Graffiti Photogrammetry, Extracting the Signs from the Walls of the Kyrenia Castle

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Contemporary photogrammetry, with the use of high-resolution sensors and correct shooting procedures, allows getting details far from the common level of perception of the human eye. This can be particularly useful in the use of macro and micro details, but it can be extremely useful also in specific situations when even quite large elements are difficult to be read and interpreted. In the case of the walls with Graffiti in the Kyrenia Castle, Cyprus Island, where a set of representations showing ancient ports, harbours, ships and boats it was extremely difficult to be read in the actual lighting situation. This is also a case study where the lighting situation is not ideal and where some logistic issues have caused the missing of a proper portable set of lights. Thus, with specific solutions, taking care about the shooting technique using state of the art camera and lens (Nikon D800e and 60 mm F2.8 Micro Nikkor), it was possible to take a well-detailed set of images to be used in the creation of an ultra-detailed 3D model of a whole set of graffiti. From this, using 3D rendering and multimedia techniques a set of proper elements has been created for dissemination and teaching purposes, allowing to enhance the perception of these artworks in the waiting for a new and more advanced permanent lighting system. The presentation will bring all the technical data from this case study, the detailed description of the lesson learned, suggestions about how to enhance the results from such a survey campaign and the complete workflow from shooting to multimedia creation/exhibition.

Keywords:
Graffiti, Photogrammetry, 3D model, Multimedia, Museum.

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INTRODUCTION

The Kyrenia ship is the wreck of a 4th-century BC Greek merchant ship. It was discovered by Andreas Kariolou, – a diving instructor – in November 1965 [Katzev 1981]. A mission guided by the archaeologists of the Pennsylvania University recovered all the remains of the hull and various fragments from the nearby area from 1967 to 1969; this operation was coordinated by Michael Katzev [Swiny and Katzev 1973]. These operations represent one of the very first experiences in nautical archaeology. Even if heavily damaged, the relic of the ship still presents enough parts to describe the whole hull and give all the elements needed to hypothesize its reconstruction [Steffy 1985]. After its restoration, in 1970, it was placed inside the Kyrenia Castle [Enlart 1899; Jeffery 1935; Hill 1948; Petre 2010], Kyrenia, Cyprus Island [Katzev 2008]. The room chosen for the exhibition is enriched by graffiti from the 13th century, representing various ships. A quite specific choice that somehow emphasizes both the exhibited elements: the ship and the Graffiti. Thus, the large size of the ship, and the visiting solution, based on a gallery elevated on pillars, reduce the visibility of the graffiti part. The museum, in facts, presents a quite traditional exhibition solution, with the ship placed more or less central to the visitors path, the access to the room is done by the “aerial” gallery, passing in front of the series of Graffiti, which, even if showing a specific story and worth of a certain attention,

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results hard to be noticed and quite unreadable by the people visiting the museum. The present paper, deriving from the Round Table "Round Table: Advances in Image-based 3D Reconstruction and Modelling (SfM/MVS[1])" in the 23th CHNT Conference, Vienna, 2018, presented in the form of a linear description the trouble/problem solving process adopted for this survey, in the hope to give a contribution to others in facing similar situations and bringing back similar positive results.

