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Shared Iconographical Representations with Ontological Models

Abstract: The need to guarantee digital archive interoperability has driven the standardization of resources forward. The tendency to make searchable on-line databases has stopped at data accessibility, often presented as a synthesis of the interpretation procedure. During data computerization, the creation of the database requires the selection of a model whose representation is left out of the encoding process. Formalising this knowledge would be helpful in reconstructing a real, semantic interoperability, especially in those areas such as iconographic analysis, where the connections between the formal representation schema used and the description of the archaeological data is greater. This contribution is based on techniques of sharing knowledge through conceptual representational models, such as ontologies. In particular it consists of extending the CIDOC CRM with DOLCE and aims at formalizing the relationship that the agent (the archaeologist) creates between an object and the model and/or theory chosen to describe it.

Introduction

The need to guarantee digital archive interoperability has driven forward the standardization of resources through the creation of dictionaries and thesauri and of open systems, open-source and having a non-proprietary format.

However the tendency to make searchable, on-line databases available to the scientific community has stopped at data accessibility, often presented as a synthesis of the interpretative procedure or as an historical reconstruction, rather than as raw data. It would be of great interest (documentary, historical and not only scientific) to guarantee the sharing and accessibility of formalized knowledge, i.e. the particular sets of theories and models which are at the base of every description and creation of archaeological records.

During data computerization, the creation of the database requires an unconscious selection of a model whose representation is left out of the normalization and information encoding process. Multiple expressions/theories/reconstructions referring to the same subject are frequently recorded in a complex way because of the limits of the available informatics tools.

Encoding this knowledge would be helpful in reconstructing real, semantic interoperability, especially in those areas, such as classification, typology and iconographic analysis, where the connections between the formal representation schema used and the description of the archaeological data is greater. This contribution is based on techniques of sharing knowledge through conceptual representational models, such as ontologies. It tackles, in theory and with practical examples, the management of knowledge in the field of iconographic analysis.

The approach consists of extending the CIDOC CRM with the Situations&Descriptions (S&D) module of the DOLCE model and aims at formalizing the relationship that the agent (in our case the archaeologist) creates between an object (material or immaterial) and the model and/or theory chosen to describe it. While CIDOC CRM can be used to outline the properties and the basic relationships of the object, the S&D module is used to formalise in detail the informative content of the same. Its analysis is then placed in one or more interpretative spheres, sometimes present in the form of competing hypotheses. The formalization of the iconographic representations using ontologies could be of particular interest to the Semantic Web community.
This paper focuses on the application of these ontological models to the Meroitic reliefs, a peculiar category of archaeological monuments characterized by scenes which are difficult to interpret without the contextual integration of graphical representations and the texts relating to them.

Historical Background

The Meroitic period started around the IV century BC when the capital and the royal cemetery of the Kingdom of Kush were moved from Napata to Meroe, in the Nubian area, corresponding to modern-day Sudan *(Fig. 1)* (Hinze 1978; Török 1997).

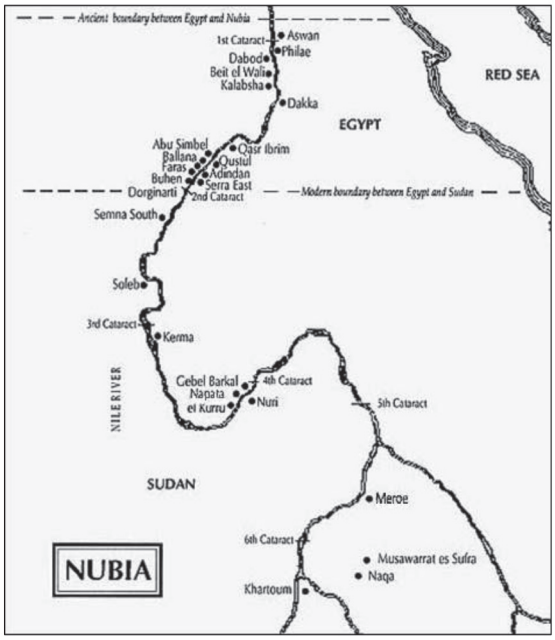

Fig. 1. Nubian region (from: http://www.homestead.com/wysinger/files/nubx92_fig2.gif).

