Digital technologies for heritage conservation labs open to the public. The case of the CALLOS project

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Abstract. Attempts to preserve materials and constructions of the past are not new but the scientific aspect of cultural heritage (CH) conservation has emerged during the last two centuries. Today, conservation comprises all examinations, treatments and documentation work towards the life extension of antiquities and the engagement of audiences with CH. In museums, monuments and archaeological sites, conservation laboratories open for regular activities and educational programs to raise public awareness and create connections with their knowledge and interests. Digital technologies support open labs toward holistic documentation of all methods, materials and results while improving physical and digital access to CH through dissemination, reducing the gap between sciences and visitors via interdisciplinary, multimedia, fun and ultimately beneficial ways that enrich the CH narratives for all. In Greece, the first conservation lab open to peers and the public is implemented by the joint research project CALLOS for the Ephorate of Antiquities of the City of Athens (EACA). The article will discuss how a web-based platform and a portal for the management and dissemination of knowledge will support conservation science and openness of a chief lab equipped with innovative diagnostic and conservation tailored-made equipment.

Keywords: CALLOS project; conservation; cultural heritage interpretation; digital heritage; digital technologies; holistic documentation; open lab; public awareness; science communication.

1 Introduction

Pausanias first described the beneficial effect of olive oil and water on the preservation of the ivory statues of the gods [1] but their perception as objects of CH emerged only during Renaissance [2]. The priority for their conservation was established after the wars and massive demolitions of the last three centuries and the progress of the sciences [3, 4]. Nowadays, preventive and remedial conservation are acknowledged to include

all measures, examination, work and documentation that hold back the decay rate and prolong the life of CH's materiality and values for the benefit of future generations [5]. All diagnosis, treatments and control processes are implemented by qualified personnel, based on historical, quantitative and qualitative measurements, via minimum intervention [6, 7], interdisciplinary approach, advanced research and technological equipment [8, 9].

During the last decades, the multidimensional field of conservation has been argued to serve as an excellent means for learning about and being engaged with CH too [10] (See Fig. 1). This claim is based on the constructivist theory, which addresses learning as a contextual and active process that takes place as a social activity, as in museums or archaeological sites, where learners use prior knowledge and interests e.g. in history or the environment to learn how to learn, take time and follow their personal path [11].

Fig. 1. The functions of conservation of CH

The multidisciplinary features of conservation are engaged with the understanding and interpretation of heritage through arts, history and all material sciences for analysis and diagnosis [12]. Conservation is connected to local topics too, such as the management and use of the collections by their communities of origin, or global issues such as climate change, illicit looting, or cutting-edge technology. Conservation combines all the components of modern pedagogy and visitors of all ages wish to learn more about it [13]. Rightly, in the last decade, conservation started to be increasingly used amongst the interpretation lines, in raising awareness campaigns and educational programs for school pupils e.o. by museums and CH organizations [14, 15] as "it offers the chance to be close to the real thing" [16] and connects beneficially people with different existential or social backgrounds with their heritage [17, 18].

Therefore, more and more museums and archaeological conservation laboratories open their doors with great appeal to the public. Some open labs invite guests during special occasions [19, 20] while in others, conservators are set on display while working through glass openings [21, 22] or in an open studio [23]. Many disseminate their work through blogs, podcasts, short films, webpages or social media too [24, 25, 26, 27]. It cannot be ignored though that conservators first opened their labs in countries where art and CH are funded by stakeholders other than the state, thus making their work public was vital for their sustainability [28].

The progress of digital technologies increases the effect of all outcomes of open labs. They support and enhance all work that is conducted during conservation, such as analysis, treatments, storage and documentation via recording quantitative and qualitative measurements, the condition reports for the objects, their storage or exhibition environment and the conservation stages with appropriate metadata, digital images, etc. They allow a holistic approach to the objects to be conserved and the conservation methodologies. Moreover, they enhance the diffusion of sciences and technologies for the information of the public and peers, while affiliating the CH communities [29].

Most often, digital technologies at the service of conservators focus on repositories for the collection and analysis of all conservation data as well as on mapping and imaging techniques for the documentation of the preservation state and the treatments [30, 31]. As for the public, and especially young visitors, applications such as digital sculpting or 3D visualizations are more popular [32]. The case of the ultra-high-resolution digital image of the 'Night Watch' by Rembrandt is a characteristic example that applies to both conservation and engagement purposes [33].

