THE USE OF 3D RECONSTRUCTION FOR ARCHITECTURAL STUDY: THE ASKLEPIEION OF ANCIENT MESSENE

R. Yoshitake [a], J. Ito [b]

[a] Doctoral student of Department of Geodesy & Surveying, Aristotle University of Thessaloniki, Thessaloniki 54124, Greece – messene2001@yahoo.co.jp
[b] Professor of School of Architecture, Department of Engineering, Kumamoto University, Kurokami 2-39-1, Kumamoto 861-8555, Japan – itoj@arch.kumamoto-u.ac.jp

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ABSTRACT:

This paper aims to use the digital recording techniques and 3DCG for the ancient monument. The author applied to use these techniques in the archaeological site of the Asklepieion, Messene. The ancient Messene was an important Hellenistic city in Mainland Greece and was well known by the description of the Roman traveller, Pausanias. The Asklepieion was located in the city centre and was the main sanctuary in Messene. The Doric peripteral Temple of Asklepios was built in a square court, which was enclosed by Corinthian porticoes (stoas). This sanctuary was excavated by A. K. Orlandos from the 1950s until the 1970s. Unfortunately, he passed away soon after that, leaving the research incomplete. The authors had an opportunity to participate in fieldwork in order to survey and study the architectural remains of the surrounding peristylar stoas. The authors reinvestigated the remaining stoas of this sanctuary, and reconstructed the Corinthian order of the outer and inner colonnades together with the roof structure. As results, the authors succeed to use the photogrammetory to make architectural drawings and to reconstruct the Asklepieion complex by 3DCG.

1. PREFACE

1.1 Introductions

The ancient city of Messene, one of the most important classical sites in Greece, is located around 17 km north of Kalamata, Peloponnesos. According to "Description of Greece" by the Roman traveller and geographer Pausanias, Messene was founded by Epaminondas from Thebes in 369 B.C. after he had beaten the Spartans near Leuktra.[*] The sanctuary of Asklepios (or the Asklepieion) was the main sanctuary of the town and was located in the centre beside Agora. A. K. Orlandos excavated this sanctuary from the 1950s to the 1970s. Unfortunately, he passed away after that, leaving the research uncompleted. In 1987, the Society of Messenian Archaeological Studies, which is directed by Prof. P. Themelis of the University of Crete, started reinvestigating the Asklepieion and performing some new extensive excavations at the site of the Theatre, the Stadium, housing quarter, etc. in the city area.[**]

The authors, as members of the Architectural Mission of Kumamoto University to Ancient Messene, surveyed the Asklepieion from 2001 to 2006. In this fieldwork campaign, the authors reinvestigated and analyzed the remaining peristylar porticoes (stoas) of the Asklepieion, to reconstruct the Corinthian order of the outer and inner colonnades together with the roof structure. The present paper aims to reconstruct this ancient monument based on architectural research on the field, while visualizing the results in 3DCG.

In the fieldwork, drawings were made for plans, elevations, and sections of the sanctuary. Some important blocks were also drawn for resorting analysis. The measurement works used an electronic total station to lay basic lines along the outer and inner colonnades and walls. Handy 5 m steel tapes were also used to measure offsets from the basic lines. For the façade of back walls, initial drafts were supported photogrammetric techniques (Topcon PI-3000) and then detailed drawings were added. The plans, elevations and sections were drawn in 1:50 scale and the blocks in 1:10 scale. AutoCAD 2004 (produced by Autodesk) was used for 3D modelling and rendering.

1.2 Remains of the Asklepieion

The Asklepieion is situated to the south of the Agora in the centre of Messene, abutting to the streets on its north and east sides. It was naturally the main religious centre of the town, but at the same time, it also had a role as political centre with its annexed Ekklesiasterion (the assembly hall) and Bouleuterion (the council hall). The Gymnasium complex is ca. 250 m to the south of the Asklepieion and the Theatre ca. 200 m to the northwest (Fig. 1, 2). In the middle of the Asklepieion, the Temple of Asklepios was built in Doric order with an altar in front of it. Many bases for statues and five semicircular exedrae were also placed along to the colonnades of the temple and the stoas. All of these were enclosed by stoas on four sides, which formed a square court. There are well-preserved monuments behind the east stoa: the Ekklesiasterion, the East Propylon, and the Bouleuterion. The west stoa has eight smaller rooms in its behind, the northernmost of which was the cult room of Artemis. Behind the north stoa was the Sebasteion, which was divided symmetrically into two identical parts at the axis of the North Propylon, which had an opening to the street at the north. There was a staircase on each wing of the Sebasteion for access the north stoa. Behind of the south stoa was separated from Hellenistic bath (Fig. 3).