The distinction between the Napatan and Meroitic Periods isn't very clear. Archaeologists frequently consider the entire period as one single phase during which slow changes occurred. Later on a new situation developed, called the Meroitic period, which lasted more than 600 years and finished around the fourth century BC.

The importance of the ancient Nubian region arose from the presence of abundant raw material; furthermore it represented an easy access to Oriental and Central Africa, rich in positional goods. Nubia was a natural passage facilitating the relationships among all the known countries, settled in the area, and fostering the development of a culture strongly influenced by Egyptian and Hellenistic elements. The presence of these different cultural components also promoted the growth of mixed and artistic handicrafts characterized by a deep revision of these external influences.

This eclectic expressiveness is particularly visible in the reliefs decorating the walls of the temples (Török 1987; Leclant 2000). These works of art, discovered mainly in the southern part of the kingdom, were official displays of the royal and divine power. They show many features belonging to Egyptian art, not only from an iconographic perspective, but also for the architecture of the buildings. Nevertheless the temples display many innovations and the appearance of new themes and compositions. The reliefs on the contrary show many Egyptian elements, especially for the presence of inscriptions encompassing the images; probably, the pairing of image-inscription was preserved for its effectiveness, as a clear medium of information of the power of the royal family.

On the walls and columns the sovereign depicted relevant scenes to justify and maintain his power and to spread precise ideological messages. Images contributed to highlight the stateliness and the wealth of the temple. In fact through the façade of the temple, the community presented itself to the God: simultaneously, from a political point of view, the king presented himself to his people (Török 1990).

The identification of the sovereign and his role occurred by means of different figurative attributes: crown, clothes, jewellery. The occurrence (or absence) of these distinguishing marks allowed to recognize gender, degree of kinship, status of each of the portrayed figures. A more distinct specification of the role each person portrayed could be deduced thanks to the inscriptions, simple or titling legend. Considering the analogies with Egyptian art, it is possible to single out some divine names and the royal title identifying each single person, such as sovereigns or divinities, clarifying at the same time the reciprocal relationships. Further the text could allow to place the scene in a precise spatial-temporal dimension. Therefore the images and inscriptions complement each other giving a clear and unambiguous message.

Unfortunately Meroitic is a language which hasn't been completely translated; for this reason understanding the meaning of the text is not easy, making the analysis and interpretation of the scenes more complex.

The text was in hieroglyphic and cursive characters, created by selecting certain Egyptian hieroglyphic and demotic letters. Both writing systems were adopted for different scopes; while hieroglyphics were used for short text, temple and royal, paired frequently to Egyptian titles, the cursive one was utilized for administrative tasks. Therefore there was a sharp distinction between the two writing systems:

the former fulfilling iconographic aims linked to the kingship, the latter used for longer texts, addressing common and ordinary practices.

The analysis and understanding of the temple images involves the interpretation of texts; this research relies upon a multi-contextual approach, which takes into account not only the archaeological context, but also the iconographic and epigraphic ones.

From Images to Database Management System

In order to arrange and manipulate the temple images, a relational database has been implemented. One of the most relevant scopes was to decompose the visible elements of the scenes into a minimal coherent unit. This approach could allow to recognize and classify the rules adopted to build the images and their meaning: thus it was possible to understand the arrangement and organization of every detailed description and the connections linking them to show a specific sense.

