



View of the Parthenon cella from the East. Photo R. Christodouloupoulou, 2018

V. Eleftheriou, 2017-2018 - The progress of the Acropolis restoration works

V. Manidaki, J. Dourakopoulos - Restoring the orthostates of the Parthenon west pediment

Ch Pinatsi, C.Koutsadelis, E. Kakogiannou -The strategic plan for the interventions on the Acropolis walls

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E. Karakitsou, E. Petropoulou, Activities to promote research and bring the restoration works on the Acropolis monuments to the fore

I. Kaimara, A. Leonti, M. Tsiolaki - «A Greek Temple»: A new web application on the architecture of ancient Greek temples

E. Petropoulou - News from the Acropolis



View of the Parthenon west side after moving the Potain crane inside the monument. Photo: V. Eleftheriou, 2018

This current issue of the Acropolis Restoration News focuses on the period defined by two important events organised by YSMA dedicated to our mentor and ESMA President, Charalambos Bouras. The two day conference on “Specialised research and implementation issues in the Acropolis restoration works carried out during the period of 2010-2015”, which took place in November 2016, and the event organised in November 2018 are extensively presented in the articles that follow. It should be pointed out that two important editions resulted from the two aforementioned events: the first one promotes the entire work of YSMA, since its establishment and is based on the texts of Ch. Bouras, while the second one contains a thorough analysis of the results of the scientific study and research conducted in recent years within the guidelines of article 16 of the Venice Charter; this research had also been incited by the encouragement and support of Ch. Bouras.

In spring 2017, the work “Restoration and conservation of the Acropolis monuments”, included in the EPAnEK NSRF 2014-2020, received a funding of 5,000,000 €; the deadline for these works was in spring 2021. In June the Service advertised 40 job vacancies of various specialties. The process of assessing about 400 applications and the need to answer the raised objections on the produced rank lists of the applicants was completed at the end of August; finally the new recruits were employed in September. Having now a staff of more than 155 people, who were professionals specialised in fields other than the ones employed permanently by the Service (civil engineers, mechanical engineers and others), allowed the Service to methodically programme and proceed with the works it has undertaken for the indicated period.

At the same time, preparations at the worksites of the Parthenon and the area B17 of the walls were completed in order to carry out the projects listed in NSRF;

in addition to these works the Potain crane was moved inside the Parthenon and the old Derrick crane was donated to the Lavrion Technological and Cultural Park (see the relevant article in this issue). The aim of these changes was not only to facilitate the scheduled restoration programmes, but also to enhance the appearance of the monuments by removing all the unnecessary installations, materials and scaffoldings.

The person in charge of the works on the Parthenon is the architect R. Christodoulou, while the scientific personnel consists of the architects Dr K. Karanasos, Dr L. Lambrinou, V. Manidaki, A. Papandropoulos, K. Skaris, and the civil engineers A. Vrouva, Dr J. Dourakopoulos and Dr E. Pasiou. The people responsible for the worksites were the marble technicians G. Aggelopoulos and S. Kardamis. The works, following a set schedule, are conducted in three areas, that is the west pediment, the north wall of the cella, and the 3rd column of the Pronaos.

The project of restoring the west pediment of the Parthenon is the most emblematic of this restoration period and is being conducted in accordance with the studies: “The restoration of the tympanum orthostate of the west pediment of the Parthenon” of V. Manidaki and L. Palaeologos, and the “Restoration of the backing wall of the west pediment of the Parthenon” of K. Skaris,

which were approved by the ministerial decision YPPO/GDAMTE/DAAM/TMAM/43085/4759/257/86/15.2.2017. It started in June 2017 with the dismantling of the central orthostate of the tympanum, which due to its specific geometry and deterioration demanded careful handling during its structural restoration. Then two more orthostates, which had similar problems, were also dismantled. The backing wall, though, had received very serious damage. After dismantling the blocks of the upper rows, it was revealed that the blocks of the three lowest rows presented exit fractures, while the extent of older interventions in the area had been exposed: for example, an architectural member which had been chiselled off, or the use of inappropriate materials (block-adhesive Meyer). The really bad condition of the marbles caused a delay in the calculations of the needed reinforcement for the bindings and the titanium clamping elements. The engineers responsible for the relevant studies are A. Vrouva, J. Dourakopoulos and E. Pasiou. Until the end of 2018 the structural restoration of the orthostates had been completed, whereas works on the backing wall were just starting.

The permanent personnel of the Service had worked on the restoration of the north wall of the cella until September 2017 when work was intensified after

employing temporary staff. This project followed the approved, since 1997, study of N. Toganidis. However, a new updated study by K. Skaris and A. Vrouva, has already been submitted for discussion to the Central Archaeological Council. By the end of 2018 all the external orthostates of the wall had been reset on the monument, while in the interior five vacuums remained expecting new marble in order to structure the 5th, 6th and 7th orthostates. The 1st row had been half-completed while the restoration of the 2nd row had started.

Finally, another work that continued was the carving of flutes on the new fillings of the third from the north column of the Pronaos.

In 2018 the process to commission the supply of new marble from the quarries Dionysos-Penteli was completed, and thus the amount of new marble that would cover the needs for the completion of works on the Parthenon until 2020 was ensured.

The process to commission the “Study of topographic and photogrammetric surveying on the Parthenon” started after NSRF approved its financing. After conducting a public tender the study regarding the complete and exact geometrical documentation of the North wall of the cella, the West pediment and the ceiling of the West wing of the Parthenon,



Dismantling an orthostate of the Parthenon west pediment. Photo: T. Souvlakis, 2017



Restoring a fragmented block from the backing wall of the Parthenon west tympanum: view before (on the left) and during the works (on the right). Photo: A. Panou, 2018

supervised by the topographic engineer D. Mavromati, was contracted out to the consortium “Elliniki Photogrammetriki Ltd - Photopo PLC”. In parallel to the above, the topographic engineer S. Kyparissi produced three-dimensional models of the dismantled architectural members with the use of photographs and the appropriate software which serve three purposes: they document the preservation condition before and after the interventions, they can be used as backgrounds for static solutions and finally they can also provide the context for implementations in the areas of information and education.

A workstation was set up (using a powerful computer system) at the Parthenon office in order to process demanding software and complex computer files.

In 2017 YSMA renewed for three more years its collaboration with the MIE University in Japan and the National

Technical University of Athens (NTUA) in order to record seismic activities with the use of a pair of accelerometers placed on the northeast corner of the Parthenon and one more recording equipment, which was placed on the south wing of the monument.

The Head of the Technical Office of the circuit walls is the civil engineer D. Michalopoulou; in the same Office work the architects K. Mamalougas, A. Hadjipapa and Ch. Pinatsi and the civil engineer Dr E. Kakogiannou. The civil engineer N. Ninis, on a part-time secondment to YSMA by the Directorate of Prehistoric and Classical Antiquities, contributed to the work of “The consolidation of rock masses and the walls”. The marble technician G. Vasdekis is in charge of the crew for restoration works.

Analogous to the cleaning and enhancement works conducted in the area surrounding the Parthenon, were the works in the area of the Propylaia, among

which the dismantling of the western-most part of the worksite canopy in order to make the east wall of the north wing of the Propylaia visible.

In 2017 the Central Archaeological Council approved the “Study for the restoration of the area B17 of the north wall of the Athens Acropolis” and the “Study for the restoration of the area B12-B13 of the north wall of the Athens Acropolis”, of D. Michalopoulou, K. Mamalougas, A. Hadjipapa, E. Aggelakopoulou and A. Tsimereki. The relevant works were all included in NSRF 2014-2020.

Priority was given to the area B17 as scaffolding had already been raised in the specific location. However, after the study was approved the scaffolding had to be modified in order to allow the removal of the wall blocks without dismantling the overlying rows. In addition, a support system was designed and constructed, aiming to buttress the area

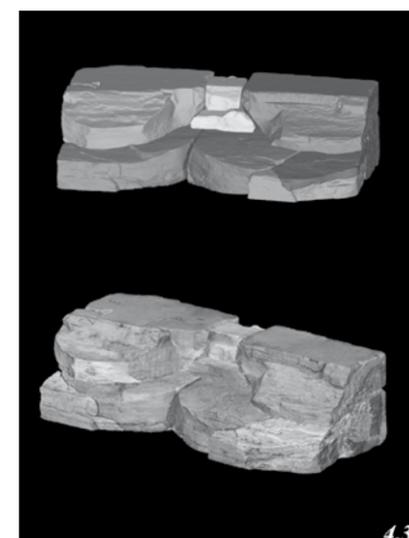
which was not to be dismantled, during the works on the underlying sections. Until the end of 2018 the latest additions had been dismantled from the intervention, the gaps in the interior part of the masonry had been filled with mortar, four new blocks had been placed on the 7th and 8th rows and the surface of the new members had been treated. An inscribed fragment that was removed from this area of the wall was given to the Ephorate of Antiquities. Finally, poros from Pitsa Korinthias was obtained for the construction of new fillings.

The crew responsible for the conservation of the walls dealt with parts of them in many areas (such as an area NE of the Erechtheion) while part of the east side of the wall on the SE corner of the Acropolis rock was repaired. After detecting problems in the area of the elevator (B14) on the north wall, the Ephorate of Antiquities of Athens closed off the north walkway, Peripatos. Our Service appointed Ch. Pinatsi and E. Kakogiannou to conduct a study and launched a public tender in order to commission the repair work of the wall in this area. The work, to be conducted within two months, is to start on 16th January 2020.

In September 2018 the cleaning of the wall and the slopes from weeds was completed after launching a public tender.

Before the beginning of works in the area B12-B13, D. Michalopoulou and A. Hadjipapa had prepared a study, while ESMA had approved to supply and install a bridge crane on a scaffolding; provisions for launching a relevant public tender for these works are under way. Moreover, A. Hadjipapa and E. Kakogiannou are carrying out another study focusing on the restoration of the internal side of the wall at the SE corner.

The public tender for outsourcing the “Geotechnical - static study of the circuit walls of the Athens Acropolis and of their rocky foundations on specific areas of priority” started in April 2017 and was completed in March 2018. The work



Three-dimensional model of a block from the backing wall of the west Parthenon tympanum and a model with photographic texture. Production: S. Kyparissi

was assigned to the consortium of the engineering companies GEOPER Consultants Engineers SA and Domos Consulting Engineers. At the end of 2018, under the supervision of D. Michalopoulou and N. Ninis and under the tutelage of a sub-committee consisting of the President of the ESMA, M. Korres and the ESMA members, M. Chronopoulos and P. Kouphopoulos, the second phase of the final study was completed while its approval by ESMA and KAS is being expected.

The “Strategic plan for the interventions on the Acropolis walls” (master plan) was the result of a collective effort of the Technical Office of the circuit walls and the Office and Laboratory of surface conservation. After a bibliographical research in the period 2015-2016, the design study of the walls started in 2017 and its first version was presented to ESMA for discussion in June 2018. The strategic plan included alternative proposals for the enhancement of the areas where the classical wall has been considerably preserved. The study (see the relevant article in this issue) was conducted by D. Michalopoulou, C. Koutsadelis, Ch. Pinatsi, E. Kakogiannou, A. Hadjipapa, E. Aggelakopoulou, E. Xynopoulou and

A. Tsimereki, and is to be re-examined together with the geotechnical-static study before being submitted for approval to KAS.

For the preparation of the above two studies there were used bibliographical data, experimental data, as well as observations made during small-scale works that have been conducted in the last five years on the Acropolis walls. The studies will therefore, after being approved, become a valid framework of principles and methodologies to be applied to the future interventions on the walls.

During the period 2017-2018 the walls as well as the entire archaeological site have been monitored with the use of various instruments: a) a network of 11 accelerometers supported by the Institute of Geodynamics of the National Observatory of Athens, b) a system of optical fibres installed by the company OSMOS Hellas on the foundation of the west wall of the Propylaia’s north wing and c) a station of geotechnical instruments installed in a well near the Belvedere tower in order to monitor backfilling works, supported by the company Edafos - Engineering Consultants SA.

Conservation works of the surface of the monuments continued on the Parthenon and the Propylaia, while on the walls they had an explorative character; small-scale conservation works were conducted on poros architectural members by the Office of Scattered architectural members. The person in charge of the Office and Laboratory of surface conservation is the chemical engineer, Dr E. Aggelakopoulou.

On the Parthenon, under the supervision of the conservator A. Panou, the conservation works at the east face of five architrave backers of the SW corner of the Parthenon were completed; the programme of conserving a total of 20 architectural members from the entablature of the west side (4 metopes, 5 triglyphs, 9 cornices and the areas of the regulae and tenia of two architraves) continued. Rescuing conservation inter-



Conservation and restoration works on the Parthenon. Top (left and right): restoring blocks on the north wall of the cella. Photo: V. Eleftheriou, 2018. Bellow (left): Carving flutes on the third column of the Pronaos. Photo: V. Eleftheriou, 2018. Bellow (right): Binding fragments on an orthostate of the Parthenon west tympanum. Photo: L. Stephaniotis, 2018



Shoring the Acropolis wall on the area B17, before commencing restoration works.
Photo: K. Mamalougas, 2017



Placing new blocks during the restoration of the wall on the area B17.
Photo: K. Mamalougas, 2018

ventions were carried out during the dismantling of the pediment blocks, while the systematic conservation of the removed blocks of the orthostate is underway. In addition, conservation works are being carried out on the blocks of the north wall of the cella before resetting them to their initial positions, while the orthostates are being sealed after setting them on their final position.

At the Propylaea, under the supervision of the conservator A. Frantzikinaki, the conservation of the columns and the overlying part of the entablature of the north wing colonnade of the monument was completed. The works and the monument's conditions were presented in the technical report written by the conservator Ir. Fragkiadaki. Works concerning the systematic conservation of the door-wall of the Pinakothiki will commence the sooner possible after the approval of the relevant technical report, written by the conservator P. Vlachouli.

The current restoration programme does not comprise any works at the Erechtheion. G. Frantzi, the supervisor of the works, completed a programme on specifying the appropriate materials for the conservation of metals and inserted documentation material into the database. She is also in charge of the conservation works conducted for the adhesion of scattered poros blocks from the archaic monuments on the Acropolis.

Planning works concerning the Acropolis walls, which started at the end of 2015 and focused on addressing long-term conservation interventions, continued. L. Aggelakopoulou, chemical engineer, Dr E. Xynopoulou and the supervisor of the conservation works of the walls, conservator A. Tsimereki, are carrying out the relevant research study. The planning includes a) the characterisation of the structural materials of the wall (stones, mortars), b) the recording of the pathology of its structural material and an evaluation of its preservation condi-

tion and c) proposals about appropriate conservation materials.

YSMA tried in the past to analyse the composition of Piraeus stone that makes up the main structural stone of the ancient wall of the Acropolis. The conducted studies concluded that Piraeus stone can be divided in two general categories according to where it has originated (the coast of Piraeus or the Munichia Hill), and two sub-categories as for its fracture toughness. Specifically, this stone is a) very tough actitis "type A" (fracture toughness $F_c=40-133$ MPa), b) mildly tough actitis "type B" ($F_c=20-40$ MPa), c) soft Munichia stone "type A" ($F_c=10-20$ MPa) and d) very soft Munichia stone "type B" ($F_c<10$ MPa). Moreover, a research was conducted in collaboration with the Directorate of Research and Technical Support for Restoration Projects in order to specify the right structural material; likewise the Conservation Office carried out further research in the laboratory trying to evaluate poros samples from active quarries in Greece. As it was impossible to find material compatible to Piraeus actitis that would be directly available to the desired dimensions and quantities, ESMA finally approved the use of stone from Pitsa Korinthias, as the best alternative for the necessary fillings in the Acropolis wall.

