The case studies presented here are just a representative selection from over 1,000 3D models of cultural heritage objects produced by the project partners during the course of the 3D-ICONS project. Each project partner has provided two case studies which have been grouped within two broad ranges of cultural heritage object - monuments and buildings, and artefacts and architectural detail. In order to summaries each case study the relevant information has been presented utilising the following guidelines:

**LOCATION**
Place name and map location of the heritage object.

**INSTITUTE**
The organisation who contributed the case study.

**DESCRIPTION**
A summary of the cultural heritage object and its heritage value.

**CAPTURE**
The methodology utilised to digitise the CH object in 3D.

**EQUIPMENT**
What instruments where utilised in the data capture?

**MODELLING SOFTWARE**
What software applications where utilised in the processing and delivery pipeline.

**PROCESSING PIPELINE**
A summary of the relevant technical steps required to go from 3D capture to online 3D delivery of the cultural heritage object.

**ONLINE DELIVERY**
How was the 3D model of the cultural heritage object being delivered online and why (URL denotes the online location for access to the 3D model of the cultural heritage object)?

**MODEL USE**
How is it envisaged that the 3D data will be used?

**LICENSE**
What IPR licensing has been employed for use and reuse of the 3D data?
MONUMENTS

01 ABBADIA CASTLE / HENDAYE, FRANCE
02 AUGUSTEUM (HERCULANEUM) / HERCULANEUM, CAMPAVIA, ITALY
03 BADIA CAMALDOLESE DI VOLterra / VOLterra, TUSCANY, ITALY
04 THE CENACLE COMPLEX / JERUSALEM, ISRAEL
05 CHARTREUSE OF PAVIA / PAVIA, LOMBARDY, ITALY
06 CHURCH OF THE HOLY APOSTLES / THESSALONIKI, CRETE, GREECE
07 CLOISTER OF THE ABBEY OF SAINT MICHEL DE CUXA / SAINT MICHEL THE CUXA, FRANCE
08 ENAME ARCHAEOLOGICAL SITE / ENAME, BELGIUM
09 HOUSE 07, SKARA BRAE / SKARA BRAE, ORKNEY, SCOTLAND, UK
10 KUTUKLU BABA TEKKE / XANTHI, GREECE
11 MAUSOLEUM OF ROMULUS / ROME, ITALY
12 SAINT LAURENTIUS CHURCH / ENAME, BELGIUM
13 SANCTUARY OF THE IBERIAN OPPIDUM OF PUENTE TABLAS / JAÉN, SPAIN
14 SKARA BRAE / SKARA BRAE, ORKNEY, SCOTLAND, UK
15 ST KEVIN’S CHURCH / GLENDALOUD, WICKLOW, IRELAND
16 TOMB OF THE RELIEFS / CERVETERI, ROME, ITALY
## Architectural Feature

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<th>Architectural Feature</th>
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<td>1</td>
<td>Capital of the Abbey Notre Dame de la Sauve Majeure / La Sauve, Bordeaux, France</td>
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<td>David di Donatello / Museo Nazionale del Bargello, Florence, Italy</td>
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<td>3</td>
<td>Griphomaquia. Sculpture of the Group of Cerrillo Blanco / Porcuna, Jaén, Spain</td>
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<td>4</td>
<td>Ladisalu Hunyadi's Marble Sarcophagus / Saint Michael Romano-Catholic Cathedral, Alba Iulia, Romania</td>
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<td>The Market Cross / Glendalough, Wicklow, Ireland</td>
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<td>6</td>
<td>Santa Cristina Sacred Well / Sardinia, Italy</td>
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<td>7</td>
<td>&quot;Suicide of Aiace&quot; Metope / Paestum, Campania, Italy</td>
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## Artifact

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<td>8</td>
<td>Chrysippus Head / Templum Pacis, Rome, Italy</td>
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<td>9</td>
<td>El Argar Pottery / Royal Museums of Art &amp; History, Brussels, Belgium</td>
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<td>10</td>
<td>El Argar Skull / Royal Museums of Art &amp; History, Brussels, Belgium</td>
</tr>
<tr>
<td>11</td>
<td>Furnitures of the Petit Trianon 3D / Versailles, France</td>
</tr>
<tr>
<td>12</td>
<td>The Goddess of Sultana Neolithic Idol / Muzeul Național de Istorie a Românie, Bucharest, Romania</td>
</tr>
</tbody>
</table>
**NAME OF MONUMENT**

**ABBADIA CASTLE**

**LOCATION**

**HENDAYE, FRANCE**

**INSTITUTE**

**ARCHEOTRANSFERT**

**http://archeotransfert.cnrs.fr**

**DESCRIPTION**

Chateau d’Abbadie is a chateau in Hendaye, Pyrénées-Atlantiques, France. Built between 1864 and 1879, it was designed in the neo-Gothic style by Viollet-le-Duc and incorporated many enigmatic features characteristic of its owner, the explorer Antoine Thomson d’Abbadie.

**CAPTURE**

Image-Based - Traditional Photogrammetry - possibility of aerial photography with drone. Better implementation of the digitization process.

**EQUIPMENT**

Nikon D800E

**MODELING SOFTWARE**

Synaps and Geomagic

**PROCESSING PIPELINE**

Treatment of the photographies (light, contrast resolution etc), point cloud processing, point cloud cleaning, meshing.

**ONLINE DELIVERY**

WebGL - Cross-browser and cross-platform compatibility - Tight integration with HTML content, including layered compositing, interaction with other HTML elements, and use of the standard HTML event handling mechanisms - Hardware-accelerated 3D graphics for the browser environment - A scripting environment that makes it easy to prototype 3D graphics.

http://archeogrid.ubordeaux3.fr/3DIcons/3diconsview3d.php?id=12

**MODEL USE**

Promotion of the cultural heritage.

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The Augusteum at Herculaneum was probably a building dedicated to the Imperial cult. Although still completely buried save for part of its entrance porch, this huge building was extensively explored and thoroughly looted by its early excavators. Many frescos and statues removed from the Augustum were carried in the Archaeological Museum of Naples. Augusteum was brought to the light through tunnel excavated in the volcanic rock. Currently the Monument is not accessible.

DESCRIPTION
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CAPTURE
Image-Based - Structure from Motion (SfM)
Digitised plans/records - All of the artefacts, which once decorated the Augusteum are now held in the National Archaeological Museum of Naples. We rebuilt the Augusteum virtually restoring the monument with all statues and frescos.

MODEL USE
The monument is not accessible and not visible therefore this is the only way to provide access to a rebuilt model of the Augusteum including artefacts and decoration held in the Archaeological Museum of Naples.

PROCESSING PIPELINE
The 3D model of the monument was generated using CAD from historical maps and building footprints taken during the excavation. The statues, actually in the Archaeological Museum of Naples, were acquired in 3D by SFM and then reallocated in their original position. Also the digitized images of frescos were reallocated. The entrance porch, the only part actually visible, was acquired by SFM and joined to the reconstructed model.

ONLINE DELIVERY
3D PDF - we do not have the permission to publish an high resolution model of the monument.
http://www.archeozone.it/3Dicons/basilica%20ercolano_3d%20fronte.avi
DESCRIPTION
The place is an old monastery in the outskirts of the town of Volterra, dating back to the 10th-11th century. The structure has been expanded and modified many times over the centuries and was severely damaged by an earthquake in the 19th century, and shortly later abandoned. The whole building is undergoing a process of slow recovering and restoration, with the aim of potentially reusing the building. The scanning campaign covered the remains of the church, in order to produce accurate and effective documentation for possible interventions, and to help better understanding the reasons of the collapse, through the study of the available historical sources, chronicles and a virtual reconstruction of the church in its original state.

