Conservation and Restoration OpenLab

Subjects: Archaeology | Computer Science, Theory & Methods

Contributor: Efthymia Moraitou , Markos Konstantakis , Angeliki Chrysanthi , Yannis Christodoulou , George Pavlidis , George Alexandridis , Konstantinos Kotsopoulos , Nikolaos Papastamatiou , Alkistis Papadimitriou , George Caridakis

Open laboratories (OpenLabs) in Cultural Heritage institutions are an effective way to provide visibility into the behind-the-scenes processes and promote documentation data collected and produced by domain specialists. Cultural Heritage (CH) institutions have been adopting new practices to improve their services and meet the preferences and needs of potential audiences. One such practice is the transformation of conservation and restoration (CnR) laboratories into OpenLabs, which allow visitors to see the various processes that take place “behind the scenes” .

OpenLabs | cultural heritage | digital applications | semantic modelling | conservation | restoration data

1. Digital Content Supporting OpenLabs

In the context of *OpenLabs*, the integration of digital applications is a common practice that varies based on the goals of each project and the level of engagement desired by participating institutions. Often, a digital platform is established to share information about the OpenLab’s operations, the experiences visitors can expect, the types of scientific or technical processes that have been or are currently being conducted around a specific theme, and logistical data related to the program, ticketing, and pricing.

Occasionally, the use of advanced digital media, such as custom-designed applications and video presentations, is incorporated. For example, at the Acropolis Restoration Service in Athens, Greece, an educational program introduced an online game called Glauka to engage children with the conservation and restoration (CnR) efforts at Athenian monuments. The game utilizes role-playing, missions, challenges, and rewards to help cultural visitors learn about specific CnR techniques and practice their newly acquired skills [1]. Furthermore, online video “tours” have been employed for ongoing excavations, showcasing critical aspects of the excavation process and expert interpretations on the project website [2].

Finally, digital presentations are featured alongside live demonstrations in OpenLabs, although such instances are relatively infrequent. An example of this is the “Conservators on Exhibition” program at the Benaki Museum, where video presentations and other activities were presented simultaneously with live conservation and restoration processes (https://shorturl.at/nzFY8, accessed on 30 April 2023). This informative presentation serves as a

valuable supplement to ongoing research and technical procedures, enhancing the understanding of spectators and visitors. Clearly, there is considerable potential for expanding upon past initiatives and innovating new digital strategies to draw in new audiences through the aid of *OpenLabs*.

2. Semantic Modelling of CH and CnR Data

In terms of semantic modelling, ample research efforts have been made in the domain of CH to organise and interlink data and to tackle interoperability issues at both the syntactic and semantic levels. CH institutions and organisations have developed several formal ontologies. An ontology is a formal and explicit specification of a shared conceptualization in order to handle essential aspects of cultural information management, such as retrieval, integration, reuse, and sharing [3][4][5]. Accordingly, the CH subdomain of CnR exhibits increasing interest in ontologies to handle the highly heterogeneous and often secluded CnR information.

A widely used top-level ontology for the CH domain is the International Committee of Documentation Conceptual Reference Model (CIDOC CRM) of the International Council of Museums (ICOM) [6]. CIDOC CRM provides the basic concepts and relations related to various CH disciplines, and is extended by ten modular models which cover documentation requirements of specific disciplines of the CH domain (FRBRoo, PRESSoo, CRMinf, CRMarchaeo, CRMsci, CRMgeo, CRMdig, CRMba, CRMtex, CRMsoc) (https://www.cidoc-crm.org/collaborations, accessed on 30 April 2023). CIDOC CRM and its official extensions have been widely used for CnR data modelling through the years [7].

Furthermore, a number of ontologies have been developed for the CnR domain in particular, and have been used for specific services regarding CnR data management, most commonly data integration and data searching services. An example is the *Ontology of Paintings and Preservation of Art* (OPPRA), a semantic model that specialises in the CnR of paintings [8]. Another example is the *Monument Damage Ontology* (MDO) [9]. MDO integrates, organises, and processes diverse information related to damage diagnosis and CnR interventions of historical buildings, and will eventually support documentation and monitoring of damage and potential intervention planning and application [10]. Another example is the PARCOURS semantic model, which has been developed for integrating CnR data from different sources to enable the querying of data in a unified way [11]. Finally, the *Conservation Process Model* (CPM) specialises in CnR of historical buildings, and was developed with two objectives: (i) to represent knowledge about the related CnR processes, and (ii) to facilitate integration, mediation, and interchange of heterogeneous CnR data at both the academic and professional levels [12].

Considering the existing practices and models, the current research aims to exploit existing models as well as to extend them in order to fully represent data regarding the CnR of stone construction material, as well as the digitization of CnR processes and the products of digitization.

3. 3D Digitization of Tangible CH

Digitization of tangible entities entails the transformation of the real world and its features to a virtual world, specifically, the digital world of computing. This virtual world comes with a particular set of rules, benefits, limitations, and opportunities. Being inherently digital, virtual entities are in essence discretised and quantized approximations of the real entities they are based on. Digitised entities may have a potentially unending life in the digital world, which makes them significantly appealing for CH applications. Because tangible heritage assets are of a three-dimensional (3D) nature, their digitization should follow a 3D digital world representation (provided we do not consider the dimension of time for the moment). 3D digitization of CH [13][14][15][16] brings new possibilities for presentation, research, knowledge dissemination, conservation, and physical duplication. The domain of CH is challenging for 3D digitization methods due to the wide range of object types, sizes, materials, and complexity. It is apparent that a complete digital documentation of CH should provide an ontologically complete picture of the objects for the future scholars and citizens. 3D digitization has now become common practice in the field of CH research thanks to decades of research and development.

4. Mixed Reality and Virtual Reality Educational Applications

A novel method was used to depict the sequence of actions taken by users of mixed reality and virtual reality educational applications as well as the process involved in developing the content, which was based on Kotsopoulos etc. 2020 [17]. The processes and functional requirements of the applications were represented and documented using process modelling diagrams (BPMNs). The awareness of the stakeholders with regard to the functionality of the apps, their features, and how end users interact with them is improved by this kind of visualisation.

Business process modelling (BPM) is expected to play a significant role in the continued development of AI by presenting sequences of action in applications at a higher level. Similar to how a corporation is blind without its management, machine learning in business applications is blind without the guiding function of BPM.

A proposed research model for representational analysis projects that incorporates different stakeholder perspectives than the one in this study was stated by Recker [18]. The model was applied to analyse Business Process Modeling Notation (BPMN), and the study highlights the importance of validation with users and communication with technique developers.

Understandability is a key quality feature of BPMN diagrams, particularly during the requirements phase of software projects; technical and non-technical stakeholders must read, validate, and review complex business processes to guide further software development [19].

Open standards such as BPMN that represent the use of knowledge and semantic data in applications are valuable tools for application design and for understanding the AI and ML models involved in the development of these data. Understanding complex black-box models can highlight the transparency, audibility, and interpretation of these models. The success of explainable AI models in the future will rely on creating novel human–AI interfaces that can facilitate contextual understanding and enable domain experts to pose questions and hypothetical

scenarios. In this way, human-designed processes and human-in-the-loop interactions can provide valuable human experience and conceptual knowledge to AI processes, which the current best AI algorithms lack [20].

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