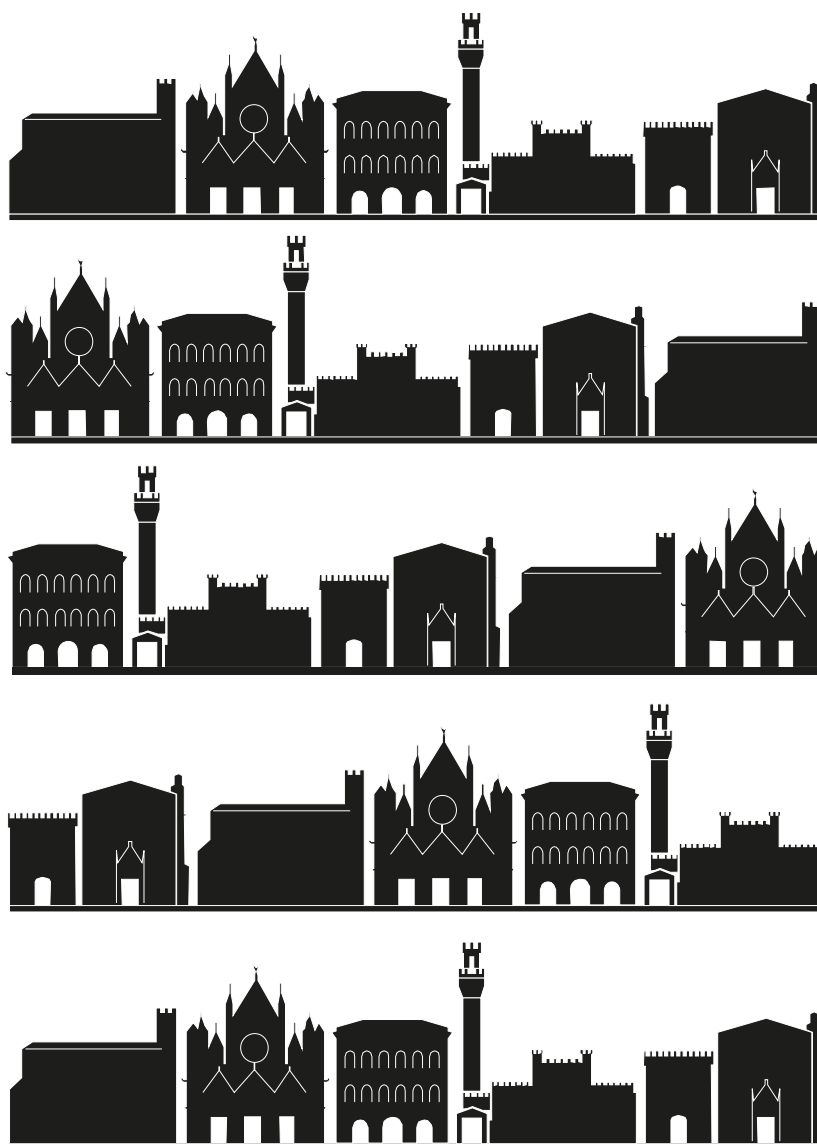# CAA2015

KEEP THE REVOLUTION GOING >>>

Proceedings of the 43rd Annual Conference on Computer Applications and Quantitative Methods In Archaeology

edited by

Stefano Campana, Roberto Scopigno,
Gabriella Carpentiero and Marianna Cirillo

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Providing 3D Content to Europeana

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Abstract: As the general public is becoming increasingly familiar with 3D content, the challenge of 3DICONS was to provide high-quality 3D cultural heritage content to Europeana, in particular the project dealing with the use of existing tools and methods to integrate them in a complete supply chain of 3D digitization and contribute a significant mass of 3D content. 3DICONS digitized a series of architectural and archaeological masterpieces of worldwide and European cultural significance and provided 3D models and related digital content to Europeana, with the objective of contributing to the critical mass of highly engaging content available to users.