Encoding and normalizing images for data management is a risky activity because frequently data derives from a subjective analysis carried out by archaeologists. Only by combining figure-persons characterized by different attributes, inscriptions, text in Egyptian and in the Meroitic language is it possible to recognize the different characters, their gender, age and status. Unfortunately sometimes the inscriptions have been used to separate different images and so it is not easy to link them to a specific person. This is particularly evident for the titles appearing in the separating bands of images represented along the columns; probably these inscriptions referred to general scopes and didn't intend to highlight a special character. Formalizing all these issues was necessary to decompose and aggregate persons, attributes and texts sometimes linked to multiple scenes.

For this purpose a typical hierarchical structure has been implemented: the temples are big containers comprehending reliefs, whereas reliefs are smaller containers consisting of numerous scenes. In some cases the reliefs may show many scenes (for instance along the columns) or a big representation as a vignette *(Fig. 2)*.

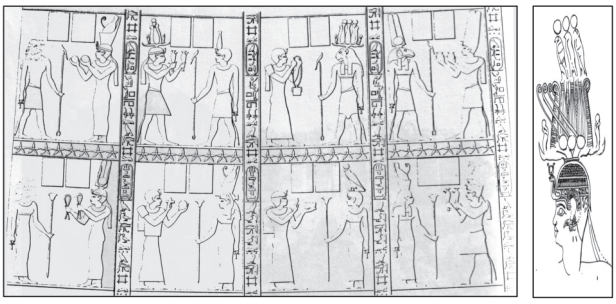

Fig. 2. On the left: a vignette: part of a relief composed by different scenes separated by vertical and horizontal inscriptions (from: Žabkar 1975, 187). On the right: Female character with headgear (from: Török 1987, 120).

A single image, belonging to a relief, can be associated to different scenes, characters and inscriptions. Finally each scene includes many persons and attributes, such as insignias, crowns, headgears, etc. The insignias have been classified according to two distinct categories: crowns and clothes.

A database is a scarcely flexible system used to codify iconography, mainly iconographic interpretations. Originated to solve issues concerning "accountant's computing", a database doesn't always comply with archaeological data management. Data is not simple lists of digits/numbers; often they are pieces of information that must be interpreted. Trying to put all data into a database application sometimes means to compress data according to a different, more structured approach. Moreover, in this field there are often different interpretations of the same object. Managing multiple and alternative hypotheses requires a more complex solution, where structuring data into tables requires for n different interpretations as many tables, making cross-searching more complicated. Furthermore reducing and decomposing the image into single minimal units of description is an arbitrary and risky task, as it deals with a subjective approach, not always easy for different users to understand. Recovering this level of implicit knowledge requires a different way to structure the conceptualization lying behind every interpretation.

A New Approach: Toward an Ontological Model

Recently, in order to overcome the limits of the application of database theory to archaeological objects, some interesting experiments have been carried out in the framework of knowledge engineering. This field of research, particularly linked to the Semantic Web Vision, focuses on extracting the meaning through the explicit formalisation of knowledge.

