how to efficiently integrate computer technology into their field of study and prove its usefulness as a valuable research asset. The computer, which looked more like a magic box than a useful scientific tool to many researchers, was originally designed for mathematical and statistical calculations (Chenhall, 1967).

One expert, professor Robert G. Chenhall Ph.D., visualized computing technology as a potential benefit in data collection applications. He began by considering ways to efficiently interface computer technology into Archaeological investigations. Dr. Chenhall, considered to

be an expert in his field, made significant advancements into computerized cataloging of archaeological collections. Dr. Chenhall, who obtained his doctorate from Arizona State University, published many works on computer integration, including a book entitled *Nomenclature for Museum Cataloging: A System for Classifying Man-Made Objects* (Albuquerque Journal, 2003).

Dr. Chenhall suggested that a well-defined set of scientific processes must be followed in an effort to stay consistent with data entry and storage. In 1967 he proposed a seven-step approach to standardizing research methods.

1. **Observation** – the ability to perform in depth and detailed viewing of artifacts, either in the field or laboratory setting. Dr. Chenhall noted a need for multiple classifications for artifacts (Valentine Jr., 2017).
2. **Conceptualization** – the organization and comparison of finds with other previously cataloged artifacts in an effort to identify and classify finds (Valentine Jr., 2017).
3. **Data Recording** – initial data recording needs to be completed in the field by pen/pencil and paper, then taken back to the laboratory for conversion into a computer readable media. The information must also be symbolized in a way that computers have the ability to perform critical mathematical analysis during the cataloging process (Valentine Jr., 2017).
4. **Data Storage** – all collected and recorded data needs detailed holding and categorization in an easily searchable symbolic form (Valentine Jr., 2017).

5. **Data Retrieval** – researchers need the ability to perform efficient extraction of various data elements of cataloged and stored Archaeological information for additional analysis (Valentine Jr., 2017).
6. **Analysis of Symbolic Data** – ability to sort key data elements for a detailed comparison to other stored information (Valentine Jr., 2017).
7. **Interpretation**- the combining of multiple data elements from multiple Archaeological sources in an effort to conclude a theory based on the cataloged data (Valentine Jr., 2017).

Dr. Chenhall remarked that a computer “...becomes a logical mechanism, a substitute for an analog device whose fundamental processes are in fact not numerical but logical (Chenhall, 1967).” He goes on to suggest that computer technology forces the Archaeologist to be more consistent in research and analysis of data. Thus, laying the groundwork for computing technology to serve as an electronic historical repository and futuristic statistical analysis tool (Chenhall, 1967).

By the 1980's, computing technology applied to historical fields of study again took an evolutionary advance. This came with the introduction of the microprocessor, which expanded computing capabilities. Not only could the computer serve as a database and analysis tool, it had the ability to perform new functions including data collection and visual presentation (Couch, 1991). This is further noted by Dr. Paul B. Pettitt, a professor of Archaeology at the University of Durham, England (Durham University, 2017). He stated in an article published in

Internet Archaeology, "The usefulness of information relates solely to its integrity in the field (Pettitt, 1998)."

These advancements in computer technology created a need for enhanced software tools such as the Dibble and McPherron field system, which is named after their creators Dr. Harold L. Dibble and Dr. Shannon P. McPherron. Dr. Dibble is a professor of Anthropology at the University of Pennsylvania's Department of Anthropology (University of Pennsylvania, 2017). Dr. McPherron is a professor of Paleolithic Archaeology with the German based Max Planck Institute of Evolutionary Anthropology's Department of Human Evolution (Max Planck Institute for Evolutionary Anthropology, Leipzig, 2017).

Their creation, developed for Middle Paleolithic site studies, utilized three individual informational databases. This program, for the first time, allowed researchers to compile information from different locations through hand-held data loggers and personal computers to be stored in a central database (Couch, 1991).

Once data was collected, cataloged, and organized, the system allowed users to select an artifact for research, displaying all reported relevant information for the user. Meanwhile, on a second attached computer monitor, the Dibble and McPherron program displayed a digitized color image of the selected artifact (Couch, 1991).

This is substantiated in an article published in the University of Pennsylvania's computing magazine *PENNPRINTOUT* by professor Randall Couch. Dr. Couch pointed out the fundamentals of obtaining the absolute most out of computer integration. Dr. Couch suggested; in order to obtain maximum integration in analysis of historical data it is dependent on both the

collaboration of data from multiple researchers and that of multiple data entry sites (Couch, 1991).

By automating traditional site recording processes, this type of integration gave researchers the opportunity to analyze daily work instantaneously. For the first-time calculations could be constantly measured, processed, and stored in measurements as small as millimeters (Couch, 1991).

Shortly after the creation of the Dibble McPherron software, Dr. Dibble began entertaining the idea of program enhancements such as the future integration of three-dimensional object data and image analysis (Pettitt, 1998). He suggested the calculation of three-dimensional data could add valuable volume and proportion calculations to historical data and research applications (Couch, 1991).

By the 21st century, historical investigations took another colossal evolutionary advancement giving birth to Harold Dibble's dream. His desire to integrate three-dimensional information into historical data collections and investigations eventually became a common scientific practice.

With such advancements in technology, scientists now have the ability to utilize a number of tools, such as Computer Aided Design (CAD) software, laser scanners, and three-dimensional cameras to create three-dimensional digital and virtual views of historical artifacts for analysis (Neamtu & Comes, 2016). The application of three-dimensional data entry and analysis is not only being utilized in historical investigation, but also in historical preservation (Chionna, Argese, Palmieri, Spada, & Colizzi, 2015).

Scientist such as Dr. Francesco Chionna, a software engineer at the University of Lecce - Modis in Milano, Italy has taken three-dimensional data collection to a new level (Linkedin, 2017). Through the utilization of what he calls Building Information Modeling (BIM), him and his team have been able to map and reconstruct historical structures through the utilization of three-dimensional cameras, stratigraphy, thermography, and tomography (Chionna, Argese, Palmieri, Spada, & Colizzi, 2015).

Advancements in computing technology applied to the fields of historical investigation have evolved rapidly since the 1960's. From its initial utilization as an electronic repository to its handiness as a data collection tool, the computer has grown exponentially in popularity in the scientific community. Thus, leaving the next chapter of computer evolution applied to historical investigations a blank page, awaiting to be written by the next technological advancements in the field.

COMPUTERIZED TOOLS OF THE TRADE

The field of Archaeology utilizes several computerized tools and technological advancements to conduct historical investigations. Scientists now have the ability to perform both chemical and physical testing to aid in artifact identification and classification through a number of different electronic devices. Such utilization of computerized tools gives scientists and researchers an investigative edge. These tools include, but are not limited to, three-dimensional modeling, laser scanning, chemical analysis, computerized x-ray technology, aerial photography, ground penetrating radar, satellite imaging, computerized facial reconstruction, and electric resistive tomography.

The field of Archaeology has come a long way since the days of British Archaeologist Howard Carter and Lord Carnarvon. On November 26, 1922, they broke through a mud door with pick and shovel to expose a room within one of the great pyramids of Egypt. Passing through the doorway with nothing more than a candle for lighting, they had discovered the tomb of King Tutankhamen commonly referred to as King Tut. (History, 2017).

As fields of historical studies like Archaeology have since evolved, so has the technological mindset of the next generation of Archaeologist. Sarah H. Parcak, an associate professor of Archaeology with the UAB College of Arts and Sciences, is one of those who have an interesting viewpoint on computers and technology (UAB College of Arts and Sciences, n.d.).

Dr. Parcak states: "If you really want to be a good archaeologist, you have to understand ancient DNA; you have to understand chemical analysis to figure out composition of ancient pots. You have to be able to study human remains. You need to be able to do computer

processing and, in some cases, computer programming (BrainyQuote, 2017).” Dr. Parcak suggest that Archaeologist of today must be able to incorporate and integrate a number of computerized analysis tools into the field of study to be successful.

Dr. Parcak’s viewpoint is consistent with that of Dr. Randall Couch with the University of Pennsylvania. Dr. Couch wrote an article printed in the University of Pennsylvania’s *PENNPRINTOUT* which summarizes how scientists can get the most out of technology. Dr. Couch’s statement directly relates to the collaborative utilization of such computerized archaeological devices; “The key to getting the most from computers is integration: Integration of the various computer tools...(Couch, 1991).”

Through the utilization of computerized technology, Archaeologist have been able to continue to make extraordinary finds and explain once unexplainable events. The following section briefly describes various computerized tools that are now commonly used by Archaeologist in the field.

GROUND PENETRATING RADAR (GPR)

Ground Penetrating Radar (GPR), consists of utilizing electromagnetic pulses to look under the soils surface. A standard GPR unit is composed of both a transmitting and receiving antenna along with a computerized central unit. As the unit is moved across the soil, electromagnetic signals are transmitted into the ground below. The GPR pulses are emitted in a cone shaped pattern, with the heaviest concentration directly under the unit. As the pulses encounter objects, they are reflected and received by the receiving antenna for processing by the computerized central unit (Persico, 2014).

