Universität Hamburg
Fachbereich Informatik
Vogt-Kölln-Str. 30
D-22527 Hamburg

Bericht 264

First International Workshop Ontology Based Modelling in Humanities

7-8 April 2006
University of Hamburg

FBI-HH-B-264/06

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In die Reihe der Berichte des Fachbereichs Informatik aufgenommen durch
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April 2006

A preliminary Ontology-based model applied to the description/interpretation of archaeological excavation

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"Lo scavo è dunque una procedura lunga e faticosa e solo la documentazione analitica delle unità stratigrafiche e la loro ricomposizione nella ricostruzione ideale possono riparare il danno della distruzione che esso inevitabilmente comporta. In tal modo lo scavo traduce forzatamente e irreversibilmente la pesantezza dei materiali e della terra nella leggerezza delle parole, dei disegni e delle fotografie. D'altra parte senza questa trasformazione la stratificazione sarebbe solo silenzio e oscurità, non esistendo che in potenza per noi".
A. Carandini, "Da Storie della Terra. Manuale di Scavo Archeologico, Einaudi 2000, pp. 17-18

Keywords: Archaeology; Standards, Documentation ,Methods; Forms, Database, CIDOC-CRM

Abstract
With the widespread use of information technology in archaeology, standards are playing an increasingly important role and standardization is going to become a key issue in the archaeological computing research agenda. On the one hand, data structure in archaeological documentation can no longer be left to individual choice if such data are to be shared in archaeological digital libraries. Cross-searching and compatibility require a high level of standardization. Showing how this can be achieved while safeguarding the investigators' freedom and complying with local regulations about documentation is one of the goals of the paper. It will report on the progress of a project aiming at mapping diverse documentation to the common, standardized CIDOC-CRM. It is expected that the adoption of CIDOC-CRM will push forward a reflection to clarify the methodology of archaeological investigation and produce archives better suited to archaeological needs.

1 Introduction: Archaeological Excavation as Destructive Test

A. Carandini (2000), one of the most important Italian archaeologists, reminds us that, as excavation is a destructive activity, it is necessary to "translate" the bulk of materials into written, photographic and graphic documentation. The need to exhaustively investigate an archaeological context, both horizontally at the open-area level, and vertically at the depth level, causes the inevitable destruction of the upper strata (even when dealing with monumental structures of particular significance) in favor of the lower ones. On-site research activity therefore translates into a documentation activity (forms/photographs/surveys), which must be as neutral as possible and not exclusively in function of the scientific (or - worse - the academic) interests of the archaeologist. To record in a objective way the discovery process of the stratigraphy, can permit other scholars to reuse the documentation gathered during fieldwork for in-depth studies and perhaps for new hypotheses.

This documentation activity - both for excavation activities and for those activities preceding the on-site investigation - has been the object in recent years of in-depth analysis and evaluation. A wide spectrum of standards and reference regulations is being defined by different national and international organisms. The main goal of these standard is to contain the excavator's natural tendency to be a narrator of stories (often already present in the mind of the archaeologist), rather than a neutral excavation "technician", have defined, The various attempts made at normalizing the production of documents of excavations have lead to the elaboration of a large number of forms. These are designed to record the overall activities of an archaeological site (be they structures or mobile finds).
Notwithstanding the release of a number of standards, often widely distributed at the national level, the archaeologist's work in the field has not undergone substantial changes. The introduction of informatics has actually complicated the picture because it added different formats, software and operating systems, chosen by each individual researcher; moreover we have different standards of documentation. This becomes evident when taking into consideration the university environment which, as it is often released from the obligation to produce and deliver "standard" documentation, has made use of a variety of different methods and systems for the recording of information. In any case the introduction of certain standards (at least as common elements used to describe the excavation and investigation procedure) has determined an initial turning point in a scientific community not very attentive as far as evaluation of raw data is concerned, but instead very busy presenting mostly syntheses.