Keywords: Europeana, 3D models, metadata, provenance, paradata

Introduction

From 2012 to 2015 the European Project 3DICONS focused on providing 3000 metadata, concerning 5000 3D models and related content, to the digital library Europeana.[1]

The 3D models range from large and complex architecture and archaeological monuments to small findings giving a broad impression of the potentiality of the 3D data capture, processing, and visualization. Through 3D models the general public can visit sites that may be in remote locations, fragile, and in some cases difficult to understand.

3DICONS contributed to the expansion of 3D models into Europeana, offering enhanced experiences for its users by bringing exciting and engaging content for archaeological monuments and historic buildings. The availability within Europeana of 3D models of architecture or archaeological monuments shows that best practices and guidelines are useful for the new initiative and 3D data collections.[2]

The project produced many reports on the 3D data-acquisition, 3D data-processing, and 3D data visualization; a large number of case studies have been presented in the guidelines report. All these contributions are downloadable for free from the project's website. They represent an updated technical pipeline of the 3D model creation, with the addition of rich metadata describing the real object and its digital replica. Mainly in terms of metadata, the project has provided an innovative schema including information about provenance and paradata in order to keep track of the complete digitization process.

The broad context of the 3DICONS was the 2020 strategy for Europe and the Digital Agenda for a flourishing digital economy, and the standards and increased inter-operability needed to support Europeana as a multilingual common access point to millions of objects for all European citizens. Europeana provides access to more than 14 million books, maps, recordings, photographs, archival documents, paintings, and films from 1500 cultural institutions across Europe. This content is beginning to illustrate the potential for Europeana to be used in schools and other services. Yet there is great potential to continue extending and enhancing the content base.[3] Europeana has itself set out in its Strategic Plan objectives, in terms of both extending the content base and in seeking to cultivate new ways for its users to participate in their cultural heritage and to enhance their experience. 3DICONS has been implemented with the aim of supporting these policy objectives by enabling increased access to important cultural heritage sites through an effective use of digital technology.

The project, carried out by an interdisciplinary consortium, including partners from different European countries and with different competences, aimed to exploit existing tools and methods and to integrate them in a complete supply chain of 3D digitization that will contribute a significant mass of 3D content to Europeana. The 3DICONS consortium consisted of sixteen organizations based across Europe, providing technical support and content to Europeana as follows:[4]

- The project has been coordinated by Centro Interdipartimentale di Servizi di Archeologia (CISA), Università degli Studi di Napoli L'Orientale.

- Two technical partners (the National Technical University of Athens and the Digital Curation Unit of the Athena Research Center) were responsible for providing the components of the aggregation service (the MINT2 mapping tool, the MoRE2 ingestion repository, and the Metadata Editor) and for providing support and technical advice to the project partners in their use of the metadata creation, mapping, and ingestion tools.

- Fourteen partners (including CISA and Athena Research Center) provided 3D content. These organizations consisted of a cross section of the different entities involved in 3D technology for cultural heritage, namely five major national research organizations, two universities and a polytechnic, two research foundations, two commercial SMEs, and two national museums.

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[1] The paper is largely based on the Final Progress Report submitted at the end of the project (January 2015). 3DICONS (3dicons-project.eu/) was a pilot project funded under the European Commission's ICT Policy Support Programme. For the general objectives of the project: D'Andrea 2012; D'Andrea and Fernie 2013.

[2] The 3D models and all digital resources provided to Europeana are available at: www.europeana.eu/portal/search.html?query=PROVIDER%3A+%223D+ICONS %22&rows=24.

[3] This was highlighted in the New Renaissance, Report on Europeana in January 2011: ec.europa.eu/information_society/activities/digital_libraries/doc/refgroup/final_ report_ cds.pdf.

[4] The complete list of participants is available at http://3dicons-project.eu/eng/About/Consortium.

3DICONS relied on the achievements of the CARARE and other European projects,[5] which have already provided digital assets on European archaeology and architecture. It used the CARARE aggregation service and extended CARARE's coverage by digitising monuments and buildings in 3D and creating a large number of related digital items such as images and videos.