THE GRAFFITI IN THE CASTLE, A HISTORICAL OVERVIEW

Ship graffiti scratched on plaster or stone surfaces are delicate. Often, they are partially preserved due to environmental factors and careless restoration projects. Their accurate and speedy documentation is highly important for their future, making possible to bring on studies aimed to the understanding of their technical details as well as their interpretation as historical social behavior. The curvature of the buildings, inaccessibility, light conditions (sometimes too strong or too feeble), the presence of multiple graffiti, sometimes over imposed one another or drawn over large areas are all problematic obstacles for the recording of these specific artworks. The technique used in documenting ship graffiti in this test, if compared to traditional methods previously attempted[2] (hand tape measurement, tracing or photography), provided an accurate speedy documentation of a significant sample, in a solution that may be extended to all the 19 ships graffiti, galleys as well as fish motifs, as a whole document, found over a plastered surface measuring up to an height of 4.20 meters from the level of the gallery. The ship graffiti mentioned in this study, by a lucky coincidence, is located on the second-floor level southern wall inner face of the Kyrenia ship wreck's exhibition gallery, which was once the living quarter of the Lusignan (1192-1472 AD) and Venetian (1472-1570 AD) rulers. Generally, dating and identification of the ship type of the graffiti is challenging. However, as they are often on the walls of a building, on castle cisterns or churches, the building they are made on represents the "terminus post quem", the date after which the graffiti were made. Therefore, in this example from the Kyrenia castle, it is possible to give an estimated date standing between the 13th and the 16th century AD. Further studies of the "scene" with nautical archaeologists and medieval historians may provide further interpretation of the ships drawn, defining if they may be considered a part of a historical event or something coming from some sort of casual drawing. At the present state of the arts in the knowledge about these artworks, it is only possible to increase the number of interpretations, while the complete certainty about their vicissitudes seems a quite difficult goal to reach. However, the historic resource of Makarias who mentions galleys reaching Kyrenia in 1374 and attacking the castle is food for the thought [Şevketoğlu 2017: 185] in rising up a possible relationship between an adventurous and dramatic event and the appearance of representations celebrating it.

PRESENT SITUATION

Entering the room dedicated to the Kyrenia Shipwreck, the remains of the boat emerge from the space, the visitors enter passing by a transparent tunnel, walking on a balcony. This U-shaped intervention allows a 180° degrees turn around the wooden structure of the ship, which is illuminated in subtle lighting. Standing behind the glass element from the narrow tunnel is probably not the most comfortable situation. A different approach to the setup of the room will be hopefully a step forward for this museum. By fortunate coincidence in museum design it is possible to read a specific paper presented in this same volume of proceedings [Ceylanlı et al. 2018]. For now, for the visitors, the focus of the attention is the ship. They barely pay attention to any other thing around; the surface of the wall is in most of the cases completely ignored. The lighting on the walls does not help, it is quite homogeneous, flattens down the traces in the plaster while the spotted and mostly brown surface completes the result in making the graffiti quite hard to be noticed.

A DIFFICULT PHOTOGRAMMETRY

During the "Kyrenia Castle Workshop" in 2018 [Bertocci et al. 2018], while taking care about the digital survey of the large Castle hosting the museum [Camiz et al. 2017], the idea about making a specific and "in depth" survey of the ship and of the graffiti developed. For both these operations, photogrammetry turned out to be the better solution in producing a detailed and well working 3D model. Thus, the two interventions came out presenting "not that easy"

[1] Structure from Motion/Multi-View Stereo

[2] Şevketoğlu [2017:185] mentions the difficulty of documenting the graffiti while the balcony and its narrow space causes an obstacle for the overall view and documentation of the ship graffiti.

situations to manage. For the ship the main issue was linked to the very dark (and somewhere shining) colour of the wood (the processing of the data from this survey is now ongoing during this writing and will be presented on a next occasion). The graffiti were presenting a quite articulated set of difficulties in operating photogrammetry; these various troubles should be described as follows:

1. It was a sort of “not expected” intervention, so the tools brought to Kyrenia were not that specific for such a survey, thus the presence of a high-resolution camera equipped with a macro-photography lens, a Micro Nikkor 60 mm F2.8 [Verdiani et al. 2018], turned out as a proper solution in giving a chance to this survey.

2. Proper lighting was missing, the very low, diffuse lighting, not optimized for presenting the graffiti, was a potential problem, forcing into long time exposures, into setting up high ISO values, into stopping down the diaphragm of the lens to wide open, or using a mix of the three above mentioned conditions that are generally well known for reducing the quality of the following results of the photogrammetric processing.

3. The floor of the gallery was quite unstable, or, better, it was enough stable for walking and visiting without feeling literaly “on a ship”, but was not stable enough to avoid movements of the tripod and shaking of the camera when other people were passing by during the visiting time.

4. The U-shaped gallery, passing in front the graffiti is a narrow space, large about 120 centimeters and just in front of a quite high element, a plaster area of variable height presenting graffiti up to three metres from the floor of the gallery. Such a condition causes difficulties for the shooting, forcing the photographer to stay quite close to the lower part and quite distant from the top part, with the result of having a very different effective size of the pixels in the close up and far shots.