CAPTURE
Terrestrial Laser Scanning - Phase based For the size of the object we required detail and rapid digitization.

EQUIPMENT
FARO Photon 120

MODELING SOFTWARE
MeshLab for 3D scanning data processing and model creation, AutoCAD for the virtual reconstruction of the original state

PROCESSING PIPELINE
Field scanning - data exporting: single scans to point-clouds with normals - point-clouds cleaning (trees, unwanted areas, people, “ghost” points) - alignment of scans (markerless, using the geometric redundancy) - surface creation - model editing for 3D printing - creation of hi-res orthographic views for technical documentation - extraction of measurement / sections / notable points for virtual reconstruction of the original state - virtual reconstruction of the original state

ONLINE DELIVERY
3D HOP - It is able to convey the hi-res model
http://artesalva.isti.cnr.it/en/virtual-visits-badia-volterra

MODEL USE
The model is not publicly available; it can be released for scientific purposes, by obtaining the permission from the superintendent. The 3D online browser is still not publicly accessible at present.

LICENSE / PAID ACCESS - NO RE-USE
**THE CENACLE COMPLEX**

**LOCATION**
Jerusalem, Israel

**DESCRIPTION**
The building complex is one of the most important monuments in Jerusalem, with a long and complex architectural history starting in the second century AD and continuing until the 14th century, hosting one of the earliest and better preserved examples of Crusader architecture of the “Kingdom of Jerusalem”. The lower floor hosts the “Tomb of King David”, among the largest cenotaphs ever built, while the upper floor is known as “The Room of the Last Supper” where, according to the Christian tradition, Jesus celebrated the Easter dinner and from where he was taken into custody prior his crucifixion.

**CAPTURE**
- Image-Based - Structure from Motion (SfM)
- Terrestrial Laser Scanning - Phase based
- Cost efficient and easy to implement.

**EQUIPMENT**
- Surphaser laser scanner, Menci ZScan

**MODELING SOFTWARE**
- JRC, point cloud, AutoCAD, ZScan

**MODEL USE**
Mostly informative

**ONLINE DELIVERY**
X3D - fast online rendering and does not require any specific software to visualise.
http://public.cyi.ac.cy/starcRepo/explore/objects

**PROCESSING PIPELINE**
- scanning - alignment of scans - cleaning of data - simplification - alignment internal with external faces - mesh.

**CREATIVE COMMONS LICENCE**
Creative Commons - Attribution, Non Commercial, No Derivatives.
NAME OF MONUMENT

CHARTREUSE OF PAVIA

LOCATION
Pavia, Lombardy, Italy

INSTITUTE
POLITECNICO DI MILANO (POLIMI)
WWW.POLIMI.IT

DESCRIPTION
The Certosa di Pavia is one of the largest and Carthusian monasteries in Italy. The construction of the whole complex was started in 1396 and concluded in 1507. The location was strategically chosen midway between Milan and Pavia, the second city of the Duchy, where the Duke of Milan held his court. The long process for completing the building makes interesting not only the building itself, but also the diachronic reconstruction of the different phases of its evolution towards its final arrangement. The motivations behind the 3D digitization of this monument in the framework of the 3DICONS project are twofold: a) although the main church inside the monastery is well known, being one of the most visited monument in Lombardy, the buildings behind the church are largely misunderstood even if full of artistic and historical evidences. This latter part have been scanned and 3D represented with a cloud of 3D points; b) most of the history of the place is "written in the stone"; therefore reconstructing the historical evolution of the building through a set of 3D models based on actual 3D scans and historical documents, makes easier to explain the monument genesis.

CAPTURE
Terrestrial Laser Scanning - Phase based. Most of the building is not easy to be reached; therefore we chose a 3D acquisition process capable to give metric results with no targets/signals added on the building surfaces, taking 3D information from a certain distance.

PROCESSING PIPELINE
Standard pointcloud processing

ONLINE DELIVERY
The model is too heavy for on-line delivery; therefore access in the form for requested DVD will be used

EQUIPMENT
Faro Focus 3D

MODEL USE
Virtual exploration/analysis

MODELING SOFTWARE
Leica Cyclone

DATA COLLECTION USING FARO FOCUS3D LASER SCANNER

ELEVATION AND PERSPECTIVE VIEW OF POINT CLOUD

HIGH RESOLUTION RENDER OF RECONSTRUCTED BUILDING

ONLINE 3D PDF MODEL

TERRESTRIAL LASER SCANNING - PHASE BASED. MOST OF THE BUILDING IS NOT EASY TO BE REACHED; THEREFORE WE CHOSE A 3D ACQUISITION PROCESS CAPABLE TO GIVE METRIC RESULTS WITH NO TARGETS/SIGNALS ADDED ON THE BUILDING SURFACES, TAKING 3D INFORMATION FROM A CERTAIN DISTANCE.

STANDARD POINTCLOUD PROCESSING

THE MODEL IS TOO HEAVY FOR ON-LINE DELIVERY; THEREFORE ACCESS IN THE FORM FOR REQUESTED DVD WILL BE USED.

VIRTUAL EXPLORATION/ANALYSIS

LEICA CYCLONE

64 65

Creative Commons - Attribution, Non Commercial, No Derivatives.
CHURCH OF THE HOLY APOSTLES

NAME OF MONUMENT
Church of the Holy Apostles

LOCATION
Thessaloniki, Greece

INSTITUTE
ATHENA - CULTURAL & EDUCATIONAL TECHNOLOGY INSTITUTE (CETI)
http://www.ipet.athena-innovation.gr

DESCRIPTION
The Church of the Holy Apostles is situated in the homonymous square in Thessaloniki, in the beginning of the modern Olympou Street. It lies south of the decumanus (Saint Demetrius Street), around 50 meters from the west city wall, near the Litea Gate, ruined today. Originally it was the katholikon (main church) of a sizeable monastery. Except for the church, little evidence remains still today from the original complex, such as parts of the precinct, a gateway to the south of the katholikon and a large cistern to its northwest. Initially the monastery covered an area of more than 10,000 square meters. The dating of the church’s construction (along with its bell tower) is part of an ongoing scientific debate. On the one hand, according to a new dendrochronological study the church was founded in no earlier than 1329. On the other hand, most scholars place the initial construction between 1310 and 1314. The designation of the church as Holy Apostles is of recent date and was said to be based on the existence of twelve vaults in the building. This popular association with the Apostles is documented in travellers’ accounts as early as 1735. The building is in a good state of preservation with much of its original construction elements intact and visible. The church’s original wall paintings and mosaics, concealed beneath a thick layer of plaster since the conversion into a mosque, were gradually uncovered and restored in various time periods, from the 1920s till 2004.

CAPTURE
Image Based Structure from Motion (SFM) & Dense Multi-View 3D Reconstruction Terrestrial Laser Scanning - Time of flight. This digitisation method allowed us to efficiently produce high quality 3D data within the time limits introduced by the project itself. SFM-Dense Multi-View 3D Reconstruction were the main methods being used for the generation of the digital 3D replica of the model.

EQUIPMENT
Samsung NX1000 Compact mirrorless DSLR 20MP 16mm, 20-50mm lenses Hexacopter (gimbal, FPV, GPS lock) Optec Ilris 360D TOF laser scanner.