The content includes many of the most famous monuments and buildings in Europe. At the end of the project some 60 such iconic monuments and sites have been made available on Europeana, incorporating about 5000 3D models of architectural and archaeological monuments, more than 17,000 high-resolution images and 287 videos. All the selected masterpieces belong to UNESCO World Heritage Sites. The process set up in the project involved technologies for both surveying and modelling (topographic surveying, 3D laser scanning, image-based modelling, etc.). A range of well-known technological solutions available for the processes was tested, and the equipment used was selected according to the features of individual objects.[6]

The paper reports on the main achievements reached by the project during its implementation and the contribution of CISA, the leader of Consortium, to the realization of these targets.

1 Project objectives

The 3DICONS project focused on creating and providing digital content to Europeana, including 3D models and reconstructions, enlarged models of important details and related images, texts, and videos. Also included and re-contextualized in 3D are objects belonging to a monument but presently located elsewhere, for example in museums. The project's activities predominantly consisted of new digitizations but also included some existing 3D data, all of which have been converted into formats accessible by Europeana users. The project complemented the collections made available to Europeana via CARARE, Europeana Local[7] and Athena,[8] which developed the content base for the architectural and archaeological heritage. An equally important aspect of the project was to develop an IPR Management Scheme specifically aimed at 3D content and which was also compliant with the Europeana Data Exchange Agreement[9] (and consequently, the Creative Commons licensing framework).

3DICONS relied on the results of previous EU projects, most notably on CARARE, for the aggregation services and guidelines on the publication of 3D for Europeana, and on 3DCOFORM for the 3D creation, management, and visualization tools. 3DICONS provided a complete digitization and publication pipeline that addresses digitization methodologies, post-processing, and conversion to end viewer-friendly publication formats and IPR aspects. 3DICONS has also updated the CARARE metadata schema to accommodate 3D content and mapped this to EDM schema[10] adopted by Europeana.

The project has worked closely with its stakeholders, with more experienced partners providing technical support and knowledge to the less experienced partners. Metadata creation guidelines and a metadata editing tool to facilitate content providers with little or no technical knowledge of XML, or metadata schemas that provide their 3D content to Europeana, were developed by the project.

Close collaboration with Europeana has established a best practice pathway for the ingestion and format of the metadata and display of 3D models and associated content to end-users.

Finally, the project has highlighted the many positive aspects that investment in 3D technology brings to the cultural heritage sector, from an effective means of documentation and monitoring of historical objects and monuments, the provision of exciting and engaging content for end-users of all ages, and the opening up of commercial and experimental opportunities for organizations which create and hold this type of content.

2 Project achievements

The main results achieved by the project are:

- The current inventory of monuments and buildings has been made available to Europeana, providing:

  - 3000 metadata relating to 5000 3D models

  - Over 17,000 images

  - 287 videos

- Where permitted, the original 3D datasets are also available for research purposes

- The update of the CARARE metadata schema, renamed CARARE 2.0

- An online Metadata Editor tool which uses reusable templates based on CARARE 2.0, has been developed for general use and is being adapted for other Europeana content projects

- The pipeline has been documented in the Guidelines and Case Studies for the acquisition and production of 3D models

- Dissemination activities have resulted in many articles and papers publishing presentations at conferences and well-attended workshops.

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[5]   www.carare.eu. CARARE is a Best Practice Network designed to involve the network of heritage organizations, archaeological museums, research institutions, and specialist digital archives in making the digital content that they hold available to Europeana. Other similar initiatives are 3D-COFORM: www.3d-coform.eu; EuropeanaConnect: www.europeanaconnect.eu; Linked Heritage: www.linkedheritage.eu.

[6]   Different deliverables deal with the acquisition process (D.3.2), the post-processing phase (D.4.3), and the publication formats suitable for the Internet and Europeana. All the information will be summarized in the deliverable D.7.3 'Guidelines', which will be ready at the end of the project.

[7]   http://www.europeanalocal.eu/.