As for the historic mortars of the wall, in addition to the previous studies conducted in collaboration with the NTUA, the Directorate of Research and Technical Support for Restoration Projects is carrying out a new research after taking samples of structural mortars from the area B17.

In relation to the mortar used for pointing the joints, the final composite, which was based on conducted studies, is a mixture of hydrated lime, metakaolin, and silica sand. Moreover, after a small-scale pilot try it was decided that the chosen composites for mortars, injection grouts and adhesive materials for fragments to be used in conservation



Restoring the east sidewall of the wall at the SE corner. The work platform can be seen on the right. Photo: V. Eleftheriou, 2018

interventions in the blocks of the wall, had to be made of hydrated lime and metakaolin.

In parallel to the above, an evaluation study is being conducted on the effectiveness of fastener materials for the blocks within a laboratory environment (on appropriately formulated samplings) and in situ at the wall in a pilot scale.

The above information as well as the documentation of the pathology of the structural materials and the preservation condition of the blocks surface were included in the Strategic plan for the interventions.

Finally another research is being carried out for the selection of appropriate adhesive materials to be used for large

fragments of Piraeus stone and where the use of metal reinforcement is necessary.

The on-going works of listing, documenting and handling of scattered architectural members in the area of the Acropolis, conducted under the supervision of the Head of the Office archaeologist Dr E. Sioumpara and the archaeologist Dr M. Lala, focused during the period 2017-2018 firstly on producing an inventory of about 400 scattered architectural members in the area of the Chalkotheke and secondly on the way they should be treated. The scattered members were documented and placed in specific areas, the majority of them on the north and east of the old Acropolis Museum.

In addition, within the context of the collaboration with the Ephorate of Antiquities of Athens for the “Reopening and new uses of the old Acropolis Museum”, a large number of architectural members was listed; among them architectural members from the Erechtheion, and groups such as fragments from the votive offering of the kings of Pergamon, located on the NE of the Parthenon, were jointed to produce new members. The blocks recommended for storage were given to the Ephorate together with their catalogues; furthermore, all the blocks kept in the old Museum, 260 scattered blocks in total, were moved elsewhere in order to start restoration works in the building. In the summer of 2018 the adhesion of poros architectural members of large dimension started, beginning as such the 3rd phase of fragment adhesion.

In 2018 the restoration of the triglyph AE 21432, which came from the archaic Parthenon, was completed, it had been reconstructed with the use of actitis stone. The latest works comprised the carving off the surfaces of the fillings,



Recording architectural members at the area of the Chalkotheke. Photo: E. Sioumpara, 2018



Conserving the entablature of the Propylaea north wing. Photo: K. Frantzikinaki, 2018

so as to imitate the tool traces of the original fragments and the sealing of the joints. The restoration of the triglyph, with the collaboration of YSMA's Office of Scattered Fragments (E. Sioumpara, L. Zaharopoulos, K. Tsirindoulakis) and the Office for Surface Conservation (E. Aggelakopoulou, E. Fragkiadaki, G. Frantzi), had started after the late ESMA President Ch. Bouras suggested to the President of the Acropolis Museum, Professor D. Pandermalis to include it in the permanent Museum exhibition. Thus, since November 2018 the triglyph is being exhibited together with a column-capital coming also from the archaic Parthenon in the gallery of the archaic monuments at the Acropolis Museum. Finally, works of inserting reports, photographs and other information into YSMA's database continued together with the drawing of scattered architectural members.

The vacancies that existed in 2016 at the Electromechanical Team of YSMA were filled in September 2017 after recruiting specialised personnel; the person in charge of this team is G. Kechagias, mechanical engineer and museologist. The team during the period 2017-2018, apart from supporting the worksites of the monuments restoration, collaborated with the Ephorate of Antiquities in a

series of actions related to documenting the networks on the rock and the slopes of the Acropolis.

YSMA's Documentation Office, with Dr E. Lempidaki as its Head, and permanent personnel the archaeologists E. Karakitsou and E. Petropoulou, the painter D. Hamopoulou and the IT technician G. Alexopoulos increased its personnel by employing the archaeologists Dr C. Koutsadelis and S. Poulou as well as the librarian, M. Maznoki. The Office continued its work of documentation and management of documents by inserting into the database material from the restoration works of the Parthenon, the Propylaea and the tower of Athena Nike, and the works of backfilling at the Erechtheion; it has also started collecting documents from the restoration works of the walls. At the same time the database of AutoCAD files was updated, while, new documents were being imported in the library (books, reports, studies, project logs and others), and finally new content was added into YSMA's library catalogue Openabekt. The photographer T. Souvlakis continued the photographic documentation of the restoration works. Within the context of NSRF 2014-2020 a three-year contract was signed for filming selected works from the restoration of the monuments.



The triglyph and the capital of the archaic Parthenon exhibited now at the Acropolis Museum. Photo: V. Eleftheriou, 2018

E. Karakitsou, after entering information concerning moulds and copies of casts into a database and completing the catalogue of iron clamps from ancient and older restoration interventions on the Parthenon, delivered the works to the Ephorate of Antiquities. Digitisation of drawings and mappings were carried out while guidelines were drawn in order to launch a public tender for the digitisation of the existing film footage. YSMA also produced copies of its documents that were sent to the facilities of the National Documentation Center (EKT) for safeguarding.

New information signs containing information about the monuments were placed on the rock, south from the Parthenon.

The Documentation Office organised a variety of activities to promote the restoration works and inform the public, among them there were events, publications, updates of its website, and the exhibition “Chisel and Memory: the contribution of marble craftsmanship to the restoration of monuments”, with which YSMA and ESMA participated in the celebrations of the European Year of Cultural Heritage 2018, in collaboration with the Directorate of Modern Culture and Intangible Cultural Heritage and the Piraeus Bank Cultural Foundation

(further information can be read in an article that follows).

Finally E. Petropoulou and E. Karakitsou wrote the minutes of all ESMA meetings.

The Office of Information and Education employs the archaeologist I. Kaimara, who is the Head of the Office, and the archaeologists L. Leonti and M. Tsiolaki; during the works, Ms K. Hadjiaslani, the former Head of the Office, assisted in many ways. Among the numerous educational programmes, which many students, pupils and teachers attended, there are also programmes addressing children with special needs, such as the students of the Special School for the Blind at Kallithea. The popular programme “Build your own temple with Lego” was also created by the Office and was greatly appreciated during the Christmas holidays by the young visitors of the Acropolis Museum. The most important digital activity of the Office was the design of the online educational game “An ancient temple”.

In 2018, YSMA and the Ephorate of Antiquities of Heraklion participated in the proposal for a research programme that was submitted by the NTUA, the Harokopio University, and private institutions in the context of an invitation by EPAnEK for funding works within

the Action Plan of “Bilateral and Multilateral Cooperation between Greece and China”. The proposal entitled SCIENCE, concerns not only the implementation of satellite interferometry SAR on recording movements-deformations, in order to diagnose and observe possible dangers the monument face, but also the exchange of information within this particular field, focusing on the Athens Acropolis and the Medieval fortification of Heraklion. A similar recording will be conducted in monuments in China. This non-intrusive method does not expose the monuments to any danger and also has the capacity to collect data from the last twenty years. The proposal has been approved and the project fiche will soon be submitted.

Works that remain in suspension is the use of the property at Polygnotou Street, use rights of which have been granted to YSMA, which intends to convert it into the “Charalambos Bouras” Centre



The listed building which will house the Documentation Center of the Acropolis Works «Charalambos Bouras». Photo V.Eleftheriou, 2018

for the Documentation of the Acropolis Works. In 2018 the Central Council for Modern Monuments approved its new use and the relevant draft study, which was written by K. Skaris. In parallel with the above, a collaboration memorandum was signed with the Friends of Acropolis Society, while the P. and A. Kanellopoulou Foundation decided to subsidize the necessary studies so as to propose the work for inclusion in the next co-funded programmes.

Throughout this previous period, YSMA's Accounting Department, under the supervision of P. Katsimichas, and its personnel of M. Mouzoura, E. Soula-kou, A. Moshouris and A. Kapalou, has contributed a lot not only to the preparation and submission of the proposal for the funding from NSRF 2014-2020, but also to the demanding work of managing the resources taken from the three fund-

ing programmes (NSRF and PIP) of the works for the restoration and conservation of the Acropolis monuments.

For the effective management of the materials P. Karabetsou, Head of the relevant department and E. Zygouras have also made an important contribution. Finally YSMA's Administration Office, despite having only two members of staff, Ch. Papanikolaou, in charge and P. Konstantopoulos, succeeded in satisfying the administration requirements of the Service.

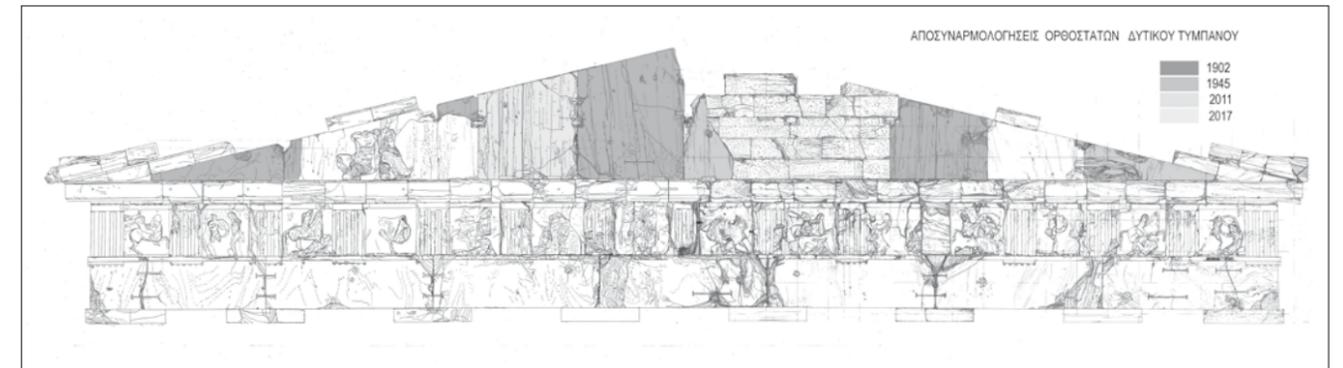
YSMA, almost twenty years in operation, has deployed until today about 52,000,000 € from the National and European resources in order to realise this impressive and successful restoration of the Acropolis monuments. Large parts of the monuments have been restored, as it is clearly indicated by the new marble fillings, while most of the scaffoldings

have already been removed. Applying the acquired experience and knowledge and with the support of the members of ESMA, as well as with the collaboration with the relevant departments of the NSRF Task Force of the Ministry of Culture and Sports and the Managing Authority of EPAnEK of the Ministry of Development, Competitiveness, Infrastructure, Transport and Networks, we are optimistic that we will complete the works within the deadline set and deliver to the public the parts of the Parthenon and the wall restored and secure.

Vasiliki Eleftheriou
Architect Engineer
Director of YSMA



A general view of the Acropolis from Philopappou hill. Photo: T. Souvlakis, 2018



Dismantling orthostates of the west tympanum in previous interventions. 1902: ΔTY1, part of ΔTY2, part of ΔTY3, ΔTY5, ΔTY8. 2011: ΔTY10. 2017: ΔTY4. 1945: Restoring part of ΔTY6.

Study of the orthostates: V. Manidaki, 2015. Surveying design: V. Eleftheriou – V. Manidaki, 2008.

The structure of the tympanum

The tympanum of the Parthenon's pediment comprises ten orthostates in the façade (TY1-TY10) and a backing wall of fifty-eight blocks of isodomic masonry placed on six courses. From the west pediment eight out of ten orthostates and two great fragments of the 6th orthostate are preserved. Only the 7th orthostate is entirely missing. The cross section of all the four central orthostates, which were obviously the higher and the heavier blocks of the tympanum differ from the others. Their builders resorted to carving part of the invisible side in order to lighten them. It is calculated that from the 5th orthostate (ΔTY5) the removed volume of the marble is about 1m³ and 2.8 ton weight. The three next orthostates on both sides of the tympanum gable are regular, in shape, with a rectangular cross-section.

Special attention was given in order to provide additional security to the horizontal connection of the four central orthostates, with the backing wall. It was used a unique and sophisticated system of eight pairs of custom-shaped clamps placed in the middle area of the orthostates height and the upper surface of the middle courses of their backing wall. These clamps have the shape of a twisted double T and are known in the bibliography as twisted-clamps. These clamps are the largest connectors that have been used in the building, reach-

ing 80cm in length and exceeding the ordinary clamps, which range between 30-50cm.

Early interventions

In modern times, the court architect Leo von Klenze, in his general proposals of 1834 for interventions on the Acropolis monuments, included the necessity to conduct repair works on the west pediment. In the period 1836-1842 under the direction of Kyriakos Pittakis, the first repair works took place for the fastening of the central orthostates. The two large orthostates were secured against overturning with the use of large connectors that were anchored on the backing wall. After the earthquake in 1894, Durm, Penrose and Magne expressed their concern about the danger of the pediment's collapse. Durm, especially, suggested that the most appropriate measure would be the entire restoration of the west pediment, with the use of new marble blocks for filling in the tympanum and its backing wall, as well as the reconstruction of all fallen cornices. In 1902, Nikolaos Balanos intervened on the pediment after completing works in the west side (1900-1902). Balanos' report on the restoration works he completed at this area is summed-up in a phrase: "the central block of the pediment was placed back on its original position and connected with iron clamps with the marble wall found behind the pediment blocks". Research revealed

though that Balanos had conducted more interventions on the west tympanum. Out of the eight in situ preserved orthostates of the west tympanum three were totally dismantled (ΔTY1, ΔTY5, ΔTY8) and parts of two other (ΔTY2 and ΔTY3), while four large clamping elements of strong profile were placed on the position of the ancient twisted-clamps, and sixteen clamps for securing the cracks were added; interventions were also carried out on the horizontal cornices underneath (ΔΓ12, ΔΓ13, ΔΓ14, ΔΓ15 and ΔΓ19).

Studies on the restoration of the tympanum - Priorities of the rescuing intervention

In the recent past, attention has been directed to the structural problems of the west orthostate. In 1997 K. Zambas, civil engineer from the technical office of the Parthenon (1984-2000), mentioned in a report that "deterioration has worsen...and that in some cases there is direct danger of big fragments falling off from the monument...".

In 2015, while examining the tympanum, after the completion of the restoration programmes on the two corners of the Parthenon west side (programme 2011-2015), it was documented the unstable condition of the central orthostates. Multiple crackings throughout the height of the marbles, some of which were caused by the oxidations of the

clamps used in Balanos intervention, as well as fractures on their footing posed a danger of crumbling that asked for immediate rescuing measures.