However, Ground Penetrating Radar does have some limitations such as depth restrictions and the inability to precisely identify small objects. Each time a GPR unit is pulled across the ground, it allows an operator to construct a two-dimensional profile of the soil below. Depending on whether the operator is using a low or high frequency antenna, depends on the depth and clarity of the operator's final 2D profile. The resulting profile consist of a series of anomalies depicted by hyperbolic shapes, in which the apex corresponds to the object's location as well as depth (Conyers, 2006).

These anomalies can potentially reflect a multitude of items such as pipes, rocks, large tree roots, or large voids. This makes GPR an excellent tool in the construction trades, especially in excavation and directional boring. This allows contractors to identify potential underground dangers such as utilities, pre-existing footers, or large boulders. However, the construction industry is not the only valid application for such technology.

It was not long after the creation of GPR technology, that advancements in its utilization soon surfaced. Scientist began constructing three-dimensional plots using GPR data. This was accomplished by establishing a precisely measured set of grid lines in a GPR scanned area. A Ground Penetrating Radar unit would initially conduct scans along straight lines across the designated test location. Once completed, the unit could then be pulled across intersecting lines at 90-degree angles within the same test site. Thus, giving the user a three-dimensional (3D) subsurface scan (Conyers, 2006).

Such grids can consist of intersections as small as one centimeter. However, as the grid intersections become smaller the amount of scanning time greatly increases. A researcher in the field, Dr. Lawrence B. Conyers noted in an article in *Historical Archaeology*, that conducting a typical 3D scan of an area 40 meters by 40 meters could take an entire day (Conyers, 2006).

Ground Penetrating Radar has been found to hold valid usefulness in the sciences, particularly in Geology and Archaeology. GPR has been successfully utilized in locating buried structures, large artifacts, disturbed ground, and voids by coffins in burial sites. However, items such as bones are too small to obtain enough reflection to be depicted accurately on a GPR profile (Conyers, 2006).

Three-dimensional profiling of GPR data gives researchers the opportunity to make a more educated hypothesis on the identification of a buried object. Researchers can now distinguish the disturbed soil of a possible grave site from that of a buried utility based on an anomaly's length and width.

Researches like Dr. Lawrence Conyers suggests GPR scans coupled with documented historical records could become a necessary tool in scientific fields of study as well as the future of property management. Dr. Conyers implies providing accurate subsurface mapping, could aid in avoiding unnecessary excavations of historically significant sites (Conyers, 2006).

COMPUTERIZED AXIAL TOMOGRAPHY (CAT) SCAN

Invented in early 1972, by British engineer Godfrey Housfield, the Computerized Axial Tomography or CAT scan revolutionized both the fields of medicine and science. By May of that year news of the invention, which created the first ever three-dimensional X-ray, reached the United States. This electronic device was a revolutionary scientific leap, since previous methods of tomography could only depict a three-dimensional object in a two-dimensional form (Calhoun Sr., 2011).

Three-dimensional images from a Computer Axial Tomography scan are obtained by taking several two-dimensional scans from various angles collected from transmitters and receivers rotating around an object. These images are then combined to create a three-dimensional dataset composed of volumetric pixels or voxels. The voxel, is simply an image element that is equal in length on all dimensions. Each voxel is then assigned a color or gray scale value to represent a visual data element of the scanned object (Scherf, 2013).

Computerized Axial Tomography was initially designed for the medical field, where it was first utilized as a diagnostic tool. However, shortly after its introduction into the field of medicine, scientist began to look for other applications. Scientist focused their attention on the fields of Archaeology and Anthropology (Scherf, 2013).

By using Computerized Axial Tomography scans, Archaeologist are able to create 3D images of small artifacts or even entire skeletal remains. Such scans could then be used to investigate internal structures without doing physical damage to the scanned object. This type

of scanning technique allowed scientist to preserve the scanned object while gathering vital internal data (Pavel, Suciu, Constantin, & Bugoi, 2013).

Typically, a full Computerized Axial Tomographic scan of a small artifact takes approximately five minutes to complete. The compilation of those individual images takes an additional four minutes. Thus, allowing Archaeologist to scan hundreds of small artifacts in a rather short period of time (Pavel, Suciu, Constantin, & Bugoi, 2013).

One area of Archaeology impacted the greatest by Computerized Axial Tomography is that of ancient Egyptian studies. Archaeologist and Anthropologist now had the ability to collect amazing data by scanning the bodies of Egyptian mummies. This allowed scientists to better understand how the Ancient Egyptians prepared their dead for burial or the cause of the individual's death (Hoffman, Torres, & Ernst, 2002).

Scientists were now able to evaluate the internal composition through the Computerized Axial Tomography scan's cross-sectional images. This gives them the opportunity to further investigate both the embalming practices as well as the utilization of packing materials during mummification. Scientists could also import the Computer Axial Tomography scans into computer imaging software to recreate a mummy's physical features. Therefore, for the first time in thousands of years a mummy could be viewed as they were the day they died (Hoffman, Torres, & Ernst, 2002).

Other Computerized Axial Tomography scan applications were also utilized in the study of dinosaurs, in particular a rare mummified Hadrosaur find in North Dakota. On larger artifacts, like the mummified Hadrosaur, a Computer Axial Tomography scanner had to be modified to

conduct a 360-degree scan. On items such as the Hadrosaur, the Hadrosaur itself must rotate from within the Computer Axial Tomography scan's transmitters and receivers. Such (CAT) scan machines as this, had to possess the capability of adjusting the strength of the penetrating X-rays (Dino Autospay, 2007).

Applications such as the Hadrosaur scans have provided scientists with a more accurate understanding of dinosaur vertebrae spacing and muscle composition. Such information has enhanced three-dimensional computer models to more accurately predict a dinosaur's speed and movement patterns. Thus, revolutionizing how Archaeologist view and reassemble dinosaur finds (Dino Autospay, 2007).

Computer Axial Tomography scans have proven to be one of the most important tools in the investigation of archaeological finds. From objects as small as a dime to those weighing tons, Computerized Axial Tomography scans have proven a wide range of usefulness to the scientific community.

LIGHT DETECTION AND RANGING (LiDAR)

In 1995, the first LiDAR or Light Detection and Ranging system was created for commercial use. Since the mid 1990's, the technology has been utilized in several valuable applications (Marcoe, 2007). Currently there are two different types of LiDAR systems in operation: aerial and ground-based. The aerial system can be utilized from a plane or helicopter whereas the ground-based system is most commonly tripod mounted like a video camera (Introduction to LiDAR Technology, 2013).

Both types of LiDAR systems utilize the same laser technology by emitting near-infrared 1064nm pulses. When the emitted pulses are reflected off an object, both the pulses travel time and global positioning system (GPS) coordinates are recorded. Once the collected data is processed, the LiDAR scan provides an X, Y, Z coordinate for site mapping (Introduction to LiDAR Technology, 2013).

A typical aerial LiDAR system can transmit between 10,000 to 150,000 pulses per second depending on the application and quality of the device. A unit that emits a lower pulse count is useful for outlining a vegetation canopy or scanning open ground. Whereas, A LiDAR unit which emits a larger pulse count is utilized for detailed mapping applications (Marcoe, 2007).

A typical aerial LiDAR device can collect as many as 9 to 10 points per square meter of surface area. This type of unit can aid in the calculation of vegetative canopy height, by subtracting the distances of adjacent points which had a quick return time from those with a longer return time. No matter which type of LiDAR device is being utilized, LiDAR systems

provides a high degree of accuracy for the total number of points collected (Introduction to LiDAR Technology, 2013).

Once an aerial LiDAR scan is completed, the data is electronically interpolated into a complex computerized mathematical algorithm to produce a very detailed finished product. The resulting data can then be superimposed by computer technology onto existing maps or satellite photographs to provide scientists with a state-of-the-art tool for investigation (Introduction to LiDAR Technology, 2013).

Aerial LiDAR scans can be useful in several different applications such as: glacial monitoring, landslide risk analysis, fault analysis, shoreline monitoring, and forest inventory (Marcoe, 2007). In fields of historical investigation, the aerial scans can be useful in archaeological site mapping. These scans are utilized to get a more detailed site-map image in areas of significant historical value (Chase, et al., 2011).

Archaeologist can use the detailed aerial LiDAR scans to identify landscape changes, structural footings, or aerial structural properties that could provide potentially significant site information. By utilizing the aerial LiDAR scans along with ground surveys, maps, and aerial photographs; scientist can learn a magnitude of important information about an archaeological site. Information such as ruin elevations and perimeter measurements can then be used to create detailed site profiles (Chase, et al., 2011).