[8]   http://www.athenaeurope.org/.

[9]   http://pro.europeana.eu/page/the-data-exchange-agreement.

[10]   http://pro.europeana.eu/page/edm-documentation.

- A Portal showing the geo-location of all acquired and published monuments.

The target users of the 3DICONS content include:

- Members of the general public, tourists, and students who wish to be able to explore and enjoy architectural and archaeological masterpieces through Europeana, which are often inaccessible to visitors either as a result of their remote locations or because conservation management restricts access to only parts of the monuments.

- The cultural institutions who are in charge of internationally and nationally important monuments and buildings and who need tried and tested mechanisms to produce high-quality 3D documentation and publish the results for Europeana as well as on their own websites.

- UNESCO and cultural institutions wishing to find new ways of delivering their missions to promote understanding and increase the sustainability of world and European heritage.

- Content providers and creative industry SMEs wishing to identify sustainable business processes and models.

The needs of this diverse set of target users provided a range of organizational and technical challenges for the project:

- Obtaining permission to access and digitize the monuments and to publish the resulting 3D models;

- Developing processing techniques that produce 3D models of good visual quality while keeping the file sizes as small as possible to enable the models to work on standard computers;

- Creating the metadata for each digital resource without the need for expert knowledge of XML or the CARARE 2.0 metadata schema;

- Producing high-quality metadata and user-friendly landing pages for the content made available to Europeana;

- Keeping abreast of the latest technical developments in 3D viewers and utilising these to the project's advantage.

3 Project activities

The main 3DICONS activities consisted of planning the content acquisition and gaining permission for access and the rights to create and publish the content, carrying out the digitization, cleaning and manipulating the datasets, post-processing these to create the require 3D models, creating the metadata and ingesting this Europeana, and publishing the models in user-friendly formats.

The first year of the project involved substantial preparation in obtaining permission for access to and scanning of sites and monuments before proceeding to the digitization phase. As an illustration of the complexity of IPR for 3D cultural heritage, around half of the original content was eventually replaced with other items as well additional content being made available where IPR was not an issue. After 18 months the

project published a report on IPR Schemes that described the various licensing scenarios and possible solutions. It appears that Europeana's adoption of the Creative Commons licensing framework along with other prominent initiatives such as WikiLovesMonuments[11] is having a positive impact, in that this is making digital content owners pay more attention to IPR while also enabling them to open up access to their collections. This change in attitude was evidenced in 3DICONS where more organizations have started to use Creative Commons for licensing since the start of the project.

During the first two years, the project partners were mainly occupied with digitizing the selected sites and monuments, some of which involved trips to remote areas and archaeological sites of great importance. Obstacles that had to be overcome were gaining access to remote sites (e.g. Skellig Michael can only be accessed by boat during the summer months), delays caused by bad weather, and restricted access times due to the monuments or museums also being open to the public — or closed for restoration. Several different scanning methods were used, from hand-held scanners for the museum objects, UAVs for large monuments, to LIDAR for complete sites.

In order to support the complete 3D model creation process, there have also been significant developments in the infrastructure and tools. At the end of the first year, the CARARE 2.0 metadata schema was published, having been updated to include 'provenance' that is specific to 3D models (e.g. dataset type, processing method, equipment and settings used, final formats). 3DICONS used the same infrastructure as CARARE, adapted to the new schema for ingestion to Europeana. It was also realized that a simple metadata editing tool would greatly speed up the creation of the required metadata and assist the less experienced partners, in addition to providing a valuable facility for newcomers wishing to use the 3DICONS pipeline. Consequently, a Metadata Editor tool was developed which has the advantages of creating reusable templates for each end-user and producing CARARE 2.0 compliant XML files for ingestion into MoRE2.

Creating the metadata and the ingestion process into Europeana proved to be a steep learning curve for all concerned. The project also implemented a strict quality-control procedure to ensure that all content provided to Europeana was of high quality; this review process led to adjustments to the metadata to improve them and also some revisions to the publishing and viewing technologies used to meet the required standards.

