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Incorporate Cultural Artifacts Conservation Documentation to Information Exchange Standards – The DOC-CULTURE Case

Dimitris Kouis\textsuperscript{a,b}\* and Georgios Giannakopoulos\textsuperscript{a}

\textsuperscript{a} Technological Institute of Athens, Agiou Spyridonos, Aigaleo, 12210, Athens, Greece
\textsuperscript{b} Hellenic Academic Libraries Link - HEAL-Link, National Technical University of Athens, Iroon Polytechniou 9, Zografou 15780, Athens, Greece

Abstract

The cultural heritage artifacts Conservation Documentation format is not universally agreed upon nor has it always been considered an important aspect of the conservation profession. Conservation records present major drawbacks, which are the fragmentary and incomplete description of the contained information and related processes. On the other hand, as strict regulations prohibit invasive testing in the conservation of art works and monuments of great historical value, new type of examination methods such as Non-Destructive Testing and Evaluation (NDT&E) techniques have become essential and are widely used by scientists. In this context, the present paper presents the DOC-CULTURE project approach to standardize the documentation of the NDT methods and their output data through CIDOC-CRM exploitation.

Keywords: Non Destructive Testing Techniques; conservation documentation; CIDOC

1. Introduction

Nowadays during the care and treatment of a cultural object with modern conservation techniques, different format of information, such as text, numerical and visual data are produced. Those data (which can characterized also as Scientific Research Data) are obtained by high-tech instruments measurements or through the performance of analytical chemical (or other) examinations methods. The outcome of these measurements concerns mainly the structure (micro/macro), the compound composition and the identification of previous restoration interventions

\* Corresponding author. Tel.: +30-210 7724487; fax: +30-210 7724488.

\textit{E-mail address:} dimitriskouis@seab.gr
and/or damage assessment data (both from human interaction or due to environment conditions). If the following data are collected for an artifact, such as object’s current condition, treatment reports done to the object in the past, observations or conclusions or restoration proposals made by the conservator, as well as object’s past and present environmental parameters, then a complete set of information is formed, known as Conservation Documentation (Moore, 2001). The previously described information is produced as the result of the Conservation main process applied to a cultural artifact. Each process phase produces different sets of data that when all combined together form the Conservation Documentation. The figure below (Fig. 1) presents the cultural heritage artifacts’ conservation main processes (namely Basic identification information, Examination techniques-Investigation and other Information, Diagnosis Information, Conservation methodology, Conservation application and Preservation etc.) where the data flows for the documentation material is generated.

![Conservation Main Processes and Documentation data flows](image)

**Fig. 1.** Conservation Main Processes and Documentation data flows.

An initial set of data elements for each conservation process phase is given at Section 2. But before presenting these findings, it is necessary to describe the new requirements of modern investigation, examination conservation and restoration techniques and methods.

### 1.1. Modern Conservation Documentation – New Requirements

In the past, Conservation Documentation consisted only from conservator (or other professionals) unstructured, handwritten, notes. Also, the long interval between restoration/preservation activities, usually from different professions, resulted in total absent of any kind of standardization in Conservation Documentation data. On the other hand, the more complete are the conservation records, the more accurate is the artifact history log, the more efficient is going to be the work of the future researcher, curator, or conservator. In the meantime, the emergence of the Digital Technology helped the transition to a new, completely electronic way of storing cultural artifacts identity and conservation information. Specifically, digital technology has established a framework where conservation documentation was easier to be produced, more accessible, more efficient (in terms of cost and time) to preserve, and provided more accurate and consistent data records.