5. People keep visiting the area during the shooting: for some reason it was not possible to obtain a stop in the visits for the time needed to take all the pictures, thus it is worth to say that being an “out of program” activity in front of the main survey of the castle, it was difficult to setup the operation for a proper management of the visitors access.

FROM TROUBLES TO CHALLENGES

The premises to this photogrammetric work were not that nice, the many difficulties should drive the idea of a too high level of possibility about losing time and producing only poor results. To go beyond this concerning and get positive about the possibilities, a series of countermeasures were taken. The main set of them can be described as follow:

1. The first one should be defined as just “philosophical”, instead than mumbling about the “not expected” as an issue, the approach was changed moving the situation from a trouble hampering the operations into a challenge, thinking about all the opportunity of success and considering the positive aspects of the tools and skills available.

2. To obtain well usable images the sensor of the camera was setup with medium ISO values (from 320 to 640), exploiting the low noise of the full frame (FX) sensor. The camera in use was a Nikon D800e, (the model with the same sensor of the D800 basic, but with no antialiasing filtering, a technical solution made to enhance the sharpness of the resulting images. The variable setting of the sensor was modified to allow long exposure times limited to two to four seconds speeds, using at the same time a remote trigger and the self-timer setup with 2 seconds of delay, in this way any accidental vibrations caused by the pressure of the shooting button was resolved. Obviously ~~then~~ it was a matter about staying motionless nearby the camera if the exposure time. All the pictures were taken directly in RAW and JPG format, exploiting the option from the camera about saving automatically both formats. Later, in the photogrammetric processing, at first model was developed using the JPG pictures only. The low but homogeneous light, with no need to correct shadow/light issues, the medium to low ISO speeds of the sensor and its minimal noise and finally the excellent quality of the JPG coming from this camera, allowed preferring this format so to speed up the following processing. The RAW format was kept behind for a following processing, yet to be done at the moment of this writing.

4. The lens in use, the Micro Nikkor 60 mm F2.8, is capable to focus at close range (33 cm minimal focus distance) [Erlewine 2011] for this it was possible to operate in the narrow space of the gallery in a more comfortable way, using a quite small tripod, quite light but with a good height, then stopping down from F2.8 to F8.0 accordingly to the positioning of the camera, opening the diaphragm (so to have faster shutting speeds and/or lower sensor ISO settings) when the sensor plane was parallel to the plaster (the scrapes of the graffiti are not deep enough to suffering of out-of-focus issues in this case) and closing when the plane of the sensor was tilted respect the plaster surface (to

allow having a larger “in focus” area with all its pixels fully usable for photogrammetry processing) [Hoddinott 2013]. In all the frontal shots the GSD was typical for close range photography, with a pixel size of about 0.003 cm. As long as it was possible, the shooting was operated moving the tripod and the camera parallel to the wall surface, with about 1/4 to 1/3 overlapping between consecutive frames in horizontal as well as in vertical, when there was no other way than tilting the position to complete the coverage, the overlapping was a little increased, obtaining a reasonable B/D ratio [Stanco et al. 2017] and then augmenting the possibility to find common features between frames.

5. The countermeasure to the stepping on the floor of the visitors was simply keeping a calm and relaxed approach to the situation in the gallery and waiting for the people visiting to pass by. So, in the end this was even useful to learn something more, gathering visitor’s opinions and noticing how much they pay attention to the presence of Graffiti on the walls. In most of the cases they were completely ignoring them, passing by and looking down to the relic neglecting the wall at their shoulders. When advised on looking back, supporting their viewing using the flashlight of their smartphones, the presence of the graffiti was immediately noticed by all of them, their reaction being between interest and surprise, rarely accompanied by questions (thus it is worth of saying that for many of them speaking in English was quite a problem), asking mostly about the age of the artwork and if such a decoration was ancient or not.