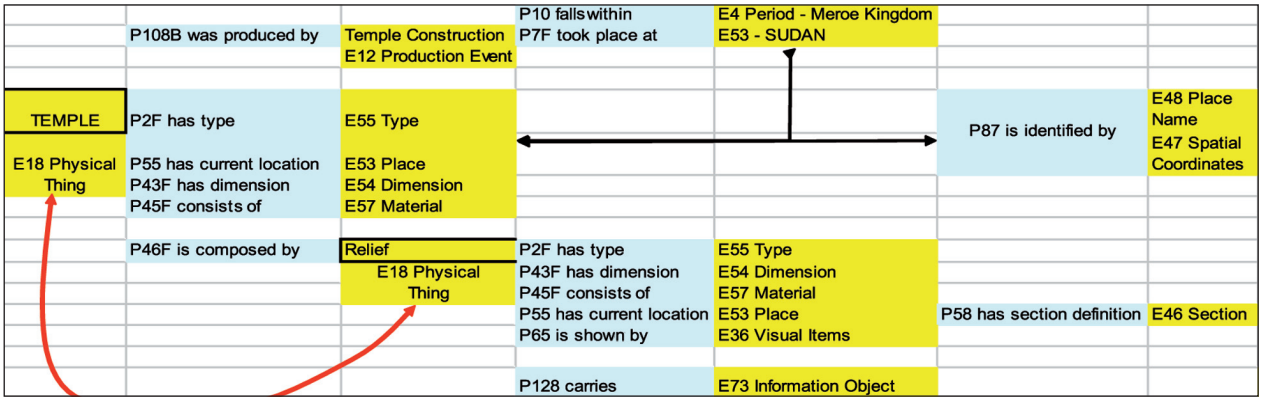

Fig. 3. Experimental coding according to CIDOC CRM.

From a database, viewed as a container of values, it is possible to pass to the ontologies that, by representing concepts and properties, allow to encode a specific domain. Using this approach it is also possible to guarantee the sharing of data and semantic interoperability.

According to the level of generality and of dependence on a particular task or point of view, it is possible to formalize the knowledge using different kinds of ontologies. While Top-level ontologies describe very general concepts (space, time, object, event, etc.), which are independent of a particular problem or domain, the domain ontologies or Task ontologies depend upon, respectively, the vocabulary related to a generic domain or to a generic task or activity, specializing the terms introduced in the Top-level ontology. Finally, Application ontologies show concepts depending both on a particular domain and task, which are often specializations of both the related ontologies: these entities correspond to roles played by domain entities while performing a certain activity.

Recently in the cultural heritage domain the CIDOC CRM ISO21127 is spreading, a domain-ontology focused on defining the underlying semantics of database schemata and document structures used in Cultural Heritage and museum documentation. CIDOC CRM doesn't impose any of the terminology appearing typically as data in the respective data structures, nor is it assimilable to Dublin Core Metadata; rather it explains the logic of what is to be documented, thereby enabling semantic interoperability.

In our research CIDOC CRM has been adopted only to describe the relationships between physical objects, mainly time and space. As each scene is either a material or immaterial object, CIDOC CRM is a useful tool to formalise the relationships between the scene, the reliefs and the temple, highlighting temporal and special links. *Fig. 3* shows the coding of these properties according to CIDOC CRM.

As one can easily see, the relief, beyond being a physical object, is also a conceptual object carrying an information, i.e. one or multiple interpretations. Nevertheless by means of CIDOC CRM it is possible to formalise the iconographic analysis and the alternative theories simply by compressing all the com-

CIDOC CRM		MPEG-7		X3D		FRBR
E73 Information Object						
E36 Visual Item	=	Image				
		Video				
			=	Shape		
E33 Linguistic Object	=	Audio				
E28 Conceptual Object					=	F1 Work

Fig. 4. Synthetic schema of CIDOC CRM extensions with other ontologies.

plexity behind the interpretation within one, single entity; according to this reasoning a physical object (E 22) is linked to E73 (Information Object) through the property P128 Carries.

Considering the limits of CIDOC CRM, a new approach based on the extension of CIDOC CRM with other ontologies has been chosen. In conformity to the CIDOC CRM model, the CRM is extensible for the needs of more specialized communities and applications. Extending the CIDOC CRM allows to specialize the domain without loosing the compatibility with the CIDOC CRM schema.

This approach has already been effectively adopted in other application fields: already some extensions *(Fig. 4)* are available, linking CIDOC CRM to FRBR for bibliographic and museum information (Doerr / LeBoeuf 2006), to MPEG-7 for Multimedia in Museums (Hunter 2002), and finally to XSD for 3D objects (Niccolucci / D'Andrea 2006).