2 Materials and methods

In Greece, the importance of conservation open labs was acknowledged for the first time in 2017 by the Operational Program "Competitiveness, Entrepreneurship Innovation 2014-2020 (NSRF-EPAnEK)". In the context of the CALLOS project (2019-2023), funded by the above-mentioned Program, the first open lab is being prepared in Athens by a consortium of conservators and scientists from the Ephorate of Antiquities of the City of Athens, Ministry of Culture (EACA), the Institute of Electronic Structure and Laser, FORTH (IESL), the Institute of Computer Science, FORTH (ICS) and Raymetrics SA. The partners will convert a conventional conservation lab of EACA into a leading open lab with tailored-made innovative technological equipment for the diagnosis and conservation of antiquities and monuments of Athens.

The open lab will be perfectly qualified for physical demonstration and accessibility. A digital platform and a portal by ICS according to the needs of EACA, will serve effective management, communication and dissemination of data as acquired during all conservation stages and will make them digitally accessible to CH peers and the public.

2.1 The platform

The platform designed is facilitated by the appropriate customization and extension of *Synthesis*, a Web-based system by ICS for the collaborative documentation of

information and knowledge in the fields of cultural heritage and digital humanities [34]. *Synthesis* utilizes XML technology and a multi-layer architecture offering high flexibility and extensibility in terms of data structures, data types and sustainability. Each documented entity, such as an object, scientific examination, or conservation activity, is stored as an XML document, readable by humans and machines. Its database server is eXist-db5, a native XML database.

Synthesis is multilingual, supporting the parallel use of multiple languages for documentation and versioning of the documented information. The data model used is carefully designed for a given application domain (here the conservation and scientific examination procedures) particularly focused on semantic interoperability. This notion is defined as the ability of computer systems to exchange data with unambiguous and shared meaning. *Synthesis* achieves this by a) linking each element of its data model to a domain ontology, b) allowing users to add metadata about the data, and c) linking a term to a controlled (shared) vocabulary or thesaurus of terms.

Synthesis users create and document entities organized in entity types, each one of them having its data structure (schema). An XML-based schema contains a set of fields organized in a hierarchical (tree-like) structure. The leaves of the tree-like structure are the documentation fields filled by the users. Fig. 2 shows a small part of the schema of the 'Conservation' entity, as configured for the CALLOS project.

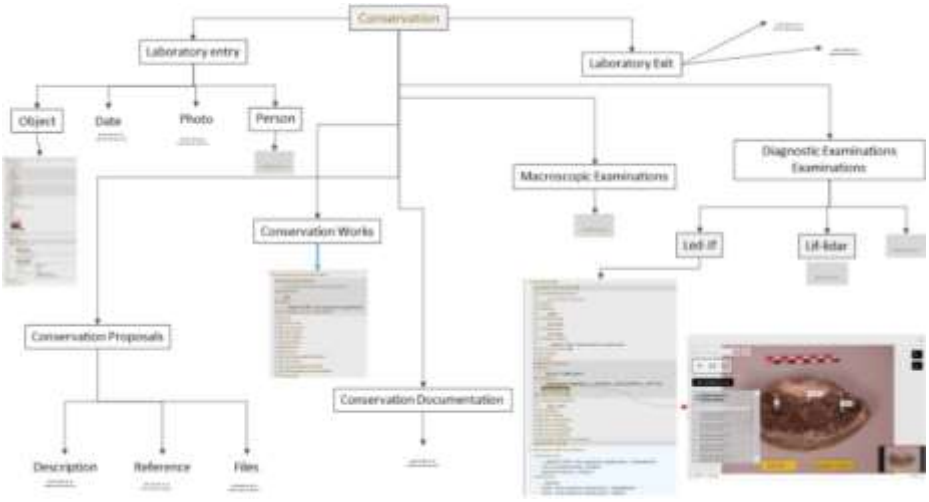

Fig. 2. A representation of CALLOS *Synthesis* tree-like structure of 'Conservation' entity. Down, an XML document of a specific conservation activity based on an XML schema

The schema of each entity type is fully compatible with CIDOC CRM[1] [36] and CIDOC CRM science model (CRMsci)[2]. Table 1 includes the CALLOS *Synthesis* entities.