POST-PROCESSING OF THE DATA

The following processing was quite a classic one, the set of about 160 pictures taken was checked and reduced to a sub-selection of 144 images, all the (few) shots with excessive shaking blur or focusing defects were removed [Guidi and Gonizzi 2014; Manganelli Del Fà et al. 2015]. . The photogrammetric processing was done using *Agisoft Photoscan*[3], starting from the alignment process, the generation of a dense point cloud (of about 3.3 million points) followed by the polygonal mesh production (setting to zero the decimation and getting a surface of about 13.5 million faces). The photogrammetry model was put in scale using a set of points taken from the 3D laser scanner point cloud produced in the same workshop, the points were connected by a “ruler” then used to receive the same measure read from the point cloud, once applied the model was scaled correctly and aligned in the same coordinates of the 3D laser scanner survey. Then, the mesh was exported to *Raindrop Geomagic Studio*[4], were the geometry was treated for polygon correction, holes capping, decimation (reducing it to 7,500,000 triangles), then imported back to *Agisoft Photoscan* for the generation of the texture on the optimized mesh (this was done producing the texture atlas divided into eight JPG images of 4000 px x 4000 px (=16 Mp).

The resulting textured model was then exported to *Autodesk 3D Studio Max*[5] for the final processing, the production of high-resolution images and of some short animations to show all the graffiti present on the plaster. In the rendering process the two main outputs, both the frontal views and the animations were organized exploiting the artificial lighting to put in evidence the graffiti work. Moving a classic digital “direct light” with parallel projection it was possible to enhance the readability of the graffiti traces. In the animations these lights were moved and turned around the model to allow a better perception of all the details present in the graffiti work. Considering the possible difficulty from some user to recognize all the elements at first and to keep high the attention on the video, during the video-editing phase, for each single graffito, a retracing of all the main carved line was placed in overlay to each boat/ship. This made it easier to display the contents, evidencing elements and details otherwise difficult to read. The retracing was made manually using a vector drawing software, *Corel Coreldraw! X6*[6], operating on a single frame extracted from the animation and then reinserted with a longer duration to allow a “stop” effect with the gradual appearance of the lines of the tracing. The lines were evidenced giving them a light orange colour, well balanced in front of the background and capable to attract attention and leave a certain “persistence of vision” to the observer [Oxon 1899]. The retraced lines were then exported in TIFF format to preserve the transparency of the background and make easier to align/manage them in the video-editing software *Adobe Premiere CS6*[7]. The video, complete with notes about the “making of” for this digital 3D model and animation is accessible in YouTube at a direct link[8]

[3] www.agisoft.com
[4] www.3dsystems.com
[5] www.autodesk.com/products/3ds-max/overview
[6] www.coreldraw.com
[7] www.adobe.com/products/premiere.html
[8] https://youtu.be/Yqw1ZrdWH1A

It is probably the best way to appreciate these graffiti if not visiting directly the Kyrenia Shipwreck Museum in Kyrenia, Cyprus Island, thus, right now, for any visitor arriving there, it is better to have a small flashlight ready to help the reading with the present state of the exhibition.

CONCLUSIONS

At the moment of the writing the production of a high-resolution image of the whole plaster element is ongoing and almost completed. Its main use will be to display the whole set of graffiti from this part to people interested in the subject, with nice potential opportunities for teaching and learning about this specific artwork. This rendering should be used to build up a panel version of the graffiti interpretation and description (for exhibition on-site and/or online viewing and downloading).

Hopefully, in the future it can be foreseen the possibility to go back to the Kyrenia Castle for completing the survey of other parts, that time with some more dedicated tools like a higher resolution camera (about 50 Mp sensor) with wireless remote control and equipped with a more versatile tripod with sliding head and column (so to allow the reaching of difficult points with ease), portable flash lighting system, with soft diffused light, compliant with the preservation of the artwork and excellent in giving faster shutting speeds and possibility of extended depth of field while fastening all the operation by the possibility of operating with the camera handheld for many positions.

At the same time some extra processing can be completed soon on the actual model to allow the production of some 3D printing tests, presenting a partial 1:1, an enlarged detail from some significant part and a reduced version of the whole plaster element. It should be a possible idea to try a complete 3D reconstruction of the represented fleet, maybe something to think about for some future day, aimed to the production of a multimedia presentation oriented to teaching the whole story from these traces belonging to an exciting past.