The other type of LiDAR system, the ground-based unit, provides the operator with a different site perspective, by conducting a scan from a single point. This type of scan can be

particularly useful in flat surface scanning such as rock faces, canyon walls, or historically significant structures (Chase, et al., 2011).

Ground-based LiDAR scans are best suited in Archaeology for the graphical external and internal visualization of historic structures. These ground-based scans can then be superimposed onto information collected from Building Information Models (BIM)'s, creating a well-defined 3D computerized structural model. These computerized structural models are ideal for both study or digital preservation. (Chionna, Argese, Palmieri, Spada, & Colizzi, 2015).

Ground-based LiDAR systems have also been utilized in the investigation of recovered marine vessels such as the Confederate Submarine C.S.S. H. L. Hunley. Ground-based LiDAR scans allow imaging around various internal structures creating an accurate internal profile of a vessel's hull. These scans can then be superimposed on to external scans using Computer Aided Design (CAD) software to create an accurate computerized model for further investigation or 3D printing reconstruction (Watters, 2012).

FORENSIC ART

Throughout history the human race has been fascinated with creating two-dimensional artistic renderings of the human face and body. However, it wasn't until a couple hundred years ago when the act of utilizing artistic rendering occurred in scientific analysis such as criminal investigations. This period gave birth to the age of the composite sketch. Such artist renderings aided in the investigations of some of the greatest criminal cases of the ages. From Jack the Ripper to the Hillside Strangler, the composite sketch has become a common forensic tool (Heafner, n.d.).

As forensic science and technology evolved into the 20th century, so did forensic art. When skeletal remains were located, scientist had the ability to do complete facial reconstruction in three-dimensions. This is assuming the skull is still in a usable form and not completely destroyed. Artist systematically apply clay to the skull in distinctive patterns and contours. The artist must pay close attention to properties such as tissue thickness, eye placement, nose thickness, and etc. (forensicartist, n.d.).

Forensic art eventually took an evolutionary leap with the aid of computer technology and enhanced graphic software. Scientists now have the ability to conduct scans of virtually any structure, from submarines to skeletal remains for computerized three-dimensional reconstruction. Researchers can now physically recreate the object through the utilization of 3D printing technology (Watters, 2012).

These same techniques have been applied to the sciences of Archaeology and Anthropology. Archaeologist such as Dr. William Kelso, who headed up the Jamestown

Rediscovery archaeological project, utilized forensic artist reconstructions during the Jamestown dig. Dr. Kelso and his team located some 400-year-old skeletal remains during their archaeological excavations. Forensic scientists were brought in to reconstruct those human skulls found in the Jamestown ruins. Through forensic art, researchers gave tangible faces to those who perished over 400 years ago in Jamestown, Virginia (Kelso, 2006).

But, Forensic artist must be careful in their reconstructive practices. Artist must rely on previously stored data to determine various features of a reconstruction project. Properties such as gender, age, and race play a significant role in the final facial features of a reconstruction project (forensicartist, n.d.). Despite major advancements, scientist feel positive future forensic reconstruction will become more computer dependent as time progresses.

Archaeologists, like Dr. Kelso, hope facial reconstruction can aid in the identification of deceased individuals found at the Jamestown site. Through comparison to historic portraits or photographic data, he hopes to find physical characteristic features that may lead to possible ancestral roots (Kelso, 2006).

UNCONVENTIONAL TOOLS

As technology progresses, there are a few unconventional tools now being utilized in the fields of historical investigation. Technological advancements such as Google Earth and aerial Drones have helped to revolutionize the gathering archaeological and anthropological data. These two tools have allowed researchers to make spectacular archaeological finds.

Google Earth, which descended from a CIA-funded project, has provided free online public satellite imaging since June 2005. This unique tool has been utilized to create presentations, enhance online games, aid in driving directions, and build flight simulators (Tarlach, 2015).

According to an article in *Discover* magazine, amateur archaeologist Peter Welch conveyed how Google Earth has aided in his historical investigative methods. In December of 2014 Welch, who is the founder of an English treasure hunting club called the Weekend Wanderers Detecting Club, accompanied by a group of fellow amateurs located the largest Saxon coin hoard ever discovered (Tarlach, 2015).

Welch told reporters that he utilized Google Earth to analyze the English countryside looking for various land formations, pointing out how easily farmland can be distinguished from former building sites. Welch noted how he used images from Google Earth comparing those to land surveys from an 11th century book. He stated, "...it was a strange shape in the hedge line, a piece of woodland, that made me ask; Why is that there (Tarlach, 2015)?"

Archaeologists in the field agree with Welch, that Google Earth has changed how many sites are located. Professor Francis McManamon of the Center for Digital Antiquity at Arizona State University agrees with Welch. Dr. McManamon suggests that aerial images in general, even satellite photographs like those taken from Google Earth are important tools in such endeavors (Tarlach, 2015).

Dr. McManamon used a site called Poverty Point in Louisiana, where scientists identified a large mound in 1913 as a prime example. He noted that in 1938 the Army Corps of Engineers flew over the site taking aerial photographs. It wasn't until after those photographs were taken did Archaeologists know the site was perfectly shaped like a bird. Thus, reinforcing how an aerial viewpoint from a plane or satellite can play an essential role in Archaeology (Tarlach, 2015).

However, airplanes and satellites are not the only ways of obtaining such valuable imaging. The 21st century has given birth to the age of drones. Drones are now considered to be one of the most useful innovations, serving a multitude of uses. From filmmaking to farming, the drone has proved that it can be utilized for multiple applications (Joshi, 2017).

One example applied to historical investigation was written by William Harms and published by the University of Chicago. Harms explained how a team of researchers from the Oriental Institute, a branch of the University of Chicago, commonly utilize drones. Harms noted how he and his team used drones to capture images of the Black Desert along the border of Saudi Arabia, east of Jordan (Harms, 2015).

According to Yorke Rowan, a senior researcher with the Oriental Institute, “Drones and photogrammetry provide a cost-effective means of quickly recording 3D data at a variety of scales for an array of research (Harms, 2015).” Rowan points out how unmanned aircraft have the ability to capture some features that may be too small to be seen from a satellite photograph. Thus, reinforcing a drone’s usefulness in such applications (Harms, 2015).

Another fellow researcher, Morag Kersel assistant professor of Anthropology at DePaul University stated, “the level of detail achieved by drone photography allows us to recognize every hole in the ground and quickly detect places where the ground has changed due to human or natural causes (Harms, 2015).”

No matter whether photographs are from Google Earth or Drone, these two tools will forever change how scientist locate and investigate sites of historical value. By coupling Google Earth to narrow down areas of interest and Drones to perform more in-depth photographs, the sky is the limit in utilizing these two tools for future historical investigations.

FINDING LOST HISTORY – USING TECHNOLOGY TO INVESTIGATE THE JAMESTOWN

SETTLEMENT

In December of 1606, 104 Englishmen under a charter issued by King James I to the Virginia Company of London, set sail from England to the New World. They arrived on May 24th, 1607 in three vessels; the Susan Constant, the Discovery, and the Godspeed. They immediately began construction on a triangular shaped fortification that would later be named the settlement of Jamestown (Kennedy & Cohen, 2016). This all male expedition, which consisted of both men and boys were sent by the King to find gold, silver, and establish commercial trade with the local natives (Grover, 1997).

After Jamestown's establishment as the first permanent English settlement in the new world, settlers began arriving by the boatloads. By 1699 Jamestown's population had outgrown its original location. It was in that year when the settlement was moved to nearby Williamsburg. Thus, leaving the original Jamestown fort, which had survived two fires and a number of Indian attacks, to succumb to the elements (Grover, 1997).

By the late 1800's all that existed of the original Jamestown settlement was the old Jamestown Church and a Battery site. Nearly 200 years after its abandonment, in the year of 1893, thoughts of preserving what remained of the original Jamestown settlement came into the public eye. A group of historians, the Association for the Preservation of Virginia Antiquities (APVA), began efforts to preserve what remained of the original Jamestown settlement site (Grover, 1997).

This sudden interest in the Jamestown site provoked Archaeologist to once again start searching for the original Jamestown fortification. However, 50 years passed without so much as a shred of evidence the original site ever existed. This caused Archaeologist to assume the original site of Jamestown had been lost to sea erosion. Therefore, in 1956 all formal excavations at the Jamestown, Virginia site cease to exist (Grover, 1997).

It wasn't until 1994 when a quest to find the original Jamestown fortification resurfaced. With the 400-year anniversary approaching in 2007, the Association for the Preservation of Virginia Antiquities (APVA) commissioned Dr. William M. Kelso to lead a new search for the original site (Grover, 1997). Dr. Kelso and his team began excavations on April 4th, 1994 in nothing more than an eight by eight-foot area (Kostelny, 2014).

During their initial excavations Dr. Kelso and his team located posts from the original palisade that extended around the fort in their test site. This discovery led to a massive Archaeological dig called the Jamestown Rediscovery Project, which continues today (Grover, 1997).