Table 1. Entities of the Callos *Synthesis*

Entities	Description of documentation purpose
Objects	Administrative & scientific data used in the conservation department
Project	Projects of the conservation department
Examinations	Scientific examinations during diagnostic actions of a conservation activity e.g LED-IF, LIBS, LIF-LIDAR
Conservation	Conservation activity
Intervention/ Restoration Works	An intervention/restoration action of a conservation activity
Preventative conservation works	Preventative conservation works action of a conservation activity
Laser cleaning	Laser cleaning action of a conservation activity
Samplings	Sampling action of a conservation activity
Samples	Samples taken during a sampling action
Devices	Devices for diagnosis & conservation actions of conservation activity
Persons	Personnel & collaborators involved in the various stages of a Project/conservation activity/actions/examination
Locations	Places where the diagnostic or conservation works took place
Bibliography	Information about bibliographic references related to all entities
Administrative documents	Official documents that are necessary for the activities/actions/works of the open Conservation laboratory
Conservation story	Popular presentation to the general public: a notable action that took place within the framework of a project or conservation activity or a diagnostic scientific examination

[1] CIDOC-CRM: high-level event-centric ontology for human activity, things and events happening in spacetime, providing definitions and a formal structure for describing the implicit and explicit concepts and relationships used in CH documentation (ISO 21127:2014- Information and documentation — A reference ontology for the interchange of cultural heritage information).
[2] CRMsci: Extension of CIDOC CRM to support scientific observation, Version 1.8, December 2022, https://cidoc-crm.org/crmsci/ModelVersion/version-1.8.

Methods	Popular presentation to the general public of a scientific diagnostic method or conservation action etc.
Information Object	Auxiliary entity used for the presentation of subject consisting of text, images/digital objects, video, sounds, etc.
Digital Objects	Metadata information about the up-loaded digital objects, like photos

Each *Synthesis* documentation field receives a particular type of value (See Table 2).

Table 2. Types of values for each documentation field of the CALLOS *Synthesis* platform

Documentation field	Type of value
Link to Entity	The user selects a different entity that is documented in the system, that can belong to one or more entity types.
Link to vocabulary term	The user selects a term from a static or dynamic vocabulary.
Link to Thesaurus Term	The user selects a term from a thesaurus of terms which is managed through the THEMAS[3] thesaurus management system.
Unformatted free text	The user provides a small piece of text that cannot be formatted.
Formatted free text	The user provides a longer piece of text that can be formatted.
Number	The user provides a numeric value e.g., an integer number.
Time expression	The user provides a date in an accepted format relevant to documentation of historical information e.g. decade of 1970, ca. 1920, 1500 BC, etc
Location coordinates	The user selects a point/polygon on a map; the field is automatically filled with corresponding coordinates. The system enables the user to query external geolocation services & get a unique ID & coordinates of the location.
Digital file(s)	The user uploads digital files of a given type e.g. image or document.

The documentation of entities is performed in a FeXML-dedicated environment which communicates with *Synthesis* and supports the creation and editing of XML documents. The user interface, as configured for CALLOS is presented in Fig 3.

[3] THEMAS: Open source Web-based system for creating, managing and administering multi-faceted and multilingual thesauri according to ISO 25964-1 and ISO 25964-2 standards; it offers an API in order to connect with external applications.

