APPLY THREE DIMENSIONS SCANNER FOR FINE ART CONSERVATION

By
Mr. Huy HONGRY

A Thesis Submitted in Partial Fulfillment of the Requirements
for Master of Arts (CONSERVATION OF FINE ART)
Graduate School, Silpakorn University
Academic Year 2021

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โดย

Mr.Huy Hongry

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรศิลปศาสตรมหาบัณฑิต
สาขาวิชาอนุรักษ์ศิลปกรรม แผน ก แบบ ก 2 ระดับปริญญามหาบัณฑิต
บัณฑิตวิทยาลัย มหาวิทยาลัยศิลปากร
ปีการศึกษา 2564

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Title	Apply Three Dimensions Scanner for Fine Art Conservation
By	Huy HONGRY
Field of Study	(CONSERVATION OF FINE ART)
Advisor	Associate Professor Surapol Natapintu

Graduate School Silpakorn University in Partial Fulfillment of the Requirements for the Master of Arts

.... Dean of graduate school
(Associate Professor Jurairat Nunthanid, Ph.D.)

Approved by

.... Chair person
(Associate Professor Kannika Suteerattanapirom , Ph.D.)

.... Advisor
(Associate Professor Surapol Natapintu)

.... Co advisor
(Associate Professor Panjai Tantatsanawong , Ph.D.)

.... External Examiner
(Colonel Associate Professor Surat Lertlum , Ph.D.)

59904201 : Major (CONSERVATION OF FINE ART)
Keyword : 3D scanner, conservation

MR. HUY HONGRY : APPLY THREE DIMENSIONS SCANNER FOR FINE ART CONSERVATION THESIS ADVISOR : ASSOCIATE PROFESSOR SURAPOL NATAPINTU

The arms of this research are to study the technique of 3D scanner for applying in the conservation of fine art which there are two objectives; the first objective is to study the technique of 3D scanner for using in the conservation of fine art, and the second objective is to get better understanding the benefits or limitation of the application of 3D scanning technology in the conservation of archaeological artifact which is a type of art objects. To reply to these objectives of this study, there is three types of art objects (Pottery, hand axe, and cannon bullet) are selected to scan with a Fuel 3D scanner. This study found that a 3D scanner is an important technology among documentation and analytical technique used for the art object conservation field. The 3D scanner is capable of photography and structural imaging including radiography, computed tomography, colorimetric, and other measurement techniques. Moreover, it is a part of the digital record of art object collection for documentation, archive, research, and publishes accessibility. It isn’t only relatively new, highly precise measurement tools, but the system of the 3D scanner also provides high quality, the high-resolution 3D archive of object‘s surface topography with measurement accuracy to the sub-millimeter level. Additionally, it allows the measurement of the surface geometry, texture, and volume of most objects. Shortly, the 3D scanner is a device that can analyze a real-world object to collect data on its shape. Then, collected data can be used to construct digital three-dimensional models, and it has an important role to document the physical and information of art objects. According to the table of object identification which are listed the main points; title, picture, period, dimension, object type, technique, maker, inscription and making, disfiguring feature, and short description for the inventory of art object, item, or collection in the database of museum work, conservation work, and other relevant works. Among these, there are two points that 3D scanner can help to complete the database which is digital 3D archive, and measurement the dimension of art objects. At the point of “Picture” in the list of object identification, a 3D digital archive is very necessary to complete this point that it is the most significant dimension that can be viewed on all sides of the object scan with high quality. This can be replaced by the photograph which is normally attached in documentation or database archive. In addition, the Fuel 3D scanner is capable to measure the art object with its function during the scanning. This point is very useful because all art objects have to know the dimension when they are listed in a database or document. The capacity of a 3D scanner; measurement of the art object and digital 3D scan are very crucial points which these work can contribute to the fine art conservation work. In conclusion, the 3D scanner is a very good tool for applying in use for art conservation work which its productions are fulfilled the database and inventory work.

ACKNOWLEDGEMENTS

First of all, I would like to dedicate my highest respect to HRH Princes Mahachakri Sirindhorn and Silpakorn University for the financial support under Her Royal Highness Princes Maha Chackri Sirindhorn Education Project to the Kingdom of Cambodia for the master degree program. I am so thankful for providing me this meaningful and grateful scholarship opportunity to pursue higher education in Thailand.

My great appreciation is directly given to my advisor, Associate Professor Dr. Panjai Tantatsanawong for guidance, suggestion, encouragement, and helpful comment. I would like to also thank for constructive suggestion and comments from our committee Assocciate Professor urapol Natapinto, and Professor Dr. Surat Lertlum, and Association professor Dr. Kannika Suteerattanapirom. Their sincere encouragement, comment and supporting of this research are very important. In addition to this, I really appreciate for all professors, lecturers, and staffs of Silpakorn University for their teaching, helping and supporting.

Last but not least, I would like to take this opportunity to express my thankfulness to my family and friends who always offer me the motivation and support during this research period.

Huy HONGRY

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CHAPTER 1
INTRODUCTION

1. Statement and Signification of the problem

Treatment for the object of material culture, documentation, and technical examination is the principle and practice in the field of art conservation. The aim of art conservation is to improve the condition of art objects by stabilizing physical condition problems and addressing surface disfigurement arising from deterioration and/or damage. So, the art conservation work strives to retain as much original material as possible and to employ the best quality materials and the most carefully considered methods available.

Sometimes a conservation treatment also requires restoration. Because it is defined as the preparation and incorporation of replacement parts and surface finishes to allow proper visual interpretation of an art object and to recapture an acceptable esthetic appearance.

On the other hand, preservation is a part of conservation, which mixes all of the varied activities involved in preventing damage and reducing the rate of deterioration for art objects, collections, and structures. Professional art conservators carry out this work to preservation issues including display methods, archival quality storage solutions, environmental condition challenges, pest management, and packing for transportation.(Metropolitan Museum of Art, 2001) So, art conservation is the preservation of art and objects of cultural heritage through examination, documentation, treatment, and prevention.

Examination
Examination of art object is the first step of conservation work which conservator have to gather and realize the information of those objects such as artistic techniques and understanding to what the artwork is, how it was made, and its condition issues.

Documentation
In this point, conservators normally document and write detailed condition and treatment reports for every artwork. This documentation becomes a part of the artwork’s permanent record.

Treatment
Conservation treatments are undertaken to repair, stabilizes, or otherwise preserves an artwork. Modern conservation practices approach the original object and the intentions of the person or people who created it with great respect. Wherever possible, conservation techniques are stable and reversible.

Preventive

Art and objects of cultural heritage are subject to deterioration through ten external factors, called the ten “agents of deterioration.” Agents of deterioration include fire, water, direct physical forces, incorrect temperature, incorrect relative humidity, pests or mold, thieves or vandals, dissociation, light, and pollutants. By mitigating the influence these agents have, collections material can be protected from damage. Actions that mitigate agents of deterioration are called Preventive Conservation and they include environmental monitoring, integrated pest management, security, storage and display, disaster response, and safe handling techniques. (Center, 2019)

Documentation is the process of gathering information about the collection for which a museum or cultural institution is responsible. As a result of proper documentation, it will allow those who are responsible to know; what it has in its possession, know if anything is missing, know where the objects are located, prove ownership of the object and create or maintain information about the collection. In addition, the standardized and structural database of archiving those art objects helps to ensure the reliability of the information, ease sharing, consistency of recording, and improve access. Indeed, an accurate and detailed description of those objects is a very important point especially in case those objects are lost, display in the exhibition, or display for public awareness. (Thames & Lie, 1999)

In order to conserve those art objects, archiving to the database is constructed by describing and cataloging those cultural objects. This is called object ID. The elementary of describing and cataloging art objects called object ID has some main points to identify an object such as, object type, material, technique, dimension, inscription and making, disfiguring feature, title, subject, date or period, maker or producer, short description and photograph. (Thames & Lie, 1999)

Object type is an important point to the record. This helps us to know the type of object. For example, is it a sculpture, manuscript, painting?

Material is referred to the resources of the object and it should be identified in the object ID. This helps us to know what material the object is made from. For example, it is made from stone, ceramic, wood, bonze, etc.

The technique of object making is important to describe in object ID. This helps us to know what technique is used in making this object. For example, its technique is carving/ print/cast, paint, etc.

Dimension of the object is also mentioned in object ID because this information tells us about the measurement and unit of measurement of the object such as height, width, depth, and diameter.

Inscription and marking are highlighted in object ID. This is mainly focusing on clearly identifiable marking or inscription on the object such as the maker’s mark or stamp, printed or inscribed text, signature, assay mark, and identifiable number.

The distinguishing figure is the important point to identify the object with noting some points such as damaged/ repairs/modification/ manufacturing defect etc.

The date and period of the object creation are shown in the object ID. This helps us to know the exact time of the object creation.
Maker refers to who was the object made by. It can be individual (painter, sculpture, carver), company or cultural group.
A short description of the object is very important to show the audiences/people what the object depicts and other most relatively information should be written to identify the object.
The last important point is photographing the object. This will help in identifying the object if it is lost or stolen. And it also helps to reduce the need to handle fragment objects that prevent unnecessary damage.
The above guidelines are very practical in object ID. To maintain information of art objects, the archiving database is made like the table below.

Table 1 Object Identification

Object Identification	
Title	
Photographing	
Date/ Period	
Dimension	
Object type	
Maker	
Inscription and making	
Disfiguring feature	
Short description	

In the documentation of art objects, databases of the art objects should be developed. Some important attributes of the objects that should be included and recorded in the database are photographs and measurements of the art objects, along with other relevant information. In the present day, some academic works clearly indicate that a 3D scanner can facilitate the works for obtaining the photographs and measurements of art objects. So, this study will conduct research to understand better the benefits or limitations of the application of 3D scanning technology in the conservation of archaeological artifacts which is a type of art object.
As a consequence of guidelines of describing and information catalog made happen, this research will apply three-dimension scanner instead of the camera photographing to scan those art object in the goal of understanding the processing of this modern technology within fine art conservation. Especially, this research documents as manual of all the processing in using the 3D scanner.

2. Objectives

1) This research is arm to study technique 3D scanner for using in the conservation field.
2) This research is arm to understand better the benefits or limitations of the application of 3D scanning technology in the conservation of archaeological artifacts which is a type of art objects.

3. The Scope of Research

The scope of this research:

The three types of art objects are selected to study as the sample for the experiment using the technology of a 3D scanner.

- Pottery, which is created from ceramic.
- Ancient cannon bullet, which is created from iron.
- Hand axe, which is a naturally occurring solid aggregate of minerals.