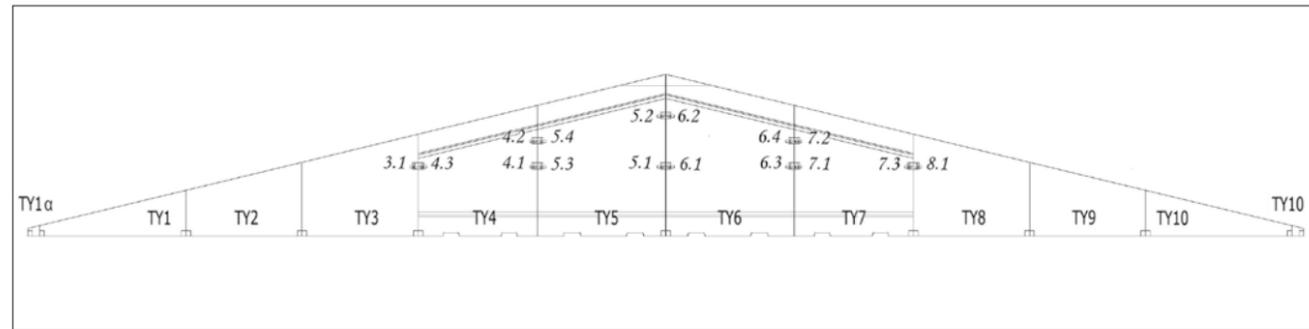
The restoration of the west pediment orthostates is part of the 4th sub-programme that focuses on the west side of the Parthenon, as it was defined by the “Study for the restoration of the west side of the Parthenon-general organisation of the project and intervention proposals on the two corners of the en-

and thoughts of the participants as well as YSMA’s personnel have been published in the Proceedings of the Meeting. The decision concerning the entire or partial completion of the tympanum is pending to be resolved after more urgent matters regarding safety will have been dealt with.

In 2016 the following studies were submitted and approved, “Study on the restoration of a tympanum orthostate of the west Parthenon pediment”, by

removal of the oxidized clamps from the previous interventions, the stabilisation of each member, and connecting them together by following as much as possible the ancient clamping system. For this reason it was found necessary to dismantle the damaged orthostates and the blocks of the backing wall allowing as such the removal of the clamps used at the Balanos restoration.

The intervention for safely consolidating the orthostates of the tympanum in-



Numbering the orthostates and twisted-clamps of the Parthenon tympanum (Code of row, number of the orthostate). Drawing: Manidaki, 2015

tablature” in 2008 by V. Eleftheriou, V. Manidaki and A. Vrouva. This study included information on the structure and pathology of the Parthenon tympanum and also alternative proposals for completing the orthostates with new marble. The study was approved by the Central Archaeological Council in 2008, with a positive decision regarding the entire filling of the tympanum. Since it was expected though to conduct a special study on the sub-programme, the question of whether the tympanum would be entirely or partially completed was raised again in a questionnaire addressed to the participants of the 6th International Meeting for the restoration of the Acropolis monuments in 2013. The two alternative proposals regarding the entire or the partial completion were presented in a poster at the exhibition of the Meeting. The theoretical reflections

V. Manidaki and “Structural problems of the orthostates of the west pediment, focusing on the risk of their overturn” by L. Paleologos; according to them priority was given to taking urgent action and to the implementation, firstly, of the rescuing intervention, which is probably the first and most crucial part of a potential planning for an entire making out. The current restoration programme is part of the wider programme concerning the west pediment, which involves the restoration of the backing wall (study by K. Skaris, 2013).

Main points of the proposed rescue intervention

The aim of this rescue intervention is, on the one hand, to treat important structural problems of the orthostates, and on the other, to safely connect them then with the backing wall. Treating these structural problems assumes the

cludes the dismantling, restoration and repositioning of 4 orthostates (Δ TY4, Δ TY5, Δ TY6 α , Δ TY8) and the in situ restoration of the third orthostate Δ TY3. Out of these 4 orthostates only the 4th orthostate was probably intact since the antiquity. The project also incorporates the restoration of the underlying horizontal cornices of the central area, because these are the blocks on which the central orthostates are standing and fixed with dowels (Δ Γ14, Δ Γ15, Δ Γ16, Δ Γ17, Δ Γ19 and Δ Γ21).

Commencing the works

The restoration of the tympanum started in June 2017 by carrying out the planned dismantling and taking down of the orthostates. Then the clamps of the previous restorations were removed and their fragments were detached. Thus the total extent of the fractures and any other damages could be assessed. Their

structural restoration was explored in an implementation study prepared by J. Dourakopoulos (Implementation study for the structural restoration of the orthostates Δ TY4 and Δ TY5, September 2018). There was also extensive collaboration with A. Vrouva on studying the seismic behaviour of the pediment. The restoration of the orthostates as structural members is expected to be complete by July 2019, while their repositioning will follow the structural restoration of the backing wall scheduled for the middle of 2020.

Implementation study for the structural restoration of the orthostates Δ TY4 and Δ TY5

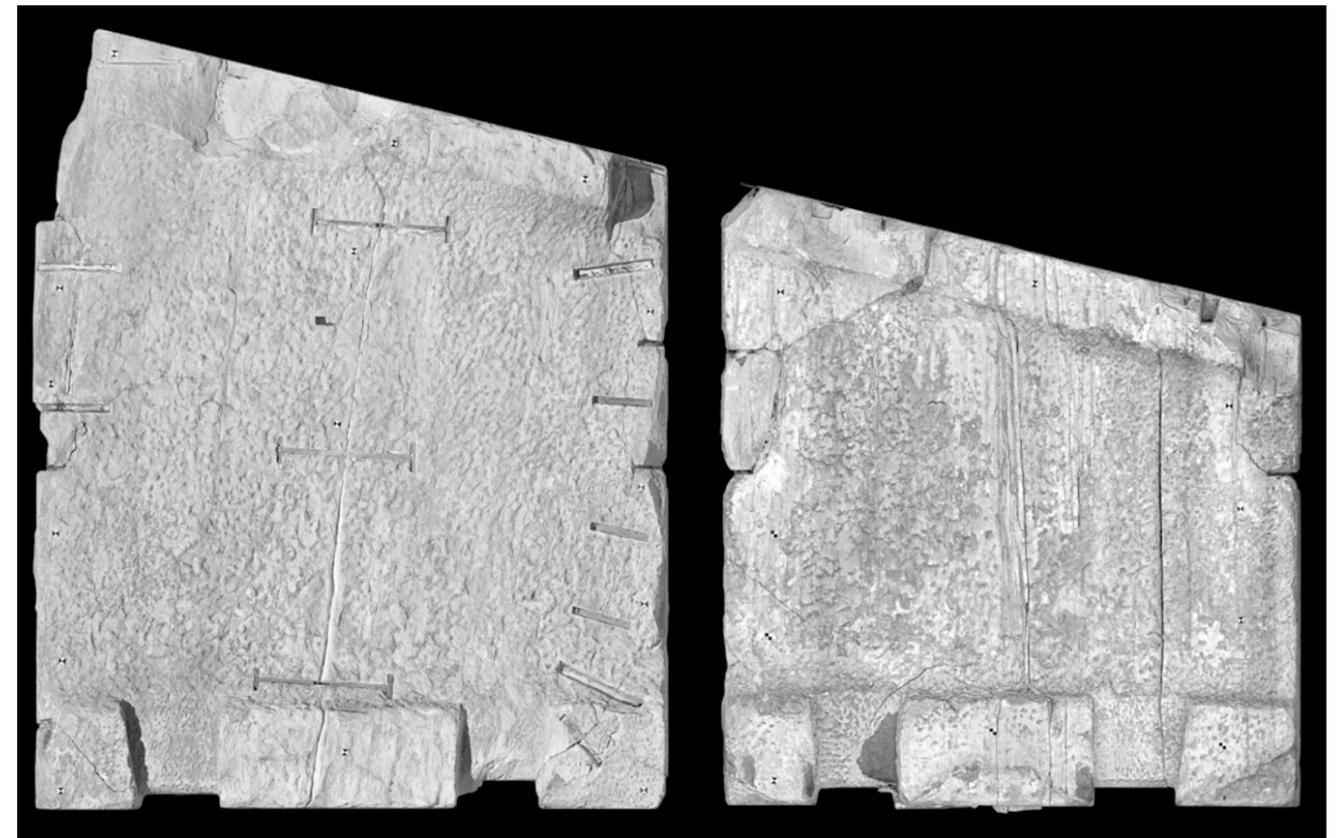
Initially, the design of the necessary reinforcement for the structural restoration of the orthostates, based on static calculations with kinematic considerations, was performed. Then, in order to test the aforementioned results and

design the clamping of the orthostates with the backing wall, dynamic analyses according to various seismic scenarios, were conducted. These scenarios were represented by the relevant recorded accelerographs, taken from the accelerographs catalogue which was composed in the context of the research programme entitled “Choosing the right accelerographs for dynamic analyses of the Acropolis monuments” (Psycharis 2014), after having been amplified with the appropriate factors. Finally, the chosen seismic scenarios were applied to the three main directions at the base of the monument.

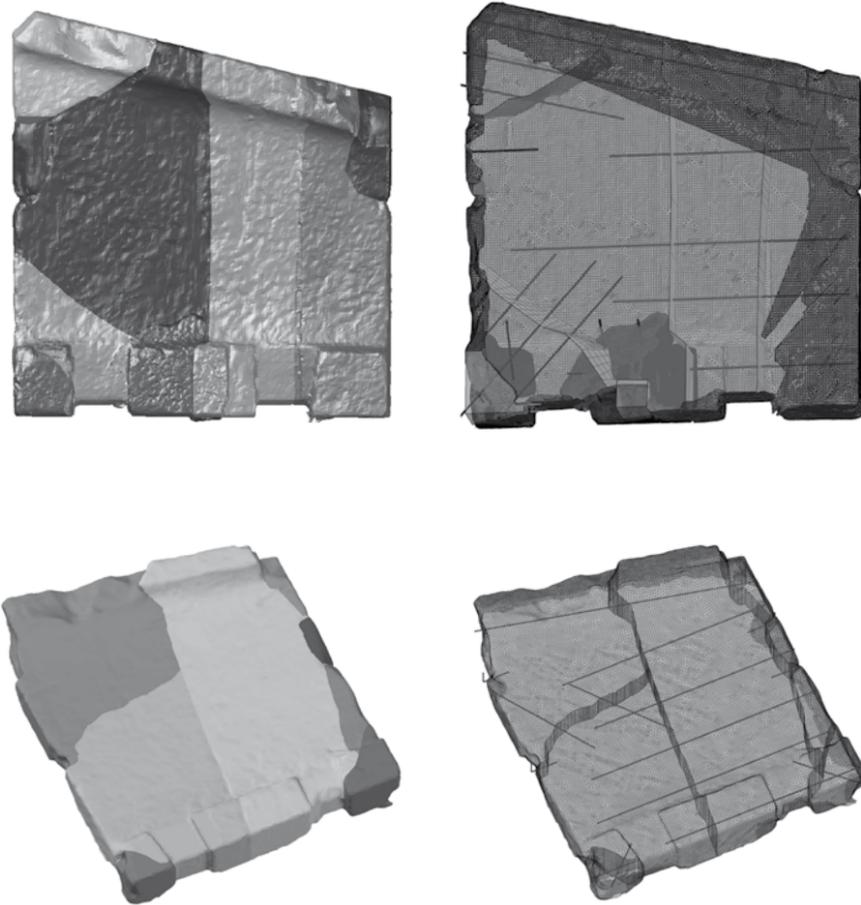
Because of the serious damage observed after the orthostates were dismantled, as it is thoroughly presented in the aforementioned study, according to which the orthostates mainly exhibit cracks throughout their width, vertical along their height and parallel to the

geological layers of the marble, it has been suggested that the reinforcements of the structural restoration should traverse horizontally, covering the largest possible length so as to consolidate these cracks and reinforce the ones that have yet to appear on opening fracture surfaces.

The study also highlights that special attention should be given to both the south corner of the orthostate Δ TY5 because of its almost horizontal crack through its width, at a height of about 1.90m from the orthostate base, and to the area at the south and middle footing of Δ TY4, which after a cannonade it has been broken into many fragments and uneven fracture surfaces. For the first case it has been suggested to place, apart from the horizontal reinforcements, inclined reinforcements in order to strengthen the horizontal crack and avoid a vertical drilling, in parallel, that is, with the



Orthostates of the west tympanum Δ TY5 (left) and Δ TY4 (right), east side. Orthophotographs: V. Kyparissi, 2018



Orthostates of the tympanum ΔTY4 (above) and ΔTY5 (below). Three-dimensional model: Above and below, on left: Different colours indicate the existence of fragments. Above and below on right: reinforcement of structural restoration. Photogrammetry: V. Kyparissi. Model: J. Dourakopoulos

crystal layers of the marble. For the second case, regarding the south and middle footing of ΔTY4, and because of the oblique fracture surfaces, it is suggested that inclined reinforcements should be placed along the width of the orthostate; moreover, some of the fragments, which cannot be joined with the others or held together with reinforcements because of their small size, should be replaced with new marble.

In addition, since the footing of the orthostate ΔTY4 has been rendered unsafe, even after joining its largest ancient fragments, and because of the uneven fracture surfaces along the narrow width of the orthostate, it is suggested that new marble fillings should be placed in the rectangular notches on

its footing that were used originally to set these members and consolidate the metal cantilevers under the pedimental sculptures. It should be pointed out that the correct seating of the orthostates plays an important role for their stability and seismic response, therefore the appropriate works should be conducted in order to secure them without though damaging the ancient surfaces. Moreover dowels should be repositioned on the base of the orthostates.

Finally, regarding the transverse clamps that join the orthostates with the backing wall, and because the cracks are located in the areas of their anchoring both on the orthostates and the blocks of the wall, it was found unsafe to restore the original geometry of the clamps. For this reason it would be better that every

clamp (four in ΔTY5 and three in ΔTY4) consists of two parts of bended bars that anchor on undamaged areas of both the orthostate and the relevant block, and which also have threaded edges that will be later used to join them together by using a specially shaped nut. When using the clamp inside the orthostate it is suggested to use dowels, perpendicular to the marble surface, placed in the middle of its width to minimize the possibility of fragmentation because of the narrow width of the marble. Moreover, it was found essential to reposition the Π-shaped connector that was placed by Balanos and joined the orthostate ΔTY4 with block 4.2 of the backing wall.

It should be noted that the dynamic analyses conducted in the above-mentioned study assumed that every block of the backing wall has been structurally restored; that is, the individual fragments of the blocks were tightly joined while their original dimensions remained the same. However, while the study was being carried out, and after dismantling the 4th and 5th courses of the backing wall, it was revealed that the blocks of the 3rd course were in bad preservation state exposing the existence of multiple fragments; in addition, there are also indications that many blocks of the 2nd course are in a similar condition. As a result, the preservation state of the orthostates and the blocks of the backing wall does not allow the development of axial forces that correspond to the dimensions of the cross-sections of the ancient transverse clamps. Therefore, it is proposed to use the appropriate decreased cross-sections so as the fracture of the clamp in the area of the marble surrounding the mortise could happen before any marble cracking.