2 Standard Thesauri and the National Reference "Best Practices"

Documentation, seen as a model for the management of the information, can be used as an instrument to "release" the potential of museums as containers and places for the exhibition of works of art. Therefore documentation is a means - the simplest - to manage an object belonging to a collection, rather than an end of the scholar (whether he/she be an archaeologist or a curator). For these reasons cataloguing standards are often defined and adopted at the national level. In the same time other standards have achieved a status which goes beyond the confines of single states. These standard are being promoted through international agreements by museum curators interested in the safeguarding of the artistic and archaeological heritage (see APPENDIX).
One might say that the simplest and most immediate type of standard is the "thesaurus". It characterizes archaeology almost as its foundation and disciplinary premise, though we can't really speak of a general reference (and generic) vocabulary, as it is connected to specific disciplinary sectors (prehistoric, classic, oriental, medieval archaeology, etc.) which are divided into sub-disciplines that further specialize the different thesauri (Etruscology, Greek archaeology, the Iron Age, etc.). At this level the primary goal of a standard is to guarantee "homogeneity" in the description of any object, a sort of single description protocol with values defined by pre-fixed lists (vocabularies, thesauri, dictionaries) chosen by each archaeological team according to specific needs.
Many standards devised especially for the management of museum collections exist. These are often implemented to guarantee a rapid and fast inventory for the objects found during an archaeological investigation on field. Thanks to widespread computerization these standards allow museums to be efficiently automated and kept up-to-date for any future developments in the sector. Moreover the use of information system (mainly Database) can force the archaeologists to adopt a common protocol.
We must distinguish various types of standards which only in certain cases may also cover the problems pertaining to the management of an archaeological excavation:

- **Catalogue** Standard: it determines the rules for cataloguing various objects;
- **Standards** regarding the terms to use in the description of an object (for example vocabularies and thesauri);
- **Metadata** Standard: it gives structure to information making it independently interchangeable from the databases used.
- **Interchange** Standard: it allows communication between computers.

The reference model for cataloguing the Italian archaeological patrimony was published in 1984 by

the Istituto Centrale per il Catalogo e la Documentazione (www.iccd.beniculturali.it), an institute of our Ministry of Cultural Heritage. It refers to a limited number of forms: Stratigraphic Trench (SAS), Stratigraphic Unit (US), Archaeological Find (RA), "Wall Covering" Stratigraphic Unit (USR), Paleo-Anthropological Remains and Archaeological Monuments (MA).
As one may read in the foreword of the Normative that ICCD released in March 2004 (*Sistema Informativo Generale del Catalogo* - Normativa 3.00): "*...the intense job of systematization of the entire catalographic process in its methodological and operative aspects... has entailed an accurate revision activity of the most frequently used catalographic forms and of the regulations regarding their compilation... To these requirements, of a technical, practical and operative nature, linked to the refinement and natural evolution of a normative occurring in its emerging aspects over a ten-year period of time, one must add those made necessary by the current and delicate phase of data diffusion which must be reconciled with the principles of privacy, safeguard and intellectual property; such demands have made necessary the insertion of appropriate fields in which the institutions responsible for the catalographic procedure are necessarily involved regarding the "sensitivity" of the information and the consequent differentiated access according to the user profile*".
In reality this activity simply translates into the creation of tables (more or less complex) designed for a wide variety of archaeological objects at different scale (Sites, Excavation, Object, Coins, etc.), for the documentation of different activities (Photo, maps, etc.) and for the management of inventories (TMA Tables, etc.).
The activity of the ICCD however is not limited to the definition of forms, but also of the format in order to guarantee an optimal management of all the resources. Through the years, along with a consistent investment of resources for the planning and implementation of forms to be compiled according to formalized ways of describing objects (vocabularies), a reflection regarding format standards has also developed. The ICCD has recently worked toward this aspect. In reference model 3.00 it has reserved a section for multimedia applications standards, underlining the advantages of using widely available commercial products, which are characterized by the use of interchangeable formats (*.tiff, *.jpeg, *.dwg, etc.) that allow a certain interoperability between the different sources.
Notwithstanding the coordinating action of the ICCD in promoting and favoring the adoption of format standards (dictionaries and forms) and of digital support (file types), documentation activity in universities has moved along different lines due to (unknowingly, we'd say) widespread computerization of the archaeological excavation; proprietary programs created for specific research projects (GIS solutions, Database, Multimedia tools, etc.) are never again used for successive investigations. The absence of a common framework determines an other important issue not simple to solve: the migration and the integration of these proprietary data and "standard" in a unique system.