Figure 1 Pottery

Figure 2 Hand Axe

Figure 3 Cannon Bullet

1.4 Definition

A three-dimension scanner is a device. It can analyze a real-world object to collect data on its shape. Then, collected data can be used to construct digital three-dimensional models.

Fine Art is the art created primarily as an aesthetic expression to be enjoyed for its own sake. The viewer must be prepared to search for the intent of the artist as the all-important first step toward communication and active participation. The most encompassing of fine art are drawing, painting, sculpture, and printmaking.

CHAPTER 2
LITERATURE REVIEW

This research will review the preview research paper which is relevant to the current technique of 3D scanners and 3D scanners applied to fine art conservation. Those sources of research will be cited from journal papers, books, newspapers, reports, thesis, and other research works.

2.1 3D Scanner

The 3D scanner is known as an important technology for documentation and analytical technique used for conservation of fine art field. Its capacity is to photography and makes the structural imaging including radiography, computed tomography, colorimetric, and other measurement techniques. Moreover, publishes accessibility, research, archive, and documentation are the part of the digital record which 3D scanner is needed to use those art objects collection. It is not only a relatively new, highly precise measurement tool, but the system of the 3D scanner also provides high quality, the high-resolution 3D archive of the object's surface topography with measurement accuracy to the sub-millimeter level. Additionally, texture, measurement of the surface geometry, and the volume of objects are allowed. (Wachowiak & Karas, 2009) Shortly, the 3D scanner is a tool that can analyze the object by collecting data on its shape, and then, the construction of digital 3D models is created by the use of collected data of the object.

In the present day, the 3D scanner has an important role in the preservation and documentation of cultural heritage. Conservators or archeologists use the 3D scanner to scan the archeological sites, monuments, and artifacts to disseminate, study, monitor, and understand those cultural or historical objects. The vast archive of 3D and color data is very essential to be securely archived. The main benefit of the 3D scanner is to record the surface and the form with high quality and keep them in the raw formats, so the data can be reprocessed. Sometimes, the data is reprocessed to rematerialize as a physical object. This is a new exploration of the ability of the scanner to rematerialize data as physical 3D objects. There are many ways which cause the destruction and damage the heritage site such as wars, tourism, commercial imperatives, aging, iconoclastic activity, incorrect restoration, and natural disaster. This led the conservator, curator, or archeologist to evaluate the importance of a high-resolution 3D model. This model help visitor to realize the complexity in conservation and it will bring the relationship between the original and the authentic. (Arte, 2021)

With its advantages and limitation of different types of 3D scanner methods subsist. The best thing is to realize the right type of 3D scanner which is suitable for the right application. Photogrammetry, time of flight, triangulation define the relationship between form and image. The 3D data can be on a vast scale, recording the topography of a landscape from great distances or it can be close range and accurate enough to document the surface of a carving; marks that are not easily visible to the human eye can be visualized for epigraphic study or condition monitoring. (Arte, 2021) The common use of the main technique of 3D scanners is listed below.

2.2 Types of 3D Scanning

2.2.1 Long-Medium Range 3D Scanners (LiDAR)

The Long-Medium Run 3D Scanners or Earthbound laser filtering (TLS) is utilized to record the common shape of huge objects, surfaces environment, and topography to get precise metrological information. The technique is broadly utilized in a landmark building, construction, surveying, and a wide range of other disciplines. This is also called long-range laser scanning. TLS includes installing a scanner in a static position, while other scanners might be mounted to vehicles for data collection from a lot of standpoints. These types of 3D scanners can also normally refer to as LiDAR scanners since ground-based scanners aren't the only type of scanner to use the technology. This sort of 3D scanner has not been utilized for recording the subtle detail of surfaces that is required to build an accurate facsimile or in the science of identifying graphemes. (Arte, 2021)

Figure 4 Long-Medium Range 3D scanner: (Focus S70 FARO)
Source: https://www.g2metric.co.il/product/faro-laser-scanner-focus-s70/

There are numerous earthbound laser scanners known as LiDAR (Light Detection and Ranging) which comprises sparkling lasers at an object and measuring the reflections with a sensor. This methodology tends to understand laser return times and wavelengths so that it can determine the position and dimensions of the object or environment. The common application of terrestrial laser scanning requires the setting up of one of these LiDAR-based scanners, as a rule on a tripod, in or close to the scanned object or environment. Then, the scanner collects the data within the frame of a point cloud a set of spatial, 3D data points. The scanner must be moved and set up at distinctive inactive areas in arrange to gather scanned data from multiple angles. To extract a precise 3D scan of a building, for instance, this should always filter it from more than one side. If we need to scan more than one large coverage of areas, we need this software to perform point cloud registration, which combines the partitioned information sets (point clouds of four distinctive exteriors of a building, for example) into one complete set. (Arte, 2021)

2.1.2 Short-range 3D scanning technologies

A short-range 3D scanner collects distance data around surfaces inside its field of notice and a 3D scanner portrays the removal to a surface at each point. This permits the 3D position of each point to be recognized. A short-range 3D scanner is as a rule characterized as one that performs best inside one meter of our scanned objects. These are more often than not isolated into the wide Contact and Non-contact categories while many different technologies can provide the 3D model of an object. As an illustration, coordinate measuring machines (CMM) are a portion of the accessible contact 3D filtering advancements, where the object is arranged and settled on a specific location, at that point examined through physical touch. This strategy is exceptionally accurate; however, its fundamental downside is its unbending nature. Non-contact innovations extend light or radiation to evaluate the surface of an object. By not intending to mention them all, the most widely used are triangulation and white light. (Brown, 2012)

The triangulation technology also makes laser light to decide the shape and position of an object, but it employments a camera to find the laser line or crosshair it projects. It is named like that since whereas the 3D scanner is in utilization, the laser emitter, the camera, and the laser line or crosshair forms a triangle. Additionally, the main principles of geometry are applied so that this could provide the 3D representation of the object: the length of one side of the triangle is known (the distance between the camera and the laser emitter), and so is the angle of the laser emitter. The third element is required so that it can measure the precise dimension of the triangle, the angle of the camera can also be used to resolve it by calculating the position of the laser projection from the camera. We can differentiate two main groups of scanners using triangulation: optical profilometers, which are fitted on a measuring arm, and portable 3D scanners. (Brown, 2012)

Mobile 3D scanners demand reflective sensors to be positioned either on or around the part to be converted, which will be used as a point of reference. Consequently, the sensors help the scanners accomplish energetic referencing, which suggests that measuring operations are specifically performed about the object. Therefore, the device, as well as the object scanned, can be moved without affecting the precision. Optical profilometers utilize their arms as a point of reference, instead. (Brown, 2012)

In general, the triangulation-based approach provides limited range offered, however, the technology itself is not just made up for the accuracy: for instance, the precision is approximately calculated or offered in tens of micrometers as a comparison to a human hair which is about 100 micrometers thick. (Brown, 2012)

Among all other short-range 3D scanner technologies, White Light is one of the 3D scanner technology that also uses triangulation and a camera system. In contrast to using a laser, it introduces either a periphery light design or a coded light design. The form of the object is then translated by measuring the returned patterns of light. White light scanners can capture a full coverage of area altogether at once, instead of measuring one line at a time. This produces a great granularity in detail, and all but the good point is that the motion distortion is also removed. To some extent, a few of them even make it possible to provide the real-time calculation of a moving object. (Brown, 2012)

Gradually, scanners that project a periphery or fringe pattern which also appeared to have been sometimes called "structured light", take their measurements over time. The techniques need to calculate several sequential projections at a given time, and their decoding happens through a worldly projection. Their come about are hence not immediate, and require the gadget to be settled, and still. Relatively, white light scanners that venture a coded design can be handheld and shifted, which significantly increments their adaptability and ease of utilization. Because their calculating coverage is large in scale, they offer very speedy resolutions. Additionally, the scanner interprets the specific light pattern for every frame that the camera captures. (Brown, 2012)

Whereas still exceptionally in a reliable manner, white light that coded light pattern scanners typically do not outperform the accuracy of triangulation 3D scanners, in contrast, they tend to offer both promising speed and adaptability. To improve the accuracy scale, we would then discover the profilometer 3D scanner, taken after respectively by the white light fringe pattern. (Brown, 2012)

On another hand, among short-range technologies, a time-of-flight 3D scanner (ToF) uses a laser range finder to measure the surface of an object depending on the speed of light. To be clear, the scanner sends multiple pulses of light, and then it determines the elapsed time which by explanation, is the time that these pulses take to arrive at the object and come back. (Brown, 2012)

Within a given view direction, a laser range finder can only calculate the position once at a time. Therefore, it needs to continuously adjust its orientation so that it can make a scan possible. By the way, we can achieve this by the mirror rotation. This could move tremendously speedy. (Brown, 2012)

When applying the ToF approach, the range between 10,00 and 100,000 points per second is used. ToF scanners are very suitable for scanning larger-scale areas because of their longer range. Nevertheless, the accuracy in short-range such as when measured in millimeters, they are found to be not qualified. In whatever way, we can also use these types of 3D scanners to provide models in situations that might contain more noise around the edges of the object, owing to the light pulse returning from two distinctive positions. (Brown, 2012)

Figure 5 F5 3D Scanners
Source: https://www.aniwaa.com/product/3d-scanners/mv4d-mvc-f5/

2.2.3 Photogrammetry

Photogrammetry is one of the technologies that make measurements using photographs quite simple. It is possible to attach photographs of an object captured from separated angles together. Capturing using a camera with unique settings in the attaching of those photos, it can be done by custom-built computer applications. What makes this special is that this kind of software determines pixels that map to the same physical location while presenting images altogether consequentially. (Kamani, 2021)

Parameters just like the central length of the lens and its twisting ought to be nourished into the program by the user to form a precise model. Phone can be utilized in Photogrammetry innovation and capturing pictures. (Kamani, 2021)

Utilizing the photogrammetry technique could introduce a lot of advantages, some of which are accuracy level and the speed while the object information is collected. However, this technique might also have its drawback, for instance, it is the time it takes to produce the image data through the application as well as the sensitivity of the final score toward the photo quality. Therefore, we need carefully select a good-quality camera that has high resolution along with DPI measure if we aim of achieving the best final result. (Kamani, 2021)

The advancement of photogrammetry can ultimately create the photos through the use of many software applications such as Blender, Reality capture, Mushroom, 3DF Zephyr, or Agisoft Metashape. (Kamani, 2021)