Initially Dr. Kelso tried to utilize computerized Ground Penetrating Radar technology, which rendered useless results. Dr. Kelso pointed out that GPR technology is an excellent resource for locating burial vaults as well as stone and brick structural footings. However, it does not produce viable results when searching for structural footings created by wood or sunken posts. He noted that there are some situations where old fashion archaeological excavation cannot be replaced by some forms of technology (Grover, 1997).

However, Dr. Kelso did point out the value of computing technology from a repository standpoint. He stated: “technology helps us manage these thousands of pieces of information that we find (Grover, 1997).” Dr. Kelso’s application of computerized technology to artifacts at the Jamestown site did not occur until after an artifact was found and its location was established. Once an artifact was found, it was inspected, photographed, cataloged, and placed in an acid free container for storage for later investigation (Grover, 1997).

During cataloging, some of the finds went through a detailed scanning process conducted by Dr. Bernard K. Means and a team of scientist from the Virtual Curation Laboratory at Virginia’s Commonwealth University. Dr. Means utilized a three-dimensional laser scanner to create a virtual 3D replica of a given artifact. This digital virtual representation could then be sent electronically anywhere in the world for further investigation by other professionals. The digital representation could also be sent to a three-dimensional printer where a physical replica could be created for hands-on inspection (JamestownRediscovery, Creating digital artifacts with 3D laser scanners, 2014).

On larger finds at Jamestown such as graves, the first step was to document the finds in their current state prior to final excavation. This was conducted by a group of scientists from the Smithsonian’s Digitization Department. Under the direction of Adam Metallo, three-dimensional scans were conducted using medium range lasers. This along with photographs of the site were digitized to help researchers further investigate tiny details of their finds that would not exist after exhuming a body (JamestownRediscovery, 3D Scanning Burials, 2015).

Once a body was removed from a gravesite, it too went under an extensive investigation process prior to computerized cataloging. First, a DNA sample was taken for comparison and matching to identify possible descendants (Kelso, 2006). Next, the body was investigated by Dr. Douglas Owsley, a Forensic Anthropologist, with the Smithsonian Institute. Dr. Owsley utilized X-Ray technology to take a closer look at the remains and record additional details about the Jamestown finds (Grover, 1997).

Dr. Owsley also reached out to employ the handy work of Sharon Long, a Forensic Artist and sculptor to aid in facial reconstruction of the skulls exhumed from the Jamestown site. Through the utilization of facial reconstruction, digital scanning, 3D printing, and computer modeling Mrs. Long was able to create a physical and virtual rendering of the unknown faces of Jamestown (Grover, 1997).

Through the use of computer technology applied to historical investigation, scientist have been able to analyze over 700,000 Jamestown artifacts. Researchers have been able to not only locate the original Jamestown settlement, but conduct a thorough investigation of its finds. Through computer models, DNA research, X-Ray technology, Computerized Tomography, and 3D scanning scientist have been able to; virtually reconstruct America's first settlement, learn how the they lived, and understand how they died (Kelso, 2006).

TECHNOLOGY AND BIBLICAL ARCHAEOLOGY – THE QUEST FOR NOAH’S ARK

When it comes to stories from the Bible most non-believers call them myths, skeptics tend to call them legends, and true believers call them gospel. Carl Olson, editor of *Catholic World Report* and *IgnatiusInsight.com* stated his opinion on biblical stories. “Christianity, more than any other religion, is rooted in history and makes strong – even shocking – claims about historical events... (Olson, 2013)”. Thus, indicating that leaving such opinions open to personal interpretation can be a questionable act. This includes such interpretation as the story of Noah’s Ark.

According to the Bible, in the book of Genesis chapter 6:13-15; “And God looked upon the earth, and, behold, it was corrupt; for all flesh had corrupted his way upon the earth. And God said unto Noah, the end of all flesh is come before me; for the earth is filled with violence through them; and, behold, I will destroy them with the earth. Make thee an ark of gopher wood; rooms shalt thou make in the ark, and shalt pitch it within and without with pitch. And this is the fashion which thou shalt make it of: The length of the ark shall be three hundred cubits, the breadth of it fifty cubits, and the height of it thirty cubits. A window shalt thou make to the ark, and in a cubit shalt thou finish it above; and the door of the ark shalt thou set in the side thereof; with lower, second, and third stories shalt thou make it (Holy Bible, 2017).”

Today many tools exist that can provide valuable insight into both the confirmation as well as the discrediting of such stories as Noah’s Ark. Through the utilization of these tools; mythical, legendary, and historical voices can now be heard speaking to us from the past. However, some question and even condone such practices. Carl Olson wrote of Pope Benedict

XVI's theory about science applied to interpretation of biblical teachings; "...there is much that is good about historical-critical and other scientific methods of studying Scripture. But these approaches have limits (Olson, 2013)."

In late 1958, a Turkish military Captain named Serket Kurtis took an interesting photograph while flying a routine reconnaissance mission over the hillsides surrounding Mount Ararat, Turkey. The photograph depicted an oval shaped structure, resting over 6,300 feet above sea level, that theorist claimed resembled a large boat or ark-like structure. This find sparked the interest of both the Turkish and American governments (Vanderman, 2014).

According to a passage in the book of Genesis chapter 8:3-4: "And the waters returned from off the earth continually: and after the end of the hundred and fifty days the waters were abated. And the ark rested in the seventh month, on the seventeenth day of the month, upon the mountains of Ararat (Holy Bible, 2017)." As a result of such coincidence, a joint Turkish-American expedition assembled in 1960 to perform an investigation of the mysterious anomaly (Bennett, Crawford, & Holender, 1999).

The expedition had little success in their efforts and was unable to either confirm nor deny details about what had actually been located. One of the scientific investigators, Dr. Arthur Brandenburger, had some interesting input on the discovery though. Dr. Brandenburger, a professor of photogrammetry at Ohio State University, indicated that more precise measurements of the phenomenon should be made by experts in the field. He noted that it was an amazing feature and that "...I have no doubt at all that this object is a ship. In my entire career I have never seen an object like this on a stereo photo. (Wyatt, 1989)."

While Dr. Brandenburger was convinced the find was significant, other researchers in the expedition were less than enthusiastic. One of those skeptics was researcher Wilbur Bishop. He noted that after doing some blasting, via black powder, they were unable to recover any evidence of wooden debris or ship related articles. Bishop felt their investigation did not produce any viable evidence that would indicate the find was anything other than that of a naturally occurring geographic formation. Thus, the disappointing results of the expedition was published in a September 5th, 1960 issue of *Life Magazine* (Bennett, Crawford, & Holender, 1999).

Even though the 1960's expedition turned up no evidence in the investigation of the boat shaped structure at Mount Ararat, it did not dissuade the curiosity of future explorers. One in particular was a common family-man from Nashville, Tennessee named Ron E. Wyatt. Wyatt began looking at the size of the anomaly on Ararat in comparison to those described in the King James Bible (Bennett, Crawford, & Holender, 1999).

In the description of the ark's dimensions, Genesis makes reference to a unit of length known as the cubit, which was an ancient unit of measurement. The cubit was based on the measurement from the tip of one's middle finger to the end of their elbow. The measure of the cubit varied in length, but the actual cubit was between 17 inches to 21 inches (Dictionary, 2017). Based on the Biblical measurements, the ark was approximately 300 cubits or 425 feet to 525 feet in length, 50 cubits or 71 feet to 88 feet in width, and 30 cubits or 43 feet to 53 feet in height.

Starting in 1977 Ron Wyatt, after gaining the proper permits from the Turkish government, began making trips to the Mount Ararat site to conduct a number of measurements and scientific investigations on the controversial anomaly. On his first trip Mr. Wyatt, accompanied by his sons, compared measurements of the site to those depicted in the King James Bible. His measurements concluded that the anomaly fit within the parameters depicted in the biblical description. He also found some other artifacts such as smooth faced, monument-like anchor stones that would later help provide substantiating evidence for his argument (Wyatt, 1989).

Prior to another of Wyatt's visits, an earthquake occurred around Mount Ararat which exposed large portions of the anomaly's sides. The earthquake revealed what appeared to be vertical fossilized structures imbedded in the soil. These vertical timber-like figures extended out of the soil surrounding the perimeter of the anomaly (Bennett, Crawford, & Holender, 1999).

In 1979, Wyatt was again permitted to visit the Mount Ararat site to conduct further investigations. The Turkish government permitted him to take two soil samples of the area for analysis. Wyatt collected one sample from inside and another from a short distance outside the anomaly. Once collected the samples were immediately sent back to the United States for analysis (Bennett, Crawford, & Holender, 1999).