Once the 3D model has been created, a suitable publication format must be selected to make the model viewable by the Europeana end-user. The project carried out extensive testing and experimentation to determine which formats were suitable, based on how well supported these were across different platforms, what sort of models suited specific publication formats, and whether the technology was compliant with IPR requirements such as low resolution and security.

Due to the varied nature of the 3D assets that have been published, as well as to the continuous evolution of the 3D presentation over the Internet, several techniques have been used for visualizing the 3D models. At present, the most suitable formats are 3D PDF for objects of low complexity

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[11] http://wikilovesmonuments.wikimedia.it/.

(e.g. museum objects), HTML5/WebGL for objects and highly complex point cloud models, Unity3D/UnReal for less complex buildings and sites and the more complex ones where the level of detail can be optimized. Pseudo 3D is also an option for highly complex models across the board. Some partners employed a web-streaming viewer for complex 3D models.

It should be noted that with the current rapid changes in 3D viewing technologies, other options have been made available during the implementation of the project and some partners have started to experiment making 3D models available in this latest platform which offers high-quality, responsive viewing on the most basic of PCs.

A number of 3DICONS partners have relied on 3D PDF as their publication format, as 3D PDF is still a powerful and multi-platform way to deliver 3D content on nearly all desktop computers. It has a simple and stable production workflow, which integrates easily into cultural heritage organizations. 3D PDF, however, has some issues concerning the delivery and availability on mobile platforms (smart phones, tablets). Other partners have used the recently developed HTML5/WebGL standards. The web streaming 3DHOP has been used to create online interactive preview for some 3D models. Partners have also developed some models suitable for the stereovision of the 3D models using a smart phone and a small Google CardBoard.[12]

Finally, the project has been widely disseminated through social media, conferences, journals, and other channels. Over 30 papers about the project have been published in conference proceedings, academic journals, and articles in national newspapers in Spain, Ireland, the UK, and Greece.

4 Impact and sustainability

One of the benefits of participating has been the transfer of knowledge between partners, enabling those newer to 3D technologies to improve their skills and the quality of their acquired datasets and resulting models. To this end, some of the partners have participated in training workshops to learn about the latest acquisition and modelling techniques, such as the use of UAVs and photogrammetry. Some partners have organized their own training workshops. MNIR (Muzeul Naţional de Istorie a României of Bucharest – Romania) hosted a summer school for other cultural heritage institutions in Romania, having gained extensive expertise from their participation in the project. FBK (Foundation Bruno Kessler of Trento – Italy) provides an annual 3D summer school as well. The 3DICONS project also organized two internal metadata training workshops and a very successful technical workshop describing the different models and techniques adopted by partners at the Digital Heritage Conference hosted in Marseilles at the end of October 2013.

The results of the work carried out by the project are available as a print-ready PDF entitled 'Guidelines' which comes with several case studies illustrating the different types of data capture and output. This can be downloaded from the Resources section of the 3DICONS website.

The 3DICONS Project has had a substantial impact on the cultural heritage community and is the leading provider of 3D content for iconic European monuments and related historical objects. The pipeline developed by the project provides several options for the capture, processing, and publication of 3D models, covering many different techniques and methodologies for a wide range of subjects, from the smallest object such as a coin to large archaeological sites. Equally important is the topic of IPR and guidelines are provided for the best way to approach this complex issue. One positive outcome from the project has been the adoption of the Creative Commons licence scheme by several of the partners for their 3D models. As illustrated by the external collaborations developed by the project, cultural heritage owners and curators are adopting the 3DICONS approach for the production of 3D models.

Within the project, several partners have gained substantial technical knowledge in order to apply this, not just for creating 3D models for Europeana but for their own documentation, monitoring, and curating purposes. Where partners have created 3D models in partnership with museums and their local authorities in charge of monuments, these organizations have benefitted from the use of 3D models for promoting their cultural heritage. This is encouraging many of these authorities to be less restrictive with their IPR and to move towards the Creative Commons model. Some examples include:

- The data collected for the Neolithic site of Knowth is now being utilized by the Office of Public Works (OPW) in conjunction with the Dublin Discovery Programme to produce an immersive experience at the Bruna Boinne visitor complex, including the use of oculus rift and unity technology. This will generate revenue for the Discovery Programme over the coming years.