Vasileia Manidaki
Architect Engineer

John Dourakopoulos
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Parthenon Restoration Project

Preface

The Acropolis wall is a monument of great historical, archaeological and aesthetic importance; thus, the condition of its preservation requires taking measures for its consolidation, renovation and protection. Given that, it is essential for a consistent restoration programme to conduct a comprehensive study of the historical and structural phases of the monument, its architectural documentation, and the examination of its structural pathology; in addition, it was considered necessary to compose a masterplan focusing primarily on defining the underpinning principles of these interventions.

The “Strategic plan for the interventions on the walls of the Athenian Acropolis”, realised by YSMA’s Technical Office for the Walls during the period between October 2017 and June 2018, focuses on the study of the monument’s historical phases, the recent interventions, its architectural documentation, the examination of its pathology and the presentation of alternative proposals for its restoration. It also discusses matters related to the coding system of the wall, its structural monitoring, its archaeological enhancement, the restoration of the western foundation wall of the Propylaea north wing, the problem of rainwater management on the Acropolis surface, the building materials of the wall and also the materials used for the conservation interventions. The following people participated in the study: Ch. Pinatsi (architect), C. Koutsadelis (archaeologist), E. Kakogiannou (civil engineer), D. Michalopoulou (civil engineer), A. Hadjipapa (architect), E. Aggelakopoulou (chemical engineer), E. Xynopoulou (chemical engineer) and A. Tsimereki (conservator).

Historical phases

The Acropolis of Athens was built on a high ellipsoid rock that dominates the landscape of Attica basin. This place was fortified for the first time during

the Mycenaean period (13th century BC) and parts of this fortification were probably preserved until the Persians invaded Athens and systematically destroyed it (480-479 BC). The few remnants of the Mycenaean wall, constructed in accordance with the cyclopean system using Acropolis limestone, can be easily discerned from later fortifications.

The construction of the new walls seems to have started right after the Persian Wars, at the time of Themistocles, when the north wall of the Acropolis was built (479 BC). A few years later the south and east walls were erected using plunder from Cimon’s victory at the Eurymedon river (469 or 466 BC), whereas during the construction of the Periclean Parthenon (448-437 BC) part of the Cimonian wall was raised. The walls, apart from their fortification role, functioned also as retaining walls of a large volume of backfilling, extending towards the south, which had considerably enlarged the surface of the Acropolis. The Acropolis though, loses very quickly its defensive importance and turns into an

unfortified sanctuary, especially after the construction of the Propylaea (437-432 BC) that left unfortified the western access.

In the construction of the Themistoclean wall architectural members from archaic buildings, destroyed by the Persians, were incorporated, often purposefully and not as simple building material. The ensemble of architectural members from the entablature of the Ancient Temple and the Pre-Parthenon column drums are two characteristic examples. In the Cimonian wall the isodomic construction system has been applied with the use of ashlar blocks of Actitis stone; yet, in its lowest section blocks from the Archaic Parthenon have been used, of which we can distinguish three architraves.

The Acropolis remains unfortified until the Late Roman period (3rd century) when its west side is fortified, probably after the destructive invasion of Herules (267 AD) and the dramatic shrinkage of the city. It is then that the Beulé



The north wall before Balanos interventions (1898). Among others we can see the wall that blocks the classical little gate (area B15), the large block erosion on the lowest dwellings of the area B16 and the chasm in the east side of the area B17. In the lower part we can see the wall of Hypapante (Photographic Archive of the Deutsches Archäologisches Institut: DAI-ATH-Acropolis-0323)



The north wall during the Balanos interventions (1904). The classical little gate has opened and the consolidation of the lowest part of the area B16 has been conducted with the use of rectangular blocks, while the restoration of the area B17 is being carried out. The intervention of L. Kaftantzoglou (1878) on the northwest retaining wall had already been concluded (Photographic Archive of the Deutsches Archaeologisches Institut: DAI-ATH-Acropolis-0617)



The northern slope of the Acropolis after the consolidation of the rock and parts of the northern wall by Balanos, in the period 1934-35. The massive walls retaining the rock mass were constructed in the framework of this intervention (American School of Classical Studies in Athens, Archives, Archaeological Photographic Collection: AK 1233)

gate with its two towers is built, while during the same period or little later (3rd or 4th century) the eastern part of the north wall is reconstructed from scratch and the north edge of the eastern wall is raised higher. This building phase, incorporating alternating zones of lower and greater height and blocks of grey and white colour, has an explicit morphological intention, in contrast with the interventions that would follow.

Throughout the Byzantine period the defence system of the Late Roman period seems to be retained without any important changes. On the contrary, during the period of Frankokratia (1204-1456), attention is paid to the fortification of the Acropolis once again, as it hosts now the palace of the sovereigns. The most emblematic work of that period is the construction of a high rectangular tower on the south wing of the Propylaia, while on the whole they cautiously re-organise and reinforce the fortification of the west side. However, after systematically dismantling the medieval and later fortifications the remaining parts that belong to the above historical periods are rather scarce.

Among them there are seven buttresses on the east part of the south wall that had been added to reinforce its bearing capacity. These buttresses were constructed with massive blocks in second use, together with straight rows of intact new bricks. It is worth noticing that reliefs were used in the 8th from the east buttress, probably either for aesthetic reasons or for averting evil; in one of these a protruding cross can be seen. In the parts of the wall between the buttresses there are many areas that can also be dated to the Byzantine or Frankish period, but we still need to investigate this matter further.

During the Ottoman period (1456-1833) the fortifications of the western side of the Acropolis were significantly

strengthened, adapted to the demands of the recently introduced technology of firearms. The powerful earthquake of 1705 makes necessary the extensive repair of the walls and in some cases even their total reconstruction. Moreover, the fierce battles that took place around the Acropolis during the Greek War of Independence (1821-1830) cause serious damages. Thus, we can attribute to the Ottoman period the extensive consolidation interventions with the use of rubble masonry on the exterior face of the wall as well as the re-building of entire parts of it in the vicinity of the Mycenaean stairway and in the middle of the east side of the Acropolis. Ottoman interventions often cover the ancient structures to such a degree that give the false impression that the latter has not been preserved, as for example the west part of the south wall.

Interventions on the wall in the 19th and 20th centuries

The Ottoman garrison withdraws from the Acropolis in 1833 and immediately afterward systematic works start for dismantling the medieval and Ottoman

buildings, including the battlements and fortifications of the west side. From the middle of the 19th century to the middle of the 20th century the walls are subject to successive consolidation interventions. On the north wall important interventions were carried out by N. Balanos, which aimed at its systematic consolidation, during the period 1899-1910, and at securing the rocky mass of the north slope in the years 1934-1935.

As for the south and east wall, despite some local interventions conducted by N. Balanos, its present form is to a large degree the result of a comprehensive restoration programme carried out by A. Orlandos during the period 1947-1950.

The interventions on the wall, having mainly a rescuing character, depending on the case include the consolidation, restoration or re-building with rubble the crumbling Ottoman masonry. Few are the cases of interventions with architectural aspirations, beyond their consolidation character. Among them there are the interventions carried out by L. Kaftantzoglou on the west retain-



The area between the 9th and 10th buttress during the Balanos intervention (1938). On the right there is the area of another intervention also conducted by him in 1919 (photographer: Voglis) (Photographic Archive of the Directorate for the Restoration of Ancient Monuments)

ing wall of the northwest terrace (1878), and by N. Balanos on the Athena Nike tower (1937-1938), both manifesting intentions to restore their classical form. Similar intentions, but through different means, can be also discerned in the intervention of A. Orlandos in the southeast corner of the wall, in which there is an attempt to imitate the ancient isodomic masonry with mortar.

Hence, the present appearance of the Acropolis walls is the result of consecutive interventions on the walls of the Classical period starting from the Late Roman era until nowadays, yet, most of these interventions do not possess any distinct characteristics. The enhancement of those historical phases with architectural aspirations still remains a challenge and should be one of the main objectives of the future restoration interventions. In addition to the above we should not overlook the historical significance of the walls, as they comprise the history of the city of Athens from its very beginning until today. Enhancing thus the architectural value of the walls of the Athenian Acropolis without erasing its historical memory constitute a major challenge for the current restoration project.

The pathology of the walls

The objective of examining the structural pathology of the walls is to document their present condition and hence identify areas that appear unsafe and request a structural study and possible consolidation plan.

The technical description of the pathology is supplemented by drawings that map the pathology of the exterior part of the walls surrounding the Acropolis rock; it also includes extensive photographic material. Moreover, the retaining walls that were built by Balanos in 1934 for the retention of the rock mass near the middle of the north side are also examined.

For every side of the wall, the areas are grouped according to the structural pathology they present, which is generally divided into two categories: in the deformation of the load bearing structure (rotation, displacement, barreling) and in the deterioration of the structural materials (cracks, fractures, weathering, material degradation, mortar erosion).

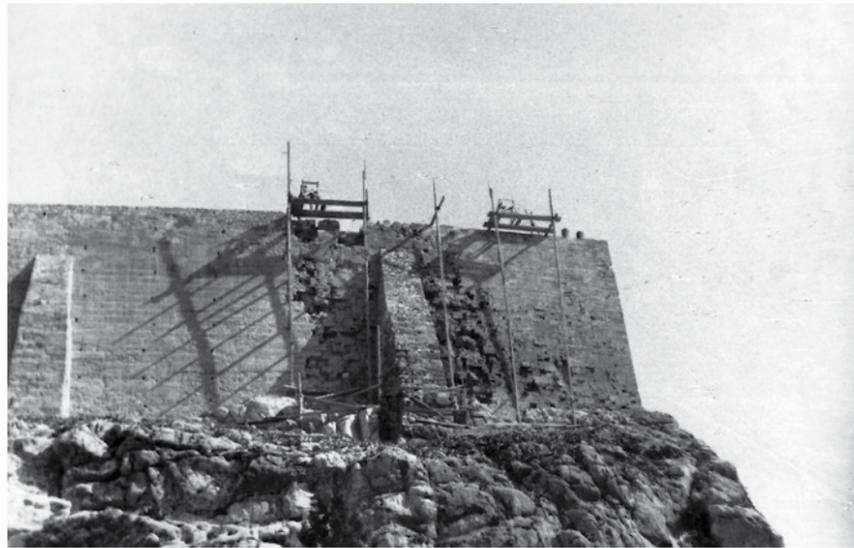
Hence, the areas that have been characterized unstable are presented below. It must be noted that every area corresponds to a photogrammetric sign and is coded under a capital Greek letter and a serial number. The letter denotes the orientation of the corresponding side of the wall (B/N/A/Δ), and the number the order the relevant area is found, from the east to the west or from the north to the south.

On the north wall the areas B3, B12 and B17 are highlighted, as inclinations relating to the vertical axis and localized curvatures can be observed. In the areas B4, B15, B16, B17 parts of the block structures are displaced to such a degree that large gaps are revealed.

In the area of the southeast corner it is observed loss of the structural continuity of the wall due to breaks of stones and extensive cracks that traverse this specific area from the crown to the base of both sides of the corner, at a distance of a few meters from the edge.

As for the south wall, emphasis should be given on its function as a retaining wall because it receives strong lateral earth pressures (active earth pressures) from the backfilling, which needs to be withheld. This backfilling, which was used to increase the level at the required height of the classical temples, is especially high (reaching 18m – 20m at the south-east corner of the Parthenon) because of the morphology of the rock on this side.

In the areas between the 6th - 7th and 9th - 10th buttress, counting from the east,



The Orlandos intervention on the eastern part of the south wall (1947). (Photographic Archive of the Directorate for the Restoration of the Ancient Monuments)

local curvatures are observed on the claddings, which may include part of the ancient construction. Due to the fact that the exterior claddings block visual inspection of the ancient construction, it is difficult to decide and conduct a study on how to intervene in these specific areas.

The main problem, apparent throughout the length of the south wall, is humidity, as it can be seen to cover an extensive area of the exterior part, presenting “damp parts” on the claddings. In many parts this has led to the erosion of the mortars used for the rubble masonry construction, leading to the creation of gaps between the blocks, displacements, or fragmentations that may lead to collapses. The above damages are more severe in the 7th buttress from the east, as well as in the area between the 11th-12th buttresses, where an extensive reduction in the mass of the construction material can be seen.

In the western wall, concavity can be observed in parts of the NW terrace area and the north tower of the Beulé gate. Extensive use of incompatible materials can be noticed in the areas Δ2

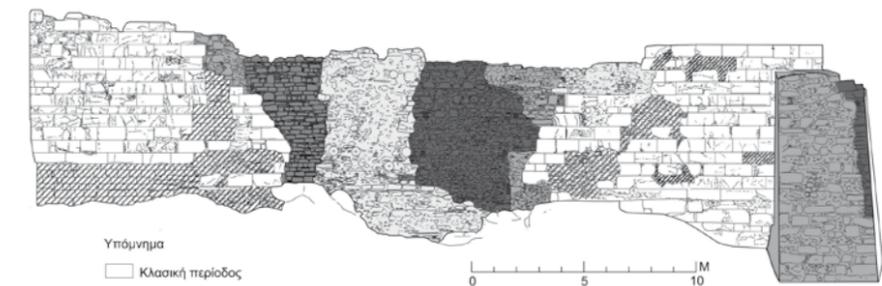
(NW terrace area), Δ5 (north tower of the Beulé gate - western view), Δ9- Δ10 (south tower of the Beulé gate).

Within the context of trying to detect the pathology of the walls it has been recommended that mechanical crackmeters should be immediately placed on the cracks of the walls in order to monitor their development and measure possible micro-movements. We suggest that 40 mechanical crackmeters be placed, the majority of which are positioned in the area of the SE corner and the NW terrace. The low cost of the crackmeters allows their application in large numbers.

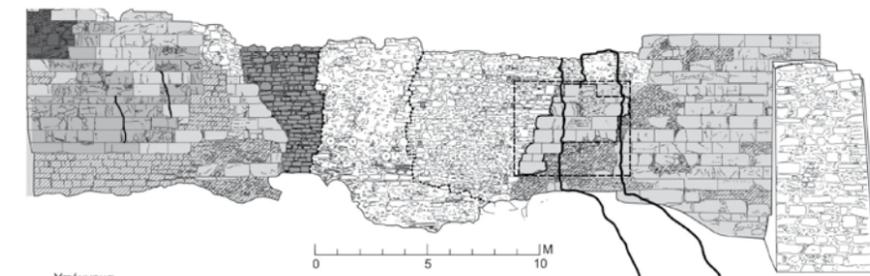
The suggested positions of the mechanical crackmeters can be seen in the drawings mapping the pathology of the walls. Finally, there has been an effort to compare the section drawings of the walls found in the bibliography with the sections produced by the photogrammetric survey; these drawings are also included in the study.

