A Proposal for the Virtual Documentation and Dissemination of Information from Archaeological Objects

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Nowadays, there are several virtual tools to document the archaeological objects for the general public. The use of knowledge network makes it possible to disseminate the content and provide access to the creation and the distribution of other types of image which were previously restricted to only a few people. In this way, the analogue image has been replaced with its digital version, assuming that it is the best approach to achieve a more comprehensive dissemination of information, without asking if the archaeological context has been marginalised. In general, virtual technology is being used to surprise, without really attempting to help explain the object, with all its historical memory. The purpose of this approach is to compare these working methods from both analogue and virtual points of view, considering problems such as the cost of modelling, the amount of time required, or the need for an expert user to manage the virtual tools. The virtual documentation will include all of the interactive information of the object, managed from a Wiki[1], including bibliography, links to archaeological database, high resolution photography[2] and 3D models of the archaeological objects obtained from both 3D scanner and digital photography using the Image-Based Modelling system[3]. In conclusion, it is considered that the traditional analogue information from these objects can and should be included in this virtual proposal.

Key words:
Virtual documentation, Archaeological context, Archaeological Database.

CHNT Reference:
María-Eugenia Polo et al. 2018. Proposal of Virtual Documentation and Dissemination of the Information of the Archaeological Object.

INTRODUCTION

The graphic representation of archaeological heritage gives added value to textual information and facilitates the dissemination and conservation of these types of objects. Until recently, the graphic documentation of an archaeological object catalogued in a museum or collection was summarised in a drawing, a photograph, or in some cases a series of them, of varying quality and detail, according to the historical moment and the fashions of the time.

For investigators, the transition from drawing to photography represented a revolution, as in addition to the time saved in this mechanical process, the idea was to obtain an immediate approach to *reality*, 'to the historical truth'; a fact that in some cases, such as that of the Lady of Elche, proved not to be the case (Fig. 1). In his study, the photographer Peter Witte analysed photographic intentionality, especially applied to this sculpture [Witte 1997]. Using the interplay of shadows and different perspectives, images were created which, at times, helped to shape the interpretation of an Iberian divinity, evoking certain mysterious features, while on other occasions this presented a high-ranking woman from pre-Roman Iberian society, in its most advanced and positive stage.

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[1] http://www.wikidot.com/
[2] https://www.flickr.com/
[3] https://sketchfab.com/

Fig. 1. The Lady of Elche photographed by: a) Pedro Ibarra (1987), b) H. Bulle (1912), c) Mas´s archive (about 1940) and d) Wagner (about 1950) [Witte 1997, 49, 53, 55, 57]

Today, the graphic representation of any archaeological object can be approached from two directions: on the one hand, approaching through the object – as a subject of study – and, on the other, exploring the global dimension that leads from a set of objects to the acquisition of catalogues of pieces; the basis of any fundamental research process.

But starting out from here how is the object approached?

In an image-based society, where more relevance is given to images than words, it is usual that in some public institutions in which "three dimensional" (3D) modelling work is carried out, these images often replace the historical background of the piece; something that should be amended, as the image without the textual past of the object lacks historical sense (Fig. 2). In addition to this is the fact that the culture of leisure generates benefits, and it is tempting to abuse technology in order to attract visitors, as also occurs in some exhibitions. This is the case of the 3D models associated with virtual realities produced by film companies that immediately attract the viewer. But is this the case for a researcher?