The samples were tested by Galbraith Laboratories in Knoxville, Tennessee and the results were given back to Ron Wyatt on October 9th, 1979. Analysis of the sample taken from the outlying area of the anomaly determined the ground was composed of silt and sedimentary

soil. Thus, indicating the area was once under water, even though the samples were taken at an elevation of over 6,300 feet above sea level. Chemical analysis of the sample from inside the anomaly indicated a high percentage of carbon, 4.95% to be exact. By comparing the carbon level from both samples, the sample from inside contained 3.07% more carbon. This indicated that the soil inside the anomaly contained a high degree of decomposing material (Shea, 1981).

However, these tests did not confirm nor deny that the site of Noah's Ark had been officially located. It did give valid reasoning for a continued study of the area. Another interesting feature of the sample from inside the anomaly was the degree of iron that was present.

This provoked Wyatt to return in 1985 to conduct additional research, utilizing some of the noninvasive technology available at the time. Wyatt brought metal detectors and a molecular frequency generator to sweep the entire interior of the anomaly (Wyatt, Noah's Ark, n.d.). Through the investigation Wyatt and his team located a number of iron hot-spots within the perimeter of the anomaly. He and his team then used survey tape to connect the dots, which yielded a pattern reminiscent to that of intersecting ribs. The resulting survey revealed the site resembled the structural skeletal layout consistent with that of a massive boat (Bennett, Crawford, & Holender, 1999).

Shortly thereafter, Ron Wyatt began to make claims that he had located the landing site of Noah's Ark. It was on June 20th, 1987, at the invitation of the Turkish government, when Ron Wyatt took part in a dedication ceremony of the Noah's Ark National Park. The governor of the

Turkish province proclaimed to the World that Ron Wyatt has found the final resting place of Noah's Ark (Bennett, Crawford, & Holender, 1999).

Such claims though produced several doubts among members of the scientific community, who made every effort to challenge Wyatt's claim. In response Dr. Sandy Day of the Engineering Center at the University of Strathclyde England created a simulated ark based on the measurements in the book of Genesis. The model was weighted in an effort to simulate a heavy animal cargo. Dr. Day and his team utilized a 220-foot wave generation tank to perform computerized storm simulations on the model (Baker & Fenton, 2010).

Shortly after the execution of the experiment, computer sensors began to measure direction changes of more than 50 degrees, indicating the model was rapidly approaching the point of capsizing. Day and his team then removed a water tight cover from the top of the model and reinitiated the experiment. In a matter of seconds, the model listed and sank to the bottom of the wave tank (Baker & Fenton, 2010).

Day and his team then decided to apply anchor stones to their model for stabilization. According to marine Archaeologists, ancient boats commonly utilized large stones suspended from ropes under a boat to stabilize the vessel to prevent rocking. Such stones usually had a hole between 2in and 4in in diameter typically weighing between (16kg) and (410kg). Many of these stones have been located in the Mediterranean Sea, Persian Gulf, and on the coast of the Red Sea as part of a maritime archaeological study by the National Institute of Oceanography (Tripathi, et al., 2010).

This is somewhat consistent with Ron Wyatt's initial trip to the Mt. Ararat site, where he noted the discovery of a few very large smooth-faced stones which resembled anchor stones. He noted the individual stones extended 7 feet from the surface of the ground with a precision drilled hole near the top. Later investigation revealed the stones were 11 feet in length overall with the remaining 4 feet sunken in the soil below (Ark Discovery International, 2017).

Dr. Day, in an effort to simulate the addition of such anchor stones, attached several weights to the bottom of the ark model. Each of which were proportional to the stones found near the Mount Ararat site. After conducting another wave simulation, Dr. Day concluded that the model was capable of taking on large waves without capsizing (throneofgod.com, 2010).

Dr. Day's initial findings were published as part of a 2010 documentary by *National Geographic* which illustrated the sinking of his ark model. However, his secondary findings utilizing the stabilizing anchor stones, were edited from the final program and never published on *National Geographic's Ark Documentary* (throneofgod.com, 2010).

This omission of Dr. Day's anchor stone test may have been the result of findings by Dr. Lorence Collins, a professor of Geology at California State University Northridge. Dr. Collins stated he tested samples of the smooth and well-shaped Anchor Stones found by Ron Wyatt and his team. The test concluded the stones were composed of Basalt, a mineral that was not common to Mesopotamia, the area where the ark was supposedly constructed. Dr. Collins further suggested the stones were probably markers for a pagan burial site (Baker & Fenton, 2010).

However, this is contradicted by a June 1998 article in *Science* magazine where a group of scientists consisting of Anthropologists and Geologists made a ground breaking find in the area formerly known as Southern Mesopotamia. They found large rectangular slabs of stone 80cm tall by 40cm wide by 8cm thick composed of synthetic basalt (Stone, Lindsley, Pigott, Harbottle, & Ford, 1998).

Based on their research, they concluded the area was once rich in alluvial silt which was utilized for a multitude of items relating to architecture, pottery, art, tools, and writing. Evidence suggested the Mesopotamians had technology to convert the alluvial silt into a material possessing both the physical and chemical properties of natural occurring vesicular basalt. The stones the scientist found at the Mesopotamian site, were flat slabs that did not have features of naturally occurring stone, but rather had the features of flat polished stone (Stone, Lindsley, Pigott, Harbottle, & Ford, 1998).

Dr. Collins, in further efforts to discredit the Noah's Ark site, stated the magnetic properties Wyatt and his team found with metal detectors were nothing more than the magnetic properties in veins of volcanic rock. He claimed the site is nothing more than a case of natural occurring phenomena. Dr. Collins was not alone in his conclusions on Mt. Ararat. Dr. Farouk El-Baz a planetary geologist at Boston University also made similar claims against Wyatt's findings (Baker & Fenton, 2010).

Dr. Collins pointed out that a structure of Noah's time would not possess any iron components in the first place. He makes note that the iron age of the area did not come into play until around 1200 B.C., which was long after the story of Noah's Ark. Both Dr. Collins and

Dr. El-Baz claimed the gridline-like structure with iron ore properties Wyatt and his team witnessed was nothing more than the remnants of symmetrical lava flows across the site (Baker & Fenton, 2010).

However, according to the book of Job chapter 28:2 "Iron is taken out of the earth, and brass is molten out of the stone (Holy Bible, 2017)." According to best estimates, the book of Job was written sometime between 1800 B.C. and 2100 B.C. (Smith, 2016).

Another mention of Iron in the bible came from the book of Deuteronomy chapter 32:25 "Thy shoes shall be iron and brass; and as thy days, so shall thy strength be (Holy Bible, 2017)." Deuteronomy was written about 1406 B.C. according to scholars (Swindoll, 2017). Even in the book of Genesis chapter 4:22 there is mention of metals such as brass and iron (Holy Bible, 2017). Thus, indicating the probable knowledge of Iron predated the accepted date of the 1200 B.C. iron age.

More substantiated evidence of the utilization of iron is found in an article written in the *Journal of Archaeological Science* in 2013. The article stated, the earliest known iron artifacts were found in Gerzeh, Egypt dating back 5,000 years. These consisted of nine small iron beads made from meteoritic iron which was hammered into thin sheets and rolled into tubes around 3,200 B.C. According to the article, such iron objects have been proven to exist either by accidental by-products from copper smelting or through the utilization of meteoritic iron (Rehren, et al., 2013).

Despite conflicting information about the Noah's Ark site, additional efforts to disprove Ron Wyatt's claims have continued. Professor Namik Cagatay, a marine geologist with the

Istanbul Technical University suggested that one must first prove that a massive flood even took place. In such an event waters from both the Mediterranean and the Black Sea would have come in contact with one another. He stated that such an interaction would produce a noticeable sediment in the sea floor since the Black Sea has a considerably less salt content than that of the Mediterranean (Baker & Fenton, 2010).

Dr. Cagatay conducted a drilling operation producing a sample of the Mediterranean Sea bed. In that sample there existed a segment of strange discoloration which indicated an interaction between the two seas. Dr. Cagatay found expired marine life capable of being carbon dated to acquire an approximate time frame for the flooding event. Dr. Cagatay concluded that a flood did occur approximately 9400 years ago, 5000 years before the proposed building of the ark (Baker & Fenton, 2010).

Another form of discrediting came from Dr. Damian Goodburn, an Ancient Wood and Ship Specialist. Dr. Goodburn stated that a boat size described in the book of Genesis would require over 150,000 square feet of wood planking just to cover the ship's outer hull. In a visual demonstration, Dr. Goodburn constructed two planks and lashed them together utilizing the same tools that Noah would have worked with during that time frame. He completed this demonstration after approximately ten hours of intense labor. Dr. Goodburn stated that such an undertaking would be next to impossible without a massive amount of resources readily available (Baker & Fenton, 2010).

Despite the controversy over the Noah's Ark National Park in Turkey, there still exist a firm belief in the historical value of the site. Through computer modeling, scientists have been

able to confirm a vessel built to the specifications established in the book of Genesis was capable of being sea worthy, assuming the resources existed for its construction.