Architectural study

The architectural study of the Acropolis walls includes the documentation of the monument and the presentation of a

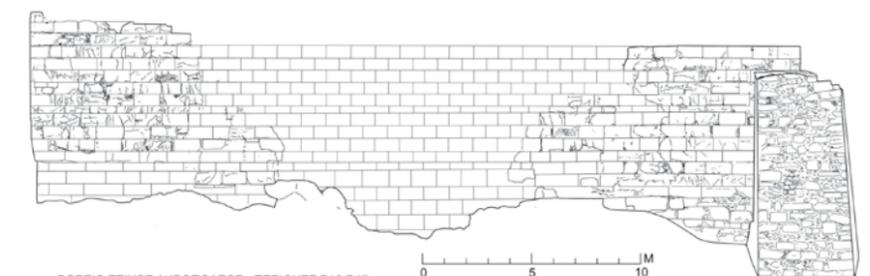


Υπόμνημα
 □ Κλασική περίοδος
 □ Μεσαιωνική/Πρώιμη οθωμανική περίοδος (:)
 □ Οθωμανική περίοδος
 □ 19ος αιώνας (:)
 □ 20ός αιώνας
 □ Τοπικές συμπληρώσεις προσώπου φθαρμένης αρχαίας λιθοδομής
 □ νεώτερες



Υπόμνημα
 □ Αποσάθρωση λίθου
 □ Απόσχιση τμημάτων λίθων / Απομείωση μάζας
 □ Τοπικές συμπληρώσεις στη μάζα του τείχους στην εξωτερική παρειά
 □ Διάβρωση κονιαμάτων
 □ Αποδιοργανωμένη λιθοδομή
 — Ρηγμάτωση
 Ελλιπής σύνδεση τοιχοποιίας
 - - - - Παραμορφώσεις (απόκλιση, ύβωση, καμπύλωση δόμων)
 — Κατακόρυφες εγκάρσιες τομές σε θέσεις με παραμόρφωση

North wall of the Acropolis, areas B16-B17. Indicative presentation of the documentation and analysis of the present state of a wall section. Above: Historical phases. (Study: C. Koutsadelis, Ch. Pinatsi. Drawing: Ch. Pinatsi, J. Trihakis). Below: Pathology (Study: E. Kakogiannou. Background: Ch. Pinatsi). Photogrammetric survey: Study for the development of GIS on the Acropolis of Athens, 2009



ΒΟΡΕΙΟ ΤΕΙΧΟΣ ΑΚΡΟΠΟΛΕΩΣ - ΠΕΡΙΟΧΕΣ B16-B17
 ΠΡΟΤΑΣΗ
 ΣΧΕΔΙΟ : ΧΡ. ΠΙΝΑΤΣΗ
 ΦΩΤΟΓΡΑΜΜΕΤΡΙΚΟ ΥΠΟΒΑΘΡΟ: Υ.Σ.Μ.Α. (Ανάδοχος: Ελληνική φωτογραμμετρική Ε.Π.Ε. & Geotech O.E.)

North wall of the Acropolis, areas B16-B17. Proposal. Drawing: Ch. Pinatsi. Photogrammetric survey: Study for the development of GIS on the Acropolis of Athens, 2009

restoration proposal. The architectural documentation of the walls was based on the existing photogrammetric drawings and also on new measurements and observations. Exploded views were drawn where individual construction phases were highlighted. Separating the phases resulted, on the one hand from the archaeological documentation and research in archive material, and on the other, from observing the masonry work, the changes and interruptions of the construction and the form of the structures. The formation of a proposal for the restoration and enhancement of the monument was based on its documentation and on the understanding of its construction history.

The monument presents ample possibilities for its enhancement and restoration of its classical phase; yet, we should bear in mind the necessity to use new material. The study aimed at defining a set of principles for dealing with later interventions on the walls, which by no means would result in treating every area similarly, since the wall is characterised by its diversity, different building history and unique problems in every section. The solution focuses on identifying the areas that can be re-

stored to their original form, in order to decide on the course of action specific interventions will follow.

Every restoration proposal is restricted by the necessity to document the initial form of the wall. The proposal concentrates on restoring the original form of the wall in the areas where it can be verified, and on preserving any later construction stages that play an important role, not only as historical evidence, but also as interventions with some aspirations. It aims at restoring the original form at areas where the wall has been haphazardly supplemented.

The solution corresponds to three degrees of intervention. The first case includes isolated stones or groups of stones which were roughly supplemented because of the loss of surface of the original stone.

The second case includes areas where the original masonry has collapsed, but it is flanked by surviving existing parts. Therefore, the connection of the restored part with authentic adjacent features, whether classical or rubble masonry, becomes an additional criterion for the restoration of an area.

The third case includes two areas, namely the westernmost parts of the north and south wall. They are not flanked by existing classical masonries, but the original structure exists behind the new masonries. These areas are at the vicinity of ancient monuments (the temple of Athena Nike and the Propylaia) and their substructures, which were also restored in the 19th century.

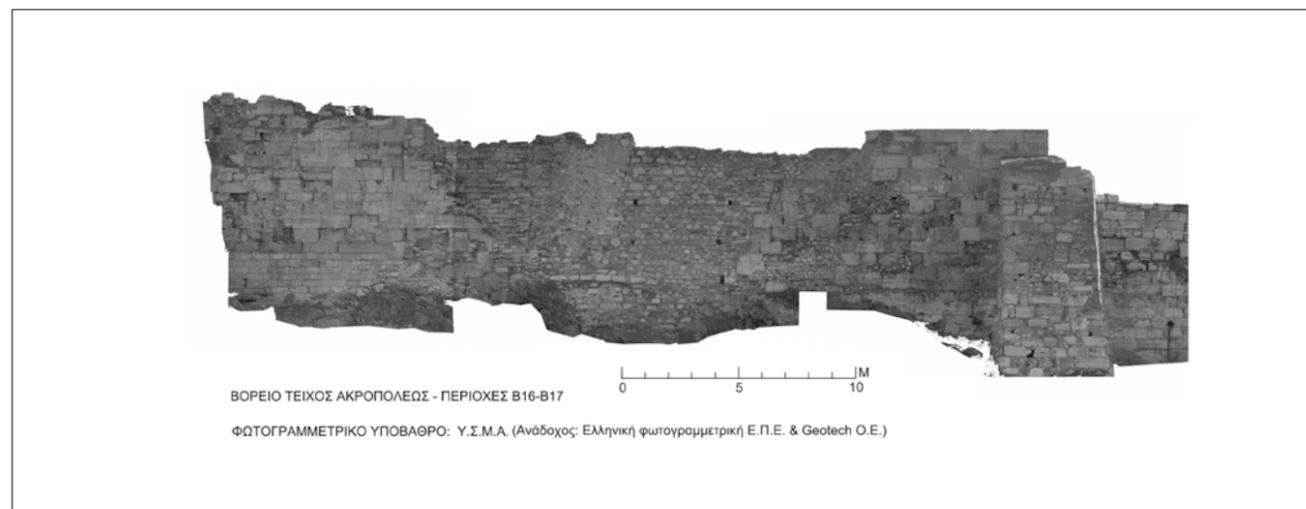
The “Strategic plan for the interventions on the walls of the Athenian Acropolis” has been approved by ESMA and it will soon be submitted to the Central Archaeological Council so as to be used as a guideline for other, future restoration studies.

Christina Pinatsi
Architect Engineer

Constantinos Koutsadelis
Dr Archaeologist

Evanthia Kakogiannou
Dr Civil Engineer

Walls Restoration Project



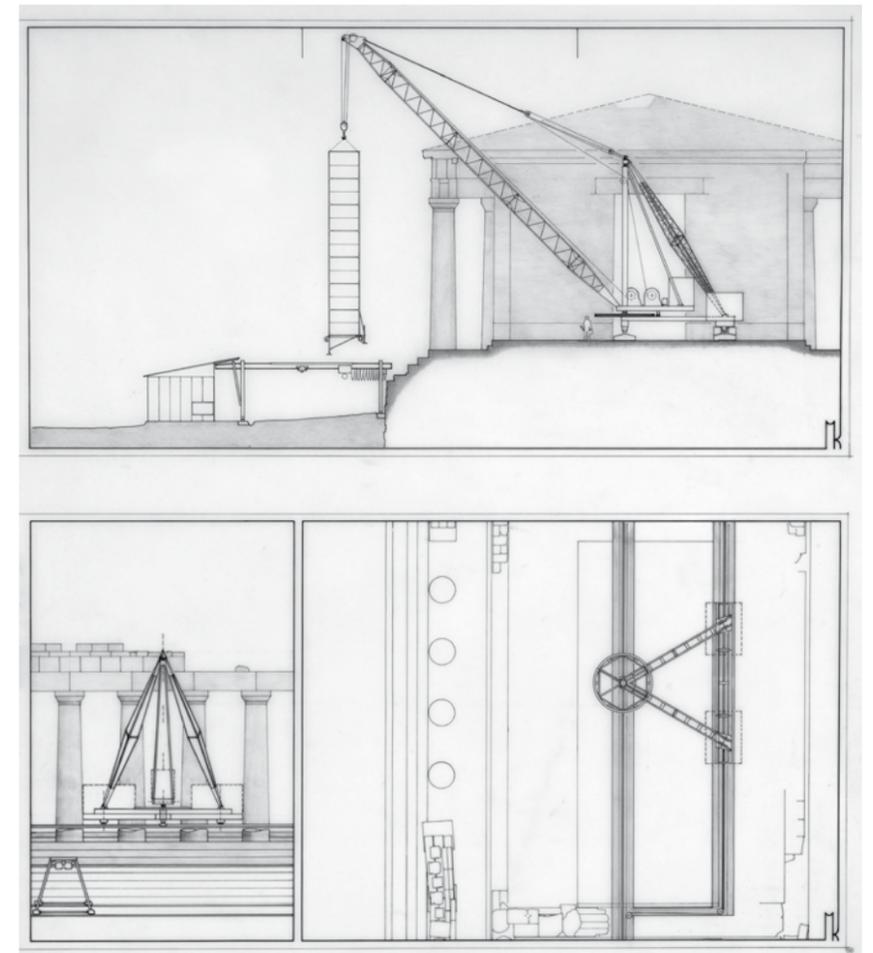
North wall of the Acropolis, areas B16-B17. Photogrammetric survey: Study for the development of GIS on the Acropolis of Athens, 2009

In 2017 the Parthenon worksite equipment was re-organised. The “Potain” crane (named after the company that manufactured it) was transported from the west side of the monument to inside the Parthenon, and the old “Derrick” crane (named after its type, a folding boom crane) was withdrawn. The transportation of their components was supported by a third crane (construction Tower crane) which was installed on the north side of the Parthenon. The old Derrick crane, which was installed inside the Parthenon in 1985 and had been unceasingly used in the restoration programmes for 32 years, was translocated at Lavrion Technological and Cultural Park, where it is exhibited as a monument of the history of the Acropolis restorations.

The new arrangement of the worksite equipment and mainly the new location of the crane and its sub-base alongside the central axis of the cella, facilitate the removal of the architectural members for most restoration works that are being or are to be conducted in the Parthenon during the following years; that is the restoration of the west pediment, the ceiling of the west wing, the west wall, the north wall of the cella, the Pronaos, and the future restoration works of the south wall of the cella and the south colonnade. Redesigning the worksite area has really enhanced the view of the Parthenon and the surrounding archaeological space, as the iconic west side of the Parthenon is now freed from the large worksite crane, which nowadays operates from a position that does not obstruct the sight of the monument. The evaluation of various alternative proposals and studies for the relocation of the cranes were made with the contribution of the mechanical and electrical engineer S. Oikonomopoulos.

The old Derrick crane

The Derrick crane was firstly proposed for the Parthenon restoration programme on the recommendation and technical description of M. Korres in 1981. The main characteristics of its design are its steady base, an equilateral triangle of an 8m side, on which a ring



Drawing of the Derrick crane (M. Korres, 1981)

of 4m diameter is placed allowing so a horizontal rotation in a 260° angle. The maximum length of the boom is 39m consisting of two edge parts, while in between there are interchangeable components of a 6m length. It employs on its steady base counterweights of concrete 2x35 tons and 20 tons on its rotating frame.

The crane was built in 1983 at the Pinguelly-Creusot-Loire factory, after the implementation design by the mechanical engineer Haulotte. It was assembled for the first time on the Acropolis in 1984 and built in the Parthenon cella in 1985. The crane, though, was finally, delivered after modifications and improvements in 1987. The total cost for the purchase, transport, assembly and modifications came to 15,054,482 drachmas (see M. Korres “The supply-

ing and positioning of a crane with a boom of 27m and lifting capacity of 12 tons for the works of the Parthenon restoration” (in Greek), September 1981, YSMA/ESMA Archive).

During its operation, the Derrick crane was shifted and rotated several times in order to obtain the optimum position inside the cella, serving the special needs of the restoration works at the eastern facade, the Pronaos, the Opisthonaos and the northern colonnade of the Parthenon.

The metallic sub-base of the Derrick crane was studied by the engineers K. Zambas and S. Angelidis in such a way as the loads of the crane were uniformly distributed over a large surface of the floor. For this reason a special system of corbelling units was designed which



The Derrick crane placed inside the cella of the Parthenon. Programme of restoring the eastern part. April 1986. Photo: Unknown, 1986

were easily shifted and rearranged inside the Parthenon cella. The crane could roll on the top of the corbelling units with the help of traction portable winches (guitars). Moreover, a slab of reinforced concrete, 25cm thick, was made over the ancient pavement in order to protect the

ancient floor and its substructure from heavy loads, deterioration and pollution during the time the operation of the crane inside the cella.

The Potain worksite crane

The MR90 Potain worksite crane manufactured by the company Potain is elec-

trically driven, travels on rails and has an inclining fully revolving boom/jib (360° rotation). The basic features of its design are the small axis distance of its trajectory (4.5m) and its direct positioning on a cross-shaped base without a tower in order to have a small height. Its mechanical properties are the lifting capacity of 3.9 tons in its maximum span (a boom of 30m length, its lifting hook is fixed on its edge). Its maximum lifting capacity is 10 tons (at 3-19m) and has the potential for a varying lifting speed of its hook, starting from a very low speed (5 tons in 0-40m/min).

The Potain crane was firstly installed on the Acropolis in 2001 to address the needs of the restoration of the north side and was moved in 2011 to the west of the Parthenon, on a strong reinforced concrete base (constructed in 2010) for the needs of the restoration works of the western front.

The new sub-base of the Potain crane: study and implementation

After studying potential alternative solutions, the new sub-base of the Potain crane was built inside the cella by using parts from the metal sub-base of the old Derrick crane (built in 1985), so as to save time and money by recycling most of the existing material and reduce any retrofitting works. The redesign was based on the initial system which was accordingly modified, taking into account the fact that the Potain weighed much less than the Derrick, and also the new sub-base has to be strengthened at its west edge. In the framework of sub-base redesign, the civil engineers Z. Konteas and A. Vrouva studied the distribution of the loads on the foundations of the Parthenon (taking into account the possible earthquake action of 30 years). Moreover the bearing capacity of the old iron units which were re-used was evaluated, and it was recommended their reinforcement with strong strips.

The siting of the sub-base inside the Parthenon was designed in such a way that the crane could be used in all the remaining restoration programmes on the Parthenon; in particular, to satisfy the special requirements in terms of lifting

loads and distances for safe operation of the crane. The position of the sub-base along the longitudinal axis of the temple, nearly in contact with the western wall, was defined by the large loads at the west front that in this particular case concern the project of restoring the west pediment (the heaviest block is the 5th orthostate –ΔTY5– weighing 7.5tons and also the 6th orthostate –ΔTY6– if its entire restoration of the west tympanum is decided). After completing the works on the west pediment and the west peristyle, it is planned several units of the sub-base to be transferred eastward so that the crane will reach the eastern part of the cella and support the restoration works of the Pronaos.