3 Informatics in the Recording of Archaeological Excavation Data

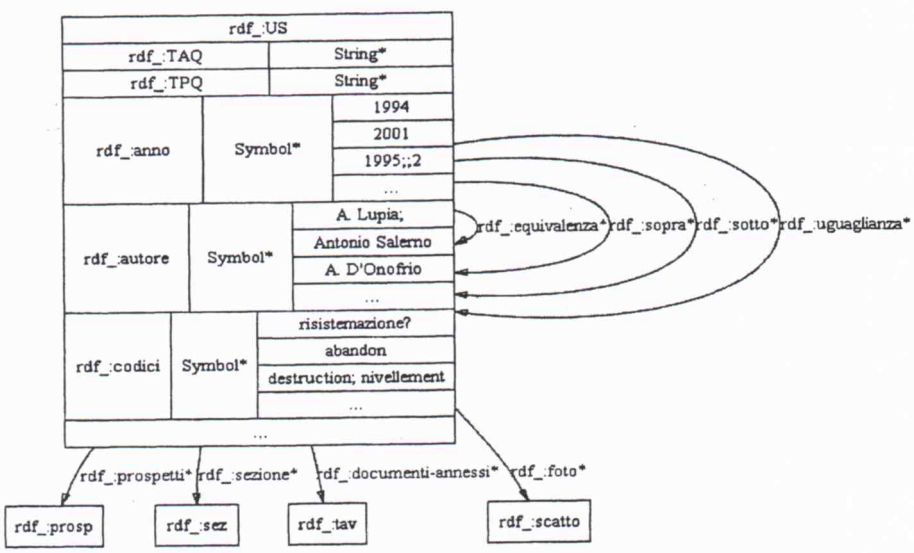
The development of research in the planning of computer applications for archaeological excavations since the mid Eighties has, especially recently, underlined some clear limitations which are largely due to the non-accessibility of the data and to digital archives that are difficult to reuse. This has occurred because computerization of a complex knowledge procedure, such as that of an archaeological excavation, often limited itself to the implementation of forms, catalogues, and tools used for searching and visualizing queries. Either with proprietary programs or with commercial instruments, the main objective of the archaeologist has been that of "preserving" documentation formalized according to his/her own specific and temporal requirements (disciplinary/academic). Although there are many completely computerized archaeological excavations, only a few are accessible and available on-line. The intellectual and material property of the person excavating (at least, as far as the Italian context is concerned) prevents the sharing and reuse of data, thus damaging the entire scientific community.
Recently, thanks to the greater availability, trustworthiness and ease of use of *open-source* tools, we have been able to note even within the archaeological field a small inversion of tendencies limited, for the time being, to the use of open-source software and no longer to commercial products: a decisive leap in the use of informatics technologies which, from instruments geared towards data conservation, become methods for different processing and for a wider distribution of data. This "revolution" (although still limited) has certainly determined a new approach in the use of computational