- PRISMA, an Italian SME developing mobile guides of heritage sites, has an agreement to use 3D ICONS models in their guides.

- The Museum of Vetulonia, Tuscany will be making physical replicas from the 3DICONS models of the same area (Etruscan sites) in preparation for an exhibition at EXPO2015.

3DICONS has provided owners of existing 3D models relating to cultural heritage and those organizations who are beginning to include 3D technology in their workflow, with guidelines and case studies to help them manage IPR issues, capture and create their models, a metadata schema tailored for 3D models, a simple tool to enable metadata to be created for Europeana, and also a showcase repository which enables a straightforward method for storing and hosting 3D content. In addition, there have been several enquiries regarding commercial collaboration and these developments are ongoing.

5 CISA contribution

CISA contributed to the creation of 3D content by acquiring and processing many statues and sarcophagi from the Archaeological Museum of Naples and some archaeological monuments in Naples (Roman Theatre, Baths of Carminiello ai Mannesi), Herculaneum (Augusteum, Terrace of Nonio Balbo, Sacello of Augustali) and Pompeii (some tombs from the Necropolis of Porta Ercolano, some domus of the Regio

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[12] https://www.google.com/get/cardboard/.

VI). At the end of the project 120 3D models were created for a total of 578 digital resources provided to Europeana.[13]

In the project CISA has been mainly involved in the aggregation and ingestion process. Furthermore CISA has contributed to update the metadata schema adopted by the previous CARARE, extending it to support provenance, transformation, and London Charter[14] paradata required for quality assurance of 3D models. One of the main 3DICONS was to develop a metadata schema able to capture all the semantics present in the digitation process (provenance) and in understanding and interpretation of data objects (paradata). 3DICONS updated the previous CARARE schema by investigating what additional data might be required and how this could be represented. This has resulted in the CARARE 2.0 schema, updated to include provenance information and paradata relating to 3D models, which was specified as an extension to the CIDOC-CRM, called CRMdig.[15] The CARARE 2.0 schema is a much richer dataset than the Europeana EDM and has made available a number of commonly used cultural heritage mappings already used in the cultural heritage sector.[16] Thanks to the recent developments of integration between CARARE and EDM and to the publication of object templates of EDM,[17] the updated CARARE2 schema has also enabled some simplification. The last OWL version of EDM[18] has been aligned to CIDOC-CRM Core Classes and some properties of CIDOC-CRM have been reused in EDM, allowing a more simple integration of CRMdig into EDM. This has enabled the provenance and paradata to be added to the CARARE schema without changing substantially the original schema and the mapping to EDM.

It is hoped that the new schema will increasingly encourage European Institutions to adopt a clearer approach in describing the features of a cultural object, the techniques and methodologies chosen for the digitations, and the motivations at the base of the creation of the digital object. The complete knowledge of the digital resource will allow a more efficient reuse of the archive, increasing the usability of the resources available online. Thus it will be easier to compare models and their complexity, any eventual innovation in their creation, and their reliability.

Furthermore, a 3D model repository has been developed and used by CISA to host and facilitate the publication of all 3D models and related content.[19]

6 Conclusions

The general objective of 3DICONS was to enhance the content base available to Europeana users through targeted 3D digitization of European architectural and archaeological monuments and buildings, selected through their listing by UNESCO on its World Heritage (WH) list or by member states as being of exceptional and outstanding cultural importance.

The project aimed to complement the collections that are being made accessible to Europeana via CARARE, Europeana Local, Athena, and other projects which have developed the content base for the archaeological and architectural heritage. In the end a critical mass of content has been delivered relating to internationally important cultural assets from many different European countries managed by European Cultural Institutions offering added value for Europeana.