MODELING SOFTWARE
Photoscan, Meshlab, Blender

ONLINE DELIVERY
X3DOM for lower resolutions, PLY (vertex paint) RAW
The X3DOM framework offers a set of basic 3D viewing functions along with progressive downloading of models as well as support for the binary version of X3D reducing lower downloading times for our landing page visitor. The current version of X3DOM is supported by a wide range of Web browsers over all major OS platforms.

http://www.ipet.gr/~akoutsou/3dicons/index.php?id=ARC3DICONS_3D_1AAP&res=L

MODEL USE
The produced data will be given to the monument’s responsible Ephorate in order to be used for any possible internal use. A short demo of visualising the 3D model and performing measurements on its surface along with a short briefing on 3D printing technologies will be made at some point by our institution to the Ephorate’s personnel which was involved in the procedures of licensing us for digitising the monument.

PROCESSING PIPELINE
The exterior was captured in 3D using the Structure-From-Motion (SFM) and Dense Multi-View 3D Reconstruction (DMVR) methods. Four aerial (utilising hexacopter equipped with gimbal, FPV, GPS and 2of Samsung NX1000 20MP compact DSLR cameras with fixed 16mm and 20-50mm lenses) and terrestrial (using 3-9m camera tripods and custom monopods, distance between capture points 60cm) photo capture sessions were performed during cloudy days. SFM processing - Agisoft PhotoScan (ver. 1.1) using a total of 4090 photos to generated the 3D model. The processing of the image sequences was performed on two computer systems (CPU IntelCorei74820K 3.7Ghz, 64GB RAM, Radeon R9 290X, Microsoft Windows 7 64-bit). Additionally, empirical measurements between strong (in terms of visibility) feature points on the surface of the monument were performed and used to scale the 3D model.
The abbey of Saint-Michel-de-Cuxa (Catalan: Sant Miquel de Cuixà) is a Benedictine abbey located in the territory of the commune of Codalet, in the Pyrénées-Orientales département, in southwestern France. It was an important cultural centre in the regency of Abbot Oliva. Parts of it now make up the Cloisters museum in New York City. The origins of Cuixà abbey lie at Sant Andreu d'Eixalada abbey, founded in about 840, and located at the head of the Tet valley. In the autumn of 878, the river broke its banks, flooding and destroying the monastery (located near the river-bed) forcing the monks to seek refuge in the surrounding countryside. The community then transferred to Cuixà, a minor cenobitic community dedicated to Saint Germanus, led by Father Protasius. In June 879, Protasius and Miro the Elder, count of Conflent and Roussillon, signed the founding treaty of the new monastery, whereby Cuixà extended its properties with those contributed by Eixalada and Protasius was named abbot. The abbey continued under the protection of the count of Cerdanya and Conflent. The territory then came under the domain of the family of Wilfred I, count of Barcelona in 870. In about 940, under the initiative of Sunifred II of Cerdanya, a new church dedicated to Saint Michael was built. In 956 the building was refurbished and made more sumptuous; the main altar was consecrated on 30 September 974 by Garí, a monk from Cluny who led five southern monasteries. When the Doge of Venice, Pietro I Orseolo, accepted Romuald's advice to become a monk, abdicated his office, and fled in the night, it was to Saint-Michel-de-Cuxa that he retired, accompanied by Romuald and his companion, Marinus, who established a hermitage nearby.

**DESCRIPTION**

**NAME OF MONUMENT**

**CLOISTER OF THE ABBEY OF SAINT MICHEL DE CUXA**

**LOCATION**

SAINT MICHEL THE CUXA, FRANCE

**INSTITUTE**

CNRS-MAP laboratory (UMR CNRS/MCC 3495 MAP)
WWW.MAP.ARCHI.FR

**CAPTURE**

Time of flight and phase shift laser scanning, terrestrial and UAV-based photogrammetry

**EQUIPMENT**

Faro Focus 3D, Trimble GX, Nikon D3X, Nikon D300, Copter 4 (surveycopter)

**MODELING SOFTWARE**

NUBES Forma, Maya

**PROCESSING PIPELINE**

**GEOMETRIC RECONSTRUCTION:**
Automatic meshing from a dense 3D point cloud (sculpted elements); Interactive and semi-automatic reconstruction based on relevant profiles (existing architectural elements)

**MODEL STRUCTURING:**
The 3D model has been decomposed in elementary entities, partially hierarchically organized.

**VISUAL ENRICHMENT:**
Texture extraction and projection starting from photographs finely oriented on the 3D model (image-based-modeling); Texturing by generic shaders.

**DATASET STRUCTURE (Geometry):**
Single 3D file structured with 1 level of detail

**DATASET STRUCTURE (Textures):**
Embedded into the 3D geometry file; Stored as external 2D files

**ONLINE DELIVERY**

WebGL – two interactive 3D models: exterior and interior.

http://3dicons.gamsau.archi.fr/europeana/index.php?VARdr=CUXA_CuxaEglisetextureextfinal_3D_1

http://3dicons.gamsau.archi.fr/europeana/index.php?VARdr=CUXA_CuxaEglisetextureintfinal_3D_1

**MODEL USE**

Education, virtual exploration, interpretation centre content, and tourism guides

**LICENCE**

Creative Commons - Attribution, Non Commercial, No Derivatives.
The trade settlement of Ename is founded by the noble family of Ardennes-Verdun around 965 AD as part of the installation of the political and administrative structure of the Holy Roman Empire, created in 962 AD. The settlement grows significantly and gets an impressive stone keep when it becomes the seat of a margraviate around 985 AD to defend the border between the Holy Roman Empire and the kingdom of France. The keep gets destroyed in 1033 AD by the count of Flanders and Ename becomes part of Flanders in 1047 AD. The count of Flanders replaces the trade settlement by a Benedictine abbey in 1063 AD, which remains active until 1795 AD, when the abbey is dismantled and the site is turned into meadows. Excavations start in 1942 for 5 years and continue in 1978 and in the period 2000-2004. The period around 1020 has been reconstructed. The period of 1040, which has been reconstructed in the period 2000-2004, is currently being revised and will not be included in 3D-ICONS. In the case of the Ename abbey, the abbey is rendered for the different key periods, in the historical landscape that surrounds it (1065, 1085, 1150, 1300, 1500, 1595, 1665, 1730). A 4D visualisation combines all periods from 1020 to 1730 and shows the evolution through time.

CAPTURE
Surveying, excavation, geophysical survey, historical research

EQUIPMENT
Leica TC 600 series Total Station, Geoscan Research RM15 Resistance Meter (resistivity) and Geoscan Research FM36 Fluxgate Gradiometer (magnetometry)

MODELING SOFTWARE
ArchiCAD 6-15, Blender 2, Vue 10-11

DESCRIPTION
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Archeological Prospection © Services of Southampton
House 07, Skara Brae

**Location**
Skara Brae, Orkney, Scotland, UK

**Institute**
CMC Associates
www.cmcassociates.co.uk

**Description**
House 07 is the most preserved of all the dwellings at Skara Brae. Early attempts at restoration resulted in the addition of a modern glass roof. This, however, has proved troublesome due to damage from increased moisture. It is hoped that further study of the stonework will produce a better solution for long-term preservation of the site.

**Capture**
Terrestrial Laser Scanning - Time of flight and Photography.

We acquired the scan data from Historic Scotland and had no input on the technology or methods used. We did photograph the house for the purpose of creating Quicktime VR films. For this we used a fisheye lens to maximise the panoramic stitching of multiple photographs.

**Equipment**
Leica C10, & Leica HDS6100 Scanners
Canon DSLR with 15mm lens

**Modeling Software**
Cyclone, CloudCompare, GeoMagic, Blender, Mudbox.

**Processing Pipeline**
Scan data was supplied as a Leica project file. We used Cyclone to export aligned point clouds as .e57 files. The .e57 retained positional data and point intensity values. Each scan was imported to CloudCompare. Points with intensity < .1 was deleted and then the files were merged and spatially subsampled to .005. Intensity data was then mapped to RGB values and the file exported as a PLY. The coloured point clouds were wrapped in GeoMagic then retopologised with Blender. Contemporary and archive photography was then used to texture the low res models using MudBox and Blender.