However, many scientists have made valid arguments, based on scientific studies and computing technology, that the site of Noah's Ark National Park is not the final resting place of the legendary ark. By utilizing computer modeling, carbon dating, chemical analysis, and photo analysis, scientist have suggested the search for the final resting place of Noah's Ark is far from over.

The collision of science and religion at the Noah's Ark National Park have not dissuaded creationist in their quest though. "Neither the individual books of Holy Scripture nor the Scripture as a whole are simply a piece of literature – **Pope Benedict XVI** (Olson, 2013)." Thus, proving the application of technology applied to biblical Archaeology has the potential to unleash both a positive good as well as a necessary skepticism.

SOLVING MYSTERIES WITH TECHNOLOGY – THE STORY OF THE C.S.S. H.L. HUNLEY

On April 12, 1861, the world would be forever changed when Confederate General Pierre Gustav Toutant (P.G.T.) Beauregard opened fire on Union Fort Sumter in Charleston, South Carolina. At the war's onset, the Confederacy had little resources and absolutely no Navy. However, it managed over the course of the war to accumulate a sizable Navel force through the raising of sunken Union vessels, captured ships, eventual ship building, and the conversion of merchant vessels (Bruun, 2000).

In May of 1861, Union General-in-Chief Winfield Scott announced a strategic military plan to President Lincoln. His goal was to strangle the Confederacy into submission by cutting off all sea access surrounding the southern states. He proposed to create a powerful Naval blockade along the coastline and extending up the Mississippi River, halting southern imports and exports. The action was creatively named the Anaconda Plan (THE CIVIL WAR ALMANAC, 1983).

The southern ports quickly fell yielding control of the Albemarle sound to the Union Navy. The losses of Hilton Head, Beaumont, Roanoke Island, and Port Royal put a massive financial strain on the Confederacy (Bruun, 2000). In response the Confederacy began to experiment with submersible vehicles.

Due to the Confederacy's poor financial situation, the submersible project required private investors. These investors, Horace Lawson (H. L.) Hunley, James McClintock, and Baxter Watson created the first Confederate submersible called the C.S.S. Pioneer. The initial idea for a submersible vessel was to tow explosives while submerging under a ship, essentially pulling the

floating explosives into the ship's hull. However, for fear of losing the C.S.S. Pioneer to the Union Navy, the vessel was abandoned and scuttled during testing. (Stauffer & West, 2017).

These setbacks did not dissuade the Confederacy nor Horace Hunley, who rallied James McClintock and Baxter Watson to build yet another submersible. The second vessel was constructed out of a cylindrical iron boiler that was 40-foot in length, powered by a series of hand cranks to propel the vessel through the water. The ends of the hull design had both a tapered stern and bow, resembling a whale or porpoise (Klein, 2014).

Despite Hunley's engineering efforts, the second prototype also ended in failure, sinking off the coast of Alabama in Mobile Bay. This second attempt discouraged McClintock and Watson who abandoned the project. Thus, leaving Hunley alone in his efforts to create the perfect Naval weapon (Hills, 2010).

The loss of Hunley's two business partners in the submersible venture did not phase Hunley in the least. He proceeded to build a third submersible, which he named the C.S.S. H. L. Hunley after himself, which conducted several successful trials in Mobile Bay. The submersible was then loaded on a rail car and shipped to Charleston to aid in Confederate General P.G.T. Beauregard's defense of Charleston Harbor (Hills, 2010).

Shortly after the Hunley's arrival at Charleston, August 23, 1863 to be exact, testing again resumed. This test ended in failure when one of the vessels officers accidentally submerged while an outer hatch was open. The result was the loss of five men, out of a nine-member crew, who drowned as the vessel sunk to the bottom (Klein, 2014). The accident occurred near Fort Johnson claiming the lives of Frank Doyle, Absolum Williams, John Kelly,

Nicholas Davis, and Michael Cane (Stroud, 2012). Once the submersible was pulled to the surface and the bodies removed, it was refitted with a new crew (Klein, 2014).

The second test occurred on October 15th, 1863 when Horace Hunley personally took command of the vessel. He wanted to test submerging the vessel under an anchored ship in Charleston Harbor. The C.S.S. H. L. Hunley took a steep dive and suddenly sank to the muddy bottom, where all aboard perished. However, it wasn't until November 7th, 1863 when the vessel was pulled to the surface along with the bodies of the eight-member crew (Hills, 2010).

After the burials of Capt. Horace Hunley, Robert Brockbank, Joseph Patterson, Thomas W. Park, Charles McHugh, Henry Baird, John Marshall and Charles L. Sprague, the C.S.S. H. L. Hunley was refitted with a new crew. The new crew was commanded by Lieutenant George Dixon, a soldier who had become known for a story about a gold coin saving his life during the battle of Shiloh (Hunley, 2017).

The massive failure of the C.S.S. H. L. Hunley opened the eyes of Confederate commanders. Thus, convincing General Beauregard of the dangers associated with submersible warfare. Concerned for the crew, Beauregard instructed Lt. Dixon to remain on the water's surface while conducting any military operations (Hills, 2010).

To avoid submerging, the Hunley was outfitted with a long spear like staff on the front of the vessel. The staff was attached to a container called an Edward Singer explosive device, which contained 135lbs of gunpowder. The new plan was to ram the spear-like staff into the hull, planting the charge, then backing away to safety before detonation (Schlachter, 2013).

February 17th, 1864, on a clear and chilly night, Lt. Dixon along with seven other sailors boarded the C.S.S. Hunley. They were tasked with affixing an explosive device on the hull of the Union ship the U.S.S. Housatonic off the coast of Charleston, South Carolina. Around 8:45 p.m. an officer on the deck of the Housatonic saw the C.S.S. Hunley approaching from the distance. It was already too late though, the submersible was too close for the ship's cannons (Hills, 2010).

The Hunley's explosive device reached its target, with the spear tearing into the U.S.S. Housatonic's starboard quarter. As a result, the device exploded and the ship immediately began to take on water, sinking to the bottom in a matter of minutes. Just after the blast eyewitness' claimed they saw the C.S.S. H. L. Hunley surface for only a few seconds then swiftly plunge under water (Hills, 2010). The C.S.S. H. L. Hunley would not be seen again for over a century.

In 1970 Dr. E. Lee Spence claimed to have found the C.S.S. Hunley while diving from the *Miss Inah*, a commercial fishing vessel anchored off the coast of Charleston, South Carolina. According to Dr. Spence he was forced to dive because one of his fishing traps had snagged something on the bottom. It was then when he claimed to have discovered the sunken ruins buried in the sea floor by sheer happenstance. However, being 3 ½ miles from shore and near the main shipping channel Spence was not equipped with radar, nor did he have any other means to record his precise location (Spence, 2011).

Dr. Spence later rediscovered and returned to the site in the early part of 1971 to take photographs of the sunken vessel. Dr. Spence located the wreckage by passing a proton magnetometer across the sea floor (Spence, 2011). A magnetometer, a common research

device at the time, was used to measure the intensity or magnitude and direction of magnetic fields (The Free Dictionary, 2017). Acting much like a large-scale metal detector.

After confirming the site was the official location of the sunken C.S.S. H. L. Hunley, Dr. Spence began the process of trying to acquire the proper permits to raise the vessel from the sea floor. It wasn't until August of 2000, and after a series of legal battles over who actually discovered the C.S.S. H. L. Hunley, before it was raised from its watery tomb (Spence, 2011).

Once the C.S.S. H. L. Hunley was disinterred, it was taken to Clemson University's Warren Lasch Institute in South Carolina for analysis. Upon visual inspection, researchers found no evidence that the C.S.S. H. L. Hunley fell victim to a hull breach from an explosion. Researchers then wondered what had actually caused the death of the C.S.S. H. L. Hunley and its crew? Scientist hoped the technology of today would provide the answer to this century old question (Schlachter, 2013).

After stabilizing the vessel for investigation, researchers brought in a three-dimensional laser scanning system to record the exterior of the hull. They wanted to conduct precise 3D scans of the entire outer hull prior to opening the vessel. By bouncing lasers off the Hunley's hull and recording the transmission time, a computer was able to build a virtual profile of the C.S.S. H. L. Hunley. This gave researchers an initial site plan of the structure to start the construction of a computerize model (Watters, 2012).

The next step in their analysis required the opening of the hull to get a visual inspection of the C.S.S. H. L. Hunley's interior. Once inside they began by carefully digging through the silt that had accumulated inside the Hunley's hull. As they removed layer after layer, they used a

more advanced 3D laser scanner that worked off of signal triangulation. This method not only gave researchers an (X, Y, Z) coordinate, but also allowed them to colorize or color code each individual item (Watters, 2012).