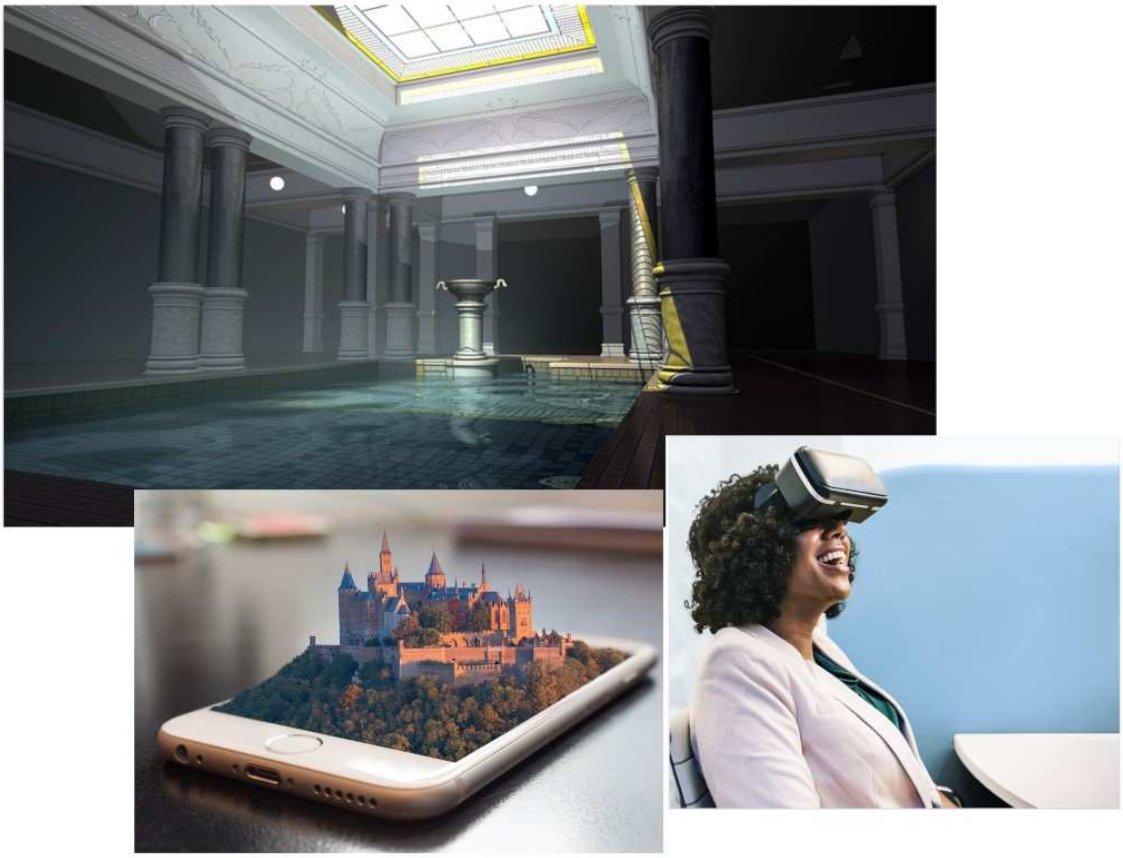


Fig. 2. Examples of the use of new technologies applied to the field of heritage (images from Pixabay)

THE USE OF 3D MODELS: SOME REFLEXIONS

The graphic documentation of the object can be studied from both a scientific and dissemination-based perspective. These 3D models are naturally useful for researchers and the general public, but it is important to say that both dimensions head in different directions, as they obviously have different objectives.

There is no doubt that the researcher obtains a formal knowledge of the piece immediately and visually, leaving to one side the other senses that give us direct contact with that object; in other words, the sensations of texture, the global volume of the object, and other connotations are lost. For example, in traditional archaeology, it has always been and continues to be essential to 'touch the pieces' in order to verify the details (Fig. 3). The continuous work provides a continuous experience that leads to a certain degree of academic 'prestige' when it comes to transmitting opinions about these objects, and about their interpretation, as G.M.A. Richter did in his study about art in antiquity [Richter 1970].

Fig. 3. Close-up of a woman offering bread in her hands (Photo: G. Nicolini)

Therefore, it seems evident that a part of this traditional sensuality will be lost in this way of approaching objects, and that for the time being, the type of consequences this will have in future works in 25 or 30 years' time cannot be gauged, if those objects are only approached through the virtual medium. This is one of the limits.

However, this capturing of objects through 3D models does have demonstrated advantages, such as immediacy when it comes to obtaining physical information about the piece (for example, obtaining dimensions and volumetric measurements) and the conservation of some of its elements, such as the irreversible process of degradation suffered by the painted decorations of some Iberian protohistoric vessels (see Fig. 4), which leads to the conclusion that within a few years, these wonders of Iberian art will have vanished [Tortosa and Ramallo 2015; Tortosa and Comino 2018]. Our own experience working with these paintings since the 1990s have proved the pictorial deterioration they suffer in their containers, in a way that from that time until today the lost details can be visually perceived. Therefore, these models would become primary sources of the past in the future and even more, the accurate virtual information would become a better source of information of the past than the object themselves.