The site of the Asklepieion slopes southward gently, while the floor of the Sebasteion, which is adjacent to the north stoa, is ca. 2.5 m higher than that of the stoas. The east stoa was

[*] Pausanias, Description of Greece, IV, 27, 5-7, Jones, W. H. S., The Loeb Classical Library, Cambridge/Mass., London, 1977.

[**] Themelis 2001.

constructed on a bed of rock, which is now partially exposed at the southeast corner, while the west part of the south stoa on a terrace supported by foundations of poros. The axis of the Asklepieion was oriented 20 degrees clockwise from the east-west geographical line, following the direction of the street network, which is supposed to have been based on the gridiron or Hippodamian system.*

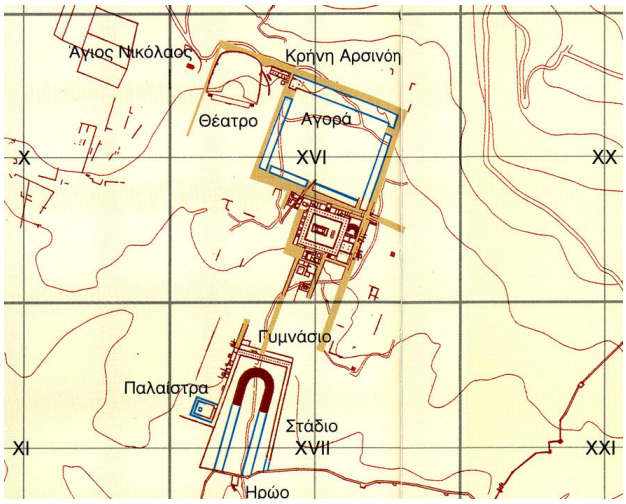

Figure 1. City centre of Messene (after Th. Chatzitheodorou)

Figure 2. Aerial view of the Asklepieion (below) and the Stadium (above) from Acropolis

The four stoas have double colonnades. The outer colonnades of the north and south stoas are approximately 52 m long, and those at the east and west stoas 47 m. The four colonnades make precise right angles. All the crepis blocks of the outer colonnades are preserved as they were. The stylobate blocks remain only near the corners, and the plinths only on the northeast and northwest corners. The column, architrave and frieze blocks are of poros, and those of the euthynteria, crepis, stylobate, toichobate and walls are of limestone. According to P. Themelis, the excavator, the whole building of the Asklepieion dates from 215/4 B.C.**

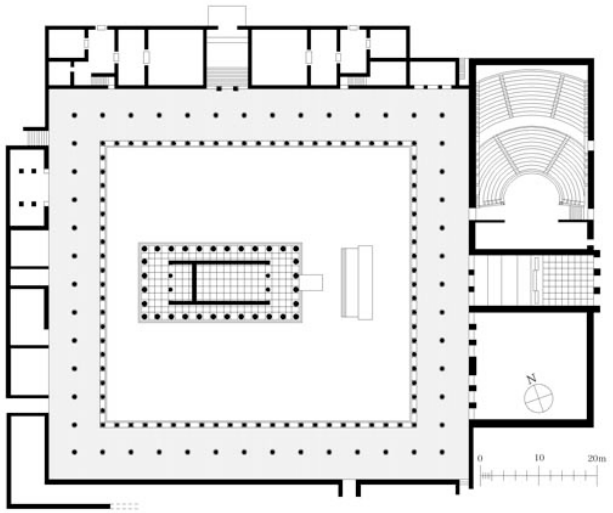

Figure 3. Plan of the Asklepieion

1.3 Architectural Remains of the Stoas

Most of the upper part of the building has fallen, but the back wall of the stoas and the east part of the building complex has remained. The foundation and krepidoma of the stoas are also well preserved. The lower part of the outer colonnades consisted of euthynteria, crepis and stylobate, and drains were set all along the colonnades. The stylobate averages ac. 0.2 m in height, and most of the blocks are missing except for some in the corners. On the crepis, all the blocks are preserved except one in the middle of the north stoa. Plinth blocks were laid on the stylobate to erect Corinthian columns. All the blocks from the lower part of the colonnades were made of limestone. The floor of the stoas is covered with soil, and its floor is slightly sloped toward the outer colonnades.