FIGURES

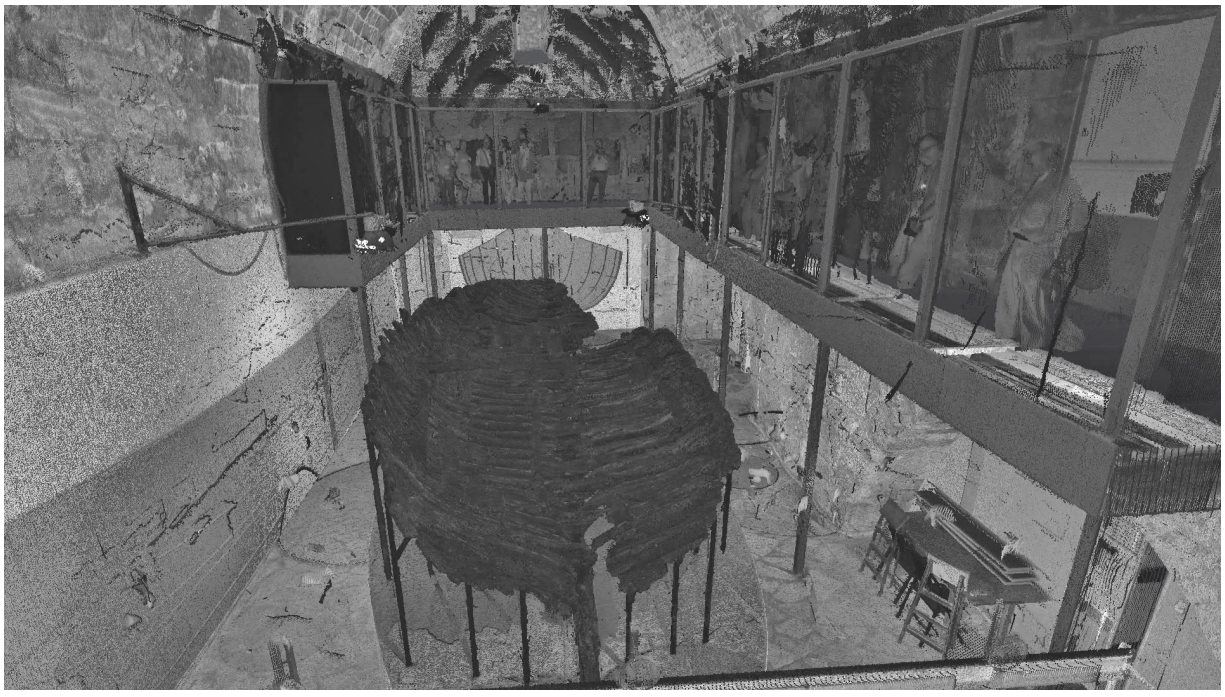

Fig. 1. View from the 3D Laser Scanner point cloud of the Kyrenia Shipwreck and its aerial gallery