Fig. 4. Iberian pottery (Museum of La Alcudia, Elche, Spain) (Archive of Iberian Iconography, IAM-CSIC)

TOOLS TO CREATE GRAPHIC DOCUMENTATION OF ARCHAEOLOGICAL OBJECTS

Today technological and instrumental advances allow any object to be graphically documented with different devices and with unprecedented metric and visual quality. The improvement of digital cameras, the use of 3D scanners, 3D printing and networks for the dissemination of information via the Internet allow for a transition from flat two-dimensional photography to the creation of a three-dimensional virtual model, as a faithful reflection of reality, which is globalised through the network. Aspects such as the quality and fidelity of the colour, texture, metrics or volume are important contributions in the definition of the piece, which help in studying it and creating accurate graphic documentation that complements the traditional historical documentation. In any case, the museum curation can always revise these criteria to adapt the documentation of the objects to the necessary circumstances.

Some methodologies can be highlighted for the creation of graphic documentation of historical objects:

Firstly, high resolution photography (using a 50-megapixel or more camera) with calibrated colour and using good lighting conditions: Archaeological photography is intended to provide accurate and reliable graphic documentation of archaeological objects, considering that the images must preserve the dimensional and chromatic properties of the objects with a reduced and controlled distortion. Digital photographic techniques have evolved with the development of cameras, lenses, and lighting, and it is possible to apply techniques and filters to enhance and improve different characteristics of the image [Felicísimo 2011].

In addition, current technology has allowed for the leap from two-dimensional photography to three-dimensional virtual models, using two consolidated techniques that make it possible to generate models of historical objects: 3D scanning, and the “Image-Based Modelling systems” (IBM systems).

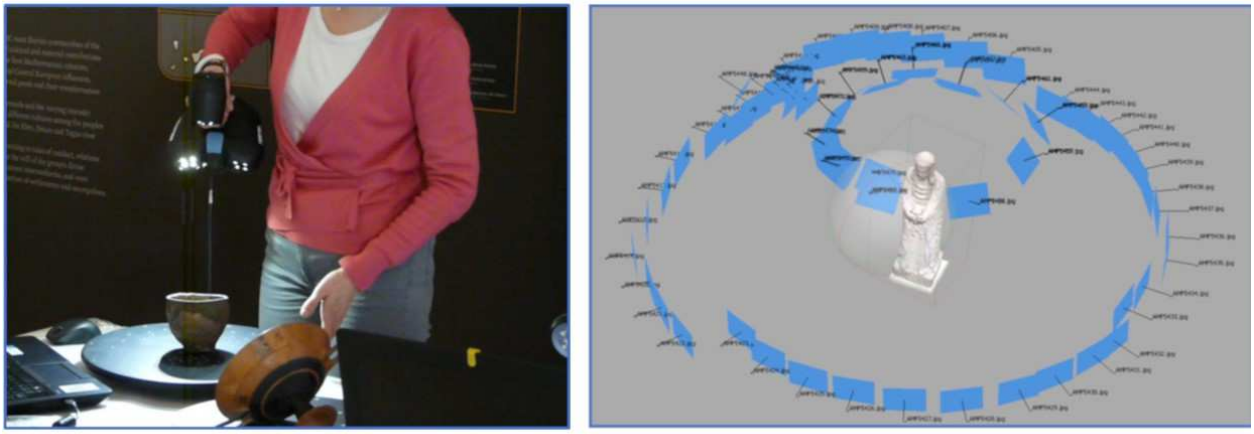
A scanner is a device that digitalises objects so that they are available in virtual format via point cloud model and image photographic texture recording. A wide range of scanners is available, and the applications in the field of cultural heritage are constantly growing, making it possible to create a faithful model of reality [Georgopoulos et al. 2016; Di Angelo et al. 2018]. For example, some structured light 3D scanners provide resolutions of between from 0.1 mm to 0.5 mm (Fig. 5 a). The structured-light scanner is a non-contact, optical system based on the projection of a calibrated light pattern onto the object to be scanned to capture the deformation of the pattern and generate a point cloud with the possibility of texture information [Mathys et al. 2013]. Generally speaking, when comparing a high resolution 3D scanner with IBM system, the first one provides a highly accurate solution, is more expensive and the learning curve is usually longer.