Figure 6 PTS-FL Photogrammetry 3D Scanner

Source: http://www.3doescanner.com/42-pts-fl-photogrammetry-3d-scanner.html

2.2.4 Contact scanning

The strategy of contact scanning includes physical contact of a test onto the surface of the object being captured. In the beginning, the object is readily held in a fixed position so that the object cannot be moved somehow. Later on, the touching probe is moved all over the object to gather the subtle elements of the object itself and all of the 3D information that is essential to form a digital record. (Kamani, 2021)

To some extent, a good number of positions on the surface require to be randomized to produce a ready-to-use model. From time to time, an articulated arm or a joint robotic arm is used to control the touching trigger probe and capture multiple angles or configurations with a good degree of accuracy. (Kamani, 2021)

Because contact scanning covers actual concrete contact with the exterior of the object which is being scanned, the transparent and reflective surfaces can be accessed with good accuracy utilizing this technique. As a result, this technique is widely chosen as it provides better accuracy over other scanning technologies that are incapable of applying scans on such surfaces. (Kamani, 2021)

Anyways, the slower speed is the limitation of using the contact 3D scanning technique. The reason behind this is that contact scanning is running the touching probe throughout the given sections of an object to gather the entire 3D information. Therefore, this process takes a great amount of time. Although there might be some drawbacks, Contact 3D scanning is interestingly presented in the application of quality control in industrial fabrication. Parts that have been recently created can be checked for any distortions or harms utilizing contact scanning. (Kamani, 2021)

Figure 7 Faro Contact Scanning

Source: https://blogs.solidworks.com/tech/2019/04/3d-scanning-technologies.html

2.2.5 Structured Light 3D Scanner

The structured light 3D scanner is a 3D scanning device that is also relatively known as a “white light” 3D scanner. It is one of the mainly used structured light 3D scanners which use a blue or white LED projected light pattern. By using these 3D scanners, there are some important elements for light projection such as bars, blocks, or other shapes onto an object. The 3D scanner has one or more sensors that see the edge of those patterns or basic shapes to decide the object's 3D shape. (Kamani, 2021)

Utilizing the same trigonometric triangulation strategy as laser scanners the distance from the sensors to the light source is provided. Structured light scanners can be mounted into tripods or handheld. Structured light 3D Scanners have some benefits as follows:

1. Provides very speedy scan times –as fast as 2 seconds per scan
2. Can cover a large scanning area –as large as 48 inches in a single scan
3. Produces in high resolution –as high as 16 million points per scan and 16-micron (.00062”) point spacing
4. Achieves result with high accuracy –as high as 10 microns (.00039”)
5. Comes with flexible options –multiple lenses to scan small to large parts in a single system
6. Introduces portability –handheld systems are very portable
7. Takes proactive measures to provide eye-safe execution for 3D scanning of humans and animals
8. Fits with various price ranges from low cost to big-budget one depending on resolution and accuracy. (Kamani, 2021)

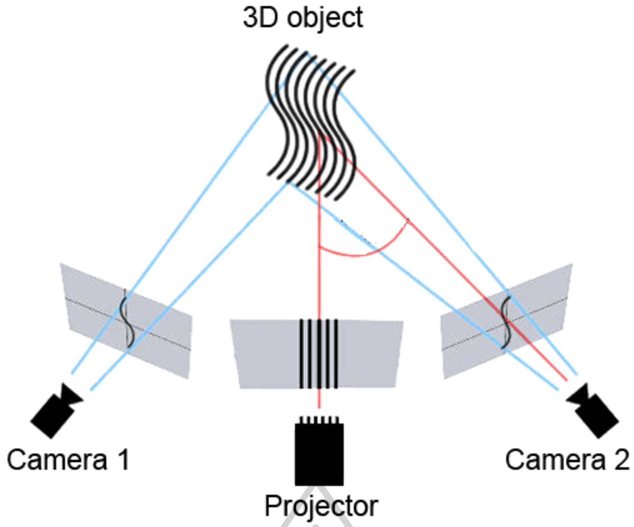


Figure 8 Structure Light 3D Scanner

Source: https://bitfab.io/blog/3d-structured-light-scanning/

2.3 Object Identification

Object identification introduces an overall standard for the minimum information required pinpointing art, antique, and antiquities. Through the collaboration of the museum community, police and customs agencies, the art trade, the insurance industry, and appraisers of art and antiques, the standard is widely stated in various uses as follows:

- As a checklist of the data required to recognize stolen or lost objects.
- As the standard documentation that builds upon the least level of data required to recognize an object.
- As a key foundation within the advancement of data systems that will permit organizations around the globe to trade portrayal of objects quickly.
- As a key component in any preparing program that educates the documentation of craftsmanship, antiques, and antiquities.

The procedure itself introduces the utilizing object identification as the major significance data categories that are partitioned into nine groups including sort of object, material, and technique, measurement, inscription, and makings, distinguishing feature, title, subject, date or period, and maker and photographing of the object. (Thames & Lie, 1999)

2.4 Related Work of 3D Scanner Apply to Fine art Conservation

The publication, named “3D LASER SCANNING OF HISTORIC MOLDS FOR DOCUMENTING THE RICHARD-GINORI FACTORY COLLECTION” described the use of 3D laser scanning to deliver the virtual models from mortar piece molds of the Richard-Ginori porcelain production line which is in Sesto Fiorentino, Italy as the portion of a long term extension to record the artifact of the plant counting porcelain form, models in wax, earthenware, and mortar and a few thousand mortar piece molds dating from the mid-18th to the early 20th century. The tedious process can adjust the maintenance of the molds. The Giant is the name given to the virtual reconstruction using a 3D laser scanner which was registered to a set of plaster molds for a statuette call. The comparison of the virtual reproduction to the first model in earthenware appears that it was a relentless copy. (Balleri, Di Tondo, Adembri, & Gherardelli, 2014)

Another publication, named “3D Reconstruction of Incomplete Archaeological Object Using a Generative Adversarial” also mentioned that the method of this study is to require a 3D filter of a broken object as input and foresee the total object as a return result. This could precisely recuperate an object structure, indeed in the case where the lost data represents more than half of the input-possessed voxels. Some situations when the unexpected objects might be reconstructed while the test is done using the real archaeological objects. As archeological objects can be incredibly contrasted, the organization is conditioned on a variable that can be a culture, a locale, or any schema of the object. The technique used in this study can recuperate most of the data from damaged objects, even in events where more than half of the voxels are lost. (Hermoza & Sipiran, 2017)

In addition to previously mentioned, the publication entitled Jamestown Rediscovery mentions about 3D technology” extended the explanation to the missing pieces to enhance the museum experience. This mission aims to make the total artifacts, pottery shards by applying the 3D scanning technique mentioned above. Then, the 3D scanning is used to scan on the pottery and model the missing pieces digitally then reproduce the fresh created pieces digital into embodied form by supplying 3D printing. (Enhance, Museum, Challenge, & Process, n.d.)

The paper named “Methodological development in 3D scanning and Modelling the archaeological French Heritage site: the bronze aged painted cave of “Les Faux” Dordogne (France)” introduces the new advancement through the various experiments worldwide of ecology. In that composition: the 3D model of the cave constitutes the general work support and the most perfect way for scientific means for the different studies tested on the locations by approximately forty researchers. Given the specific context, a partnership among archeologist and surveyors, from INSA Strasbourg permit the group to build a newly invented technique of information obtaining based on contact-free measurement procedure in arrange to secure 3D documentation. This work is conducted in compliance with the assumption that the site is fair. By the way, the different methods using terrestrial laser scanning, digital photogrammetry, spatial imaging system have been employed to render the geometric and photo-realistic 3D model from mixing of locations cloud and photogrammetric image for both visualization and accurate documentation aiming. Some different scales of procuring and jumpers resolutions have been connected agreeing to the subject: worldwide volume cave, parietal representation, deposits... the point of this article is to of the articulation of the distinctive 3D innovation tried in this exceptional location and the integration of attractive estimation within the model. (Burens, Grussenmeyer, & Guillemin, 2014)

Depending on the fruitful of overworks in applying 3D scanning to fine art conservation, it illustrates that 3D scanner has a vital part within the utilization of the fine art of conservation section. Therefore, this study brings to a successful issue of the 3D scanner to apply in art conservation by scanning the art object for object identification instead of using a camera.

CHAPTER 3
RESEARCH METHODOLOGY

This study is focusing on "Applying 3D Scanner to Fine Art Conservation", which aims to study the technique 3D scanner for using in the conservation field and develop the manual of object conservation by using the technology of 3D scanner. This chapter is going to demonstrate the research methodology.

3.1 Data Sources

This research will use the data that collect through other research papers relevant to 3D scanner use in fine art conservation. Those important data are cited from journal papers, books, newspapers, reports, thesis, and other research works

Importantly, this research will consult with specialists who specialize in various skills such as:

1. Mr. Panjai Tantatsanawong, associate professor of Computing department, Faculty of Science, Silpakorn University
2. Mr. Surapol Natapinto, associate professor and former dean of archaeology faculty at Silpakorn University.
3. Mr. Surat Lertlum, remote sensing, and geographic information systems.

3.2 The Material of the Study

3.2.1 3D Scanner

The 3D scanner is a device. It can analyze a real-world object to collect data on its shape. Then, collected data can be used to construct digital three-dimensional models. There are many types of 3D scanners. One of them, SCANIFY F3D2001 is selected to use in this study.

SCANIFY is a handheld, point-and-shoot 3D scanner built to enable consumers and professionals to 3D scan objects in high-resolution shape and color in a tenth of a second.

Software-SCANIFY comes with Fuel3D Studio software, which allows scanning to be manipulated and exported to popular file formats for 3D printing and on-screen application (STL, OBJ, PLY). (*Studio 2*, n.d.)

Figure 9 SCANIFY FUEL3D
Source: https://www.amazon.de/FUEL3D-SCA109-Scanify-3D-Handscanner/dp/B00PBUL04O

3.2.2 Art Object

Three art objects are selected to study: Hand Axe, pottery, and ancient cannon bullet.

3.3 The Procedure of the Study

In order to get the 3D digital file of the art object, those art objects are scanned by using SCANIFY then export to those 3D digital files. The final 3D digital file is copied to the archive table of object identification in point of "3D digital".

Table 2 Object Identification

Object Identification	
Title	
3D Digital	
Date/ Period	
Dimension	
Object Type	
Maker	
Inscription and Making	
Disfiguring Feature	
Short Description	

3.4 Timetable of the study

This study will take time four months which starting from May to August 2018.

Table 3 Timetable of Study

Main Activities	May to August 2018			
	May	June	July	August
Collect the relevant data	✓			
Object Scanning practicum		✓		
Analysis data			✓	
Conclusion and presentation				✓

3.5 Object of identification form

In Conclusion, the study of the applied 3D scanner to fine art conservation mainly focus on the practice of using the 3D scanner, discussion with other relevant research paper such as object identification, and consult with the specialist in term of 3D technologist and historical art field. Importantly, the result will fulfill this below archive table.