Dismantling, relocating and assembling the cranes

The proposal regarding the process of relocating of the existing cranes was made after looking into various alternative solutions, and considering the available space and the capacities of the worksite equipment (cranes, bridge crane, vehicles). The solution to dismantle and reassemble the Potain crane by using the existing Derrick crane was evident since it has been tried out again when the Potain was moved from the north to the west side of the Parthenon. A crucial drawback though was the necessary transfer of the Derrick alongside the west wall in order to dismantle the Potain crane, and then to rebuilt it on the east side so that it could erect the Potain crane in the vacant area that would remain towards the west wall. This solution was quickly discarded as it was realised that the Derrick crane could not meet the needs for lifting the heavy parts of the Potain at a distance of 30m, due to the frequent operating problems it had had recently.

As a result there was the need to install a third temporary supplycrane to help with dismantling the Potain, the Derrick crane and its existing sub-base. This solution allowed us not to invest any money in repairing the Derrick, whereas dismantling the sub-base freed the space of the cella where we could assembly from the beginning and more accurately

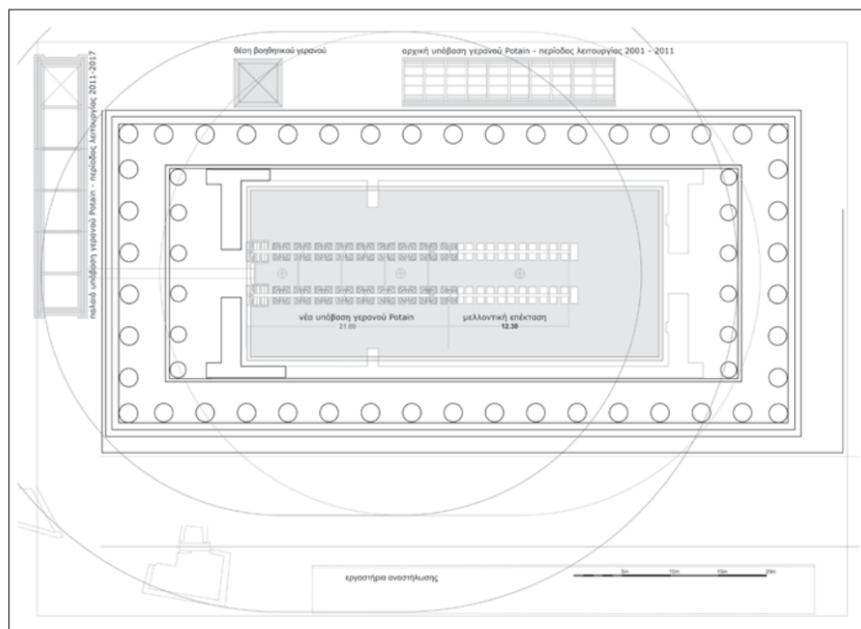


The Potain crane placed on the west side. Programme of restoring the west side. Photo: V. Eleftheriou, 2011

a new sub-base. Moreover, during the period the Derrick parts were being dismantled, the Potain crane was free to operate at the worksite works.

The third crane was built on the north of the Parthenon at a distance of 15m east from the northwest corner. This position was chosen because, on the one hand, the two existing cranes and the temporary supply one, had to be at an appropriate distance with each other and, on

the other, this rather small crane was uncertain whether it could carry out the previously mentioned works. On the north side of the Parthenon there was also enough space to temporarily place large parts of the dismantled cranes that could be transferred with the tractor of the YSMA to the southwest corner of the old Acropolis Museum and then towards the crane at the supply area of the Acropolis.



Principal geometric characteristics of the new sub-base of the Potain crane inside the Parthenon. There can be seen the older sub-bases on the west and north of the Parthenon (in grey the protective concrete slab inside the cella).

Study: V. Manidaki - R. Christodouloupoulou



The temporary installed crane in operation. Photo: V. Manidaki, 2017

The works of translocation of the cranes were conducted in 3 months, from October to December 2017. This time of the year was chosen to take advantage of the relatively low tourist season and to limit the disturbance of the visitors. By the summer of 2017 all the prerequisite works, such as the purchase and processing of all the supplementary materials for the construction of the new sub-base, were completed. The works of dismantling and assembling the cranes, was implemented by the company Inter-crane after the YSMA had published a call for tenders (actions D-E, H-L). At the same time the personnel of the YSMA under the supervision of the engineers of the project conducted the following works: preparing the space where

the cranes would be placed, laying the new sub-base and transferring by using YSMA's vehicles, the components of the cranes during their relocation (actions, A, B, C, F, G).

The successive actions of all the conducted works can be summarised as follows:

A. Dismantling the old sub-base in parts, except for the ones where the old Derrick crane was seated, and transferring them outside the Acropolis in order to reinforce them.

B. Casting in a reversible way 4 reinforced concrete bases on the Acropolis rock, on a spot northwest of the monument.

C. Transferring components of the temporary installed crane, from the supply

area of the Acropolis to the northwest corner of the Parthenon.

D. Building the temporary installed crane on the casted base by using the Potain crane, on the northernmost edge of its lifting trajectory.

E. Using the temporary installed crane to dismantle the old Derrick crane and placing its components on the north platform and inside the cella.

F. Using the temporary installed crane to dismantle the remaining base of the Derrick crane and assembling the material on specific places inside the cella; transferring any surplus material to the supply area of the Acropolis.

G. Building of the new sub-base, made of new and old material, assembling the new ready-made metal parts (longitu-

dinal stress beams, transverse-clamped beams, clamped slabs and rails), with the help of the temporary installed crane. The specifications of the manufacturer referring to the rails being horizontal and parallel to the main beams were complied. The horizontality, the alignment and parallelism of the rails, were followed by the levelling survey. The needed corrections for their accurate levelling were made with the insertion of tinplate strips under the rails.

H. Reinforcing the load-bearing parts of the new sub-base on the spot by welding additional strips, as well as its west edge, in accordance with the static study.

I. Dismantling the exterior Potain crane with the help of the temporary installed crane and transferring its components inside the monument.

J. Reassembling the Potain crane on the new sub-base with the use of the temporary installed crane.

K. Dismantling the temporary installed crane with the help of the relocated Potain crane and transferring its components outside the Acropolis.

L. Transferring gradually the components of the old Derrick crane to the area of the Acropolis supply crane and then transporting them to Lavrion.

It should be mentioned that the transportation and handling of the oversized, bulky and heavy components of the cranes, as well as the materials and tools needed to complete the project, was a very demanding and difficult task. Their transportation started from the supply area of the Acropolis on the east foot of the Rock, where they were first unloaded and then raised to the Rock with the use of the hoist crane. Afterwards they were moved on a rail-mounted rolling platform along the south wall, and were loaded on YSMA's tractor in order to transfer them in along the eastern and northern side of the Parthenon to the northwest corner of the monument. All these transfers had to be completed by 9 am to avoid distracting the visitors. So, for the actions K and L, we planned an internal way, using the interior crane and the south bridge-crane of the Parthenon. The determination and the experience of the technicians of the Parthenon con-

tributed to the successful conclusion of the entire project.

In order to preserve and enhance the decommissioned Derrick crane it was suggested by the supervising engineers of YSMA its donation to the National Technical University of Athens. Soon after the approval of the donation by ESMA and the immediate response of the NTUA, the crane was re-assembled and exhibited at the Lavrion Technological and Cultural Park where it could be used in educational programmes on the history of restoration. Lavrion, a place

where silver was mined and thus was a financier of the Parthenon construction, will once again be associated with the works carried out on the Acropolis with the help of the "Iron Titan" of its contemporary restoration.

Rozalia Christodouloupoulou
Architect Engineer, Head

Vasileia Manidaki
Architect Engineer

Parthenon Restoration Project



Moving the Potain crane in the Parthenon cella. Above, left: Transferring component of the temporary installed crane with the use of YSMA vehicles. Photo V. Manidaki, 2017. Above, right: Dismantling the Derrick crane with the help of the temporary installed crane. Photo V. Manidaki, 2017. Below, left: Assembling the Potain subbase using material from the Derrick subbase. Photo R. Christodouloupoulou, 2017. Below, right: Assembling components of the Potain crane inside the Parthenon cella. Photo V. Manidaki, 2017



The Potain crane inside the Parthenon cella. Photo: R. Christodouloupoulou, 2019

ry: recalling moments of the Propylaia restoration” was designed by YSMA’s Documentation Office and under the art direction of the photographer, T. Souvlakis.

The exhibition comprised 44 photographs from the Propylaia restoration works, arranged in an innovative way: instead of following the chronological order of the works, the material was grouped around seven thematic pivots that summarise the emotions and situations someone experiences while working daily at the worksite: self-denial, labour, collaboration, zeal, admiration, innovation and companionship. The photographs were systematically selected from the rich photographic archive, managed by YSMA’S Documentation Office, through a specially designed digital database. The selected photographs allude to the multiple readings a document offers and the abundance of information a researcher may retrieve from



The photographic exhibition «Chisel and Memory» in the Catholic chapel in the Old Fortress of Corfu. Photo T. Souvlakis, 2018

a well-organised Archive. Besides the obvious information about the progress of the works, the photographs also indirectly document the development of restoration methods and techniques, and show the protagonists of the projects, the transformations of the archaeological landscape etc. The exhibition comprised an exhibit consisting of an original bench with a pointing device, a mould and a marble filling, with an aim to help the visitor understand the process of producing fillings of new marble, according to the traditional technique of copying shapes which has been implemented on the Acropolis works and which guarantees the reversibility of the interventions. The exhibit was created by the marble technicians G. Desypris and M. Bon.

The exhibition was held in the multi-purpose hall of the permanent exhibition “Men and tools”, at Plaka, from 18th November to 9th December 2016, in collaboration with the Museum of Modern Greek Culture. In the opening the President of ESMA, Professor M. Korres honoured us with his presence while welcoming speeches were delivered by YSMA’s Director V. Eleftheriou, the Director of the Museum of Modern Greek Culture, Dr E. Melidi and the Emeritus Director of YSMA, M. Ioannidou. In the summer of 2017 (from 12th to 26th

of August), after an invitation to be included in Tinos Festival, the exhibition was hosted at the Giannoulis Chalepas Museum, Tinos. The marble technicians P. Georgopoulos and G. Vidos contributed significantly to the transfer of the exhibition to Tinos. A year later (from July 20 to September 30, 2018), on the initiative of the Greek ambassador Dr V. Dikopoulou, and under the auspices of the Greek Embassy in Vilnius, the exhibition “Records of Memory” was held in the National Library of Lithuania, as a contribution to the celebrations of 100 years of restoring Lithuania’s Independence. YSMA’s Director, who had been invited to attend the exhibition opening, delivered a lecture about the restoration works on the Acropolis. Moreover, the

Documentation Office published a leaflet in English, edited by E. Lempidaki.

Responding to the great deal of interest the visitors expressed for the exhibition, the Direction of YSMA took the initiative to enlarge its content; thus, the exhibition was reorganised, under the title “Chisel and Memory: the contribution of marble craftsmanship to the restoration of the monuments”, in order to include photographic material from all the monuments on the Acropolis rock. The exhibition in its renewed content was incorporated in the events organized by the Ministry of Culture and Sports for the European Year of Cultural Heritage, 2018. This exhibition contains 107 photographs from restoration works at the Erechtheion, the Parthenon, the Propylaia and the temple of Athena Nike, and is organized in six thematic units: self-denial, labour, collaboration, zeal, pride and companionship. The exhibition material was

selected by Y. Alexopoulos, IT consultant, E. Lempidaki, E. Karakitsou and E. Petropoulou, archaeologists and K. Mamalougas, architect. The photographs selected expressively portray the contribution of marble technicians to the multifarious work of restoration and enliven moments from the daily life of the worksites on the Acropolis rock. For this new production YSMA collaborated with the Directorate of Modern Cultural and Intangible Cultural Heritage that contributed to the exhibition the film “Tinian marble craftsmanship”, produced in 2015, after Marble craftsmanship was included in the UNESCO Intangible Cultural Heritage List.

The exhibition “Chisel and Memory” toured many places; it started from the

city of Corfu, after an invitation by the Ephorate of Antiquities of Corfu. It was held in the Catholic chapel, in the old fortress of Corfu, and remained there from the 6th to the 30th of July 2018. At the opening of the exhibition (6th July 2018) welcoming speeches were addresses by YSMA’s Director and the Head of the Ephorate of Antiquities of Corfu, Dr D. Rigakou. The exhibition’s next stop was Mytilene where it was transferred after receiving an invitation from the Ephorate of Antiquities of Lesvos. The exhibition was held in the New Archaeological Museum of Mytilene from the 9th to the 27th of August. At the opening the Head of the Ephorate, Dr P. Triantafyllidis, addressed the visitors. On behalf of YSMA the architect Dr K. Karanasos attended the opening. The Director of the General Directorate for the Restoration, Museums and Technical Works Dr A. Androulidaki honoured the event with her presence. In the autumn of the same year, after the invitation of the Piraeus Bank Group Cultural Foundation (PIOP) the exhibition was transferred to Thessaloniki in its recently restored Conference Centre located in the heart of the city’s commercial centre. The exhibition was held there from the 1st to the 31st December 2018. This time the exhibition included a presentation of YSMA’s educational programmes and it was enriched with a number of parallel events organ-



The photographic exhibition «Chisel and Memory» at the Conference Center of the PIOP. Photo E. Petropoulou, 2018

ised by PIOP. An interesting seminar was organised addressing teachers (28th September 2018) where the Director of YSMA and the Head of the Department of Information and Education Ms Ir. Kaimara presented YSMA’s work. On behalf of PIOP the Director of the Museum Network Mr A. Lapourtas presented the educational programmes of the Foundation. At the opening of the exhibition, held on 29th November 2018, Dr M. Andreadaki-Vlazaki, the General Secretary of the Hellenic Ministry of Culture and Sports sent a welcoming speech, while introductory speeches were delivered by V. Eleftheriou, A. Lapourtas, and also by Dr A. Kontogiorgi, the Head of the Museum Sector of the Directorate of Modern Culture and Intangible Cultural Heritage. For the exhibition in Thessaloniki YSMA prepared a billboard containing information about the completed and on-going restoration works, responsible for the design of which was P. Konstantopoulos.

On the occasion of the exhibition “Chisel and Memory”, YSMA’s Documentation Office produced two publications. The first one is a triptych brochure, designed by the architect Ir. Vaina during her voluntary work at YSMA. The second one is the exhibition catalogue, an elegant publication under the art direction of the archaeologist of the Documentation Office Ms S. Poulou. T. Souvlakis cu-

rated the photographic material used in both publications, while the writer was responsible for the editing.

The organisation of the two photographic exhibitions is part of a broader group of activities organised by the Documentation Office aiming at informing the public about the works. In this particular case, the Office attempted a different, more substantial approach towards the public, opening a window in the daily life of the worksites and allowing the visitor to see what happens “behind the curtain”. The initiative proved for one more time that a remarkable part of the public –especially in the towns of the Periphery– has a constant interest in the Acropolis works. Responding to the request of informing the public opinion arises not only as an obligation for YSMA but also as a necessity, since contact with the public provides feedback to the YSMA personnel and enlivens the enthusiasm that they usually invest in their work.