IBM systems recreate the virtual model from a series of overlapping digital images of the object being represented, and are based on the principles of automated photogrammetry and computer vision (Fig. 5 b). IBM systems are based on multi-view 3D reconstruction technology and use algorithms such as “Structure from Motion” (SfM) and “Scale Invariant Feature Transform” (SIFT) [Wu 2007]. There are several open-source and low-cost IBM applications that make it possible to create 3D models of objects or scenes in an easy workflow, as the process does not require advanced knowledge of 3D data processing. Conversely, IBM systems provide less metric resolution than the 3D scanner, especially in large objects or scenes. In the same way as 3D scanners, IBM systems have a

wide range of applications in the field of cultural heritage [Pierdicca 2018; Palomar-Vazquez et al. 2017; Polo et al. 2017].

Both techniques (3D scanner and IBM systems), with their advantages and disadvantages, can work alone or together [Dostal and Yamafune 2018; Carrero-Pazos et al. 2018] to the point where it can now be said that the techniques of creating 3D models for heritage purposes have reached a stage of maturity, taking into account the large number of publications and scientific journals dealing with this topic [Katz and Tokovinine 2017].

Of course, current technology offers other devices that can be used to create virtual models and obtain more comprehensive information from the archaeological object, such as spherical cameras, thermal cameras, or multispectral cameras [Šedina et al. 2019].



a b

Fig. 5. a) 3D scanning of the material from Medellín (National Archaeological Museum, Madrid, Spain), b) The image shows the photographs taken to create the 3D model: a total of 74 photos from different perspectives

DISSEMINATION OF THE INFORMATION

Once the graphic information of the object has been generated, the next step is to disseminate it through different channels. There are several networks and platforms for disseminating heritage information. It is not the aim of this paper to list them all, but the dissemination of historical information through the Internet is sufficiently developed, and there are public and private initiatives that support different formats.

This may be the place to emphasize an aspect that needs to be developed: standardization for metadata, not of the archaeological object, but of its representation or model. A review of the standards for the dissemination of 3D models shows that there is not yet a specific and complete proposal for the construction of metadata. There are only some technical fields related to the file format (for both images and 3D models [Harpring 2017]), dimensions in height and width, resolution, file size, and visualization software [Baca et al. 2006] but in general there are no standards that indicate the recommendation or obligation to include technical characteristics [Previtali and Valente 2019; NISO 2007]. Actually, some essential aspects of the 3D models construction are obviated; e.g. in the case of photogrammetric models: number of images used, distribution of the same, modelling software, correction of greys, use of colour profiles, illumination, “Colour Reproduction Index” (CRI) of the textures, uncertainty of the dimensions; in the case of scanned models: scanning technique, texture capture (yes or not, dimensions, colour space), nominal resolution…

On this subject, we want to comment that one of the projects we develop has a section of analysis and proposal of specific metadata structures for images and 3D models including essential technical aspects (proposed as mandatory) and developing optional extensions that cover from the specification of illumination to georeferencing.

Sketchfab, founded in 2012 in Paris, is undoubtedly the most used application for viewing and sharing 3D models created by different users. Initially, these users found it very difficult to show the 3D models to the public because of the intrinsic difficulty involved in finding the right tools to handle models in three dimensions. The release of *Sketchfab* was a success both at individual level (involving artists, designers, architects, or engineers) and at institutional level (museums, schools, businesses, etc.). Today, there is a community of more than 1.5 million registered users, with more than 3 million shared 3D models. The statistics on the number of downloads and views of models on this social network, as well as the number of followers, reveals the level of interest in this way of sharing virtual information. *Sketchfab* provides a good amount of resources with a very flexible configuration in

lighting, appearance of textures, postprocess filters, etc. The part reserved for metadata is, in our opinion, something that needs to be improved for the reasons explained in the previous paragraph.

Sketchfab has been used to disseminate 3D models from archaeological objects obtained by both 3D scanner and IBM techniques and catalogued in different collections (Fig. 6). The whole process involves scanning, processing, and uploading the 3D model, which usually takes between one to four hours depending on the size and complexity of the object.