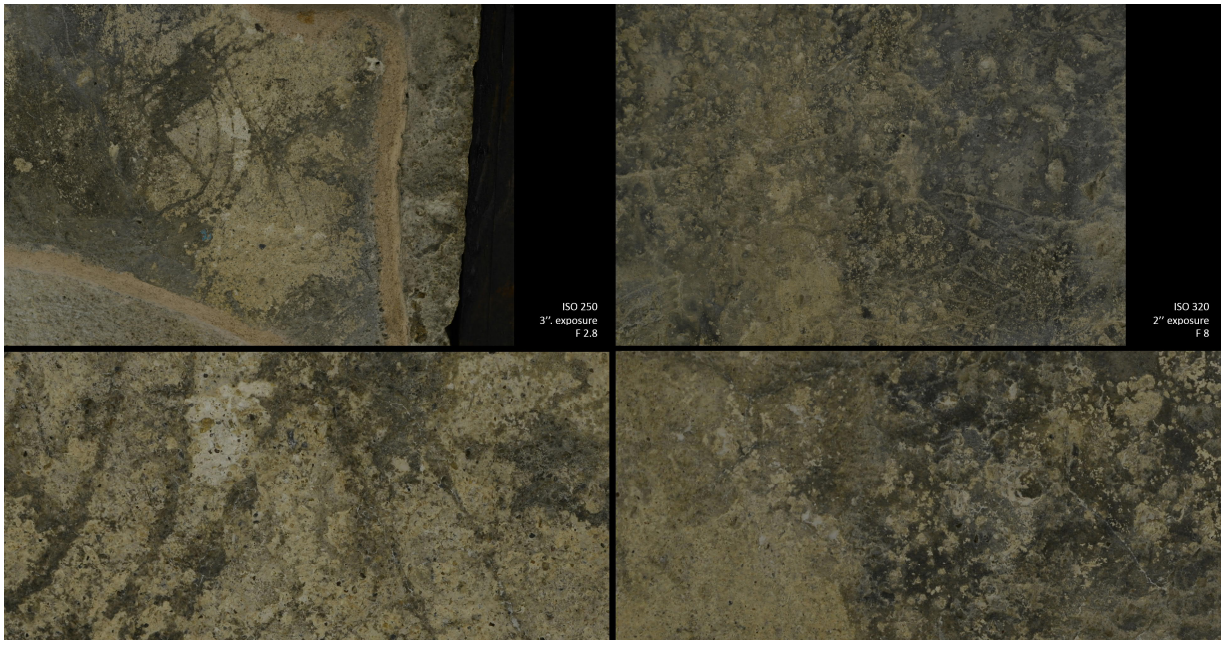

Fig. 2. Sample shots from the photogrammetry campaign, on the top the full shot, beneath it the enlargement of a detail from each shot to allow the reading of the quality of the resulting image

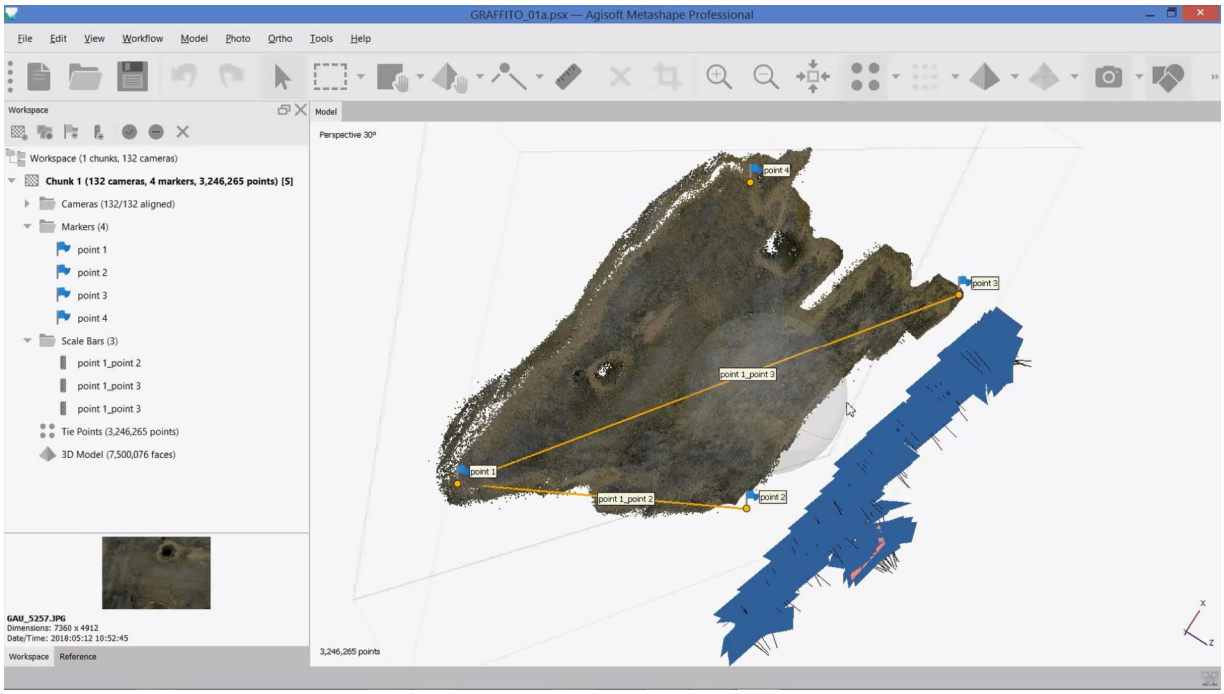

Fig. 3. Processing in Agisoft Photoscan, point cloud and the putting in scale of the model