Elena Karakitsou
Archaeologist

Evi Petropoulou
Archaeologist

Documentation Office



From the opening of the photographic exhibition «Chisel and Memory» held in the New Archaeological Museum of Mytilene. Photo K. Karanasos, 2018



The introductory video of the game

Preface

In October 2018 the YSMA's Department of Information and Education completed the creation of a new educational web application named "A Greek Temple" (ancienttemple.ysma.gr). The application draws elements from the Department's museum kit, of the same name. Similar applications have already been developed and had been used, such as the museum kit "The Parthenon Frieze" and the teacher's pack "Acropolis and Restoration", whereas the Acropolis Museum family backpacks developed by YSMA have had their printed material similarly enriched with web games.

The subject of the new application is the architecture of the ancient Greek temples. It targets children older than 9 years, teachers interested in using it within the classroom environment and also parents who wish to use the educational games of the application together with their children.

The use of new technologies in the field of culture has the potential to attract greater public interest, in particular the young, offering multifaceted educational experiences. It also contributes to increasing people's awareness and the cognitive, aesthetic and emotional familiarity of the public with the monu-

ments. Finally it enables public understanding of the importance attached to the protection of cultural heritage. YSMA's Department of Information and Education has extensive experience in designing digital activities, commencing the development of educational web applications as far back as 2008. "A Greek Temple" is the sixth successive digital application and there has been an effort to encompass the conclusions drawn from the evaluations of earlier applications.

The application is designed in Greek and English and was funded through the National Strategic Reference Framework

"ESPA 2014-2020". Its design, development and artistic editing was carried out by DIADRASIS.

The design of the application

Exploiting the full potential of new information and communication technologies in the area of museum education has enabled us to engage the visitor in the learning experience. For this reason, in addition to the prime objective, of acquainting the users with the architecture of the classical temples of the antiquity, the following goals were set to:

- promote the gamification of learning
- enrich the school lesson
- expand the experience of visiting the monument
- encourage further learning
- help children develop various skills (imagination, observation, language skills, critical thinking, collaboration).

It was also imperative that the necessary principles used for the design of the application should be defined and based on contemporary theoretical approaches of museum education.

Thus, a balance between educational games and entertainment had to be initially established and maintained. That is, besides providing knowledge of the particular subject matter the application needed to include games that could



Creating an avatar

contribute to recreation, inspiration and pleasure, but retain their educational dimension. Users should not need to have specialized knowledge to navigate the application, the content would be arranged and structured in levels of thorough knowledge and finally there should be a separate unit for teachers.

Consequently, there are visitors in a web page who would be able to choose to participate in an activity based on their available time or their level of familiarity with the subject. Moreover, the development of the application drew on the principles of Discovery Learning, according to which, digital activities function as entry point to the content and not as a monitoring role, strengthening as such, the user's propensity for interaction and exploration. Discovery Learning also accords with contemporary theories of Constructivism where learning is considered as a continuous and dynamic communication process, both personal and social, which presupposes active receivers who process the messages according to past experience, beliefs and interests. Likewise, the users are given the possibility to creatively exploit the content by encouraging self-expression. Other important parameters that influenced the design of the appli-

cation arose from the desire to motivate the visitors to replay the games, and also to provide feedback from their answers.

Finally, priority was also given to matters concerning the clarity of the rules of each game, an attractive layout, the visual coherence of the screens and the usability of the navigation.

Technical characteristics of the application

As it can be seen from the technical specifications of the project the application complies with the accepted standards that correspond to the demands for designing a website and is compatible with the most widely used operating systems and web browsers. In addition, all the necessary processes-interventions have been carried out in its structure and content in order to allow and search engine optimization. Contemporary techniques for the promotion and presentation of cultural content on the Internet have also been used to ensure the application's best possible presentation and its integration into different environments. Finally, the application also facilitates the production of reports and statistical data analysis based on multiple criteria (Google analytics) and supports an interactive access to all its content.



Presenting the thematic units of the game

The content of the application

The application is exclusively focused on the architecture of monuments found in Greece that belong mainly to the Archaic and Classical periods. Its emphasis is on the monuments of the Athenian Acropolis as they epitomize the fullest and most beautiful expression of Ancient Greek temples during the Classical period. Moreover, the procedures of planning and construction of these monuments are better known from Athens, where the democratic regime had elaborated institutions for all public matters.

The educational storyline of the application combines characters, challenges and rewards for children. The core mission of the user is to become an architect who will design a new temple for a small town in Attica during the Classical period. The user is introduced to the application by a short video that explains the goal of the game in a pleasant, brief and easy to understand manner.

Then the user can access the main part of the application by creating a user name that enables the players to return to the game as many times as they wish either to complete the challenges or better their score. The next step for the player involves creating an avatar. Users can customize the appearance of their avatar by choosing names and characteristics, so they can identify with the specific hero each time they log in to play the game or even create multiple avatars.

Similar opportunities are available for identification with the six characters that appear in the next screen of the application and correspond to its six thematic units. Every character through his/her role that is relevant to an ancient Greek temple presents a corresponding theme.

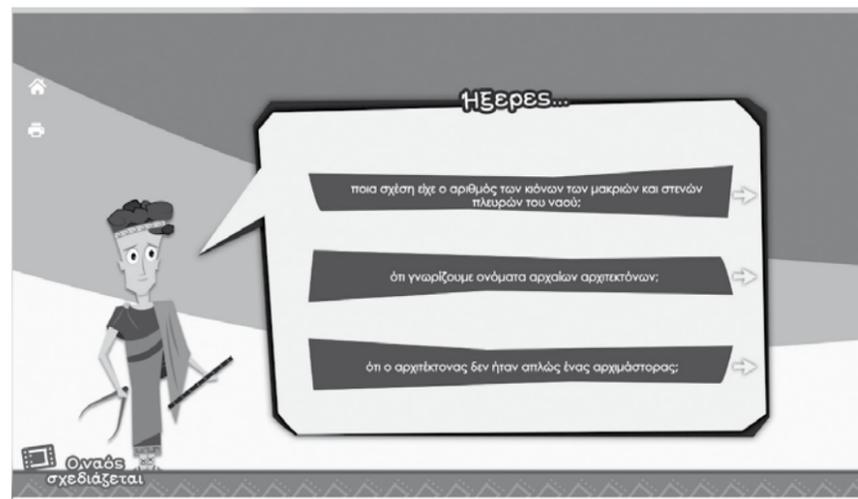
Thus, the Priestess presents the unit that concerns the functions and uses of a temple and its surrounding space, the



Presenting a character of the game



Game: "A sacred Space"



Unit "Did you know that..."

temple Builder presents matters related to the planning and design of a temple, the Architect presents the unit about the typology of ancient temples, the Quarryman the necessary construction steps from the quarry to the worksite, the Stonemason the morphology of the temple and finally the Sculptor its sculptural decoration. In every unit, apart from the character that presents the specific topic, there is also a game or an activity.

The information that the user is expected to study is integrated in the activity, so the player has to read the texts and look into the pictures in order to complete each challenge. The exploration of the content is thus carried out through the game that also entertains and at the same time allows the children to develop various skills. The different challenges of the games accord with the known typology of mini games (puzzles, matching games, quizzes, dexterity games, and observation and memory games) with which the children are familiar. Short and explicit instructions help the users to understand what is required by them in each challenge. Likewise, popular game tools, such as game points, levels of difficulty, time and scoring tables are used in order to motivate the users' interest and encourage further engagement with the challenges.

Every time the player answers correctly, feedback information is displayed on the screen, which helps the user deepen their knowledge in the specific topic. The additional information is introduced progressively avoiding a teacher-centered model of information provision and the exercise of teacher control that underlies traditional educational processes in school based learning. The next level of the game, "Did you know that...", operates on the same educational principles. Here again the character that guides the player's avatar uses a question and

answer format to shed light on various views of the past, relevant to the topic presented.

Monuments as they are displayed in rich photographic and graphic visual material, the three dimensional representations, and also the design adaptations of the application, become a vehicle for the user's time travel. Thus by exploiting the pedagogical significance of the monuments, such as the themes of authenticity, materiality and aesthetics, the students feel that the challenge they participate is not another school activity but an exploration of new content in a much broader meaning.

The narrative is completed with the unit that refers to neoclassicism and how ancient architecture influenced modern times. The user has already completed their mission, he/she has become an architect who is asked to help another architect of the 19th century to draw a Neoclassical building, which subsequently appears on the screen with the total score

and the player's ranking. This reward encourages the children to play again and spend longer time on the games.

The application is supported with additional features, such as a term explanation mechanism (active data glossary), and the design of 2D/3D animation, where the content is shown in a flexible and attractive way motivating as such the students to learn. In addition, printing and email options are available so the players are facilitated and the communication with other users is enhanced.

Finally a separate webpage entitled "Learn more" supplements the game and adds more specialised content knowledge on the subject. The application follows the structure of a game, as there are corresponding subject units where the user can find more information to enrich their lesson. The webpage also offers the possibility to incorporate other applications (video, ppt, pdf), allowing constant updates of information and content enrichment.

Among the future plans of the Department are the systematic evaluation of the application after a period of time and the collection of evaluative information that can be used in to the development of similar activities. A pilot evaluation has already been conducted with teachers and students completing questionnaires during the final stage of the applications development in order to assess its usability; yet, the whole experience of application also requires evaluation.

Epilogue

The educational web application "A Greek Temple" attempts to offer to its users a comprehensive multifaceted and visual representation of the past, shifting the educational focus from passive information to activity. The users have a central role in structuring their own knowledge as they learn through their own actions in the world of play. History, characters, objects, the environment of the game, levels, movements, sound and visual effects, effective interface with the user, combination of challenges and actions, are all features that characterize the application and contribute to the creation of an interactive, pleasant and meaningful experience.

Irini Kaimara
Archaeologist, Head

Asimina Leonti
Archaeologist

Maria Tsiolaki
Archaeologist

Information and Education Department



Unit "Learn More"

During the years 2017-2018 YSMA remained active in keeping the public informed, complying so with the international requirements for sharing information related to the Acropolis monuments and the restoration works, despite the difficulties arising from the expiration of temporary staff contracts and from awaiting its inclusion in a new funding programme. Since September 2017, though, YSMA has been able to employ new staff in fixed-term contracts that allowed the renewal of its personnel and accomplishment of its goals.

Educational activities

During the second half of 2016, 2017 and 2018 YSMA's Department of Information and Education conducted various educational activities addressing teachers, students, families and the general public. More specifically, 285 educational programmes, carried out in the Acropolis Museum for 6,350 Primary and Secondary School pupils, incorporated subjects related to the Parthenon sculptures, the ancient temples and the Olympian gods.

In addition, the Department participated in 2017 in the celebrations of the "European Heritage Days" with educational programmes for Secondary School students on the subject of "The Acropolis in the life of Ancient Athens". The students toured the Rock, learned about its topography and history, focusing on both the religious role of the Acropolis during the classical period and the part it played in the political and cultural life of the city.

Finally, during the Christmas celebrations of the Museum the educational programmes conducted during the years 2016-2017, targeted children between 7-11 years old, with the subject "Building your own temple with Lego". The young friends got to know the Acropolis monuments through the models and the architectural sculptures that are exhibited in the Museum and then by using their creativity and imagination they made their own constructions out of Lego. In 2018 the workshops titled "Wishes and Symbols...", conducted in collaboration with the archaeologists-hosts of the Museum, focused on chil-



Educational programme "Building your own temple with Lego". Photo T. Souvlakis, 2017

dren between 6-11 years old. The children made New Year cards inspired by the Museum exhibits that symbolise health (a snake), love (Eros), power (lion), wisdom (owl), prosperity (pomegranate) and also achievements (wreath).

The free educational material provided by the Department to the school community and the general public has increased the number of people who can benefit from it. In particular, 16,100 students in 340 schools of the Country have used the museum kits of the Department, while the educational material prepared for use by families and created in collaboration with the Acropolis Museum is thought to have been exploited by 12,200 Greek and foreign families.

In 2018 the thematic activities of the Museum were enriched with a new brochure for the younger visitors, from 3 to 5 years old, titled: "Spot the animals in the Acropolis Museum". The new brochure encourages children to discover some well-known and favourite animals inside the museum with the help of Goddess Iris. The discovery activity becomes even more entertaining as the children wear the masks of the two animals they find in the brochure and explore the museum through their eyes.

Six hundred and ninety teachers attended the training seminars on the use of YSMA's multifarious educational material either in their school environment



Educational programme "The Acropolis in the life of Ancient Athens". Photo T. Souvlakis, 2018



Discovery brochure for youngsters and their parents. Photo T. Souvlakis 2018

or inside the Museum. Moreover, a new online educational game was created under the title "A Greek temple", drawing on the architecture of the ancient Greek temple and addressing pupils older than 9, teachers and the general public. The application was developed within the context of the Operation Programme "NSRF 2014-2020".

Finally, it should be mentioned that the archaeologists of the Department of Information and Education contributed to the relevant scientific discourse by attending conferences. On 13th January 2017 the archaeologists Ir. Kaimara and A. Leonti participated in the Workshop of the Greek Committee of the International Council of Museums (ICOM-CECA) with the presentation titled "New educational activities for the Acropolis and its Museum". Additionally, the Head of the Department Ir. Kaimara partook in the one-day conference of the Department of History and Archaeology at the University of Cyprus, in Nicosia, on 17th November 2017. The title of the presentation was "The Acropolis and Education: open access activities for various members of the public".

Publishing projects

During this period YSMA's publishing activities, edited and organised by the Documentation Office, involved many

important projects. Besides the publications directly connected with the events extensively described in the relevant article of the present issue, we should mention the printed publication titled "Interventions on the Acropolis monuments, 2000-2012: Completed projects" (in Greek with abstracts in English). The specific publication, which is the coordinated effort to thoroughly present the restoration works during the above-mentioned period, was published for the first time in digital form and distributed to the participants of the 6th International Meeting for the restoration of the Acropolis monuments. The Head of the Documentation Office Dr E. Lempidaki edited its recent, 3-volumes, printed version.

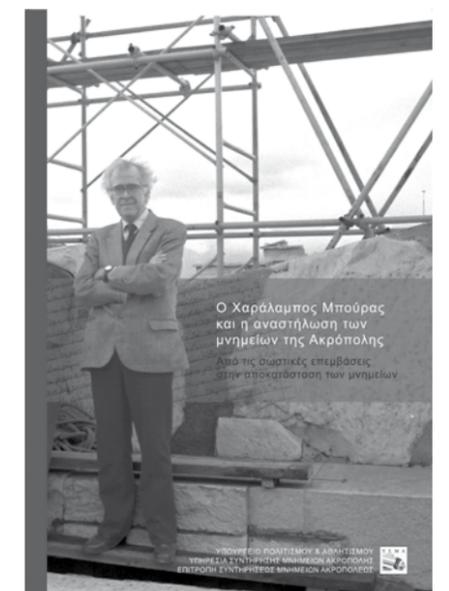
In 2018 YSMA produced an interesting and special publication titled: "Charalambos Bouras and the restoration of the Acropolis monuments" (in Greek). The edition comprises selected texts of Ch. Bouras and his unpublished proposals which he submitted as the President of ESMA to the Central Archaeological Council for the approval of studies regarding YSMA's restoration works (years 2000-2016). The texts are supplemented with an article by E. Petropoulou: "Charalambos Bouras as a founder member and President of the Committee for the Conservation of the

Acropolis monuments: views and standpoints for major restoration issues". The publication was edited by E. Lempidaki who was also responsible for collecting the material and for selecting and commenting on the photographs that capture the Acropolis monuments before and after the implementation of the restoration programmes.