This allowed researchers to colorize each set of skeletal remains found inside the Hunley's interior for individual identification (Watters, 2012). What researchers found in relation to the skeletal remains, was they had decomposed in place. There was no indication that anyone in the vessel moved from their seated position when the vessel went down, indicating they were either dead or unconscious when the vessel faltered (Schlachter, 2013).

Once the contents of the interior were exhumed and scanned, researchers could begin the process of analyzing the structural integrity of the craft. By using Computer Aided Design (CAD) software, researchers were now able to bring together the external and colorized internal laser scans to create a virtual model of the C.S.S. H. L. Hunley. This allowed researchers to view the vessel in three-space and create a physical 3D model through the utilization of a 3D printer (Schlachter, 2013).

However, these internal and external scans did not answer the question of why the C.S.S. H. L. Hunley sank to the bottom of the sea. This task would be left up to the dozens of researchers working on the Hunley project.

Shortly thereafter, on April 17, 2004, thousands of people crowded into the Magnolia Cemetery in Charleston, South Carolina to witness the last Confederate funeral in America's history. A column of uniformed re-enactors stretching 1 ½ miles in length carried Lt. George

Dixon, Arnold Becker, C. Lumpkin, Frank G. Collins, J. F. Carlsen, (unknown) Miller, James A. Wicks, & Joseph F. Ridgaway to their final resting place (Stroud, 2012).

In the wake of the interment of the C.S.S. H. L. Hunley sailors, scientists again concentrated on trying to explain the cause of their deaths. Prior to the recovery of the vessel, scientist suspected the C.S.S. H. L. Hunley faltered due to ballast failure, which prevented the vessel from returning to the surface (Blankenmeyer, Weise, & Scafuri, 2016).

This theory was fueled by a statement taken in 1902 from William Alexander, one of the survivors from the August 23, 1863 sinking of the C.S.S. H. L. Hunley in Charleston Harbor. He stated that misunderstanding of the ballast system during testing proved fatal that day, citing the lack of watertight ballast compartments as one of the contributing causes (Blankenmeyer, Weise, & Scafuri, 2016).

Now that scientist had access to the vessel, a thorough investigation could be conducted on the aft ballast system to prove or disprove the ballast theory. This was conducted by Clemson researchers Stephen Weise and Michael Scafuri along with University of Oxford researcher Bradley Blankemeyer. However, the team was unable to make a conclusion on the ballast failure theory. They noted there existed several unanswered questions that must be answered before they could accurately determine if the ballast equipment was capable of functioning properly that day in 1864 (Blankenmeyer, Weise, & Scafuri, 2016).

However, a new theory of what happened to the C.S.S. H. L. Hunley sailors was discussed in great detail in a University of Florida Journal called *PLoS ONE*. Researchers Rachel M. Lance, Lucas Stalcup, and Brad Wojtyla concluded the sailors died as a result of shock from

the underwater explosion. They conducted a number of experiments and mathematical computations supported by computer analysis to conclude and confirm their findings (Lance, Stalcup, Wojtylak, & Bass, 2017).

Citing their results, they were able to determine the crew would have endured a fatal pressure shock or air-blast from the explosive device placed on the hull of the U.S.S. Housatonic. They noted how the deadly shock wave from the explosion could transfer faster through the water than through air. The sudden blast created an air-blast that would have caused fatal brain or pulmonary trauma, that instantly killed the entire crew (Lance, Stalcup, Wojtylak, & Bass, 2017).

This was substantiated by a piece of debris that was recovered from the C.S.S. H. L. Hunley site. Divers located part of the spear-like staff that delivered the explosive charge to the hull of the U.S.S. Housatonic. The staff was covered with a piece of brass that appeared to have exploded around the wood. This indicated to researchers that the explosive device detonated when the vessel was within eighteen feet of the U.S.S. Housatonic, proving the crew received a massive fatal shock from the blast (Schlachter, 2013).

Through the utilization of computerized technology, researchers have solved the mystery surrounding the C.S.S. H. L. Hunley, recovered a piece of lost history, and brought lost soldiers back home. Scientist are now tasked with preservation of the remaining recovered artifacts, in an effort to create a useful educational tool to carry on the story of the C.S.S. H. L. Hunley.

FROM PRESERVATION TO EDUCATION – A BRIEF EVOLUTION OF 3D

Computer technology has changed so dramatically over the past 50 years, such that yesterday's dream has now become today's reality. Today we have the ability to bring the Great Pyramids of Egypt into our living room and take our own self-guided tour, walking down the same corridors Egyptians did over 4500 years ago.

Teachers can even take an entire class on a tour of the Smithsonian Natural Museum of History from the confines of a school classroom hundreds of miles away. All of which is viewed in three-dimensions (3D), allowing you to view in all directions, as if you were actually standing there. However, such advancements did not occur overnight.

The history of three-dimensional or 3D technology can be traced back to 1844 from the work of a Scottish physicist named Sir David Brewster. Brewster noticed by viewing an object from different angles, it created a life-like visualization. His experiments led to the creation of what he called the stereoscope. The stereoscope utilized multiple lenses to create a three-dimensional effect for the viewer (Stereoscopy, 2004).

By the turn of the 20th century the process of three-dimensional viewing had advanced into the anaglyphic moving picture. Thus, bringing the dawn of 3D glasses which gave onscreen characters a life-like effect. By viewing the anaglyphic movie through glasses possessing two different colored filtered lenses, the audience had the ability to view the characters literally projecting from the big screen (Brown.edu, n.d.).

Then, by the late 20th to early 21st century, the sky was the limit with three-dimensional imaging. From holographs to 360-degree cameras, three-dimensional imaging sparked a mass integration of science, computers, education, and visual effects. This is illustrated, through the application of three-dimensional technology applied to archaeological studies, in a 1991 article published in the University of Pennsylvania's *PENNPRINTOUT* by Dr. Randall Couch (Couch, 1991).

Dr. Couch sites the work of Dr. Harold L. Dibble, an Anthropologist with the University of Pennsylvania. Dr. Dibble stated: "The central issue of archaeological context is understanding provenience – how objects lay in the ground (Couch, 1991)." According to Dr. Couch, Dr. Dibble's theory to improve archaeological context hinges on improving methods of 3D image manipulation. This will allow scientist to not only improve visualization, but also calculations of proportion and volume of the located artifacts (Couch, 1991).

However, technology was not limited to just the sciences like Archaeology and Anthropology. Scientists such as Lucio Colizzi, a Software Engineer with the University of Salento in Lecce, Italy had different aspirations of 3D technology in mind. Colizzi along with Francesco Argese, Vito Palmieri, Francesco Chionna, Italo Spada, and Lucio Colizzi published an article entitled *Integrating Building Information Modeling and Augmented Reality to Improve Investigation of Historical Buildings in Conservation Science in Cultural Heritage* journal (Chionna, Argese, Palmieri, Spada, & Colizzi, 2015).

Colizzi approached the utilization of 3D technology from a little different perspective. He and his team made a series of developments in the fields of Building Information Modeling

(BIM) and Augmented Reality (AR). Their goal was to utilize 3D technology in an effort to electronically preserve historic structures even after their physical demise (Chionna, Argese, Palmieri, Spada, & Colizzi, 2015).

By collecting images of a structure through both standard and 360-degree cameras, Colizzi and his team were able to create a digital representation of a structure. By applying these photographs to Computer Aided Design (CAD) software along with principles of construction and building materials, they were able to create a virtual digital representation (Chionna, Argese, Palmieri, Spada, & Colizzi, 2015).

Colizzi also references in the article how, through the utilization of CAD software, they have the ability to add additional layers of information. He noted they could overlay laser measurements, X-ray scans, and thermal images to get a true life-like representation. He noted that such a representation could be useful in calculating a number of physical characteristics of the structure room by room or as a whole (Chionna, Argese, Palmieri, Spada, & Colizzi, 2015).

These types of applications, coupled with the utilization of the internet, have led to a massive creation of three-dimensional virtual projects. Once such project was a virtual tour of the Great Pyramids of Giza created by Dassault Systems, a French owned design company, along with the assistance of the Museum of Fine Arts in Boston, Massachusetts (PHYSORG, 2012).

This particular virtual tour incorporated written historical information into the project, providing the user with background information on the site. According to a Dassault spokesperson: "Users will be able to roam throughout the necropolis, visit the carefully

restored tombs, access shafts and corridors, as well as browse all the information on the occupants of each burial chamber, including the dates of discovery and objects collected (PHYSORG, 2012).”

Another excellent example is the Smithsonian National Museum of American History’s virtual tour. Teachers and students now have the ability to navigate the site by century, ethnic history, or recommended readings. The site offers a comprehensive tour of the museum’s current exhibits accompanied by a time line of events (National Endowment for the Humanities, 2017).