Knowledge gained from the 3D-COFORM project has already made a valuable contribution to the early work packages of 3DICONS and it is evident that many of the partners have built on know-how gained from previous research and digitizing activities. In addition to adapting the MINT metadata mapping and MoRe repository tools to work with the new CARARE 2.0 metadata schema developed in 3D-ICONS, NTUA has used experience gained from CARARE and their other involvement in other Europeana content supply projects, to enhance the tools and add new features to facilitate metadata creation and processing.

As nearly all the content is being digitized for the project and most partners had little experience in recording metadata with their 3D models, a tool was needed to simplify and streamline the metadata creation process. This has resulted in the development of the online Metadata Editing Tool, which enables reusable templates to be created and used and outputs fully CARARE2-compliant metadata records that can be ingested directly into MoRE2. This tool has been adapted for use by other Europeana projects.

Some issues arose during the work on publication formats for which solutions were found:

• Display technology did not function well on low-end computers. This has required some partners to use additional resources and external technical support to improve their viewer technology.

• Certain partners were allowed to make low-resolution 3D models available due to their national legislation and copyright restrictions. This has required a fine balance between the size of the 3D model and making available an object that is still pleasing to the viewer, regardless of the restriction.

• Due to certain browsers not being able to handle 3D PDF (as they have embedded PDF viewers to circumnavigate the security problem with Adobe), partners have been required to use the HTML command that forces the PDF file to be downloaded in their metadata so that it can be viewed correctly in Adobe Reader.

A portal (http://3dicons.ceti.gr/) was originally developed for the presentation of the 3DICONS items on (i) a geolocation

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[13] Data created by CISA are accessible at www.europeana.eu/portal/search.html?qt=false&rows=24&qf=DATA_PROVIDER%3A%22CISA+-Interdipartimental+Center+for+Archaeology%22. Metadata have been published under the terms of the Creative Commons CC0 1.0 Universal Public Domain Dedication and therefore can be reused by third parties without any restrictions. CISA contributed to the Deliverable D.2.1 (Digitization planning report), D.4.2 (Interim Report on Metadata Creation) and D.6.1 (Report on metadata and thesauri). All deliverables are accessible on the project website.

[14] www.londoncharter.org.

[15] http://www.ics.forth.gr/isl/index_main.php?l=e&c=656.

[16] E.g. LIDO: www.lido-schema.org/schema/v1.0/lido-v1.0-schema-listing.html; and MIDAS www.heritage-standards.org.uk/midas/docs/meta/index.html?url=/midas/docs/meta/midas_meta_xsd.html.

[17] http://europeanalabs.eu/wiki/EDMObjectTemplatesProviders.

[18] http://lists.w3.org/Archives/Public/public-data-shapes-wg/2015May/att-0053/EDM-v524-120820.owl.

[19] See Achille Felicetti's contribution at the CAA Conference 2015.

system; and (ii) to present the rich metadata provided by the CARARE 2 schema, and it was soon used by the partners to check the validity of their data before they was published in EUROPEANA. The capability to publish data in the portal a very short time after it was published in MoRE2 was crucial for this operation. The partners were able to see their data published and decide if corrections were necessary before the final submission to Europeana. At the same time, if their data were already published in Europeana's portal, there is a direct link to them in the Portal so they can view them as they are presented in Europeana. One further facility provided by the Portal was the statistical summary of the digital resources (by type) for each partner. This was useful for the partners to check against the number of records published in MORE2 as it would identify any issues if there was a mismatch. It allowed the content providers and the project management to track the monthly ingestion targets specified in the Ingestion Schedule and to report the ingestion progress to the Commission. Although the number of metadata records created and published was intended to be tracked in the Progress Monitoring Tool, this function was superseded by the Statistics report in the Portal, as the numbers (and type of digital resource) are extracted automatically from the metadata published in MORE 2, providing a greater level of detail and saving time as no manual input of the figures is required.

Acknowledgements

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