The 3D model can be downloaded in OBJ format, according to Creative Commons Licenses. These licenses are a) attribution, others can distribute, remix, tweak, and build upon the model as long as they credit the author, b) Non-commercial, the model cannot be used commercially c) no derivatives, the model can be redistributed but not modified, and, d) share alike, the users can remix, tweak and build upon the model but the new creation must be under identical terms.

Every 3D model not only provides information about the technical procedure used, but also a historical description of the piece.

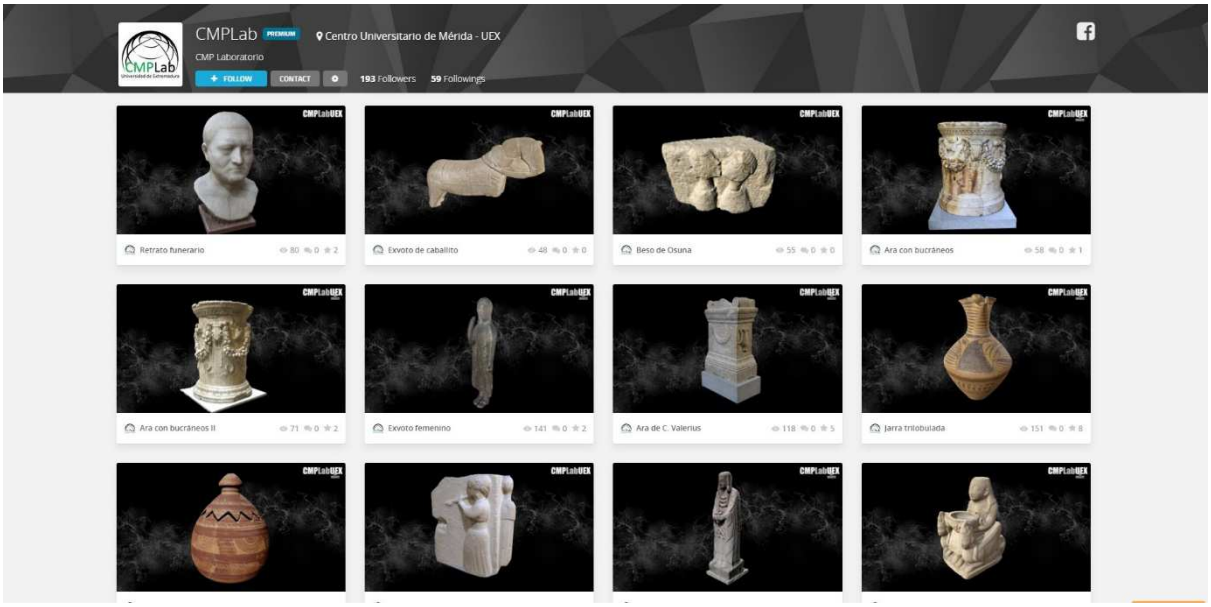


Fig. 6. 3D models obtained by both 3D scanner and IBM techniques and uploaded to Sketchfab[4]

Flickr is a website that allows users to share, store, sell, buy and download photos and videos over the Internet. It was created by Ludicrop in 2004, bought by Yahoo! in 2005 and finally owned by SmugMug since April 2018. Using free or professional accounts, authors tag their creations with metadata with the geographical location, and the type of license used (Creative Commons license) (Fig. 7). Of course, there are a number of rules of use and good practices related to privacy and copyright, with the idea of making images available to the public with a much higher photographic quality than those normally available in the online catalogues. Moreover, Flickr is a social network used to search and link photographs to personal blogs and other social networks. Flickr offers a free storage space for 1000 photos but it is possible to upload unlimited images in the paid version.

Usually, making and processing a high-resolution photography takes about thirty minutes. The process includes importing the images, adjusting the colour temperature, correcting the background, adjusting the texture level, resizing the image, and exporting it. Some specific protocols (filter or special techniques) may take one hour.

[4] https://sketchfab.com/secad

Fig. 7. Flickr page showing two collections and an example of the metadata.

In order to jointly disseminate texts, models and images, Wikis can be created (Fig. 8). This collaborative site, which can be edited by users, makes it possible to include all of the information about the piece – such as its original location, current location, description, history, image, 3D model, bibliography, or specific details and anecdotes –in such a way that it becomes a complete virtual catalogue of the historical objects. Links to Sketchfab, Flickr, official databases, or any other interesting resources are also included.