Currently there exists hundreds of online three-dimensional virtual tours from around the world. From the Historic Centre of San Gimignano in Italy to the United States Capitol. The Leaning Tower of Pisa to The American Museum of Photography (Rivas, 2010). This is just a taste of great things to come in the science of three-dimensional imaging. Thus, providing evidence that such advancements in three-dimensional imaging exhibit both educational and preservative qualities. Through the construction of virtual tours, the electronic pages of history can now exceed physical existence.

THE UNSOLVED MYSTERY OF THE SACRED RIDGE MASSACRE

As far back as the 1930's the state of Colorado has shown interest in obtaining water from the Animas River, which is situated in the La Plata River Basin. By the mid 1960's those interest was formulated into a project proposal called the Animas-La Plata project. It wasn't until September 30th, 1968 when Congress officially authorized the construction of the project through what was called the Colorado River Basin Act (Delaney Southwest Research Library, 2017).

In 1986 the area was finally secured as part of the Colorado Ute Indian Water Rights Final Settlement Agreement in exchange for development funds totaling \$60 million. Thus, dropping Indian claims to the rivers in the San Juan Basin area. This allowed for construction to begin October 26, 1991 on the half-billion dollar federally-funded Animas-La Plata project (Delaney Southwest Research Library, 2017).

The Animas-La Plata project's plan was to create a 1,500-acre reservoir, south of Durango, Colorado in La Plata County. This area, which is heavily populated with wildlife, is situated approximately 6,800 feet in elevation, providing an excellent location for a reservoir project. However, the project would impact a large number of archaeological sites, which required an environmental impact study. SWCA Environmental Consultants were brought in to conduct an analysis of the area, which was completed on September 30, 2005 (Potter & Chuipka, 2007).

SWCA excavations uncovered three pit structures, called Site 5LP2026, commonly referred to as Sacred Ridge (Potter & Chuipka, 2007). During those pit excavations, 14,882 human bone fragments, dating back to around 800 A.D., were located and cataloged. Researchers also recovered a large number of other animal remains, including those of mutilated dogs (Viegas, 2010).

Archaeologist stated this area was first populated around 700 A.D and the settlements were relatively small in size. Prior to that, the area was roamed by a number of mobile hunters and gatherers. Excavations at the Sacred Ridge site confirmed some of Archaeologist's statements, but also revealed the settlement was much larger than originally anticipated. The find encompassed nearly 11.6 acres and contained over 22 underground pit houses. Archaeologist also determined the site included public structures such as a domed circular building, palisade, and a two-story structure (Bower, 2010).

Analysis of the human fragments at Sacred Ridge indicated to researchers an episode of mass human mutilation. Jason Chuipka, with Woods Canyon Archaeological Consultants, noted the remains suggested a large degree of planning and violence. He along with his colleague James Potter feel there must have been some form of social meltdown to cause such a violent event (Viegas, 2010).

However, the big question the find generated was the proceedings that surrounded what initially happened at the Sacred Ridge site. According to researchers, they have been able to confirm at least thirty-three men and women were tortured, mutilated, and buried at the site roughly 1,200 years ago. Anna Osterholtz, a researcher with the University of Nevada, Las

Vegas, noted the victims showed signs of blunt-force trauma to the feet as well as tool marks to other parts of the body (Archaeological Institute of America, 2014).

Anna noted in her research that she identified signs of hobbling or immobilizing one's feet and ankles at the Sacred Ridge site. Analysis of remains revealed there were signs of bones in the feet being crushed, chopped, and beaten in such a manner the outer tissue was peeled completely off. Evidence also existed that ankles were severely beaten and broken, regardless of age or sex (De Pastino, Evidence of Hobbling Torture Discovered at Ancient Massacre Site in Colorado, 2014).

Researchers also documented numerous cut marks on bones, marks that were measured in groups rather than individually. They noted that some of the remains showed signs of systematic dismemberment along with scrape and chop marks. Some of the remains also showed signs of execution tactics. There was also a number of charred remains found in hearths, which indicated disposal of limbs by mass burning (Bower, 2010).

Captivated with the Sacred Ridge find, researchers began to investigate the possible causes associated with the mutilated remains. They started by looking at the possible social interactions of the Sacred Ridge people. From Witch hunting to cannibalism, all kinds of theories and scenarios began to surface surrounding the mutilations at the Sacred Ridge site (Bower, 2010).

John McClelland with the Arizona State Museum's Osteology Lab conducted an analysis of some of the various remains. McClelland noted that analysis of the bones indicated the Sacred Ridge people had a different diet from other inhabitants of that time period. He also

noted the remains from Sacred Ridge were not just disarticulated at random from among the overall population. McClelland suggested the mutilations at Sacred Ridge was well-planned and not just a rash incident (Viegas, 2010).

Additional biological analysis of the Sacred Ridge remains were also conducted by Ann Stoddard with the Field Museum in Chicago. Her research aided in confirming McClelland's findings. Stoddard further stated the mutilation appeared more like genocide than mass murder, which coincides with statements by researchers like James Potter and Jason Chuipka. She suggested a possible food shortage may have provoked anger toward the better provisioned Sacred Ridge people by rival settlements (Bower, 2010).

Based on the size of the settlement, researchers speculate the area was well-populated by a number of different people. Archaeologist feel that many of the tribes in the area lived in very close proximity to each other, based on an abundant water source along with a variety of native wildlife and plants. However, this did not explain what triggered the violent mutilations at the Sacred Ridge site (Bower, 2010).

Some researchers have tried to relate finds at similar sites found in southeastern Utah, known as Mesa Verde and Chaco Canyon. Archaeologist located a cave site where similar mutilations occurred sometime around 700 years prior to those at Sacred Ridge. The cave contained over 90 dead, and was described as a "sudden and violent destruction of a community by battle or massacre (De Pastino, 2013)."

Another site that shares a common relationship with Sacred Ridge is located at Sand Canyon, a former Pueblo Village location in southwestern Colorado. Finds at the Sand Canyon

site indicate a number of violent deaths occurred sometime after 1277 A.D., which is roughly 475 years after the Sacred Ridge massacre (Kuckelman, 2010).

Researchers found a number of victims who were subadults and were genetically related, indicating entire families died. Based on the positioning of the bodies, researchers have concluded the Sand Canyon people were murdered while trying to protect their precious water supply. Thus, indicating violence may have been the result of starvation and/or lack of a suitable water (Kuckelman, 2010).

Puzzled by the inability to find a viable social theory behind the events that transpired at the Sacred Ridge site, scientist began looking into possible environmental factors. Researchers turned to dendrochronology, the study of tree-rings. Through advanced computer modeling of tree-ring data, scientists are able to determine seasonal climate changes and site dating. They are also able to estimate both temperature and rainfall changes on a yearly basis. These scientific investigations coupled with data from ice cores, coral reefs, and cave rocks give scientist a look into past climates (Riebeek, 2005).

Computerized interpretation of tree-ring data revealed Sacred Ridge was occupied from around 700 A.D. to shortly after 803 A.D. The data also revealed the area had undergone some fairly severe climate changes as well (Potter & Chuiipka, 2007).

According to computer models generated by the Weather Science Foundation, there were abnormal drops in both temperature and precipitation around 750 A.D. thru 755 A.D., 765 A.D., 770 A.D., and a period between 790 A.D. thru 800 A.D (Harris-Mann Climatology, n.d.). There were also abnormal increases in both precipitation and temperature shortly after 770

A.D. until shortly after 775 A.D., 785 A.D. thru 790 A.D., and shortly after 800 A.D. thru 810 A.D. (Harris-Mann Climatology, n.d.).

Analysis of the Sacred Ridge site also revealed the inhabitants left sometime after the Sacred Ridge massacre occurred. Scientist have speculated the area was left vacated sometime around the year 803 A. D. (Bower, 2010). This date also corresponded to paleoclimatology data which suggested an abnormal temperature increase between 800 and 810 A.D. (Harris-Mann Climatology, n.d.).

Researchers studying climatology data from the area, noted that such changes in temperature and precipitation varied geographically and affected areas differently. However, they stated that such changes would have had a detrimental effect on the groundwater supply, agriculture, and the biotic community. Researchers feel situations such as these brought both drought and flood conditions. However, they feel this is probably not the only reason for the depopulation of the region, but could have played a key role (Van West & Dean, 2000).

Despite the power of computer analysis, the mystery surrounding the massacre at Sacred Ridge still remains unsolved. However, as computing power evolves scientist hope to one day solve the events surrounding the Sacred Ridge Massacre. Computer analysis of the Sacred Ridge site proves despite computing technology some limitations in modeling and analysis still exist.

CONCLUSION

Through the examples cited herein, I have provided valid evidence that computer technology applied to historical investigation serves an overall collective good. Whether this motivation is based on solving mystery or locating the lost, the extent of this collective good is, and will forever be, opinionated. Computing technology, despite some theological limitation, has a legitimate place in the sciences of historical investigation, bridging the philosophical gap between science and historical interpretation.

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