But the form of Conservation Documentation is not universally agreed upon, nor has it always been considered as an important aspect of the conservation profession. Many standardization bodies and international organizations, related to cultural heritage have issued direction for Conservation Documentation, such us the ICOM-CC (International Council of Museums – Conservation Committee, http://www.icom-cc.org), the ICC (International Institute for Conservation of Historic and Artistic Works, http://www.iiconservation.org) and both AIC (American Institute for Conservation of Historic and Artistic Works, http://www.conservation-us.org) and CIC (Canadian Institute for Conservation of Historic and Artistic Works, http://www.cci-icc.gc.ca/), while standards like the Conceptual Reference Model of the International Committee for Documentation (CIDOC-CRM) (Boeuf, et. al., 2013) and the Spectrum (Dawson & Hillhouse, 2011) were (or are being) extended to include (partially) conservation data.

But the major drawback to conservation records is still the fragmentary and incomplete description of the related information and processes. This lack of standardization also reflects to the information systems developed...
by the software companies and used from culture heritage organizations (Green & Mustalish, 2008). An important requirement for a cultural heritage information system is the ability to manage, among other, all the information that is generated by conservation, preservation, and scientific activities, including examination records text output, treatment reports, analytical results, and accompanying images in digital format (pictorial output).

Nowadays, where the strict regulations prohibit invasive testing during the conservation of art works and monuments of great cultural value, new type of examination methods such as Non-Destructive Testing and Evaluation (NDT&E) techniques have become essential and are widely used by scientists. They have proved to provide substantial information in the cultural heritage preservation area, mainly in the form of visual data. Also, while there is ongoing research, concerning image annotation tools, 3D representation and reconstruction, virtual restoration image plug-ins etc. there are no relevant standardized methodologies and procedures for image analysis, annotation and numerical data processes so as to provide a wide range of potential applications in a user-friendly way for those involved in the conservation and preservation of cultural heritage (i.e. conservators, conservation organizations or bodies, restoration centers, etc.). All the above new type of information demands both documentation and information scientists combined efforts, in order to provide the proper standards for creating, managing, storing, accessing and preserving the conservation data. It is globally accepted that conservation data and metadata standardization efforts are the first step towards their inclusion to the Research Data Management (RDM) (Tenopir et al, 2013) activities and their sharing and re-use (Darby et al, 2012), as well as their Digital Preservation (DP) (Palma et al, 2013). The previous described concepts, between other, are included in the main objective of DOC-CULTURE project.

1.2. Related work

Many research teams have been conducting projects around cultural heritage objects and their metadata (mainly CIDOC-CRM) in relation to publicity through the web, interoperability, preservation/restoration decision-making support etc. Moreover the NDT&E techniques are becoming essential for conservators/restorators, before and after applying any type of interventions.

In this context, in (Kiousi et al, 2012), a complete methodology is proposed, that enables decision-making in cultural heritage protection, and recognize as key element of their system that all cultural heritage content are stored in a database, while interoperable description of the data allows for a universal accessibility of the content from heterogeneous devices and platforms.

The TIVAL project (Locatelli et al, 2012) aims at supporting the integration of different, distinct and heterogeneous multimedia contents into a comprehensive and accessible portal, in order to present information supporting a critical analysis of a piece of cultural heritage. To support their goals they adopt the domain ontology derived from CIDOC-CRM in organizing their contents.

The importance of CIDOC CRM is also recognized by many others either as a metadata mapping guide or as the intermediate stage for crosswalks between other standards or by providing extensions to the core model. Specifically, in (Karagiannis et al, 2009) NDT&E methods are used for to analyze Byzantine Iconography, while the results as mapped to CIDOC-CRM standard. In (Binding et al, 2008; Gaitanou et al, 2012; Gergatsoulis et al, 2012; Ore & Eide, 2009; Kakali et al, 2007) various metadata mappings and crosswalks are proposed between standards such us Dublin Core, Text Encoding Initiative (TEI), Resource Description Framework (RDF), while CIDOC-CRM remains the junction point. In (Lamsfus et al, 2005) the art-E-fact ontology extension was developed, following the general trend where many communities (e.g. eLearning, telemedicine, cultural heritage) adopt the same methodology, in order to standardize their contents and data models facilitating the integration and exchange of content coming from heterogeneous data sources.