Art Object 1: Hand Axe is created from stone.

Table 4 Object Identification of Hand Axe

Object Identification	
Title	
3D Digital	
Date/ Period	
Dimension	
Object Type	
Maker	
Inscription and Making	
Disfiguring Feature	
Short Description	

Art Object 2: Pottery is created from Ceramic.

Table 5 Object Identification of Pottery

Object Identification	
Title	
3D Digital	
Date/ Period	
Dimension	
Object Type	
Maker	
Inscription and Making	
Disfiguring Feature	
Short Description	

Art Object 3: Ancient canon bullet is created from iron.

Table 6 Object Identification of Cannon Bullet

Object Identification	
Title	
3D Digital	
Date/ Period	
Dimension	
Object Type	
Maker	
Inscription and Making	
Disfiguring Feature	
Short Description	

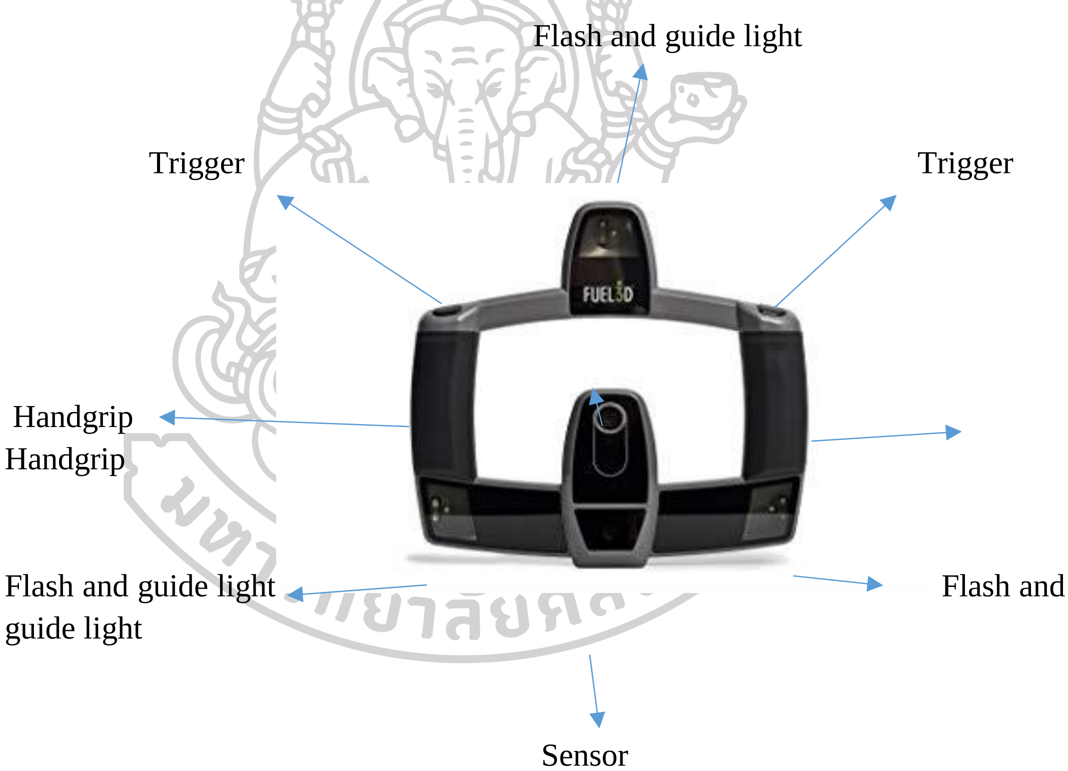
3.6 Scanning Program and the Art Objects

SCANIFY is a handled, point-and-shoot 3D scanner built to enable consumers and professionals to 3D scan objects in high-resolution shape and color in a tenth of a second. Software-SCANIFY comes with Fuel3D Studio software, which allows scanning to be manipulated and exported to popular file formats for 3D printing and on-screen application.

Three art objects are selected to scan: hand axe which is created from rock, pottery which is created from ceramic and cannon bullet which is created from iron.

Figure 10 Hand axe, Pottery, and Cannon Bullet

Scanner Overview



3.6.1 Set up the material

To begin setup, connect the scanner to the computer via the Micro USB cable. The scanner will also need to be connected to a power outlet. The right LED on the rear of the scanner should light up blue when it is receiving power.

A hand axe is selected to scan.

Figure 11 Hand Axe

Before a scan can be taken, a project must be selected. To create a project, select the '+' icon within the 'active project' pane. This will open the new project... 'dialog'.

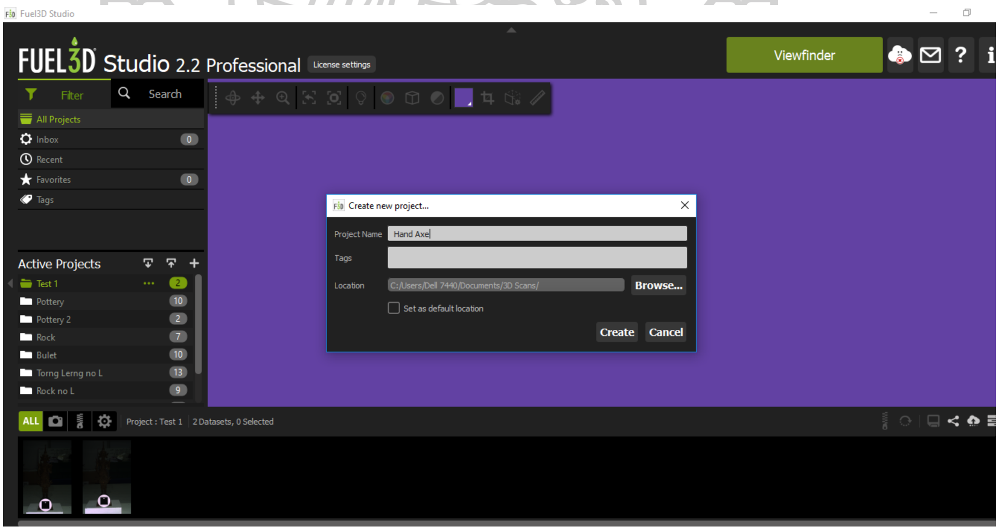


Figure 12 Interfaces to Create Project

.

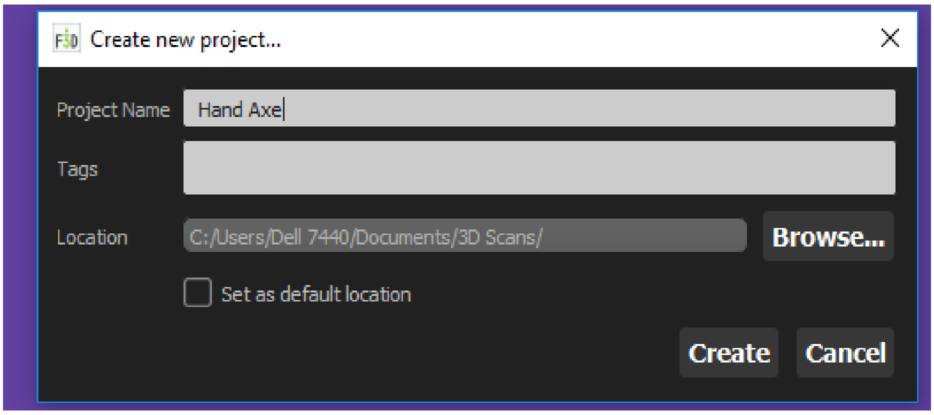


Figure 13 New Project

Within this dialog a name can be set for the project, tags can be set to improve the filtering option, and a save location should be seat. All scans taken whilst in this project will be stored within the save. All scans whilst in this available. Each scan dataset maybe around 30MB in size.
It is possible to change the project name or any tags after a project has been created by right-clicking on it in the project list pane and selecting "Edit".

3.6.1.1 The viewfinder

Click on the "viewfinder" button, located in the top right of a studio, to open the viewfinder dialog. The Viewfinder displays a live preview of what is being viewed by the scanner and it will help with aligning the scan art object. The viewfinder button becomes active once a scanner is attached to the PC running Studio.

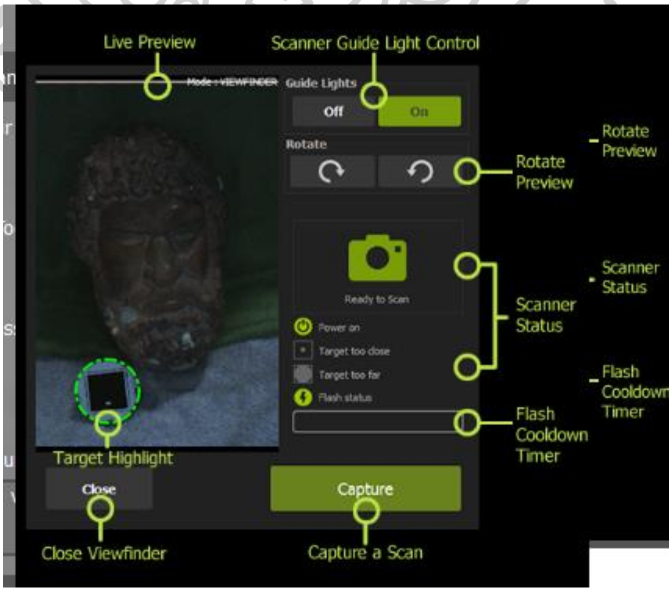


Figure 14 the Viewfinder Display a Live

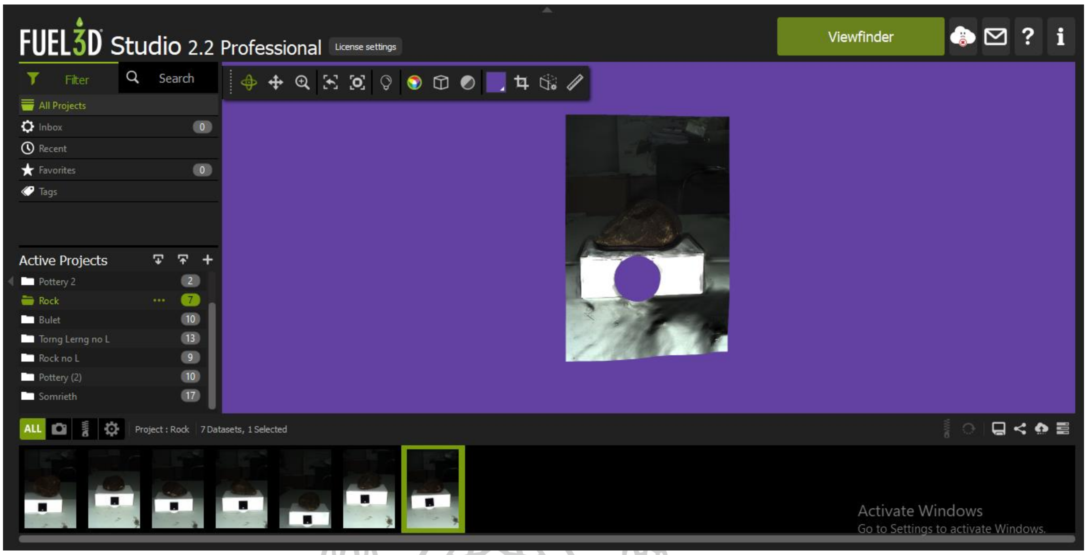


Figure 15 Hand Axe Scanning

3.6.1.2 Capturing

To take capture the target is required to be in view of the scanner.