applications currently used as resources for the on-line publication of data, mostly through thematic portals. However the absence of standards or, in some cases, the wide range of standards that compete against each other, seems to have caused an objective difficulty in the recovery of formalized data which are thus treated according to different knowledge-based domains.
The absence of interoperability, caused by the diffusion in recent times of different platforms, programs and formats, is determined nowadays mainly by a profound semantic diversity, only partially solved by the definition and circulation of thesauri and thematic dictionaries. Perhaps what still impedes a real and true interoperability between on-line resources, the portals and thus the data is the absence of a clear formal representation of knowledge-based models that are at the basis of the normalization and computerization of information. Although the passage from Relational Databases to "mark-up language" has made the data normalization process more flexible, thus more "aware" of the quality of the information, rather than the quantity, it hasn't always been possible to understand how the researcher's capacity has lead him/her to the classification/interpretation, thus to the formalization of the data. This difficulty emerges even more clearly if one thinks of the need, common to most archaeological investigations, to reuse previously compiled documentation, often formalized according to systems and excavation methodologies which differ from those based on the principles of archaeological stratigraphy.
Each new archaeological hypothesis will be build on the documentation previously acquired during the investigation on field. It is easy to figure out how each historical and graphical (3D or virtual) reconstruction is influenced by the quality of the recorded documentation.

4 Mapping of archaeological forms into CIDOC-CRM

Considering how dangerous it is to "convert" older data to newer digital formats, as is any translation from one language to another, we started a project aiming at defining standards that are able to guarantee interoperability between different archives without modifying, "altering" or sacrificing the archives created by each archaeologist. We wanted in the same time maintain not only the data and the documentation collected, but also the methodology utilized in order to better understand how data have been created and then processed. Our project doesn't consist of recognizing and underlining the fields common to the different structures present in the written texts and/or in the forms (for example: place, location, period, chronology, phase, stratigraphical relations, etc.) as it might appear to a simple definition of metadata, rather it consists of "extracting" from each a representation of the conceptual model the archaeologist has referred to during his/her fieldwork and that has translated into documentation. The objective is not limited to attempting, whether it be refined or not, to integrate multi-temporal and stratified databases, rather to the necessity of "comprehending", and so of "representing" in a "transparent" manner, the processes carried out by the archaeologist in his/her own knowledge-based domain (stratigraphical excavation, open-area excavation, in-depth trench excavation, artificial strata excavation). To guarantee interoperability between different repositories (formalized using different standards) the first step should be to have a common standard. But it is impossible to force the archaeologists to use the same protocol or standard sacrificing their point of view. To avoid to build a new standard useful for all the community of archaeologists (as a super-standard), we decided to have a new approach using an ontology for understanding the work of the archaeologist on field. Other proposals, with the same our scope, are failed because based on the idea of a common distributed infrastructure to guarantee the interoperability among archives.
To "describe" in a formal way the archaeologist's activity the ontology was deemed particularly useful; the ontology is synthetically defined as formal cognitive models in a certain. Each archaeological method can be simply described as a task-ontology which produces as object of its activity a specific documentation. So it is impossible verify the documentation without knowing the method selected by the archaeologist. In the same way is impossible to guarantee the integration of different data acquired on the same area by different archaeological team.
The primary objective of our research has been to analyse the documentation gathered during the stratigraphical excavation, which currently represents the most consistent corpus of data available also in digital format according to national rules. An experimental project regarding the mapping of excavation forms according to the CIDOC-CRM standard (Crofts, Doerr, Gill, Stead, Stiff, 2005) has

been initiated and its primary role is "*to enable information exchange and integration between heterogeneous sources of cultural heritage information*".
Considering that its final goal is to supply the semantic definition necessary to transform a dispersed heritage of localized information into a coherent global framework, CIDOC-CRM is a formal ontology intended to facilitate the integration, mediation and exchange of heterogeneous cultural heritage.
Although this knowledge-based model has been implemented especially for the documentation of museum collections, CIDOC-CRM may also be adopted to describe the documentation gathered in the course of field investigations. We chose the CIDOC-CRM because it is *event-oriented*: in terms of content the archaeological documentation activity may be easily schematized: it documents a past event occurring during an archaeological era (archaeological strata) and, at the same time, it documents the action of the modern-day scholar. Any excavation activity and its pertinent methodology may be easily described following this conceptual formalism.
Our project is based essentially upon recognizing the correspondence between different classes of CIDOC-CRM and the fields defined in the forms chosen as samples for this experiment. In synthesis our objective is to propose an extension of the CIDOC-CRM classes and to pinpoint as many sub-classes and/or relationships for the structure of certain excavation forms (which are standard on ministerial forms and on those forms created by a university team). As defined by CIDOC-CRM, extension signifies that CRM classes subsume all classes of the extension, and all properties of the extension are either subsumed by CRM properties, or are part of a path for which a CRM property is a shortcut. The model we chose does not limit on simple (but whether broad) description of the archaeological "categories"; thus it inherits all the sub-classes and relationships of CIDOC allowing a more sophisticated formal analysis of the recorded data.
This global project will build on previous research with similar goals, among others the one concerning excavation forms from the archaeological of Cumae (Crescioli, D'Andrea, Niccolucci, 2002; D'Andrea, Niccolucci, 2002) - originally formalized according to a proprietary standard. The Cumae forms have been converted to RDF and visualized with the Protégé editor as in fig. 1