The back wall of the north stoa is preserved in very good condition up to the floor level of the Sebasteion. The wall consisted of toichobate, orthostate and its crowning course, and all the wall blocks were made of limestone. The part of crowning course was finished roughly, so probably was finished by stucco. The orthostate blocks were seemingly joined with clamps, since many holes of breakage were found on the top of the orthostate, indicate that iron clamps were removed from the joints, while the wall of the east stoa is preserved mainly along the Ekklesiasterion. At the south stoa, it is clearly observed that the orthostate of the south wall was formed with two rows of vertical blocks on its outer and inner sides. However, peculiarly, the upper parts of the walls are completely gone in contrast to the good condition of the orthostate. There were no rooms behind the south stoa, while there were eight rooms attached at the back of the west stoa. However, the back wall of the west stoa is completely gone.

1.4 Dislocated Blocks

More than two hundred architectural blocks, belonging to the stoas, remain within and around the Asklepieion. Thirty-three blocks were measured and drawn in our survey. Almost all the blocks are made of poros; the plinth blocks and sima blocks are made of limestone. The blocks have been deteriorated or weathered to some extent due to the softness of poros. The measured dimensions inevitably include some errors due to this deterioration and weathering. It is noteworthy that some parts of entablature of the east and west stoa were found as they fell down, probably due to an earthquake. They are left as they were

* Mueth-Herda, S., Street Network and Town Planning of Ancient Messene, in 'Symposium for International Collaborative Studies on Ancient Messene', Tokyo, June 29, 2002, pp. 16-30.

** Themelis 2001, p. 82.

found, and the original surfaces of the entablature remained mostly intact.

1.5 Column blocks

Also noteworthy is the fact that the columns were not only fluted, but also reeded on the lower part.[*] It is said that the reeded flute aims to avoid damage to the fragile arrises from traffic passing through the colonnade. An aesthetic function of flute is to show strong contrast of light. Detailed investigation of the site shows that there were two kinds of columns with reeded flutes on the lower parts. One is a smaller column with twelve reeded flutes all around, and the other a larger column has nine normal flutes half way around and eleven reeded flutes on the other half. After the analysis, it is evident that the smaller columns were used for the outer colonnade and the larger columns for the inner colonnade: This is primarily because the round plinth of the inner colonnade was slightly bigger than the rectangular plinth of the outer colonnade, and secondly because the smaller column had reeded flutes half way around on its lower part. Measurements of the dimensions of the base, the shaft, and the capital support this hypothesis. The latter reason is an aesthetical point of view. That is, the columns of the outer colonnade should have been unreeded on their outer faces to produce the sharp shadow lines created by unreeded flutes. The reeded flutes spoil this effect.
Twenty base blocks were found: seventeen on the round plinths of the inner colonnades and three left on the ground. Two of them were measured and drawn in our survey. All the column bases were combined and carved with lower parts of column shafts. There are two types of base blocks, which are corresponding to the type of column.

Figure 5. Corinthian Capital

The capitals of the columns are Corinthian type (Fig. 5). Every capital differed in the form of its acanthus leaves, volutes and decorations, etc. However, they can be categorized into two types: one is smaller in size with comparatively large volutes and twenty four acanthus leaves; twelve leaves in lower and upper rows, while the other one is larger, without any volutes and with sixteen acanthus leaves; eight leaves in each row. They are of sandy poros and not in good condition, having been damaged, deteriorated and weathered. It was observed that they were finished with stucco. Small sculptures of Nike and Eros (or Cupid) were carved on the sides of each capital with their hands opened and placed on the helix at their sides. They have their wings expanded from their shoulders and were placed in the middle of abacus. As discussed above, the smaller capital might have been used as an outer colonnade, and the larger one might have been as an inner colonnade.