The target plays multiple roles. It allows for images to be aligned accurately is used to help selecting the correct distance from the subject. The correct range for use with the scanner is 37cm. The target will highlight green when the scanner is within this correct range. It is then possible to press either trigger to take capture or click on the "Capture" bottom of the Viewfinder window. The Captured scan will begin processing in the project's item list panel at the bottom of the screen. Once a scan is captured there is a cool-down period of 30seconds before it is possible to take the next scan.

LEDs Indicator

The right LED will illuminate while the scanner is receiving power. The left LED will illuminate when the ViewFinder is running on the computer. The top and button LEDs can be used to help track the target by providing feedback on when the scanner is in range. To activate the tracking LEDs the trigger button must be half-pressed. When the scanner reaches the correct range from the target then all LEDs will light up. If the bottom LED flashes the scanner must be moved away from the target. If the top LED flashes the scanner must be moved closer to the target

Figure 16 The scanner away from the target, the bottom LED flashed

Figure 17 The scanner close the target, the top LED flashed

Figure 18 When the scanner reaches the correct range from the target then all LEDs will light up. All LEDs light up the scanner is ready to scan

3.6.2 Viewing the Scan

Opening a scan

To open a scan, a project which contains scans must be selected. All scans contained within that project will then be displayed in the item list panel. Select a scan to view it in the 3D viewer by clicking it.

Selecting a scan will load it into the 3D view area. This allows for visualization of the scan as well as other advanced operation that can be used before exporting a scan.

The scan can be controlled by using the mouse and/or keyboard. It is possible to rotate the scan with the left mouse button. Hold down the right mouse to pan the scan. Scrolling the middle mouse zooms in and out.

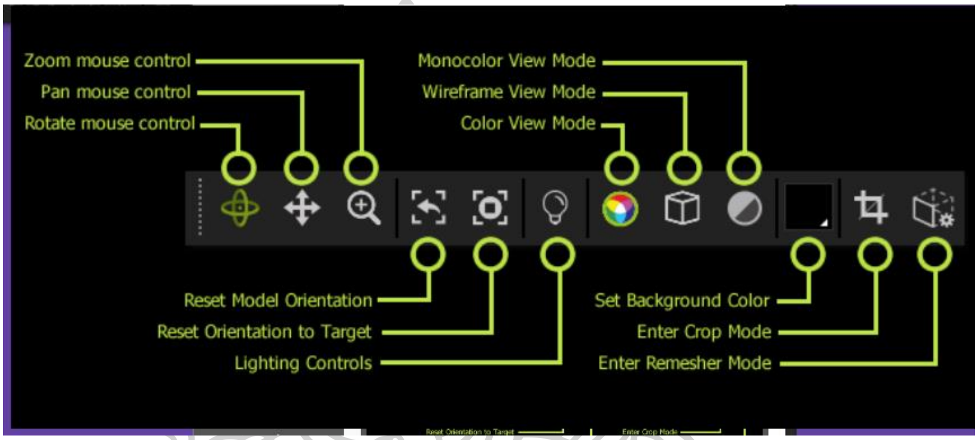


Figure 19 3D Viewer Tool

3.6.2.1 Exporting the Scan

A scan can be exported by clicking the ‘export’ button in the lower right pane. This will open the export dialog. A directory must be set to export set and a filename must be set. It is also possible to export in one of the available formats, OBJ, PLY, or STL. Selecting OBJ or PLY opens the option to allow the exporting of color information as normal. Selecting multiple scans in the item list and selecting export will export all of those scans to the selected folder.

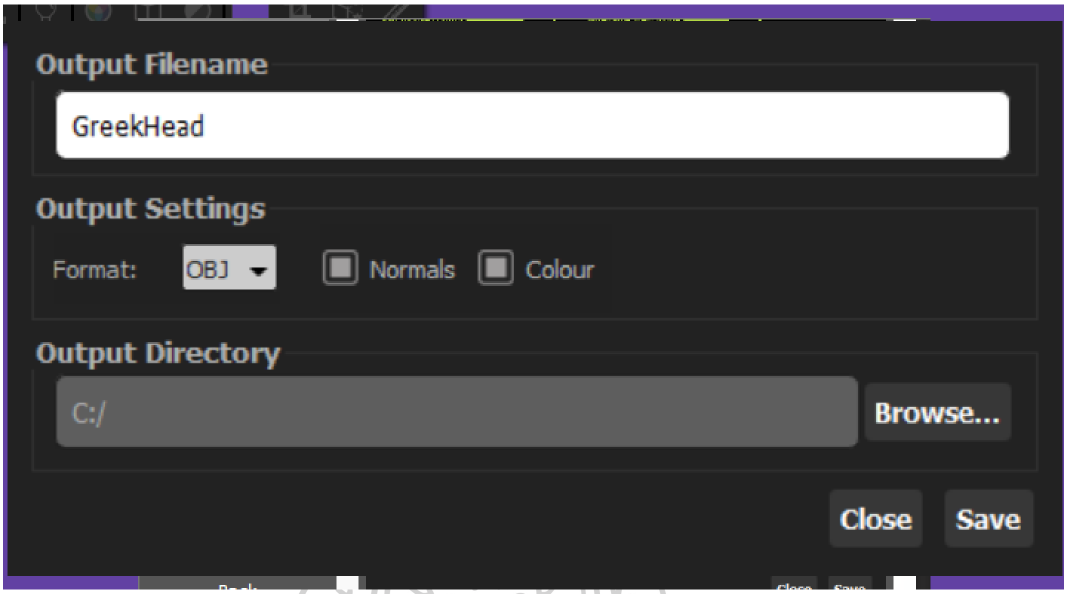


Figure 20 Export the Scan

3.6.3 Cropping the scan

3.6.3.1 Entering cropping mode

To enter cropping mode a scan must be open in the 3D viewer. If a scan is open the ‘Crop Mode’ button will be active. Click it will open the Crop Manager.

It is also possible to enter crop mode when in stitching. To do so, however over a scan in the scan tool and select the crop icon.

Figure 21 Cropping Toolbar

3.6.3.2 The crop manager

It is possible to create two types of crop-zone. A positive crop zone will cut away areas of the scan that are not contained within the selected area. A negative zone will cut away the selected area. This may be useful to remove the target from the scan. An unlimited number of crop zones can be created within a single scan, however, a negative crop zone must be placed on top of a positive crop zone.

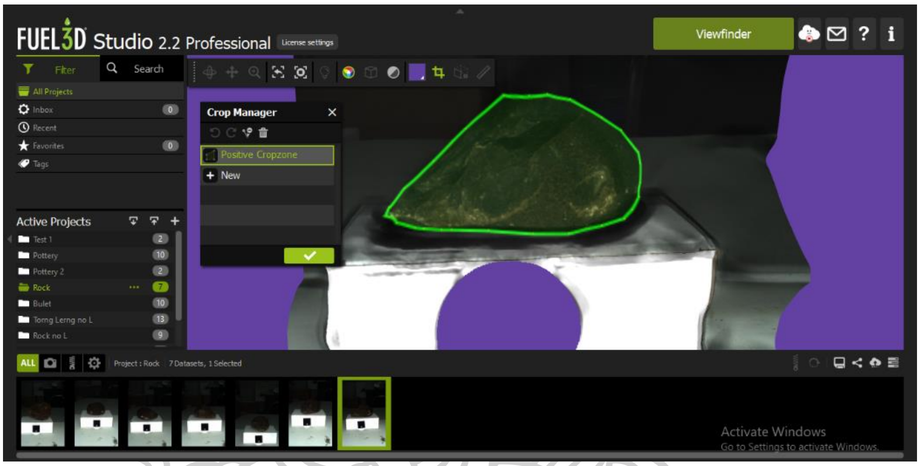


Figure 22 The Scan Cropping

3.6.3.3 Creating a selection

To create a selection of a crop area, a crop zone must be selected within the crop management. If no crop zone is available select ‘New’ and then select ‘Positive crop zone’. The point can then be placed upon the scan by clicking on it. Place points around the area to keep. If a mistake is made it is possible to remove a node by right-clicking and selecting ‘Delete Node’. Nodes can be moved by dragging.

When finished, confirm the selection by clicking the green check button. This will then close the crop, the crop manager, and display the cropped model. Cropping aims to remove bad data that is not required for exporting, remeshing or stitching.

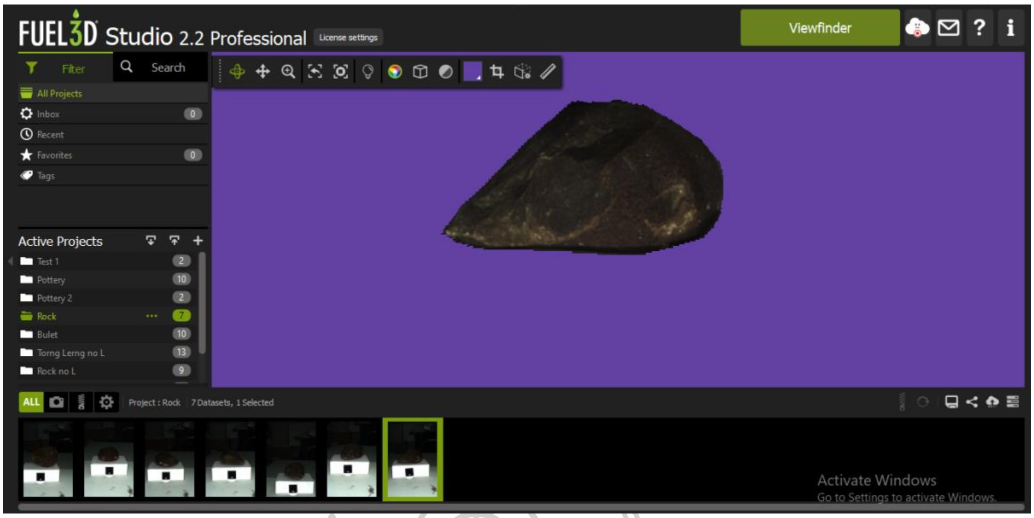


Figure 23 The Scan Cropping

3.6.4 Remesher Tools

To enter remesher tools, a scan must be open in the 3D viewer. If a scan is open, the option to select 'Remesher Mode' is available. Select the button from the toolbar to open the Remesher tool dialog.