The graph shows a plane structure without relationships and with circular-type references. All information is placed on the same level, thus no hierarchy is visible, according to this method of structuring data.
In order to extract the relationships between the data, we have proceeded to extend the ICCD forms beginning from an initial analysis which has lead to the "conversion" of certain types of information into classes and of others into properties.
Analyzing the ICCD form it appears that several fields, like the Cumae form previously considered, are placed according to implicit relations not included in the form structure. The most evident

"anomalies" for instance concern chronology and the author. Dating may refer to the archaeological event, to the excavation or to the documentation; in a similar way, the author may be who produced the event in the past, the excavator or the form compiler. In fact the form label simplifies understanding it, but a simple conversion shows, as in the previous case of Cumae, how difficult it is to extract a semantic structure from the fields. For the sake of brevity we will not deal here with all the fields of the ICCD form, but it is worth while dealing with some contradictory situations. A difficulty evidently emerges – with a clear impact on the documentation quality – for the field "stratigraphic reliability": does it depend on the nature of the excavation (for example an investigation performed with a mechanic device provides less data than a brush-made one) or on the archaeologist's perplexity about the interpretation of the stratigraphy (basing on experience/competence)? Neither an appropriate metadata system is sufficient. Why the archaeologist chose a system (the mechanic device) instead of the brush? Possibly he/she was interested to reach as soon as possible the lower layers and evaluated as irrelevant the sacrifice of a layer in the overall economy of the excavation management and interpretation. Often such information is available in the "interpretation" field, a sort of "black hole" where the archaeologist puts the most important data for the laboratory reconstruction of the excavation. In a similar way, the attached documentation (photos, drawings) is compressed by the methodology chosen.

Another aspect emerging from the semantic reading of the US form derives from the so-called stratigraphic relations, that is the spatial and temporal relations among different Stratigraphic Units (natural/anthropic actions discovered during the excavations and individually numbered). In this case they are not class attributes, but relations among US forms documenting events that happened before/after the event recorded in the form.

This preliminary analysis produced a first manual mapping consisting in the recognition of the correspondence between the classes of the US form and the entities of CIDOC-CRM. In this case, using Protegè we created for every entity a sub-class corresponding to the US form fields. The documentation process of such mapping is shown in fig. 2, illustrating two fields and one relation with the proposed corresponding CIDOC-CRM classes.

ENTITY-TAG	**CONCEPT**	**CRM-ENTITY**
<AIE_01_SCHEDA_US>	US positive form	*E31_document*
NOTES	Each unit in the excavation has a corresponding US form. The tag refers to the database report or, alternately, to the paper sheet concerning the unit.	
RELATION	**WITH**	**NOTES**
P70_documents	AIE_13_us	
P4_has_time_span	AIE_06_anno	
P70_documents	E5_event	Event: excavation

ENTITÀ-TAG	**CONCEPT**	**CRM-ENTITY**
<AIE_39_DIRETTORE>	Director of excavation	*E82_actor_appellation*
NOTES	Name of the director of the excavation. Tag used in forms: US, USM, USN.	
RELATION	**WITH**	**NOTES**
P11_participated_in	E5_event	E5_event (excavation) P108_has produced: AIE_01_scheda_us
P49_is_former_or_current_keeper_of	AIE_01_scheda_us AIE_41_scheda_usm	

PROPERTY -TAG	**CONCEPT**	**CRM-PROPERTY**
<AIP_12_ANTERIORE_A>	Before to (US, USM, USN)	*P120_occurs_before*
NOTES	Chronological relationship with positive and/or negative stratigraphical unit. It refers to the USM, US, USN chronologically and immediately before to the unit in exam. Tag used in US, USM, USN forms.	