**Online Delivery**
None Provided

**Model Use**
Initially for educational resources and teaching packs. Then expand to cover on-site interpretation and site management.

**Colourised Dense Point Cloud Model of Internal Features**

**Dense Point Cloud Model of Internal Structure with Intensity Colourisation**

**LICENCE / PAID ACCESS - NO RE-USE**

© Historic Scotland
**NAME OF MONUMENT**

**KUTUKLU BABA TEKKESI**

**LOCATION**
XANTHI, GREECE

**INSTITUTE**
ATHENA - CULTURAL & EDUCATIONAL TECHNOLOGY INSTITUTE (CETI)
HTTP://WWW.IPET.ATHENA-INNOVATION.GR

**DESCRIPTION**
The monument is located in the middle of a cultivable area on the west coast of the Vistonida lake in Xanthi, Greece. It is considered as one of the most important Ottoman monuments in the area and it may have been built in the late 15th century. It was possibly built on the ruins of an Orthodox Christian temple that was dedicated to Saint George Kalamitziotis.

**CAPTURE:**
Combination of Close Range Laser Triangulation (Optec Iiris 36D), Image-Based - Structure from Motion (SfM) and Image-Based - Dense Multi-View 3D Reconstruction

**EQUIPMENT**
OPTEC Iiris 36D, Samsung NX1000 Camera, UAV, Total Station

**MODELING SOFTWARE**
Aegissoft Photoscan, Meshlab, Blender

**PROCESSING PIPELINE**
The data collection phase included partial scans using TOF laser scanning, terrestrial and aerial photoshooting along with total station and empirical measurements on strong features on the surface of the monument.

The post processing included cleaning and alignment of the partial laser scans, the 3D reconstruction of the image sequences using an SfM implementation (Aegissoft Photoscan). Texture mapping was implemented within the SfM software and the 3D model versioning and video sequence generation was performed with the help of Meshlab and Blender.

**ONLINE DELIVERY**
X3DOM for lower resolutions, PLY (vertex paint) RAW, due to its ability to be visualised to a wide range of Web-browsers without the need of installing any plug-in. Additionally it offers progressive downloading and binary encoding for large models.

http://www.ipet.gr/~akoutsou/3dicons/index.php?id=ARC3DICONS_3D_1Kio&res=L

**MODEL USE**
The different versions (geometry and texture resolutions) gives the ability to the digital replica of the monument to be used in a wide range of applications related to visualisation and dissemination.
**MAUSOLEUM OF ROMULUS**

**DESCRIPTION**
The Mausoleum was made by the Emperor Maxentius for his son Romulus. This Mausoleum belongs to a series of monuments like the Pantheon characterized by a common architectonic plan. A small part of the exterior is preserved while the architectonic structure of the interior is completely readable.

**CAPTURE**
Image-Based - Structure from Motion (SfM) Terrestrial Laser Scanning - Time of flight
Here the major topic was a comparison between different techniques namely image based and range based. In both cases we had pro and con, so we decide to proceed with both of them.

**EQUIPMENT**
CANON 650D, CANON 60D Faro Laser Scanner

**MODELING SOFTWARE**
Photoscan, Sfera, Geomagic, Rapidform

**PROCESSING PIPELINE**
Photo shooting, laser scanner acquisition, total station acquisition of GCP - Photo selection, referencing based on GCP and dense point cloud extraction - Alignment of point clouds from laser scanner - Hi-poly mesh models from laser scanner and from Photoscan - Textured model from Photoscan - Mesh decimation and conversion of model in X3D for web visualization

**ONLINE DELIVERY**
X3Dom - This method has been used previous within other projects.

**MODEL USE**
Tourism and educational/academic purposes.

**LOCATION**
ROME, ITALY

**INSTITUTE**
CNR-ITABC. www.itabc.cnr.it

**FINAL 3D MODEL FOR WEB PUBLISHING**

**FARO LASER SCANNER WORKING DURING THE 3D ACQUISITION**

**INTERIOR OF THE MAUSOLEUM OF ROMULUS**

**POINT CLOUD IMAGE BASED OF THE INTERIORS AND EXTERIORS OF THE MAUSOLEUM OF ROMULUS**

**CREATIVE COMMONS LICENCE**
Creative Commons - Attribution, Non Commercial, No Derivatives.
EXCAVATIONS IN THE SAINT LAURENTIUS CHURCH (1999-2002)

DESCRIPTION
The Saint Laurentius church was probably built around 995 AD in the new trade settlement Iham (today: Ename) which has been founded around 965 AD. This church has a main nave, two side naves, a double east choir and a west choir. The church is built in a pre-Romanesque, Ottonian style and is not only one of the oldest standing churches in Belgium, but has been extensively studied and excavated and contains a range of exceptional fresco wall paintings (the oldest in the Low Countries).

The excavations (1999-2002), the detailed research on the building and its history and restoration, provide sufficient data to reconstruct the evolution of the Saint Laurentius church from its conception around 995 AD until today. All virtual reconstructions have been commissioned by the Provincial Museum of Ename in the period 1998-2014. The current virtual reconstructions have been made for the period 1020 to 1730. Besides interactive 3D, video, stills and photographs of the monument and its excavation will be provided. The reconstructions are supported by two blogs, one about the trade settlement and one about the abbey.

CAPTURE
Surveying, excavation, stone by stone analysis by building history experts, historical research

EQUIPMENT
Total Station, non-digital measuring devices

MODELING SOFTWARE
ArchiCAD 6-15, Blender 2, Vue 10-11

PROCESSING PIPELINE
The 3D models were originally hand modelled in ArchiCAD from the plans made by the surveyors. These 3D models, made in the period 1997-2004, have been imported in Blender, where they have been revised, improved, retextured and completed. The terrain has been transformed into terrain maps for Vue, the vegetation (as provided by the expert in historical landscapes) into terrain types for Vue, with the correct types of vegetation and distribution of that vegetation. The buildings, resulting from Blender, have been imported in Vue. The methodology is explained in detail here. This all yields a 3D scene in Vue that yields outstanding visualisations through rendering. We organise the rendering in a Object VR way (i.e. a camera rotating 360 degrees around a fixed point) and turn the resulting images into an interactive visualisation through the software Object2VR. In the case of the Saint Laurentius church, the church is rendered for the different periods in the historical landscape that surrounds it.

ONLINE DELIVERY
Not online yet. The online delivery will use the software Object2VR, which is HTML5 based. An example of the result can be seen here. Additional results will be still images and videos of the 3D models.

MODEL USE
By providing clickable zones, a lot of information can be provided about the reconstructed period, turning the interactive reconstruction into an explorable world, that can be used for education, virtual exploration, scholarly interpretation and quality tourism.

REAL TIME UNITY 3D VISUALISATION OF SAINT LAURENTIUS CHURCH AND ENVIRONMENT IN 1300

AUGMENTED REALITY VISUALISATION OF SAINT LAURENTIUS CHURCH AROUND 1020 WITH PRESENT VIEW (TOP)

Creative Commons - Attribution, Non Commercial, No Derivatives.
The oppidum of Puente Tablas is located 3km from Jaén (Spain). It is one of the most relevant examples of the culture of the Iberians (VI-I ct. B.C.). Undoubtedly it is an example of unique sanctuary in the Iberian Peninsula at the time of the Iberians. According to the Attic red-figure ceramics, it is dated in the first half of the fourth century B.C. The sanctuary covers an area of 300 m² and it is divided into three terraces partially flag-stoned. The first terrace consists of cella, antecella and courtyard with the entrance at sanctuary. The second terrace is notable for having a second floor on a side room and especially for the existence to the west of four small caves, three of them in front of a platform with three small holes (probably an altar for libations) with a possible oracular function. The third terrace only has one room, while the rest of the space must be open and connected with a small channel crossing the sanctuary in north-south direction.