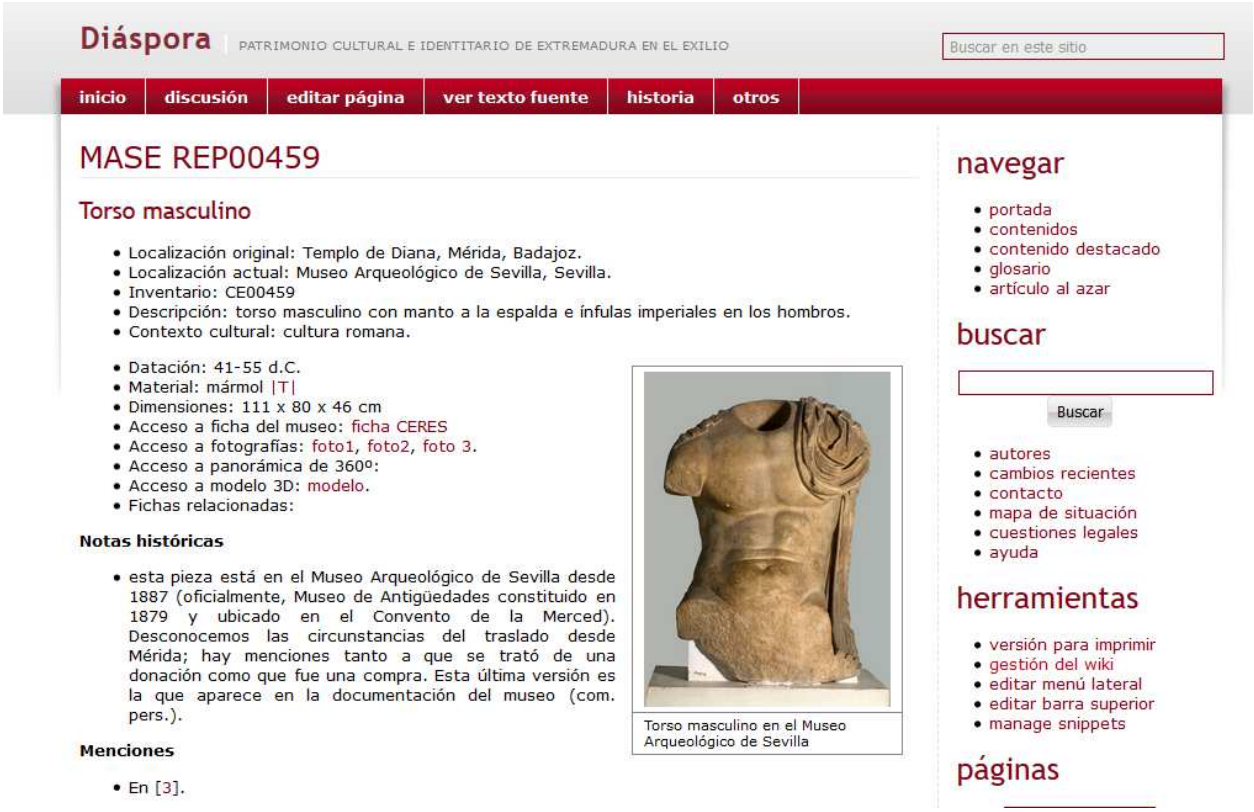


Fig. 8. Example of jointly disseminated texts, models and images using Wikis (currently in progress)

At this point, it is necessary for a multidisciplinary team (historians and technicians) to work together in order to achieve an accurate graphic documentation of the piece without losing the historical perspective.

INTEGRATING THIS TECHNOLOGY INTO ARCHAEOLOGICAL STUDIES

So how should researchers integrate these technologies into their studies?

Projects of this kind[5] should be approached from the perspective of transversality, both in terms of the working instruments that are used (files, objects, etc.) and of the interdisciplinary nature of the working team itself (Fig. 9). 'Objects' are approached through biographies in which it would be possible understand both the useful life of these pieces, which corresponds to their archaeological use, and the historical part that corresponds to their discovery up to the present day. Their varying steps - through different museums or collections - are defined both by historical contexts and by personal circumstances, sometimes resulting in their different national or regional identities prevailing in different episodes, and whether or not they have formed a part of the creation of these histories [Tortosa et al. in press].