Thus, by creating sub-classes for every CRM class singled out, it is possible to inherit from the latter all the properties defined by CIDOC. Fig. 3 shows how such mapping has been realized.

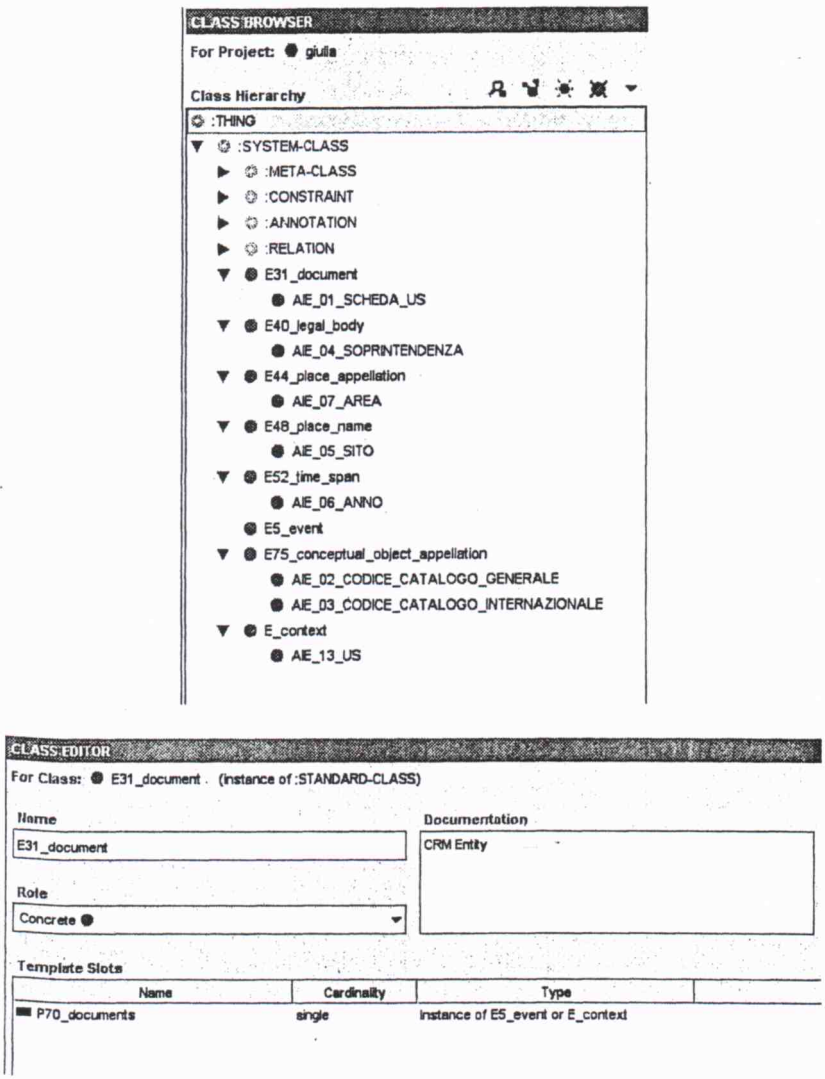
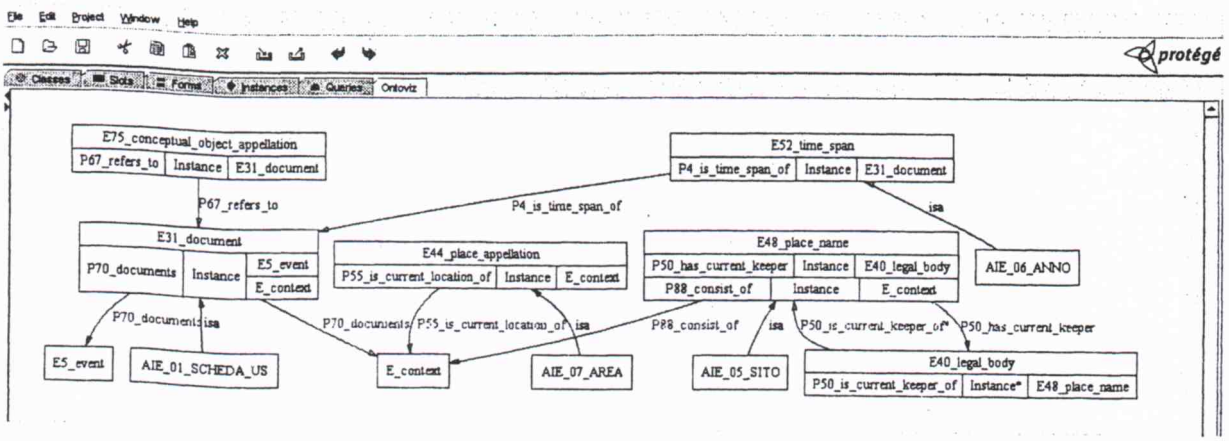