[*] J. J. Coulton, The Architectural Development of the Greek Stoa, Oxford, 1976, p.112.

1.6 Entablature

Twelve meters of the entablature of the east stoa was excavated intact as it had fallen on the east side of the altar. It was found 5.3 m away from the east colonnade with its exterior facing down and with its geison touching the altar all the way along. Part of the entablature of the west stoa was also found at the west side of the temple. It is likely that the same earthquake caused the simultaneous collapse of the stoas, judging from the fact that the blocks lie parallel with the colonnade.
The architrave and frieze were combined and carved as one block (Fig. 6). The architrave was divided into three fasciae as usual. The frieze had a relief of alternating bucranii (bull-heads) and phialae (round vessels for libation), which were festooned continuously.

Figure 6. Architrave-frieze Block with decorative relief

Behind the outer architrave-frieze block, the backer, or inner architrave-frieze block was set, and is shorter than the outer block. The architrave was divided into three fasciae, and the frieze was simply planned without relief.
Thirteen cornice blocks were found and they have dentils on the front and small cuts to support rafters on the back. There are also evidences that some of the architrave-frieze blocks were reused as cornice blocks of the west stoa. Some sima blocks were found and are now stored in the museum. On the front of the sima, there are spouts of lion heads, and between them was a relief of rinceaux as decoration. The spacing between the lion heads is ca. 0.5 m, so this indicates that there were five lion heads in each axial space.

2. ARCHITECUTRAL DRAWINGS BY PHOTOGRAMMETRY

2.1 Systems

Topcon PI-3000 is application software for 3D measuring, 3D modelling and 2D pictures, so this system also enables us to make Digital-Ortho-photo two pictures from different viewpoints.
Measuring work is as follows (Fig. 7):
1) To calibrate your digital camera. It is possible to analyze various kinds of target with various sizes, from few cm to 100 meters. Moreover, this system is useable in laptop computer so that we could analyze data on the sites. The principle of PI-3000 system is based on stereo method: combination of more than al camera, before taking photos (you may can calibrate it after taking photos). It is necessary for camera calibration by selected lens and digital camera and obtains the interior orientation parameters (focal length, principal point, lens distortion).
2) Put picture data in your laptop and open it in the PI-3000 software.

3) Make orientation. Orientation is to calculate the photographing position of cameras, based on the image coordinates of the corresponding points on the left and right images. More than six corresponding points should be correlated.
4) Determine the common measuring area of two pictures within one model. We determine this common area on the stereo-images, rectified to become visible in 3D from the required parameter by the orientation. We can also determine easily on the two images displayed simultaneously at right and left on the same PC display.
5) Once the common area is determined, we make automatic measuring (stereo-matching). Through this automatic measuring, we can process thousands of points altogether at a time and obtain the 3D coordinates.
6) After the work of 3D measuring, you can make 3D model in automatic and manual. It is also possible make rendering image, texture mapping image as well as contour line image by making a wire-frame out of the 3D point clouds.
7) Finally, we output the data of reconstructed. Since this can be output as DXF, PDF, CSV and VRML data, so we input them into CAD to make drawings or bonding other data, etc.