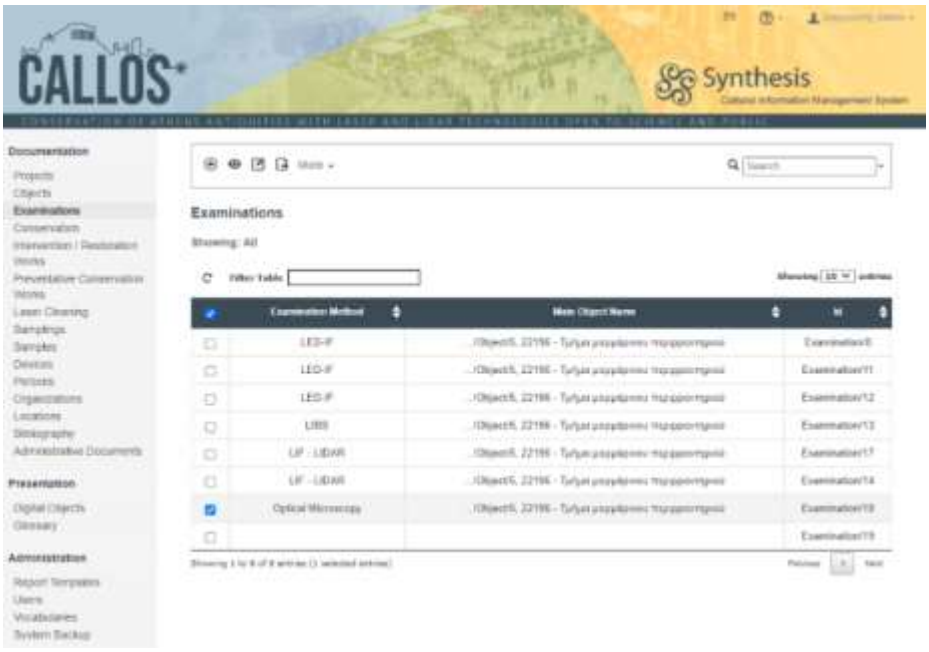

Fig. 3. The user interface of *Synthesis* for CALLOS project

2.2 The Portal

The CALLOS portal aims to disseminate knowledge of key issues and innovations and share information about conservation practices and applications of laser technologies to objects or monuments. Its design supports multiple dimensions of access and an effective presentation of an overview of the contents with a «semantic roadmap» to reach the point of interest shortly. The dimensions are phenomena of the object (elaboration, alteration, intervention), methods of diagnosis, imaging techniques, visual features, object context and history as employed in real conservation cases.

The portal will explain with example images the construction, decay and conservation of an object or monument. Concepts (terms) organized as a thesaurus of semantic poly-hierarchies allow retrieval from higher and narrower concepts. It will be populated by the conservation processes conducted in the Open Lab of EACA and will be used to improve access to information about state-of-the-art laser applications for the analysis and conservation of CH. To disseminate and exploit the knowledge produced, specialized entities have been designed to the CALLOS platform.

The CALLOS portal will be dynamic. XML-based entry sheets will allow users to define new content, verify the consistency of referred items and integrate new content consistently placed into the CALLOS Platform. Entry sheets will be populated by the conservators and will be exploited for the compilation of multimedia *Conservation Stories* or the design of a *Search the collection* interactive application to engage the users with cultural heritage and scientific issues.

3 Conclusions

Activities and functions of open labs advance conservation, engagement and knowledge regarding CH. The work of CALLOS has already attracted more than 500 people from various target groups through several communication events such as European Heritage Days, Researchers' Night, etc (See Fig. 5).
Digital technologies employed for the portal are expected to increase the impact of EACA on the public while the platform will enable conservators to directly measure and assess their data advancing to useful conclusions. How many statues were covered by biological crusts? Which laser cleaning parameters were chosen? Where was a vase found, where is it stored and under which conditions? When did sampling occur and where are the permits? These are only some of the questions conservators and their present or future peers regularly ask and are answered thanks to CALLOS outcomes.

Fig. 4. The CALLOS social media accounts effectively communicated dates and content of events and provided details for the participants, their interests and impressions

The digital outcomes of the project will support the duties of an open hub that is entitled to labor over monuments that are part of the world's CH. Work and research on their conservation are imperative. For this interdisciplinary effort, experienced conservators and IT scientists involved with CH constantly exchange their terminology and workflows towards the architecture of the tools and the curation of data [36].

But the use of digital technologies raises concerns too as it involves high costs, sets a framework for new work protocols and procedures and requires high expertise [37]. Conservators will replace traditional mapping with sophisticated digital mapping techniques and will upload all analyses and treatments, the content of paper registration forms and conservation reports as digital files into the platform entities. Moreover, they will be trained in data entry and management and will have to do so along with their previous routine. They will have to be precise when selecting decay and conservation terms from the thesaurus for their peers and at the same time, they will have to write *Conservation Stories* in plain language and host physically accessible public events.

The challenge is two-fold since public CH organizations have to keep up with the costs required for their hosting, updates and maintenance too. What is well understood is that open labs equipped with digital technologies are addressed to more heritage stakeholders and new work mentalities, workflows and CH policies are required.

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