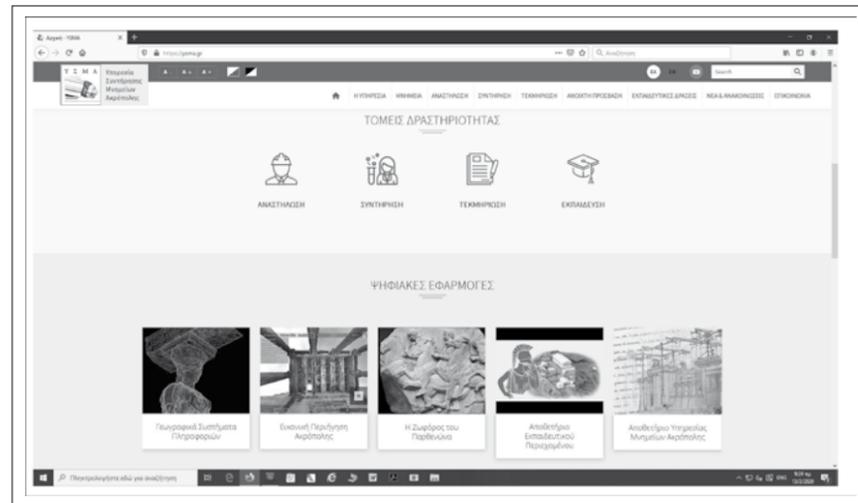
Updating the library catalogue

The library of YSMA is a specialised library that supports scientific research and projects of the Service's personnel within the context of the restoration and conservation programmes. The library maintains a collection of about 4,700 monographs and journals covering the subjects of archaeology, classical architecture, the restoration of ancient monuments, the management of archaeological sites and stone conservation. Its major collection is constantly renewed by donations and book exchange with scientific organisations of related fields.

YSMA's library catalogue uploaded its holdings in 2015 after adopting the service for the management and operation of library catalogues provided by the Na-



The publication about Charalambos Bouras and his contribution to the restoration of the Acropolis monuments



The new website of the Acropolis Restoration Service: www.ysma.gr

tional Documentation Centre (EKT), OpenAbekt (<https://ysma.openabekt.gr/el>). Through this YSMA allows distant access to its titles to anyone interested, retrieval of the complete text of its publications and access to part of its archived material (studies, proposals etc.) that has been produced within the context of the restoration programmes.

Since September 2017 Ms M. Maznoki has been responsible for the management of the application. In the period until the end of 2018, 321 new titles had been added, while there had been an effort to improve and systematise the organisation of the existing documents and the subject headings of the catalogue. The addition of new titles to the catalogue and also its digitised data management have turned YSMA's library into a valuable and convenient tool in the service of monument restoration.

Renewing YSMA's website

In 2018 YSMA proceeded with redesigning its website and renewing its content. Renewing its website, which had been operating in its previous layout since 2011, was of vital importance to the Service so as to provide complete infor-

mation about its scientific, administrative and educational activities. The person responsible for the design of the new website was the archaeologist of the Documentation Office Ms S. Poulou, while the implementation of the project was commissioned to an independent contractor. The renewed website of YSMA is easier to manage by the Service



Contributors to the event dedicated to the memory of Charalambos Bouras. From left: 1st row: V. Eleftheriou, A. Choremi, C. Hatziaslani, F. Mallouchou-Tufano. 2nd row: D. Pandermalis, M. Korres. Photo T. Souvlakis, 2018

personnel while it provides a modern and user-friendly environment. An important consideration taken into account for the design of the website was to address various "users" that is, visitors of the archaeological site, students and teachers of all educational stages that would like to enrich their lessons, scientists from the Greek and international academic community who search for information about the restoration works, and finally, professionals that can be informed about projects put out to tender. Exclusively for this last group emphasis was given to designing a website where interested parties would be directly and thoroughly informed, and within the time limit, about the progress of the public tender. The redesigning of the website also enabled the update of its content in order to include the current works on the monuments. The renewed content was edited by E. Petropoulou except for the part that concerns the educational programmes where Ir. Kaimara was responsible. YSMA's website and all the applications it runs are accessible in the address: www.ysma.gr.



The Director of YSMA V. Eleftheriou with professors and members of the Architectural Institute of Japan. To her left the Greek Ambassador, Mr L. Karatsolis and to her right Prof. T. Hanazato. Photo J. Nagata, 2018

An event dedicated to Ch. Bouras

Two years after the loss of Charalampos Bouras YSMA, in collaboration with the Committee for the Conservation of the Acropolis Monuments (ESMA), the Acropolis Museum and The Friends of the Acropolis Society (EFA) planned an event dedicated to the academic and founder of the restoration works on the Acropolis. YSMA's Documentation Office was responsible for the organisation of the event that took place on 23rd November 2018 in the amphitheatre of the Acropolis Museum. The participants who talked about Ch. Bouras' timeless contribution to the conservation and protection of the monuments on the Rock were the President of the Acropolis Museum Board of Directors, Prof. D. Pandermalis, ESMA's President Prof. M. Korres, the Deputy President of ESMA Prof. F. Mallouchou-Tufano, YSMA's Director Ms V. Eleftheriou and the General Secretary of EFA, Ms A. Malikourti. During the event footage from B. Tsokas film "Ch. Bouras: The Man, The Scientist, the Teacher", produced by Diazoma, was shown. Moreover, the following YSMA's recent publications were presented: the proceedings of "Specialised

research and implementation issues in the Acropolis restoration works carried out during the period of 2010-2015" and "Charalampos Bouras and the restoration of the Acropolis monuments", which were dedicated to his memory. The amphitheatre of the Acropolis Museum was filled with colleagues, partners, students and friends of Ch. Bouras attesting so how topical his speech and thinking were, and the profound influence he had on the field of the restoration of ancient monuments.

Participation in the Road Trip Project

On 15th April 2018, two young people from Europe, Luisa from Germany and Louis from Belgium visited the Acropolis within the context of the participation of the Ministry of Culture and Sports in the Road Trip Project. This is an initiative funded by the European Union that addresses young people who, while travelling around Europe, are guided around large technical, scientific and cultural works that were financed by the European Union. YSMA's Director Ms V. Eleftheriou and the Head of the Special Service of Culture and Tourism of the Ministry of Culture and

Sports Ms M. Komvou showed the two young people around the restoration works. The Head of YSMA's Department of Information and Education Ms Ir. Kaimara and the archaeologist of the Documentation Office Ms S. Poulou participated in the guided tour as well. During the tour around the archaeological site the two young people had the opportunity to get acquainted with the monuments, while at the same time they were informed about the on-going restoration works. The digital applications of YSMA/ESMA (website, educational applications, virtual tour) presented in a portable appliance (tablet) were used as visual aids to help them understand better the works on the Acropolis and enhance their visit.

A radio feature on the station 89,5

In October 2017 members of the scientific personnel of YSMA took part in a radio feature of the Church of Greece radio station (89,5) about the Acropolis works. It included interviews with the Heads of the various Offices and Departments who presented the works conducted in the worksites on the Acropolis, the projects related to enriching the Archive and disseminating knowledge, and finally the educational activities of the Service. During the week from the 9th to 16th October 2017 the people who took part in the interviews were: YSMA's Director, Ms V. Eleftheriou, the Head of the Parthenon restoration programme, Ms R. Christodouloupoulou, the Head of the Documentation Office Dr E. Lempidaki, the Head of the Department of Information and Education, Ms Ir. Kaimara and the Head of the Walls restoration programme, Ms D. Mihalopoulou.

Lectures – publications

Within the period of the last two years YSMA's personnel has been involved in many multifarious projects, which is apparent by the large number of lectures and publications mentioned in this article.

YSMA's Director V. Eleftheriou presented the work of the Service in a series of lectures drawing on theoretical issues related to the restoration of ancient monuments. On 28th February 2017 she gave a lecture in English within the context of the 7th International Workshop on the Acropolis organised by the Academia Adrianea on the subject of "Restoration interventions on the monuments and Documentation". Dr K. Karanasos participated in the same workshop with a paper on "The restoration of the Propylaia, from theory to implementation. The case of the intervention on the NW corner and the restoration of the west façade" (in Italian). For two consecutive years YSMA's Director participated in the seminars organised by the Polytechnic University of Bari, establishing as such a close and on-going collaboration between the people working on the Acropolis projects and the particular educational institution. The matters discussed in the seminar conducted from 13th to 16th July 2017 and from 4th to 8th June 2018 concerned special restoration issues from the Acropolis of Athens and Lindos. The President of ESMA, Prof. M. Korres, the Deputy President of ESMA Prof. F. Mallouchou, the architect Dr. K. Karanasos and the civil engineer Ms A. Vrouva, also taught at the same seminars.

In addition, V. Eleftheriou, accepting a series of invitations, presented the restoration programme for the Acropolis monuments to several educational institutions abroad. For example, on the 6th and 7th April 2017 she gave a talk presenting the development of the Acropolis works, at Pompeii and Naples, after receiving an official invitation by the Director general of the Pompeii archaeological Park, Massimo Ossana. On 27th November 2017 she presented YSMA's work to the Technical University of Munich, after an invitation by the Department of Architecture. The following year she gave two lectures in Japan: on 6th March 2018 at the Department of Archi-



Professor V. Lambinouidakis lecturing in front of the YSMA personnel at the archaeological site of Epidaurus. Photo G. Kehagias, 2018

ecture of the MIE University and on 7th March 2018 at the Architectural Institute of Japan. Later on, on 7th June 2018 she talked about the work of the Service to the School of Architecture of the University of Basilicata, Matera, Italy.

During the same period, V. Eleftheriou contributed to two important publications. Working together with E. Tavouktsi and R. Christodouloupoulou they presented the paper: "The restoration of the northwest corner of the Parthenon entablature: designing connectors of the architectural members" to the 3rd International Conference on protection of historical constructions (Lisbon, 12-15 July 2017), whose proceedings were published later. Moreover, she participated in the co-authored paper with K. Pitilakis, S. Karafagka, O. Dinoudi and I. Kalogeras titled: "Seismic hazard analysis of the Acropolis of Athens and seismic analysis of the Propylaia colonnade" which was published in the proceedings of the 16th European Conference on Earthquake Engineering (Thessaloniki, 18th to 21st June 2018).

The architect V. Manidaki gave a lecture on 29th January 2018 on the subject of: "The faces of the stones – New research on the sawn blocks of the Parthenon frieze" (in Greek) in the British School at Athens. Later on (22nd February 2018) she participated in a seminar at the British Museum presenting the paper: "Behind the Parthenon sculptures: discoveries in the construction of the west pediment and the frieze", while on 4th May 2018 she participated in a seminar of the Ancient Architecture Discussion Group with a paper titled: "From design to construction and back to design: New observations on the Parthenon". The architect Dr K. Karanasos – apart from his contribution to the postgraduate programme of Academia Adrianea and the Polytechnic University of Bari which was mentioned above – gave a lecture on the subject of the Propylaia restoration, on 23rd March 2017 at the Postgraduate School of Architectural Conservation of the University of Edinburgh.

The Head of the Conservation Office Dr E. Aggelakopoulou participated together with S. Sotiropoulou and G. Kara-

giannis in a project that was presented in the 9th International Round Table on polychromy in ancient Sculpture and Architecture (London, 9th November 2018). The title of their presentation was "The architectural polychromy on the Athenian Acropolis. New data obtained through recent in situ noninvasive analytical investigation of the colour remains on the Parthenon and Propylaia".

The Head of the Inventory, Documentation and Cataloguing of Scattered Architectural Members Office Dr E. Sioumpara participated on 23rd February 2017, as the main speaker, in an International Conference at the University of Munich. The title of her presentation was: "The first monumentalisation of the Acropolis in the 6th century BC. As attested in the material evidence of the new city of Athens" (in German). She presented the same subject to the Heidelberg University (in German) and the 36th Training Two-day Conference of the Greek Association of Licensed Tourist Guides (8th February 2018, lecture in Greek). E. Sioumpara also participated in the International Conference which she co-organised with Prof. O. Pallagia at the Acropolis Museum, on 19th May 2017. The title of her conference paper was: "The Acropolis after the Persian destruction and before the Periclean miracle". Together with N. Makri they took part in the 3rd Greek-Turkish Epigraphic Congress at the Aristotle University of Thessaloniki by presenting the paper: "New inscriptions from the Acropolis and the graphic reconstruction of Arion's honorary pedestal" (in Greek, 1st July 2017). On 21st February 2018 she participated in a conference at the German Archaeological Institute presenting a paper titled: "Destruction and construction of order. Reuse of building materials at Attic sac-

tuaries after the Persian Wars". Finally, on 23rd April 2018 she participated in the conference BRAU 4 at the Hellenic Maritime Museum of Peiraus where she presented a paper titled: "The restoration of ancient architectural members: the case of the poros triglyphon of the Archaic Parthenon. Research, management, exhibition".



Iakovos Kladios (1971-2018)

Educational excursion

In spring 2018 the Director of YSMA suggested that the Service organise an educational excursion to Epidaurus as a training activity for the personnel. The excursion, where 75 employees of YSMA participated, took place on 18th May after it had been successfully organised by E. Karakitsou and G. Kehagias. During this day trip we were fortunate to be toured around the archaeological site, the theatre and the Epidaurus Museum

by Professor Emeritus V. Lambrinouidakis, who in his lecture presented archaeological and restoration issues. Moreover, we had the opportunity to discuss matters concerning restoration techniques and conservation materials with members of the scientific personnel of the Epidaurus restoration project. Concluding we can say that such activities do not only contribute to training the personnel but also to promoting better relationships among the staff of the Acropolis worksites.

A heavy loss

Completing the review of the last two years we were saddened to hear of the loss of our colleague Iakovos (Makis) Kladios who died together with his parents during the devastating fire that ravaged Attica on 23rd July, 2018. Makis started working as a marble technician at Epidaurus and since 1995 in the restoration works of the Propylaia. He progressively increased his skills by dealing with difficult tasks that demanded special dexterity and abilities. In the period between 2002 and 2006 he was part of the group that constructed the Ionic capitals that today adorn the central passageway of the Propylaia, while since 2016 he was working at the restoration of the Parthenon. He was pleasant and good-natured, polite, sensitive and righteous, participating

in every collecting endeavour honouring the position he had chosen in order to be at the service of the monuments' protection.

*Evi Petropoulou,
Archaeologist
Documentation Office*

*From the photographic exhibition
«Chisel and Memory: the contribution of marble
craftsmanship to the restoration of monuments
(YSMA/ESMA 2018)*

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Hellenic Ministry of Culture
and Sports

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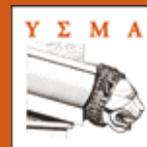
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