**CAPTURE:** Image-Based - Traditional Photogrammetry & Dense Cloud Photogrammetry. The data acquisition using photogrammetry require less time and less investment in equipment than others techniques.

**EQUIPMENT**
- Canon EOS 40D & GoPro Hero 3

**MODELING SOFTWARE**
- Agisoft Photocan

**PROCESSING PIPELINE**
- Photo Acquisition (250 photos) with coordinates for geo-referencing - Processing pictures (light but first image of tripod is wrong correction, conversion to HDR) - Selection of photos providing better performance when generating the model - Orientation of photos using Agisoft Photocan - Generation of a disperse point cloud with Agisoft Photocan (total points: 283,157) - Generation of a dense point cloud with Agisoft Photocan (total points: 24,234,925) - Generation of mesh from the dense cloud of points (polygons: 4,866,134) - Through this process we obtain a high resolution 3d model without photographic texture, ideal for viewing on landing pages such as 3dHOP. The simplified model is obtained (decimate mesh), reducing the mesh to a maximum of 300000 polygons. We apply to this simplified model the photographic texture for conversion to 3DPDF model.

**ONLINE DELIVERY**
- 3DPDF - Conversion to 3DPDF produces a format that is easy to handle. 3DPDF has been widely accepted as the presentation format, because it allows encapsulation and presentation of 3D models with contextual information and links that supply a range of visual angles on the models. Also, this is software compatible with the main operating systems (Windows, Mac OS, Linux).

**MODEL USE**
- Researchers
- Teaching both high school and University
- Dissemination of the culture of the Iberians
- Archaeological routes

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- Researchers
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- Archaeological routes
**NAME OF MONUMENT**

**SKARA BRAE**

**LOCATION**

SKARA BRAE, ORKNEY, SCOTLAND, UK

**INSTITUTE**

CMC ASSOCIATE

WWW.CMCASSOCIATES.CO.UK

**DESCRIPTION**

Early neolithic site located on Orkney Island, Scotland. Discovered in 1850 after a storm washed away coastal sand dunes. The site was in remarkable condition however it's proximity to the coast places it a great risk from further erosion.

**CAPTURE**

Terrestrial Laser Scanning - Time of light and photography. The site was scanned by third parties, we had no influence on the methods or technologies used.

**MODELING SOFTWARE**

Cyclone, CloudCompare, GeoMagic, Blender, Mudbox.

**EQUIPMENT**

Leica C10, & Leica HD56100 Scanners

Canon DSLR with 15mm lens

**PROCESSING PIPELINE**

We received the scan data as a Leica project file. Using Cyclone we exported each of the scans in two point cloud formats, e57 & PLY. The e57 format allowed us to retain the registration and intensity data. On a house by house basis each of the e57 files were opened in CloudCompare. Data less than 1 intensity was removed as bad scan records, the files were merged and then spatially subsumed to .005 Intensity data was then converted to RGB and the resulting point cloud exported as a PLY. DISC offered to help with the next section by wrapping the dense clouds with GeoMagic. The triangulated mesh was then opened in Blender and retopologised to produce a lightweight quad mesh. Archive and contemporary photograph was then used to texture the models using Blender & Mudbox.

**ONLINE DELIVERY**

Undecided, fulfilment of 3D will be carried out by Historic Scotland. The scan data is rights controlled, Historic Scotland wanted to manage future sales.

**MODEL USE**

We hope to see the data used in three areas:
1. Primary school education packs
2. Tourist interpretative guides
3. Site management and third level studies.
**NAME OF MONUMENT**

**ST KEVIN’S CHURCH**

**LOCATION**

GLENDALOUGH, WICKLOW, IRELAND

**INSTITUTE**

THE DISCOVERY PROGRAMME

WWW.DISCOVERYPROGRAMME.IE

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**DESCRIPTION**

This is the only stone-roofed building to survive at Glendalough and it incorporates a croft between the barrel-vaulted ceiling and the roof which may have functioned as an anchor-hole. It was originally a small rectangular single-celled church with a miniature round tower belfry at the W end. A later chancel and sacristy were added at the E. The roof of the oratory is steeply pitched and corbelled while the outside of the roof stones are roughly dressed to the slope. The only access to the belfry was through the croft which in turn was accessed through a small square hole in the vault. A former wooden floor is indicated by beam-holes on all the walls at the springing of the arch. This room was lit by a small square-headed E window. Only the foundations of the chancel are now visible but the stone-roofed sacristy at the NE angle of the church still stands with a simple lintelled opening in the S wall and a small round-headed window at E. The belfry has one window at each of the two lower floors and rectangular openings on the top floor at the four cardinal points. It was at one stage likened to a chimney and so the church became known as St Kevin’s Kitchen.

**CAPTURE**

Terrestrial Laser Scanning - Phase based. Provides rapid, accurate and dependable building survey data, which can be evaluated onsite. Panoramic Imaging – Provide full image texturing to replace scanner imagery.

**EQUIPMENT**

Faro Focus 3D

Gigapan Pro, Canon 5D MkII

**MODELING SOFTWARE**

Faro Scene, Trimble ReалWorks, Geomagic, Autodesk Mudbox, 3DS Max, XNormal, Photoshop, MeshLab, MARI, PTGUI

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**PROCESSING PIPELINE**


**ONLINE DELIVERY**

WebGL - Two lightweight models: one with photo texture and one with ambient occlusion to display the structural components of the building, are hosted online using SketchFab. This allows for very short load times and has the ability to generate psuedoVR content for users who cannot use WebGL. SketchFab also allows for First person viewing mode which allows the exploration of spaces.

www.3dicons.ie/index.php/3d-content/sites/26-st-kevins--church-glendalough

**MODEL USE**

Education, Conservation, virtual exploration, augmented reality, interpretation centre content, and tourism guides, 3D printing, provide access inside building which is normally closed

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Licence
The surveying team in the Banditaccia Necropolis while carrying the equipment for the survey of the tomb.

NAME OF MONUMENT
TOMB OF THE RELIEFS

LOCATION
CERVETERI, ROME, ITALY

INSTITUTE
FONDAZIONE BRUNO KESSLER (FBK), ITALY.
WWW.FBK.EU

DESCRIPTION
The Tomb of the Reliefs, dated IV century B.C., is the most beautiful and well known tomb in the Banditaccia Necropolis (a UNESCO site since 2004) situated northwest of Cerveteri (Rome). The tomb features the typical dromos leading to the entrance. Today the entrance is closed by a steel and glass door which allows to preserve the micro-climate conditions inside the tomb. Tourists are generally not allowed to enter this tomb.

CAPTURE
Combined TOF scanning and photogrammetric surveys were carried out to obtain the complete 3D model. The TOF range data were used to derive the geometry of the tomb, while the photogrammetric images were used to derive the photo-realistic high resolution texture.

EQUIPMENT
Lens Nikkor 14-24mm
Leica Scan Station 2
DSLR Camera Nikon D3X

MODELING SOFTWARE
Polyworks InnovMetric software
3DS MAX software
In-house FBK software

PROCESSING PIPELINE
All the scans acquired during the survey were aligned together to generate a dense 3D point cloud of the tomb. The cloud was then triangulated to derive a polygonal model (mesh) which was finally textured with a high-resolution image.

ONLINE DELIVERY
A navigable panoramic view of the interior of the tomb is integrated as part of the web page canvas.