3.6.4.1 Remesher tools

Select one of the remesher buttons to set the variables and apply the operation to the scan.

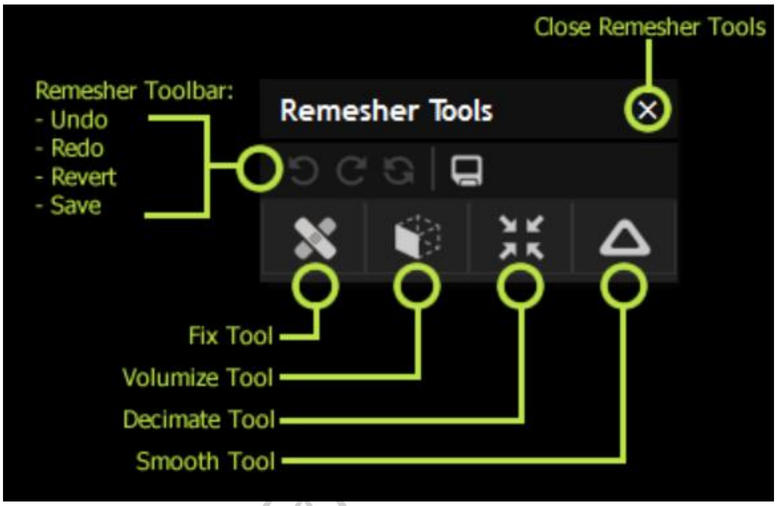


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Figure 24 Remesher Tools

3.6.4.2 Fix tool

The fix tool will fill holes in the open mesh as well as smooth the outer edges. It's recommended to do this before creating a volume. Setting a higher minimum hole size will be a larger hole. This value is the maximum number of edges the system decides is considered a hole. A higher number of smoothing iteration will create a smoother edge; however, setting this too high may remove a larger amount of vertices and edges around the edge of the mesh.

3.6.4.3Volumize tool

The volume tool will create a fully enclosed model which makes it possible to better 3D print the model or the model for use in other 3rd party software. Once a scan has been given a volume it is no longer possible to use the fix for volumization tool unless the scan is reverted or undone to a previous unvolumization state.

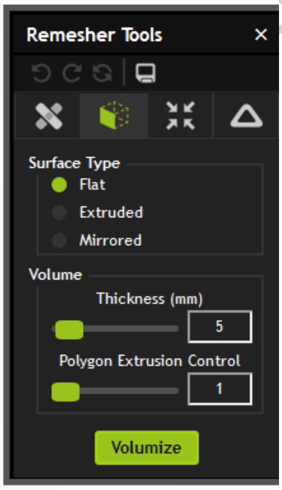

Figure 25 Volumized Tool

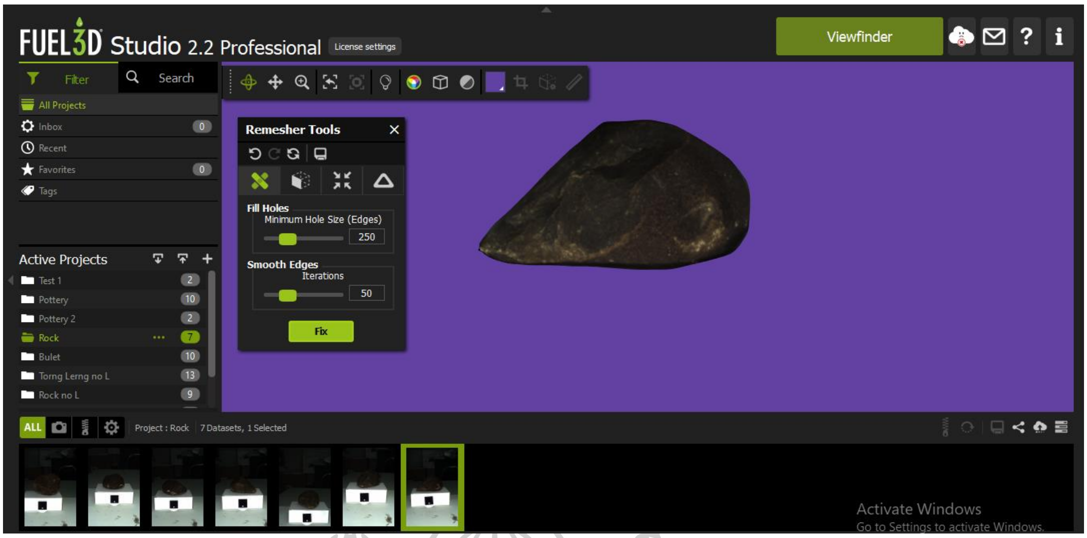

Figure 26 Afer Remeshing

Selecting a surface type will change the type of volumization that is applied to the scan. The flat will provide an output with a flat back. Extruded will apply a copy geometry to the rear and flip it inside out. Thickness applies a distance in millimeters from the front mesh to the rear mesh. Polygon extrusion control dictates the number of vertices that are generated within the volumized area. Selecting a surface type will change the type of volumization that is applied to the scan. The flat will provide an output with a flat back. Extruded will apply a copy geometry to the rear and flip it inside out.

Thickness applies a distance in millimeters from the front mesh to the rear mesh. Polygon extrusion control dictates the number of vertices that are generated within the volumised area. Setting a value of ‘1’means that the front face will be joined directly to the rear face.

3.6.4.4 Smooth tool

Smoothing attempts to even out the overall geometry of the mesh.

Selecting a higher number of iterations will result in a smoother mesh surface.

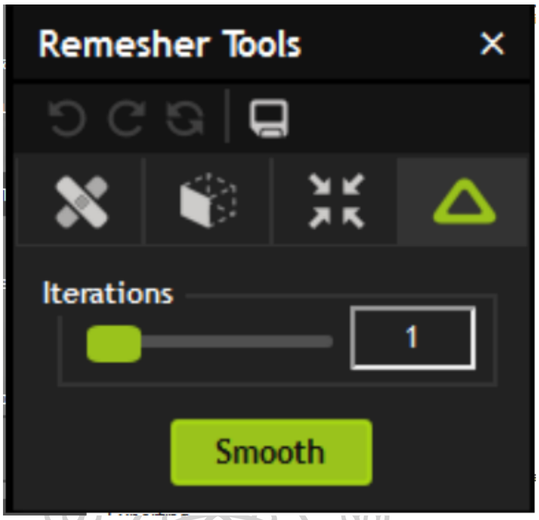

Figure 27 Smooth Tool

3.6.4.5 Exporting

A scan can be exported, with remesher tools applied, by clicking the ‘save’ icon. This will open a dialog to select an output folder. It is possible to save the model in PLY, STL, or OBJ. Selecting the OBJ format will also export the texture information.

3.6.5 Stitching

3.6.5.1 Creating stitch group

To create a stitch group, select each scan to be stitched together in the item list panel. This can be done by dragging over the scans or selecting each by holding CTRL and left-clicking. Right-click on one of the scans and select ‘Registration and Stitching ‘, or select the registration and stitching button from the right-hand menu of the item list panel. Creating a stitch group will prompt the entry of a name for the group. A new item will be added to the item list, a registration and stitch group, this means that it is possible to re-enter that stitch group even after closing the studio. This item will be opened automatically and each scan in the stitch group will begin loading in the 3D viewer.

On the right side of the 3D viewer, a new panel will have appeared that contains all scans within the registration and stitching item. These are currently located in the ‘Ungrouped Scans’ panel, where all un-stitched scans will first appear.

There is also a toggle for alignment mode, automatic mode should work well for when there is enough detail between each scan which the system will be able to align correctly with. Hovering over a thumbnail in the stitch group panel will display additional options for cropping, hiding the scan, and removing the scan from the stitch group.

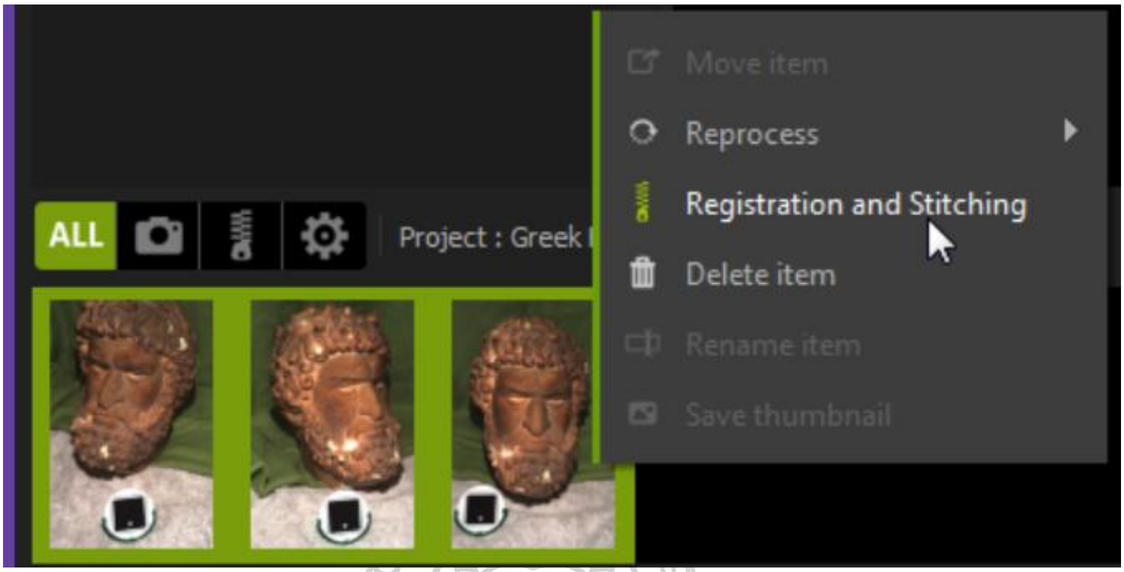

Figure 28 Creating the Stitch Group

3.6.5.2 Cropping your scans

Before aligning your scans it is important that all scans have been cropped to remove any bad data. Bad data can be seen best when viewing scans in Monochrome view mode. Bad data is anything that does not appear to have been captured correctly, such as pulling at the edges, and the target will be cropped out also.