Fig. 4 shows the graph representing the hierarchy between the sub-classes and its relationships



From a methodological point of view, the work carried out so far seems to align itself with what has already been experimentally accomplished by the Centre for Archaeology of English Heritage (Cripps, Greenhalgh, Fellows, May, Robinson 2004) which, as declared in the foreword, is based upon the attempt to model a conceptual frame for all the archaeological data created by man; rather than by an extension, the mapping in this case has been carried out by simplifying the CIDOC-CRM classes.
In the future our objective will be to formally "describe" other types of forms and/or document representation in order to test the potential of such an approach and to guarantee the interoperability between information pertaining to an archaeological context investigated over a long period of time.
In conclusion our scope was to understand the conceptual model used by archaeologists to record data excavation in order to propose a new form for the documentation according the semantic structure supplied by CIDOC-CRM. Only through this way will be possible to obtain a real data integration and a reuse of data without altering and sacrificing the specific background and targets of each archaeologists.

ACKNOWLEDGEMENTS

Work on the global mapping system quoted in chapter 4 is presently carried on within the project named AMA, by a partnership formed by CISA, CIMEC, IAA, Oxford ArchDigital, PIN, ROB, University of Kent, University of Oslo, UNIREL, and VARTEC. Researchers include, among others, the author of the present paper, who was the principal investigator for the Cumae mapping research reported here.
AMA is developed in the framework of the EU funded Network of Excellence EPOCH (http://www.epoch-net.org/), which also partially supported the author's attendance.
Special thanks to Giulia Marchese for starting the mapping of the US and SYSLAT forms on CIDOC-CRM.
EPOCH is funded by the European Commission under the Community's Sixth Framework Programme, contract no. 507382. However, this presentation reflects only the authors' views and neither EPOCH, nor the European Community are liable for any use that may be made of the information contained herein.

BIBLIOGRAPHY

Crescioli M., D'Andrea A., Niccolucci F. (2002), XML Encoding of Archaeological Unstructured Data, in G. BURENHAULT (ed.), Archaeological Informatics: Pushing the envelope, Proceedings of the 29th CAA Conference, Gotland April 2001, BAR International Series 1016, Oxford, pp. 267-275.

Carandini A. (2000), "Da Storie della Terra. Manuale di Scavo Archeologico, 2000.