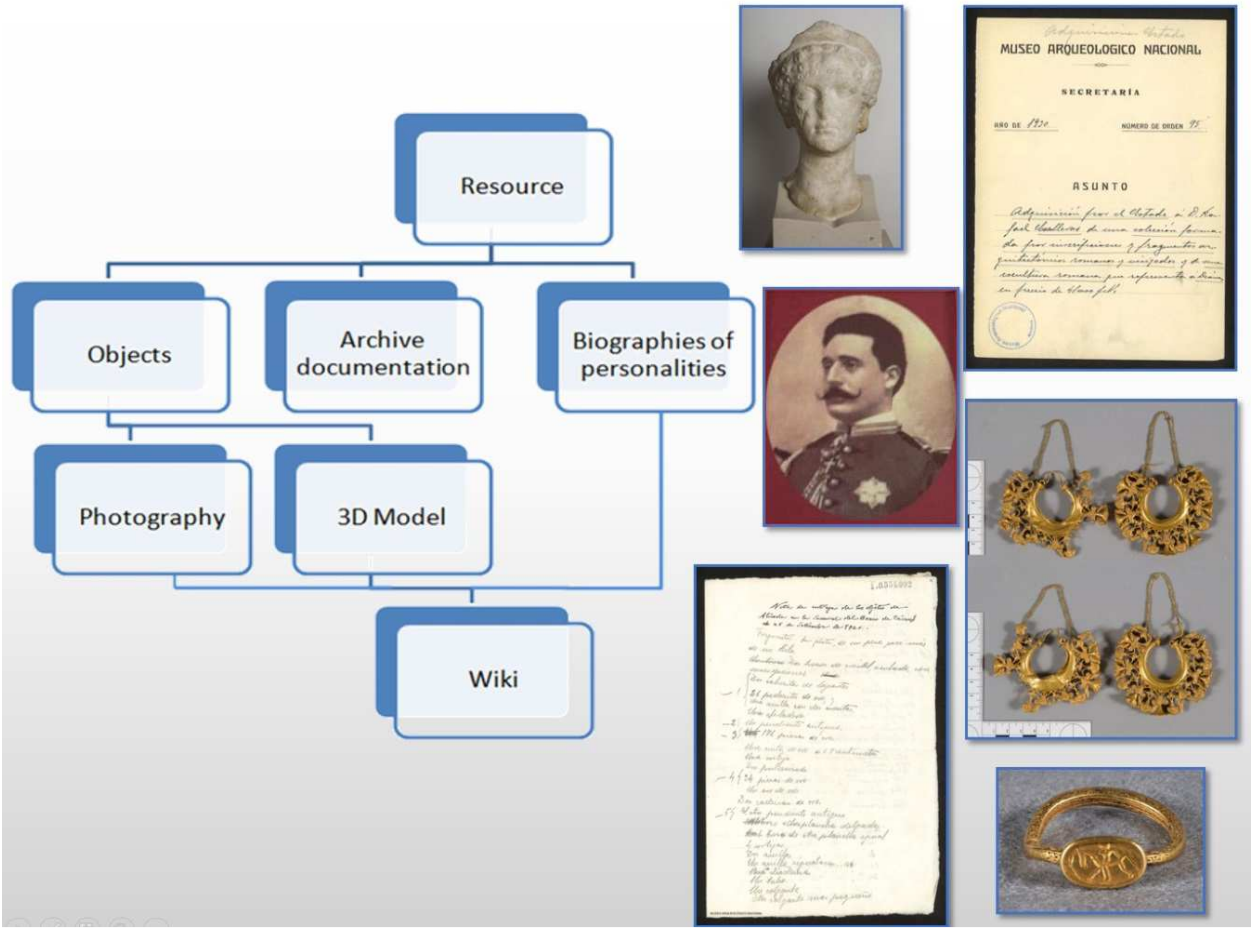


Fig. 9. Flow chart showing the working process.

Obviously, being able to access any kind of catalogue of elements is a 'treasure' in itself. The question is what do researchers require in order for this investigation to be effective and useful? Both technological and knowledge-based protocols should be created for these objects, in which their biographies should be integrated, considered as biographies of the entire useful life of an object, from when it had a specific function in the past, until it was discovered and forms a part of contemporary history as a reference of the past [Gosden and Marshall 1999] [Ballart

[5] Diáspora, a heritage in exile (Proyecto de I+D+i de Extremadura, IB16212); REMAN3D (Project HAR2017-87897, Ministry of Economy, Industry and Competitiveness of Spain).