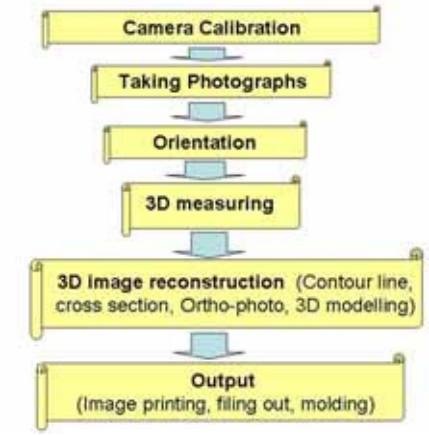

Figure 7. Flow chart

2.2 The Architrave-Frieze Blocks

The targets were three architrave-frieze blocks, which was about 7.3 m (in length), 0.75 m (in height) and 0.35 m (in width). The Architrave-Frieze block is timber block putted on the columns and support the roof of colonnades. As we discussed, the blocks have decorations three steps of facia (horizontal bands) in architrave part, and have buclanii and phialae combined with festoon in frieze part (Fig. 6, 8). For taking photos, put 22 target seals on the blocks to measure 3D coordinates by electric total station (Topcon TS), and then took photos by digital camera. The environment of taking pictures are as follows: the object distance was around 1.1 m, distance between viewpoints was around 0.4 to 0.75 m, focal length was 18 mm, and 16 photos were used. In this occasion, one pixel is equal to about 0.4 mm in horizontal direction, about 1 mm in vertical direction. Working hours was 30 minutes for taking photos and 5 day for making 3D model. As a result, the authors succeed to make 3D model with clear texture mapping: the 3D model with texture is so enough clear to see three steps of fasciae, bull-heads and phialae decorations that the draftsman certainly be able to use for basic sketch to make final drawings.

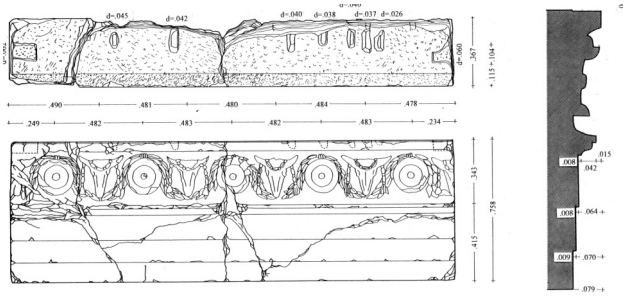

Figure 8. Final drawing of architrave-frieze block (Elevation and profile section)

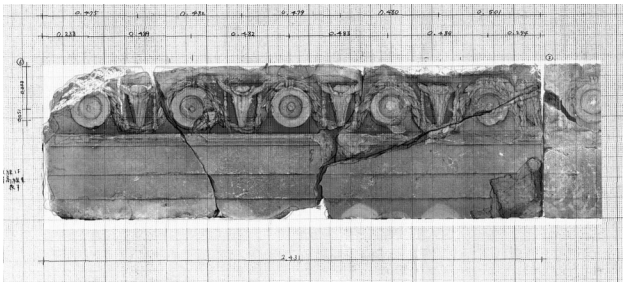

Figure 9. Comparison drawing with hand drawing and ortho-photo of Architrave-frieze block

Fig. 8 shows architectural sketch one of the architrave-frieze blocks (the length of which is about 2.4 m) in original scale 1 to10. It took seven days for the architectural sketch by hands; two days to detailed measuring (because the block is too heavy to rotate by human power), three days for general sketch and two days for decoration part. Fig. 9 shows comparative pictures the ortho-photo and the hand made sketch of the same block of PI-3000. The hand made sketch are digitalized by scanner and adjusted to have same pixel per inch as the ortho-photo. With comparison, there is 1 mm difference between these two pictures in the edge and clacks of the block. The cause of this might be from the difference of definition of facade of the block, that is, there is difference of viewpoint. It is also suspected that scan machine and camera lens make distortions. Secondly reason is the shape of difference between these two pictures of frieze decoration. It might be caused from using template when we make drawings by hand, not because of distortion of camera lens. As an evaluation, the ortho-photo is enough collect (under 0.5 mm in generally) as an architectural sketch for final architectural drawings. In addition, photogrammetry can make decoration drawings quicker than hand drawing.

3. RECONSTRUCT OF THE ASKLEPIEION BY 3DCG

Following the detailed investigation of ruins and architectural blocks, the authors succeeded in restoring the stoas, which have the Corinthian order of the outer and inner colonnades together with the roof structure. Roof structure of the stoa was restored from the cutting of wooden crossbeams and rafters. After the analysis of these evidences, we made it clear that the stoas have sloping crossbeams from the outer column to the inner column, and from the rear wall to the inner column, slopping in two directions. The rafter and the purlin may have been used for the crossbeam, and the rafter was probably supporting directly the terracotta roof tiles (Fig. 10).