MODEL USE
The 3D model was generated to allow the complete virtual visit of the heritage which is now not always accessible, but visible only through a glass door. The 3D modeling product was used for a multimedia and travelling exhibition in Bruxelles, Trento and Stockholm. (http://3dom.fbk.eu/en/node/95).

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The Capital of the Abbey of Notre Dame de la Sauve Majeure is a representation of Daniel between two lions. The Grande-Sauve Abbey or Sauve-Majeure Abbey is a former Benedictine monastery near the present village of La Sauve in the department of the Gironde, in a region once heavily forested. Although now in ruins, the remains of the abbey are still of great interest in terms of Romanesque architecture, especially because of the many sculpted capitals still surviving. In 1998 the abbey ruins were included as part of the UNESCO world heritage site of the pilgrimage route to St. James of Compostela.

**DESCRIPTION**

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**CAPTURE**

Image-Based - Traditional Photogrammetry. Easy to implement in the location

**EQUIPMENT**

Nikon D800E

**MODELING SOFTWARE**

Synaps and Geomagic

**TEXTURED 3D MODEL OF THE CAPITAL FOR ONLINE DELIVERY THROUGH WEBGL**

**PROCESSING PIPELINE**

Multiple photographies, post processing of the images, cleaning of the 3D model.

**ONLINE DELIVERY**

WebGL - Cross-browser and cross-platform compatibility. Tight integration with HTML content, including layered compositing, interaction with other HTML elements, and use of the standard HTML event handling mechanisms. Hardware-accelerated 3D graphics for the browser environment. A scripting environment that makes it easy to prototype 3D graphics.

http://archeogrid.u-bordeaux3.fr/3Dicons/3diconsview3d.php?id=15

**MODEL USE**

Promotion of cultural heritage

**LICENSE**

Creative Commons - Attribution, Non Commercial, No Derivatives.
NAME OF ARCHITECTURAL FEATURE
DAVID DI DONATELLO

INSTITUTE
ISTI-CNR
WWW.ISTI.CNR.IT

DESCRIPTION
Marble statue of King David, with the head of Goliath at his feet. The statue is a renaissance masterpiece, and it is one of the earliest work of Donatello. The 3D scanning has been carried out to create a replica for a temporary exposition, since moving the artefact is not possible.

CAPTURE
Close Range Laser Triangulation
The size of the object (human scale) required a level of detail between 1mm and 0.3mm, good enough for documentation and physical reproduction, not necessary for study of minute details. Ability to work on scaffolding and to move around the statue easily.

EQUIPMENT
Minolta VI 910 laser scanner

MODELING SOFTWARE
MeshLab

PROCESSING PIPELINE
• Planning
• On-field acquisition
• Range scan alignment
• Range scan merging
• Hole filling
• Final mesh optimization / cleaning / decimation
• Photographic alignment and color mapping

ONLINE DELIVERY
3D HOP - only tool able to cope with the high-resolution model

MODEL USE
It is not available to the public, only for research purposes, after agreement with superintendence

http://vcg.isti.cnr.it/europeana/david_donatello/landing/david_donatello.html

Creative Commons - Attribution, Non Commercial, No Derivatives.

LOCATION
MUSEO NAZIONALE DEL BARGELLO, FLORENCE, ITALY

PHOTOGRAPH OF THE DONATELLO’S DAVID

POST PROCESSING - ALIGNMENT OF RANGE SCANS

FINAL HIGH RESOLUTION MESH MODEL
Griphomaquia is a sculpture belonging to the group of Cerrillo Blanco (Porcuna, Jaén), undoubtedly the most important group of sculptures attributed to the culture of the Iberians. Dated in the 5th century BC, the sculptures reflect various aspects of an Iberian lineage grouped into different clusters: ancestors, warriors, fighting against animals, hunting scenes, etc. The Griphomaquia is part of a collection of fantastical animals which battled against Iberian hero, who unarmed, grasps the Griffin left ear and nose. At that moment, the Griffin thrusts his claw on the hero’s leg.

Height = 70 cm; Width = 84 cm; maximum thickness = 33 cm; Weight = 168 Kg

Given the relevance of the sculptures of Cerrillo Blanco (in which Griphomaquia is included), we aimed to obtain 3D models using the most appropriate methodology in terms of time, quality and the end use of the models. To do this we started analyzing the conditions under which the sculptures were exhibited. The main problems we faced were:

A - Lighting conditions: Transparency/Reflectance
B - Complex morphology of the object
C - Location and Accessibility:
   - Sculptures on raised platforms of a meter high and with little space around (less than 40 cm).
   - The weight, the extended visiting hours in the Museum of Jaén and the payment of insurance to move the sculptures make impossible the positional changes.

Given the above limitations, it was decided to discard photogrammetry and to use self-positioning laser scanning as the most appropriate method.
LADISALU HUNYADI’S MARBLE SARCOPHAGUS

DESCRIPTION
Sarcophagus of John Hunyadi, the brother of Iancu Hunyadi, a Hungarian noble and knight banneret from the House of Hunyadi, who died in 1442. The funerary monument is placed in the southern collateral of Saint Michael Roman Catholic Cathedral, near the Renaissance stair case with the coat of arms built by the bishop Vardai. On the sarcophagus, made of marble, are represented, in a Gothic style, mythological and biblical battles, all with reference to the life of the knight.

CAPTURE
Image-Based - Structure from Motion (SfM) & Traditional Photogrammetry. This 3D digitisation process is a low-cost technique suitable for a museum.

EQUIPMENT
Canon EOS 5D Mk II ISO 100, t=1/60/ zoom lens EF 24-105 AF IS @ 35 mm f: 22

MODELING SOFTWARE
Agisoft Photoscan

PROCESSING PIPELINE
Data capturing with Canon Eos 5D Mark II, - Processing and post - processing in Agisoft Photoscan: photo alignment - build dense point cloud - mesh generating, and texturing.

ONLINE DELIVERY
3D PDF - It is the most suitable solution for this type of visualization
http://mnir.ro/3D/MNIR_3D_12_Idol_2_INV_10_2326.pdf

MODEL USE
Basic knowledge about the artefacts and also for scientific purpose

LOCATION
SAINT MICHAEL ROMANO-CATHOLIC CATHEDRAL, ALBA IULIA, ROMANIA

INSTITUTE
MUZEUL NAȚIONAL DE ISTORIE A ROMÂNIEI (MNIR)
WWW.MNIR.RO

NAME OF ARCHITECTURAL FEATURE
The Market Cross

**DESCRIPTION**

Now in the Visitor Centre, the ‘Market’ Cross was reassembled in the 19th century from fragments scattered on the site. It may have originally stood opposite the west doorway of the cathedral. It bears a full-length figure of Christ wearing a crown and dressed in a knee-length tunic. Beneath him is an ecclesiastic and two standing figures, possibly patrons. The cross form is unusual and may have been influenced by Ottonian metalwork. Drilled holes in its stone surface may have held precious jewels, stones or even relics. The artistic style would suggest that it dates to the mid twelfth century.