Hernández 2012]. In this way, similar units of information would be obtained for different cultural contexts. In all likelihood it will take some time to achieve all these objectives, but it will be necessary to work towards them.

Another point of discussion is if the technology is being used to surprise. The analogue image of material heritage is replaced with its digital version, assuming that it is the best approach in order to achieve a more comprehensive dissemination of information, without questioning whether the archaeological context is being marginalised. The authors believe that the traditional analogue information of these objects can and should be included in this virtual proposal. Of course, as scientists there is an obligation to combine both choices. The answer can be found through transversality, both in terms of the study instruments as well as the research team (historians and engineers) and the globality, from a variety of study instruments (biographies, 3D models, high resolution photography ...) up to the multidisciplinary nature of the research team. This consideration about multidisciplinarity served as the basis for planning the projects.

One proposal is to create protocols that combine the technological and historical aspects of the pieces. With this aim in mind, a series of 'notebooks' have been created in collaboration with the National Archaeological Museum, called 'Iberian Notebooks in 3D' [Felicísimo et al. 2017] (Fig. 10). The aim of these notebooks is to show how building 3D models creates a new form of communication, through which archaeological objects can be presented and understood both by specialists and the general public, recognizing that all information has diverse audiences and goals.

Fig. 10. Iberian notebooks in 3D[6]

CONCLUSIONS

Through the historical discourse which has taken us from photography to 3D models, we have learned these techniques are not only useful to spread archaeological knowledge but they also become receivers of the objects' volume, helping to preserve their physical characteristics within a specific time frame, as it happens with the paintings of the Iberian receivers we have already seen. At the same time, the graphic representation of archaeological heritage facilitates the dissemination and conservation of these types of objects and, in some cases, the accurate virtual information would become an improved source.

These techniques of creating graphic documentation for heritage purposes have reached a stage of maturity, therefore it is possible to disseminate this kind of information through the Internet, using public and private

[6] http://dehesa.unex.es/handle/10662/7470

initiatives, social networks and websites, that support different formats, in order to achieve an effective channel of communication, allowing more effective sharing of material culture in large volumes.

In an image-based society, it is easy to abuse technology so the virtual representation of the archaeological objects replaces the historical background of the pieces and it produce a loss of its historical sense. The graphic documentation of the object can be studied from both a scientific and dissemination-based perspective considering that these perspectives are useful for researches and general public, who have different objectives. With this proposal we present a method of analysis extracted from the work experience in our two indicated research projects, in which we propose the integration of technologies based on volumetric representation and archaeological objects. A totality concretized in pouring all is information in the *wikidot*, an online instrument where the public can interact and choose the level of information they wish to access.

Another issue to emphasize is the lack of standards for metadata, not of the archaeological object itself, but of its representation or model.

In conclusion, at an informative level, the creation of these 3D models and graphic documentation in general is perceived as beneficial, above all because of their enormous accessibility. However, at a scientific level, as often occurs in processes that are constantly being modified, it seems that there is often a lack of reflection to confront and interpret historical processes: we are witnessing a digital explosion often from a solely positivist perspective; something that can also be seen with other technological methods applied to archaeology. It has been observed that there is a lack of deliberation about the proper application of new technology in cultural heritage. As a result, it is necessary to appeal to the normalization of the organization and management of all this information, in order to obtain these vast amounts of information that provide us with an overview of the historical processes that can be extracted from archaeological objects.

ACKNOWLEDGEMENTS

This work is part of the DIÁSPORA Project (IB16212) supported by the Government of Extremadura (Spain) and cofounded by the European Regional Development Fund, and REMAN3D (Project HAR2017-87897, Ministry of Economy, Industry and Competitiveness of Spain).

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Imprint:
Proceedings of the 23rd International Conference on Cultural Heritage and New Technologies 2018.
CHNT 23, 2018 (Vienna 2019). http://www.chnt.at/proceedings-chnt-23/
ISBN 978-3-200-06576-5

Editor/Publisher: Museen der Stadt Wien – Stadtarchäologie
Editorial Team: Wolfgang Börner, Susanne Uhlirz