The alignment of scans depends on how accurate the underlying data is and how each scan can relate to the other. Large, flat surfaces with no distinguishing features will struggle to align correctly.

3.6.5.3 Aligning the scans

To begin aligning drag one scan on top of its matching pair and then release the mouse. This will create the stitch group for that particular scan and the system will begin aligning those models. Keep aligning more scans by dragging each on top of the matching pair from the “Ungrouped Scans” to the “Stitch Group”. Many scans can be aligned together. The more scans that are added to a registration and stitching item the more system and graphical memory will be required.

3.6.5.4 Completing the stitch

Once all scans are aligned select the “Stitch” button within the stitch group panel. The scans within that stitch group will then enter a fine alignment process to improve the overall alignment.

A dialog will then appear which requires you to select whether you want the meshes to be stitched as a volume or a surface.

3.6.5.5 Inspecting and exporting

Once you have chosen your stitch type click the accept button. The aligned scans will be processed and reconstructed; the output will then be displayed. It is possible to export the reconstructed model as PLY, OBJ, or STL, Selecting the cross will return back to the stitch group. Color data is not currently available when reconstructing a mesh.

3.7 Art Object

3.7.1 Hand Axe

Hand Axe might be the common tool of the Stone Age. It is made of prehistoric stone. The stone tool is selected to study with aim of understanding the cultural indication of tool use and manufacture. It is found out that prehistoric stone was used to make a variety of different tools and weapons throughout histories such as arrowheads, spear points, hand axe, and querns to grind cereals in flour. In addition, a hand axe is used for cutting meat and skinning, and for scavenging. It was possibly used for throwing at animals to kill or injure them while hunting.

The hand axe is a very useful tool which it is the oldest tool in existence, almost 2 million years old. The earliest type of hand axe is called the “Acheulean Hand-Axe” and it is from the Paleolithic age, the oldest part of the Stone Age. Moreover, the hand axe was made from different types of hard rock, like flint, obsidian, and granite. The hand axe had sharp tips on it when the later Stone Age people learned how to make sharp-edged on them through a process to reduce to a small piece from the surface.

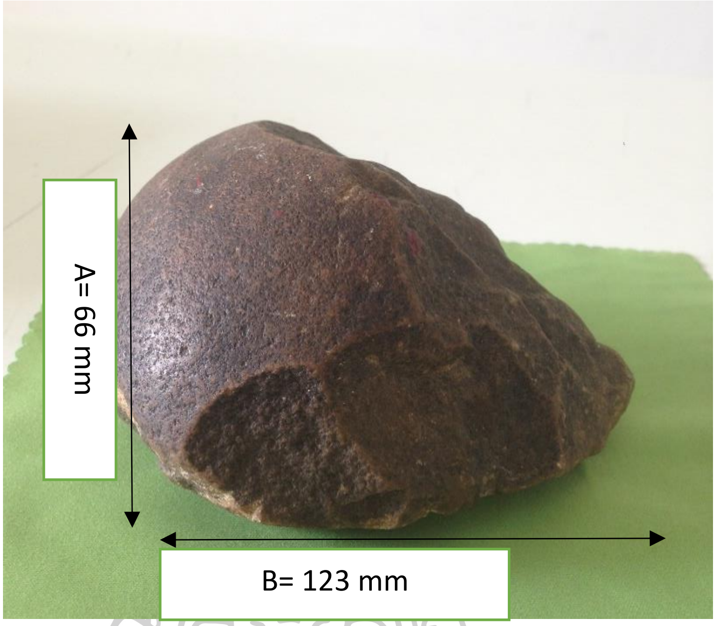

Figure 29 Hand Axe

3.7.2 Pottery

Pottery is the processing of forming clay with water and other materials into the object of the desired shape and heating them to high temperatures (1000-1600 °C) to be hard and durable. Many potteries are purely utilitarian, but many can also be regarded as ceramic art. A clay body can be decorated before or after firing. There are three main majors sources types of pottery that are created; earthenware, stoneware, and porcelain. Pottery is one of the oldest human creations, originated in the age stone such as the ceramic object Doni Vestonice found in the Czech Republic dating back to 29 000 -25 000 BC, pottery vessels that were found in china in 18 000 BC, pottery artifact is found in Japan in 10 500 BC, in Russia in 14 000 BC. Pottery is commonly used to serve food, beverage, and water.

Figure 30 Pottery

3.7.3 Cannon Bullet

The Ancient Cannon was created in China in the 12th Century by developing from firework which was the popular amount Chinese that used in the religious ceremony of their beliefs. The first use of ancient cannon is in China in 1132 BC in terms of the military mission. In the 14th Century, the use of this weapon was spread to states of South East Asia such as at the end of the Angkor period and Ayutthaya as well.

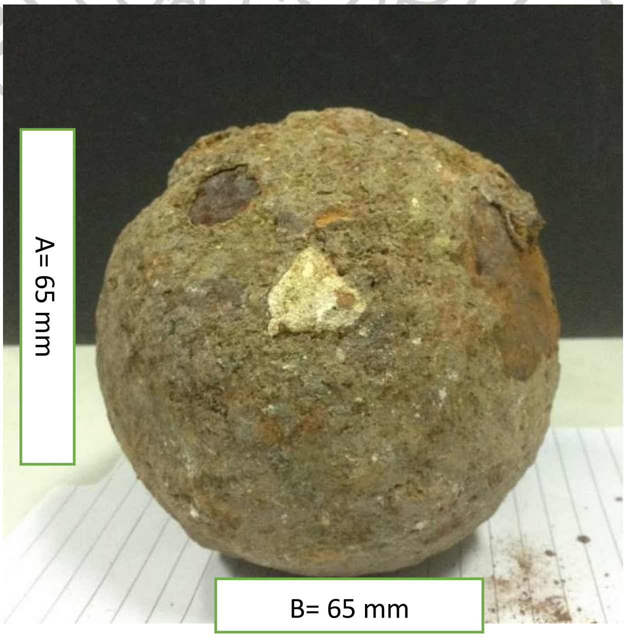

Figure 31 Cannon Bullet

CHAPTER 4
RESULT AND DISCUSSION

4.1 The result of art object scanning

In conclusion, the study of the applied 3D scanner to fine art conservation mainly focus on the practice of using the 3D scanner, discussion with other relevant research paper such as object identification, and consult with the specialist in term of 3D technologist and historical art field. Importantly, the result of this will fulfill this below archive table.

4.1.1 Hand Axe

Art Object 1: Hand Axe.

Table 7 Object Identification of Hand Axe

Object Identification	
Title	Hand Axe
3D Digital	
Date/ Period	Early prehistory
Dimension	12mm 66mm
Object Type	Stone tool
Technique	knapping
Maker	Unknown (human in prehistory)
Inscription and Making	This is a hand axe that was found at Kanchanaburi province and stored at the lab of the archeology faculty of Silpakorn University.
Disfiguring Feature	Good condition
Short Description	Hand axe is the common tool created from stone which is used in the daily life of humans in various functions; hunting, cutting meat, skinning animals in the stone age.

4.1.2 Pottery

Art Object 2: Pottery is created from ceramic

Table 8 Object Identification of Pottery

Object Identification	
Title	Pottery
3D Digital	
Date/ Period	2017
Dimension	Height: 93mm, Width: 65mm, Width: 114 mm
Object Type	Plows pot
Maker	Ceramic factory in Chantaburi Province
Technique	Molding
Source	Ban Tao Mao, Chantaburi province
Inscription and Making	No inscription
Disfiguring Feature	Good Condition
Short Description	Pottery is commonly created from clay with water to form into the object. Then it is fried till be durable at the high temperature. Besides art function, pottery is normally used to serve food, beverage, and water.

4.1.3 Ancient Cannon Bullet

Art Object 3: Ancient Cannon Bullet which is made from Iron.

Table 9 Object Identification of Cannon Bullet

Object Identification	
Title	Ancient Cannon Bullet
3D Digital	
Date/ Period	17^{th} -20^{th} century A.D early
Dimension	Height: 65mm, Width: 65 mm
Object Type	Icon cannon bullet/ round shot
Technique	Casting
Maker	Unknown
Inscription and Making	No inscription
Disfiguring Feature	It was been a long time in the ground which causes the rust surrounding its surface.
Short Description	Ancient cannon bullets is firstly made in China in the 12^{th} Century. Then this weapon was spread to use in the state of South East Asia in 14^{th} in military activities or war.

4.2 The Contribution of the 3D scanner to conservation work

According to the table of object identification which are listed the main categories; title, 3D digital scan, period, dimension, object type, technique, maker, inscription and making, disfiguring feature, and short description, these are very important tools to the inventory of art object, item, or collection in the database of museum work, conservation work, and other relevant works. In this way, there are two points; 3D digital, and dimension in the database of inventory which a 3D scanner is capable to make it. As a result, this study observed and found that the 3D scanner has an important role to contribute in fine art Conservation's work in various functions such as; measurement the object, 3D digital scan, and reconstructing the incomplete object.

4.2.1 Measurement of the object

Measurement of the object is a necessary point in object ID or documentation of artifacts' collection because this information tells what are the measurement and unit of measurement of the object which are height, width, depth, and diameter. This is a common practice in the identification of art objects. In this way, the scale and ruler are used to measure directly on the object. Base on the study and experiment of using the 3D scanner. A 3D scanner is a modern tool that is used to scan the object as 3 dimensions and it is possible to measure the dimension by its function without using the ruler or the scale. Fuel 3D scanner has the tool of its function to measure the scanned object which are length, contour length, Multi-segment length, and area. In order to enter the measurement tool of the Fuel 3D scanner, a scan has to be opened in the 3D viewer and the measurement tool will show on the 3D scan and click on it. This will show the phrase "Measurement tool" and select on the function and dot two points on the 3D scan it will show the result of the measurement with the millimeter unit.

Additionally, Sung Tra, archive manager in Cambodia who has been more involved in the conservation work mentions 3D scanners can help conservators in terms of measuring the object. Normally, when a condition report has been created the size of the object must be measured with the ruler. But, with the modern technology of 3D scanners, it is capable to measure the object by itself. So the function of the measurement tool of the 3D scanner has contributed to art conservation work.