Finally, as mentioned before, the NDT&E techniques role becomes crucial as they are used more and more during examination and investigation of cultural objects (Avdelidis et al, 2007; Cheilakou et al, 2014).

2. The DOC-CULTURE Project

The DOC-CULTURE (Development of an integrated information environment for assessment and documentation of conservation interventions to cultural objects with Non Destructive Techniques – NDTs) research project aims at exploring the problems inhibiting in the damage detection and conservation interventions
assessment of cultural artifacts through the use of NDTs (Non Destructive Testing Techniques), while at the same time to propose a metadata extension including the derived information. The final outcome of the project is to develop an Integrated Information Environment (IIE), through the interdisciplinary collaboration in three different research fields, which will cover the following objectives:

- Standardization of NDTs application methodologies.
- Creation of a complete set of techniques and software tools for digital image analysis and processing of the NDTs output data.
- Standardization of the documentation process of NDT methods in decay detection and conservation interventions assessment and expansion of the relevant standards.
- Integrated Information Environment for the documentation of NDT processes and its implementation model.

Apart from traditional examination and testing techniques (especially Non-Destructive Testing Techniques – NDTs) “data sets”, project’s research activities focus to the production of more information. Specifically:

- State-of-the-art methods for image analysis and processing with adjustment of their functional parameters (e.g. optimization, resolution and contrast increase, re-coloring, etc.).
- Implementation of algorithms for graphic pattern detection (detection of areas, patterns, colors etc.)
- Development of techniques for 3D reconstruction and representation of the NDTs results through a combined use of special information.
- Innovation of methods and production of special filters for the projection of the virtual state of cultural artifacts after the virtual restoration plug-ins, in order to have the best possible assessment after the conservation interventions.

The research activities in the field of conservation documentation target that standards apply to all new knowledge produced and thus make it not only available to all but also registered it to an open data system which will allow exchange, transfer and incorporation by collaborating institutions. In this direction the following will occur:

- Standardization and documentation of all methods used and metadata produced during the implementation of NDTs.
- Standardization and documentation of all metadata produced during the analysis of NDTs and the various processing techniques.
- Standardization and documentation of all image annotation metadata.
- Promotion of all standards expansion, which will be formed to issuing bodies and to the scientific community for further discussion, input and awareness.

Finalizing, the creation of an Integrated Information Environment (IEE), which will give the ability to annotate cultural artifacts with NDTs data, and consequently annotate these data with notes and metadata from the conservator’s point of view (NDT Image Annotation Tools) is promised. The IEE will provide the means for establishing a proof-of-concept testbed, while it will help project’s research team to refine and improve their findings. The paragraphs that follow present the methodology towards conservation documentation, NDTs examples and a CIDOC-CRM example.

2.1. Methodology towards Conservation Documentation

The basic conservation steps are depicted in Fig.1. As it can be seen, step 2 & 3 can be repeated before and after any conservation/restoration application (step 5), in order to identify the impact to the cultural object (condition assessment). The aim of the DOC-CULTURE project is to model the conservation procedures through the CIDOC-
CRM standard (step 1 through step 5) and emphasize on the documentation of NDT&E techniques data results (step 2).

The step 1 - Basic identification information is the point that all information concerning the cultural artifact is collected (see Fig. 2). Parameters like object type (meaning painting, sculpture, book, paper, building etc.), name-title, creator, creation date, physical characteristics, description, historical information, owner should be collected and cataloged to the proper fields. Also, it is necessary to provided any bibliographic records related to the object and conservation related information such as the environmental conditions and previous conservation/restoration data in any form (structured or unstructured). The more information collected in step 1 the better for conservators.

Step 2, referred here as “Exams – investigation information” describes the actions that conservators have to implement before proceeding to the condition evaluation report (see step 3). Step 2 parameters are the conservator’s information, date of application, photos and annotation remarks etc. Also, the previous conservation information (if exists) should be analysed and included in the Observation report.