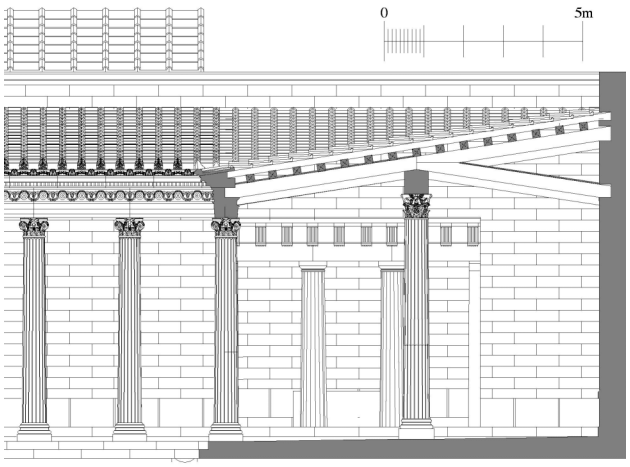

Figure 10. Restored section of east stoa
(View from south to north)

The authors also made a 3DCG model in AutoCAD based on the restoration drawings (Fig. 11). The 3D model is also based on drawings of other scholars; the Doric Temple and Altar were based on the drawings of A. Orlandos, while the Ekklesiasterion, the East Propylon, and the Bouleuterion were based on the drawings of A. Papadoukonas. In order to achieve a better visual result, the authors used images of the site, as textures on the 3D computer model.

From the reconstructed 3DCG, we can relive the Asklepieion as it was to Pausanias during the first century AD. The courtyard of sanctuary is strongly enclosed by Corinthian colonnades from four sides (Fig. 12). Although it is not clear why the Corinthian order was chosen in Hellenistic Messene, there probably was a major victory, which gave the Messenians the funds. It is thought that the city was allied with Philip V of Macedonia, but unfortunately, we have not found any inscription to prove construction period until now.

There are indeed other examples of the stoa, with Corinthian order, for example, the stoa in Muse of Valley and the south stoa of Olympia, but those stoas have Corinthian order only at the inner colonnade: In the case of Messene, Chorinthian order was used not only inner colonnade but also in the outer colonnades. Corinthian colonnades on such an extensive scale are unknown in Greece or Asia Minor until the second century AD. Due to comparison of digital photos and CG view, it is possible to see the Acropolis between the Doric Temple and the Altar. From 3D CG, we can see the symmetrical and axial plan of the Asklepieion. The colonnade of stoas and the Doric temple follows grid town planning, which faces the Acropolis (Mt. Ithomi), so that the axis of the sanctuary leads to the direction of the Acropolis (Fig. 13). This type of planning of the sanctuary was one of the first predecessors of the later Hellenistic and Roman sanctuaries. However, there was no detailed information or analysis about its architecture, and thus these new measurements and drawings provide new architectural information for the study of the Asklepieion.

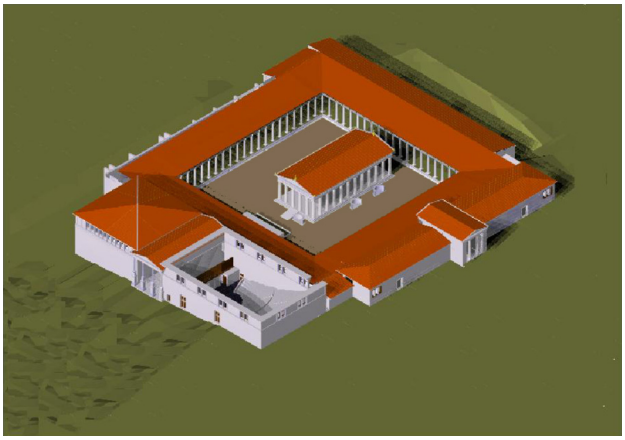

Figure 11. Whole view of 3D model of the Asklepieion

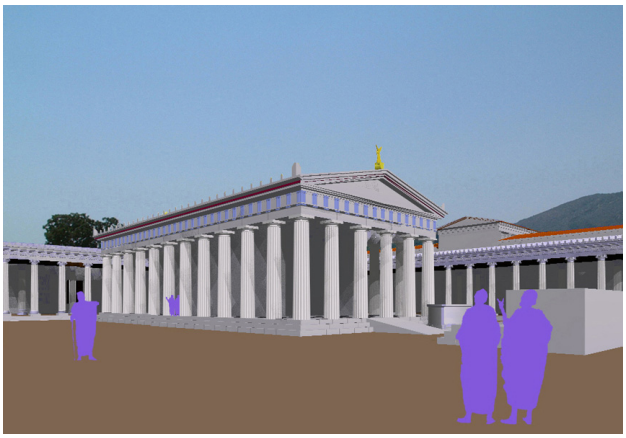

Figure 12. The Doric Temple and surrounding Stoas in side of the courtyard (3D CG)