Cripps P., Greenhalgh A., Fellows A., May K., Robinson D. (2004), Ontological Modelling of the work of the Centre for Archaeology, September
(http://cidoc.ics.forth.gr/docs/Ontological_Modelling_Project_Report_%20Sep2004.pdf)

Crofts N., Doerr M., Gill T., Stead S., Stiff M. (2005), CIDOC CRM Special Interest Group, Version 4.2, June 2005 (http://cidoc.ics.forth.gr/docs/cidoc_crm_version_4.2.pdf)

D'Andrea A., F. Niccolucci (2002), Database di scavo ed Internet. L'accesso remoto all'archivio Syslat, in B. d'Agostino, A. D'Andrea (a cura di), CUMA. Nuove Forme di Intervento per lo Studio del Sito Antico, Atti della Giornata di Studio, Napoli 12 Febbraio 2001, AION ArchStAnt, Quad. 14, Napoli 2002, pp. 167-175.

Normativa 300 (2004) http://www.iccd.beniculturali.it/standard/normative_300.html

APPENDIX *International Standards*

CDWA (Categories for Description of Works of Art), elaborated by the **Getty Research Institute** and created with the objective of supplying a guide for describing objects of art. The Getty has created different vocabularies: the *Art & Architecture Thesaurus* (AAT), the *Thesaurus of Geographic Names* (TGN) and the *Union List of Artist Names* (ULAN). On the Getty Research Institute website you may find some on-line resources which are particularly useful for obtaining information regarding the principles of organization and cataloguing of the archives (www.getty.edu/research/institute/standards/cdwa/).

CHIN (Canadian Heritage Information Network), created in 1972 to prevent illegal importing, exporting or transfers of cultural artefacts belonging to Canada, it has become an important reference point for the development and implementation of standards for catalogues. CHIN has produced many standards for museums: *Artefacts Canada: Humanities/Dublin Core Mapping*: a mapping of the fields found in Artefacts Canada: Humanities and the Dublin Core standard (www.chin.gc.ca).

CIDOC-CRM (Conceptual Reference Model), is a formal ontology created to facilitate the integration, mediation and exchange of heterogeneous information pertaining to Cultural Heritage Patrimony. CRM is the culmination of more than a decade's worth of work regarding the development of a Standard operated by the *International Committee for Documentation* (CIDOC) of the *International Council of Museums* (ICOM). The project began in 1996. Since 2000 the CIDOC-CRM *Special Interest Group* collaborates with the *working group* ISO/TC46/SC4/WG9 in order to give the CRM the form and status of International Standard (http://cidoc.ics.forth.gr).

CIMI *(Consortium for the Interchange of Museum Information),* founded in 1990, it has as its objectives the intent to supply the guidelines regarding the use of new technologies in museums. The CIMI has released the CIMI Standard Framework based on the Standard Generalised Mark-up Language (SGML) for data structure and ANSI Z39.50 for researching and querying the databases. These standards have been used as demonstrators in certain projects: one of these projects was CHIO (Cultural Heritage Information Online) in which were involved many international museums during the testing phase (www.cimi.org).

EMII (European Museums Information Institute), established between MDA and CIDOC after a conference in 1999 as a network of 17 European nations, having as its objectives to simplify on-line access to European museums (www.emii.org).

MDA (Museum Document Association) utilizes certain standards such as *MDA objects Thesaurus* and the new *SPECTRUM*. The former represents a thesaurus for the compilation of catalogue forms, while the latter, published in 1994, is a museum standard. Created per to promote the good development of museum cataloguing, this standard is based upon metadata and in particular uses XML to codify the information. It can be used in all areas of museum activity, for cataloguing, documentation and management of the museum (www.mda.org.uk).

MIDAS (A Manual and Data Standard for Monument Inventories) is an agreed statement of best practice for the compilation of inventories of monuments. MIDAS has been compiled by national organizations involved in the recording of England's monuments (www.english-heritage.org.uk/midas/).

RLG (Research Libraries Group) a not-for-profit group composed of over 160 universities, national libraries, archives, historical societies and other institutions that develop and study the applications used in the field of cultural heritage. RLG is currently working on a project regarding metadata and the management of collections of digitalized images (www.rlg.org).