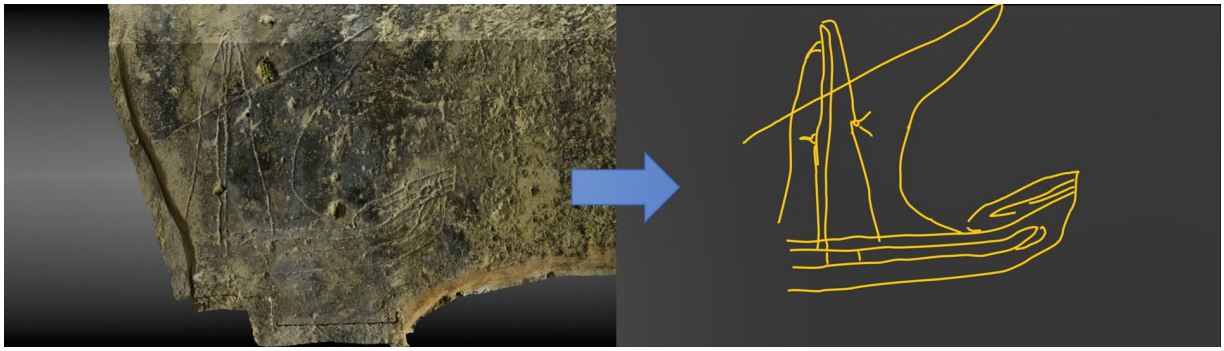

Fig. 4. The retracing of the graffiti into vector drawings

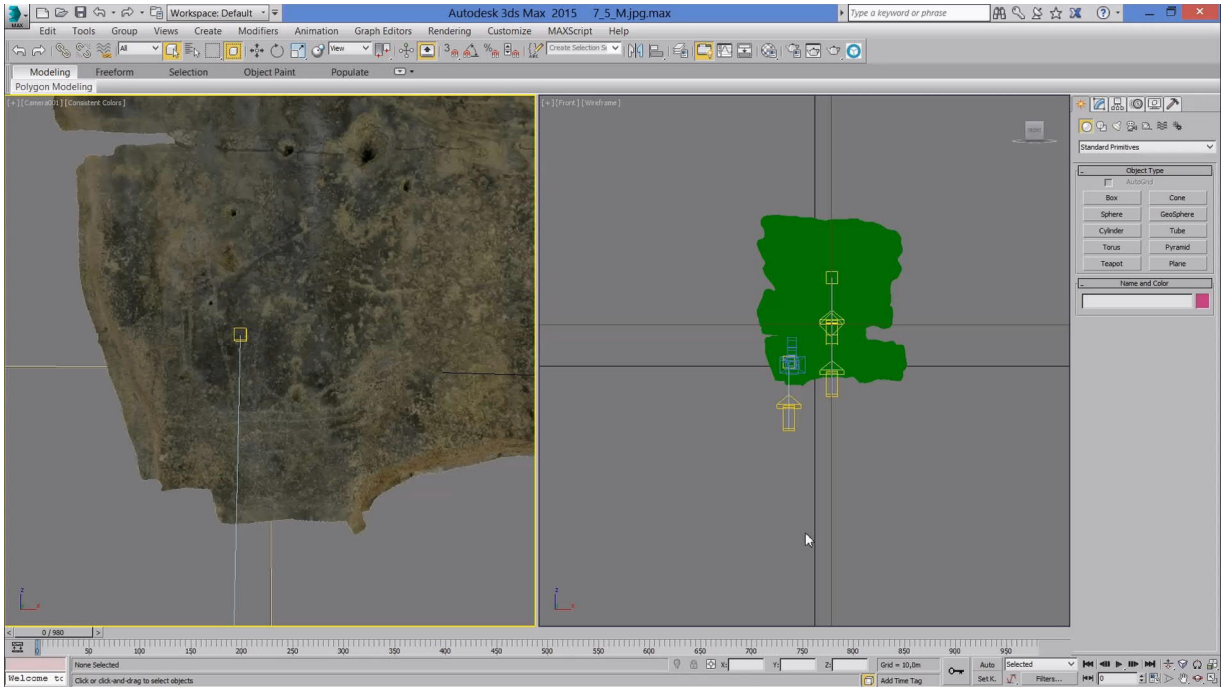

Fig. 5. Preparation of the animation with light motion in Autodesk 3D Studio Max

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