**CAPTURE**

Structured Light

**EQUIPMENT**

Artec EVA

**MODELING SOFTWARE**

Modelling Software
- Artec Studio, Geomagic, Autodesk Mudbox, 3DS Max, XNormal, Photoshop, MeshLab

**PROCCESSING PIPELINE**


**ONLINE DELIVERY**

WebGL - Two lightweight models: one with photo texture and one with ambient occlusion to display the surface morphology are hosted online using SketchFab. This allows for very short load times and has the ability to generate pseudoVR content for users who cannot use WebGL. Also allows for embedded narrative.

www.3dicons.ie/index.php/3d-content/sites/14-the-market-cross-glendalough

**MODEL USE**

Education, Conservation, virtual exploration, augmented reality, interpretation centre content, and tourism guides, 3D printing of artefacts

**LICENSE**

Creative Commons - Attribution, Non Commercial, No Derivatives.
The archaeological site is one of the most important architectonic representations of the Nuragic culture in the island of Sardinia. It has never been systematically documented and this is the reason for our 3D scanning at the site, i.e. to obtain accurate measurements of the stones, plans of the site and attempt a virtual reconstruction based on this material in order to estimate its original shape.

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**CAPTURE:**
Terrestrial Laser Scanning - Phase based

**EQUIPMENT:**
Surphaser laser scanner, digital camera, total station

**MODELING SOFTWARE:**
JRC, point cloud, autocad, blender, 3dmax

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**MODELING SOFTWARE:**
JRC, point cloud, autocad, blender, 3dmax

**INSTITUTE:**
The Cyprus Institute, STARC
www.cyi.ac.cy/starc.html

**LOCATION:**
Sardinia, Italy

**PROCESSING PIPELINE**
Various scans were aligned, cleaned, meshed and imported to the various post processing software: JRC for cross sections, measurements, extraction of features, AutoCAD for plans drawing and static calculations, and blender / 3d max for virtual reconstructions.

**ONLINE DELIVERY**
X3D - most efficient in terms of interaction with 3D model
http://public.cyi.ac.cy/starcRepo/explore/objects

**MODEL USE**
Provide the possibility to investigate both the above and below ground parts of the structure - useful as an educational tool as well as for comparative research.
**NAME OF ARCHITECTURAL FEATURE**

"SUICIDE OF AIACE" METOPE

**LOCATION**

PAESTUM, CAMPANIA, ITALY

**INSTITUTE**

FONDAZIONE BRUNO KESSLER (FBK), ITALY. WWW.FBK.EU

**DESCRIPTION**

Metope carved in sandstone from the Sanctuary of Hera in Sele (Paestum, SA). The artefact is relevant for virtual representation of Magna Graecia and Roman heritage.

**CAPTURE**

Combined photogrammetric and triangulation-based strip projection scanning surveys were carried out to obtain the complete 3D model.

**EQUIPMENT**

DSLR Canon EOS 600D + Lens Canon 18-55mm
Panasonic DMC-TZ7 Triangulation-based strip projection ARTEC 3DMH scanner

**MODELING SOFTWARE**

Agisoft Photoscan, In-house FBK software, Geomagic Studio

**PROCESSING PIPELINE**

In-house developed and commercial photogrammetric tools were used to generate a dense 3D point cloud of the heritage artefact. The cloud was then triangulated to derive a polygonal model (mesh) which was finally textured with a high-resolution image.

**ONLINE DELIVERY**

WebGL - The WebGL model is integrated completely into all the web standards of the browser allowing GPU accelerated usage of physics and image processing and effects as part of the web page canvas.


**MODEL USE**

The model is not publicly available; it can be released for scientific purposes, by obtaining the permission from the superintendent. The 3D online browser is publicly accessible.

**LICENCE**

Creative Commons - Attribution, Non Commercial, No Derivatives.
**NAME OF ARTEFACT**

**CHRYSSIPPUS HEAD**

**LOCATION**

Templum Pacis, Rome, Italy

**INSTITUTE**

CNR-ITABC. www.itabc.cnr.it

**DESCRIPTION**

This bronze statue was in the library of Templum Pacis in Rome belonging to a group of portraits of ancient writers and philosophers. The subject of this statue is one of the most important philosophers from the ancient world (he formulated Stoicism into a definitive system). "Chrysippus of Soli (c. 279 BC – c. 206 BC) was a Greek Stoic philosopher. He was a native of Soli, Cilicia, but moved to Athens as a young man, where he became a pupil of Cleanthes in the Stoic school. When Cleanthes died, around 230 BC, Chrysippus became the third head of the school. A prolific writer, Chrysippus expanded the fundamental doctrines of Zeno of Citium, the founder of the school, which earned him the title of Second Founder of Stoicism." (cit. wikipedia).

**CAPTURE**

Image-Based - Structure from Motion (SfM)

**EQUIPMENT**

(Canon EOS 650 with a 18-55 mm lens)

**MODELING SOFTWARE**

Photoscan, Blender

**PROCESSING PIPELINE**

X3Dom - This technology has been used in previous projects of the VHLab. http://192.167.233.8/emanueldemetrescu/3DICONS/x3dviewer.php?doi=ChrysippusHead

Online Delivery

Photos shooting and reference measures in real world - Photos selection and SfM creation of a hypoly mesh (82M polygons) - Cleaning and hole closing with Meshmixer - Re-import of the model in Photoscan - Low-Poly version of Chrysippus Head (500K polygons) - Texture creation with Photoscan - Import in Blender 3D - Texture correction with digital painting (small artefacts in the upper part of the model and an important integration in the bottom part, hidden during the photo shooting due to preservation issues and permissions from the museum) - Color clustering for specular maps extraction (green parts are oxidized bronze) - Extraction of normal maps from Hi-poly model - Shader creation combining three channels (diffuse, specular, normal).

**IMAGE OF ORIGINAL 3D CAPTURED DATA E.G. POINT CLOUD, MESH MODEL**

**MODEL USE**

Both tourism and academic/non profit educational channels.

**IMAGE OF HI-POLYGON MODEL OF CHRYSSIPPUS HEAD WITH VERTEX COLOR (92M POLYGONS)**

**LICENSE**

Creative Commons - Attribution, Non Commercial, No Derivatives.
Pottery recovered from graves in south east Spain, from El Argar culture. El Argar was a Bronze age culture which thrived, 2200 -1500 BC. The Siret brothers (Belgian mining engineers) working as surveyors in Spain in the 19th century recovered this material in their spare time. The archaeological remains of El Argar are dispersed throughout European heritage institutions, which make it difficult material to study. The 3D models enable remote access and reduce cost and hazard for transportation.

**Pottery recovered from El Argar sites**

**Royal Museums of Art & History (KMKG), Brussels, Belgium.**

**MODELING SOFTWARE**

Image-Based - Dense Multi-View 3D Reconstruction

Suitable for this kind of objects. Limited 3D technical expertise needed. The museums have their own photographic department therefore only a small investment was required.

**CAPTURE**

**Equipment**

Equipment: Nikon D7000 with 60 mm macro lens.

**OVERVIEW OF POTTERY SHAPES. ORIGINAL DRAWING OF THE SIRET BROTHERS**

**NAME OF ARTEFACT**

**EL ARGAR POTTERY**

**LOCATION**

ROYAL MUSEums OF ART & HISTORY, BRUSSELS, BELGIUM

**INSTITUTE**

ROYAL MUSEums OF ART & HISTORY (KMKG), BRUSSELS, BELGIUM. www.kmkg-mrah.be

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**PROCESSING PIPELINE**

Object photography, using a hand operated turntable in a white round wall studio (100 - 200 images per object) - In Agisoft Photoscan: Masking the background of individual images - Generation of dense pointcloud - Generation of mesh - Application of texture - Export as 3D PDF & obj

**ONLINE DELIVERY**

3D PDF - This is the method KMKG applies for 3D digital models

3dicons.kmkg-mrah.be

**MODEL USE**

The general public will access to low res models through the KMKG website. Researchers will receive high resolution .obj files upon request.