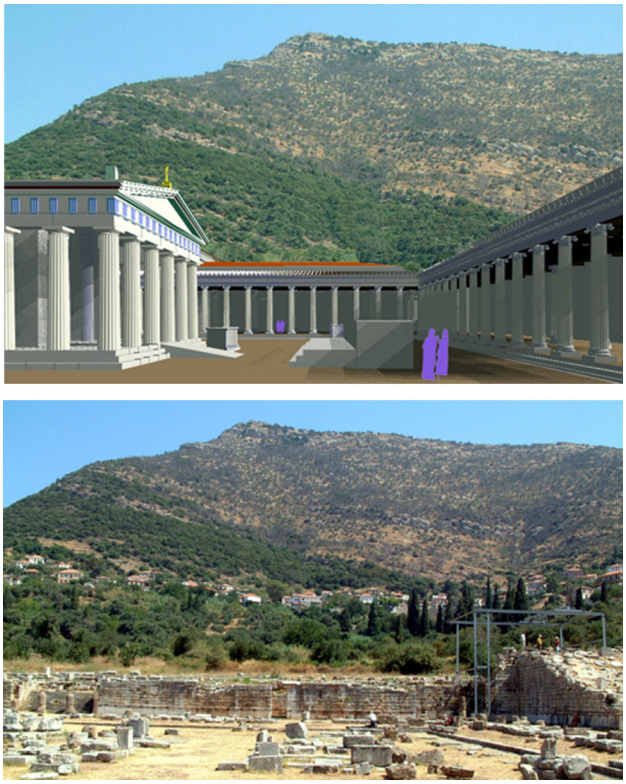

Figure 13. Comparison of present view (below) and reconstructed CG (above)

4. SUMMARIES AND CONCLUSIONS

In conclusion, the authors have succeeded to make 3D models of the stoas of the Asklepieion of Messene, and to visualize their shapes with whole buildings of their unknown form In addition, we have managed to depict a 3D CG model of the scene as it follows of restarted drawings, made from survey and analysis in the site. According to the excavators, the Asklepieion of Messene dated at the end of the 3rd century BC, although the date when the columns of the stoas were erected is still somewhat uncertain. After the reinvestigation and reconstruction work, the authors were able to make the architectural character of the Asklepieion clear. The surrounding square stoas play the role of the background perspective to the temple, which was situated in the center of the court. This is probably in order to give an impressive visual effect to the visitors. In addition, the Asklepieion in Messene shows architectural characteristics of late Hellenistic architecture in its symmetrical and axial plan. 3DCG demonstrates how its effect was of Corinthian order to the façde of the courtyard. The reconstruction and analysis of the Asklepieion of Messene is essential and the main points are summarized as follows:

1) The author made it clear that the photogrammetry is useful for making architectural drawing in archaeological site, especially for decorative architectural members.

2) The Corinthian order was used in the outer colonnades of stoas. The outer Corinthian columns, which had larger diameters than the inner columns, had twenty-four flutes and their lower parts were reeded on the inner faces. The inner columns had reeded flute all around on the lower part.

3) Roof structure of the stoas was restored from the cutting of wooden crossbeams and rafters. After the analysis of these evidences, the stoas may have had sloping crossbeams from outer column to inner column, and from rear wall to inner column, slopping in two directions. Rafter and purlin may have been used on the crossbeam.

4) By using 3DCG, we can observe how its effect of architectural planning of the Asklepieion was. The square courtyard with surrounding colonnade give an impressive visual effect to the spectators, and gives the perspective view to the temple that was situated in the center of the court. This type of planning of the Asklepieion in Messene was one of the first predecessors of the later Hellenistic and Roman sanctuaries.

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