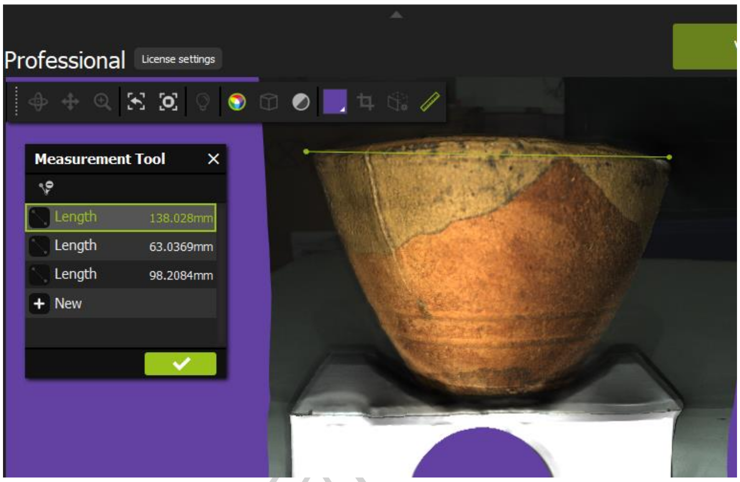

Figure 32 The Length of the Pottery: 138.028 mm

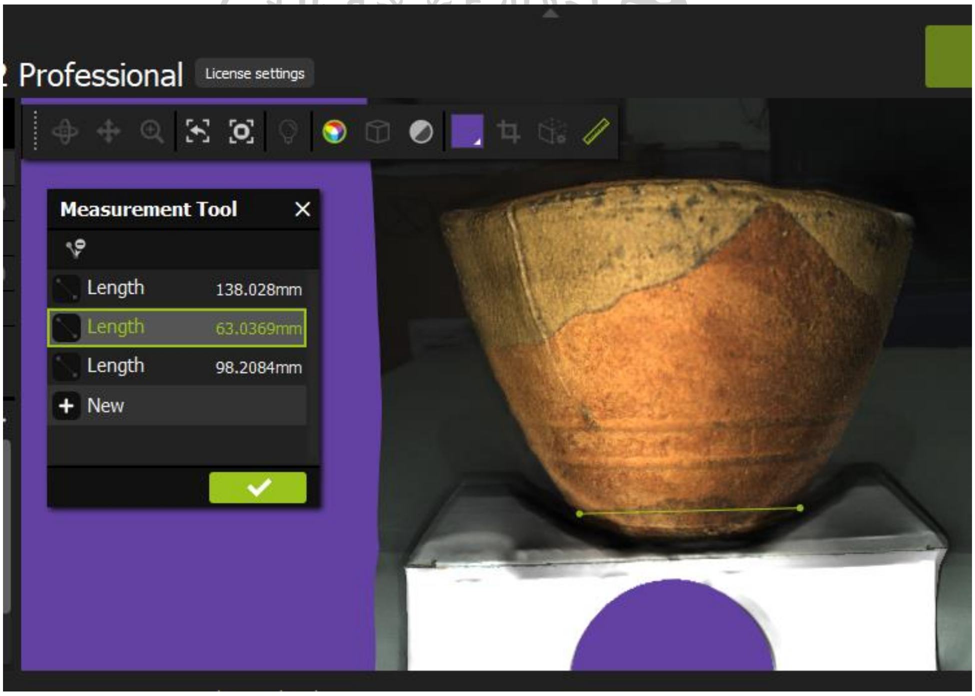

Figure 33 The Length of the Pottery: 63.06 mm

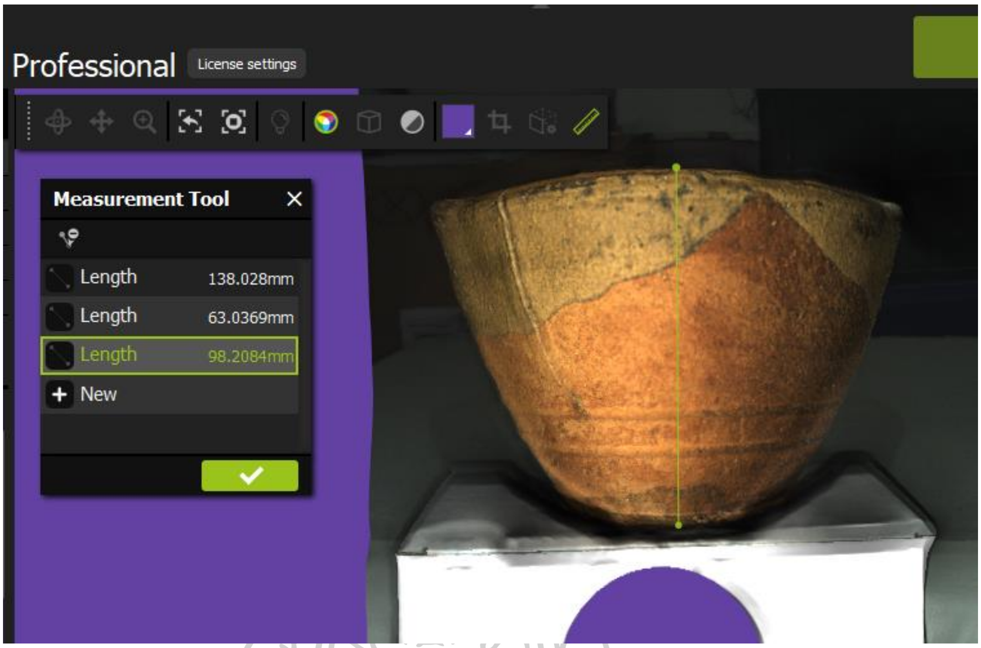

Figure 34 The High of the Pottery: 98.2 mm

4.2.2 Digital of 3D Scan

In order to conserve the object or archive the database, photographing the object is commonly used. This helps in identifying the object when it is stolen or lost. Photographing can also reduce the need to handle fragile objects and prevent unnecessary damage. Particularly, 3D scanning can be used to replace the photographing that is the most significant dimension that it can be viewed as the 3D form that shows all sides of the object to identify livelily. This can be archived in the form of a detailed digital 3D scan that also contains precise information about the physical data of an object. Most scanning images are viewed in black and white or with color-coding for design purposes and they can also contain true color. As a result, 3D scanning is most useful for documentation, archiving databases, and documentation. Sung Tra, archive manager in Cambodia who has been more involved in the conservation work mentions 3D scanner is a very important tool that can help conservation work. The first one is when the conservators do the condition report of the art object they have to document the information and condition of those objects. So if the object can be scanned it will provide us high quality of the 3D scan and we can view clearly of color or damaged part of the object. So, in the database or documentation of art objects, digital 3D scan has an important role that can be replaced photographing.

4.2.3 Reconstruct the incomplete object

In order to find out the original shape of the fracture of the object, a 3D scanner can estimate the complete object. The 3D scanner is used to scan fracture objects as input and prognosticate the complete as output. This can recover an object structure, even in the case where the missing information represents more than half of the input occupied voxels. When the real archaeological objects are tested, some cases of unexpected objects are reconstructed. As archaeological objects can greatly differ between them, the network is conditioned on a variable that can be a culture, a region, or any metadata of the object. This method can recover most of the information from damaged objects. Chea Sok, the conservator in Cambodia, mentions a 3D scanner is an important tool with modern technology that is useful for documentation, inventory, or storing in the archive database of a digital art object. He added that a 3D scan provides high quality and high resolution of the 3D archive which it can be viewed the full surface object and many sides of the shape. Importantly, the 3D scan can be used to find out the missing information of fracture objects that original format can be predicted or reconstructed after scanning. For example, the missing carving on the wall is scanned by the 3D scanner and 3D scan is capable to predict the original form of the object before it is damaged.

To sum up, the ability of a 3D scanner is to precise data from objects that can be used to carry out a variety of procedures and applications. The list and description of the ways of the 3D scanner are being used in art, archaeology, and conservation which this study found are very important and helpful points for applying in art conservation; measurement the art object, digital 3D scan, and estimate the incomplete object.

CHAPTER 5
CONCLUSION AND SUGGESTION

The arms of this research are to study the technique of 3D scanner for applying in the conservation of fine art which there are two objectives; the first objective is to study the technique of 3D scanner for using in the conservation of fine art, and the second objective is to get better understanding the benefits or limitation of the application of 3D scanning technology in the conservation of archaeological artifact which is a type of art objects. To reply to these objectives of this study, there is three types of art objects (Pottery, hand axe, and cannon bullet) are selected to scan with a Fuel 3D scanner.

This study found that a 3D scanner is an important technology among documentation and analytical technique used for the art object conservation field. The 3D scanner is capable of photography and structural imaging including radiography, computed tomography, colorimetric, and other measurement techniques. Moreover, it is a part of the digital record of art object collection for documentation, archive, research, and publishes accessibility. It isn't only relatively new, highly precise measurement tools, but the system of the 3D scanner also provides high quality, the high-resolution 3D archive of object's surface topography with measurement accuracy to the sub-millimeter level. Additionally, it allows measurement of the surface geometry, texture, and volume of the most objects. Shortly, a 3D scanner is a device that can analyze a real-world object to collect data on its shape. Then, collected data can be used to construct digital three-dimensional models, and it has an important role to document the physical and information of art objects.

According to the table of object identification which are listed the main points; title, picture, period, dimension, object type, technique, maker, inscription and making, disfiguring feature, and short description for the inventory of art object, item, or collection in the database of museum work, conservation work, and other relevant works. Among these, there are two points that 3D scanner can help to complete the database which is digital 3D archive, and measurement the dimension of art objects. At the point of "Picture" in the list of object identification, a 3D digital archive is very necessary to complete this point that it is the most significant dimension that can be viewed on all sides of the object scan with high quality. This can be replaced by the photograph which is normally attached in documentation or database archive. In addition, the Fuel 3D scanner is capable to measure the art object with its function during the scanning. This point is very useful because all art objects have to know the dimension when they are listed in a database or document. The capacity of a 3D scanner; measurement of the art object and digital 3D scan are very crucial points which these work can contribute to the fine art conservation work. In conclusion, the 3D scanner is a very good tool for applying in use for art conservation work which its productions are fulfilled the database and inventory work.

Suggestion the using 3D scanner for fine art conservation

1. In applying a 3D scanner to fine art conversation, the right, and suitable 3D scanner have to be selected which it's the possibility for the art object.

2. The museum, conservation, and cultural institution should have a 3D scanner for practical work. Because it is too much help those works.

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VITA

NAME	HONGRY HUY
DATE OF BIRTH	17 June 1990
PLACE OF BIRTH	Takeo Province, Cambodia
HOME ADDRESS	Takeo Province, Cambodia