**CAPTURE**

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**Equipment**

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**MODELING SOFTWARE**

Agisoft Photoscan

**CAPTURE**

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**ONLINE DELIVERY**

3D PDF - This is the method KMKG applies for 3D digital models

3dicons.kmkg-mrah.be

**MODEL USE**

The general public will access to low res models through the KMKG website. Researchers will receive high resolution .obj files upon request.
The El Argar buried their dead in burial jars, complete with status symbols like silver crowns, bracelets and bead necklaces. One of the jars still contained a skull wearing a crown. The skull has been reproduced in 3D using photogrammetry.

**NAME OF ARTEFACT**

**EL ARGAR SKULL**

**LOCATION**

ROYAL MUSEUMS OF ART & HISTORY, BRUSSELS, BELGIUM

**DESCRIPTION**

The El Argar buried their dead in burial jars, complete with status symbols like silver crowns, bracelets and bead necklaces. One of the jars still contained a skull wearing a crown. The skull has been reproduced in 3D using photogrammetry.

**CAPTURE**

Image-Based - Dense Multi-View 3D Reconstruction
- Suitable for this kind of objects.
- Limited 3D technical expertise needed.
- The museums have their own photographic department therefore only a small investment was required.

**INSTITUTE**

ROYAL MUSEUMS OF ART & HISTORY (KMKG), BRUSSELS, BELGIUM. WWW.KMKG-MRAH.BE

**EQUIPMENT**

Equipment: Nikon D7000 with 60 mm macro lens.

**MODELING SOFTWARE**

Agisoft Photoscan

**PROCESSING PIPELINE**

Object photography, using a hand operated turntable in a white round wall studio (100 - 200 images per object) - In Agisoft Photoscan: Masking the background of individual images - Generation of dense pointcloud - Generation of mesh - Application of texture - Export as 3D PDF & .obj

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**INSTITUTE**

Royal Museums of Art & History, Brussels, Belgium

**LOCATION**

Royal Museums of Art & History (KMKG), Brussels, Belgium. www.kmkg-mrah.be
The Petit Trianon, built between 1762 and 1768 during the reign of Louis XV, is a small château located on the
grounds of the Palace of Versailles in Versailles, France. The park of the Grand Trianon includes the Petit Trianon.
The château of the Petit Trianon is a celebrated example of the transition from the Rococo style of the earlier part of
the 18th century, to the more sober and refined, Neoclassical style of the 1760s and onward. Within the queen’s
apartment, one discerns Marie Antoinette’s incessant need for privacy: the decor of her boudoir displays an
inventiveness unique to the age, featuring mirrored panels that, by the simple turning of a crank, can be raised
or lowered to obscure the windows. Her bedroom, although simple, is also elegant in accord with her general
style, provided with furniture from Georges Jacob and Jean Henri Riesener. The wallpaper was painted by
Jean-Baptiste Pillement.
The Goddess of Sultana Neolithic Idol

Name of Artefact

The vessel, known as The Goddess of Sultana, is modelled in a human shape. The facial features are under the rime. The eyes are marked by incisions with eyebrows in relief; the mouth is depicted by a large incision with a range of holes into lip and the nose is pointed. The big ears are perforated. The legs are short and thick. A special attention is devoted to the buttocks and the hips, which are emphasized. The schematic arms are modelled in an interesting position: the right arm holds the left one which reaching toward the chin, suggesting a person who is thinking.

Processing Pipeline
Data capturing with Canon Eos 5D Mark II, - Processing and post-processing in Agisoft Photoscan: photo alignment - build dense point cloud - mesh generating, and texturing.

Online Delivery
3D PDF - It is the most suitable solution for this type of visualization.

Model Use
Basic knowledge about the artefacts and also for scientific purpose.

Description
The vessel, known as The Goddess of Sultana, is modelled in a human shape. The facial features are under the rime. The eyes are marked by incisions with eyebrows in relief; the mouth is depicted by a large incision with a range of holes into lip and the nose is pointed. The big ears are perforated. The legs are short and thick. A special attention is devoted to the buttocks and the hips, which are emphasized. The schematic arms are modelled in an interesting position: the right arm holds the left one which reaching toward the chin, suggesting a person who is thinking.

Capture
Image-Based - Structure from Motion (SfM) & Traditional Photogrammetry. This 3D digitisation process is a low-cost technique suitable for a museum.

Equipment
Canon EOS 5D Mk II ISO 100, t=1/60/ zoom lens EF 24-105 AF IS @ 35 mm f: 22

Modeling Software
Agisoft Photoscan

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APPENDIX 1: ADDITIONAL 3D-ICONS RESOURCES

PROJECT REPORTS

D.2.1 Digitisation Planning Report, Paolo Cignoni (CNR) and Andrea d’Andreà (CISA)
D.2.3 Case Studies for the Testing the Digitisation Process, Anestis Koutsoudis, Blaz Vidmar and Fotis Amaoutoglou (CETI) and Fabio Remondino (FBK)
D.3.1 Interim Report on Data Acquisition, Gabriele Guidi (POLIMI)
D.3.2 Final Report on Data Acquisition, Gabriele Guidi (POLIMI)
D.4.1 Interim Report on Post-processing, Livio de Luca (CRNNS-NAP)
D.4.2 Interim Report on Metadata Creation, A. D’Andrea (CISA) with the collaboration of R. Fattovich and F. Pesando (CISA), A. Tsaoussis and A. Koutsoudis (CETI)
D.4.3 Final Report on Post-processing, Livio de Luca (CRNNS-NAP)
D.5.1 3D Publication Formats Suitable for Europeana, Daniel Pletinckx and Dries Nollet (VisDim)
D.5.2 Report on publication, Daniel Pletinckx and Dries Nollet (VisDim)
D.6.1 Report on Metadata and Thesauri Andrea d’Andreà (CISA) and Kate Fernie (MDR)
D.6.2 Report on Harvesting and Supply, Andrea d’Andreà (CISA) and Kate Fernie (B2C)
D.7.1 Preliminary Report on IPR Scheme, Mike Spearman, Sharyn Emilsie (CMC)
D.7.2 IPR Scheme, Mike Spearman, Sharyn Emilsie and Paul O’Sullivan (CMC)
D.7.4 Report on Business Models, Mike Spearman, James Hemslay, Emma Inglis, Sharyn Emilsie and Paul O’Sullivan (CMC)

All Project reports are available at fro the 3D-ICONS website at the following URL: http://3dicons-project.eu/index.php/eng/Resources

PUBLICATIONS


Online: www.isprs-ann-photogramm-remote-sens-spatial-inf-sci.net/II-S/W1/151/2013/
Yiakoupi, K., Hermon, S., 2013. Israel Case Studies: The room of Last Supper and The Tomb of King David Hall, Presentation, Digital Heritage 2013, Marseilles, France, Session: “Exploring the 3D ICONS project: from capture to delivery”.
APPENDIX 2: PROJECT PARTNERS

Visual Dimension bvba (VisDim) Belgium
Archeotransfert, France
The Discovery Programme Ltd., Ireland
Koninklijke Musea Voor Kunst en Geschiedenis (KMKG), Belgium
Athena Research and Innovation Centre in Information Communication & Knowledge Technologies (CETI), Greece
Centre National de la Recherche Scientifique (CNRS-MAP) France
Muzeul Național de istorie a României (MNIR), Romania
National Technical University of Athens (NTUA), Greece
CMC Associates Ltd., UK
Consiglio Nazionale delle Ricerche (CNR-ISTI), Italy
Politecnico di Milano (POLIMI), Italy
Universidad de Jaen, Andalusian Centre for Iberian Archaeology (UJA-CAAI), Spain
Consorzio Interdipartimentale Servizi Archeologici (CISA), Italy
The Cyprus Research and Educational Foundation (CYI-STARC), Cyprus
Fondazione Bruno Kessler (FBK), Italy