Step 2 main goals are to produce the Final Examination report where the condition assessment is included. Condition assessment is achieved by the application of destructive and non-destructive testing techniques, as the corresponding report should describe in details (Testing Techniques report). The results from the examination / investigation and the comments from conservation experts are forming the Final Examination report.
The rest of the steps (3, 4 and 5) are also important for the conservation lifecycle. As it can be seen from Fig. 4 the output data format is mainly reports. Specifically step 3 delivers the Condition report and the Condition evaluation report, step 4 the Conservation proposal, the Conservation schedule and the Risk Analysis, while in step 5 the conservation / restoration process takes place producing a new set of data mainly in pictorial and report like format. As mentioned before one of the main aims of DOC-CULTURE project is to establish a standardized documentation framework as far as concerns the NDT methods during conservation cycle. In this direction the next two paragraphs present an example on how this can be achieved by using a actual NDT method (the Infrared Thermography) and the CIDOC-CRM.

2.2. NDT example - Infrared Thermography

Thermographic testing (or Infra-red thermography IR) is very important in the diagnostics of buildings and large art works (like wall paintings, artifact surfaces, sculptures, mosaics etc.) (Maldague 2001; Ludwig 2004; Sfarra et al., 2012). Through IR various thermographic approaches decay detection and assessment of cultural heritage objects can be performed. IR technique produces mainly images that can be further processed in order to reveal surface structure anomalies or internal discontinuities or environmental effects (e.g. moisture). As an example the figure below (Fig. 5) depicts the thermographic inspection of painting, where after advanced processing over the raw data, the presence of subsurface defects are revealed.

The IR application procedure and more over its data output are not standardized resulting in low interoperability and total absent of information exchange between various information systems. IR data are usually
stored in reporting documents (e.g. Microsoft word documents), where information is unstructured and non-standardized. An initial attempt for “potential” metadata/data sets of the IR technique is presented in Fig. 6.

Specifically, instrument profile (meaning technical and other characteristics), methodology approach (e.g. passive or active) and output data can lead to a first level of standardisation. The above example could be further refined and included as part of the conservation documentation to information exchange standards such as CIDOC-CRM.

2.3. The CIDOC-CRM example

Based on the previously presented example, where an NDT technique was analyzed in order to create a simple metadata/data framework, the CIDOC-CRM standard could be used or expanded/adapted further to accommodate the output information. The figure that follows (Fig. 7) depicts the matching between CIDOC-CRM classes and object properties and the NDT techniques such as IR thermography metadata set as defined above.
In the current example class like **E14.Condition Assessment** can be extended to facilitate destructive or not destructive testing techniques during conservation procedures. The output data deriving for these methods (e.g. IR Thermography) can be easily modelled either through the existing classes (eg. **E39.Actor**, **E63.String**, **E36.Visual item** etc.) or by proposing new ones.

### 3. Conclusions

The importance of NDT&E methods during cultural heritage objects conservation and restoration process is high. They offer conservators the ability to perform in depth condition evaluation of the under examination artifacts without any impact to their physical form. NDT methods, along with other destructive testing techniques, when applied, produce various sets of data like numerical, text and images (diagrams, spectrum figures, thermography images etc.). Nevertheless, NDT methods application and the produced results are not standardized, resulting low interoperability among different conservation teams and difficulties during information exchange.

DOC-CULTURE project is the first integrated attempt to create a standardization framework for NDT methods application, during conservation of cultural objects. Also, it is going to provide an extension proposal in order to include NDT methods output data to metadata models such as the CIDOC-CRM standard.

This paper illustrated the methodology followed in the DOC-CULTURE project, by presenting the Infrared Thermography technique. An in depth analysis of this technique provided valuable information that were used in order to expand CIDOC-CRM with the needed classes/properties in order to accommodate the extra data. This is an ongoing research work and more accurate and complete results are expected in the nearby future.
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References