As the scope of the research was to embed theories and knowledge into the iconographic interpretation, it was decided to adopt the S&D model (Gangemi / Mika 2003) representing a module of the Top-Ontology DOLCE (Descriptive Ontology

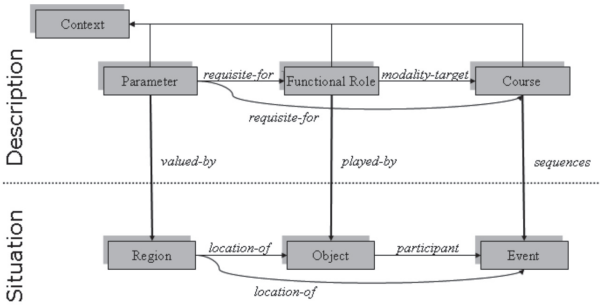

Fig. 5. S&D Schema (from: http://www.w3.org/2001/sw/Europe/events/foaf-galway/papers/fp/descriptions_of_social_relations/).

for Linguistic and Cognitive Engineering). S&D is an ontology design pattern that provides a context model and allows to clearly outline two layers of representation: the context and the level of state-of-affairs (observations of objects and sequences of events). S&D is a generic pattern for modeling non-physical objects whose intended meaning results from statements, i.e. it arose in combination with other entities. For example, a norm, a plan, a social role or an interpretation is usually represented as a set of statements and not as a concept.

S&D axioms capture the notion of situation as a unitarian entity out of a state of affairs (SoA).

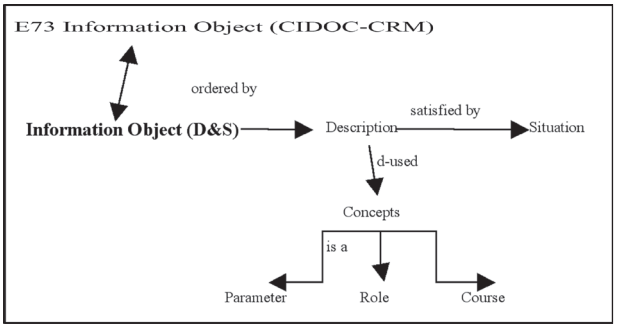

Fig. 6. CIDOLCE ontology.

A description is an entity that partly represents a (possibly formalized) theory T that can be conceived by an agent. A situation is constituted by the entities and the relations among them that are mentioned from a SoA *(Fig.5)*. Due to its neutrality, S&D can generalize the distinction between state of affairs and description, in order to obtain an epistemological layering. This layer Li defines that any logical structure is built upon a SoA structure that is described according to a theory Ti. In other words, Ti describes what kind of ontological commitment Li is supposed to have within the epistemological layer that is shared by the encoder of an ontology.

According to this CIDOC CRM and S&D can be joined through the equivalent entities "Information_Object" *(Fig. 6)*; in S&D the concept Information Object is considered a social object pointing out the dependence of the meaning of the physical object on a specific encoding system (theory, rules, etc.).

Starting from this model, integrating the CIDOC CRM for physical elements and S&D for the interpretations and related descriptions, it is easier to describe each image according to a formalized conceptualization. While the physical description, with its temporal and spatial basic elements, can be easily managed using CIDOC CRM, the equivalence with Information_Object allows to pass to the description of the scene exploiting S&D model.

Conclusions

The project is based on the application of ontologies in order to create a flexible tool for the managing of multiple and often alternative reconstructions. Considering the scarce adaptability of metadata (like Dublin Core) or thesauri (like ICONCLASS) to describe the depictions of the Meroitic reliefs, it was decided to experiment the applicability of existing ontologies for Cultural Heritage.

The tests, carried out so far, seem promising and encouraging. In the future the new CIDOLCE ontology based on the equivalence between the CIDOC and DOLCE entities called Information Object will be implemented. By means of this new approach a bottom-up method for selecting the basic elements composing each scene (characters, attributes, texts, etc.) will be chosen: all database fields will be mapped on this model. According to the new pattern it will be possible to formalize specific interpretations or alternative hypotheses without loosing the minimal units of representation.

Finally the same methodology will be experimented on the pottery typology, another field of research characterized by the presence of different classification methods, frequently deeply diverging.

References

Doerr / LeBoeuf 2006

M. Doerr / P. LeBoeuf, Modelling Intellectual Processes: The FRBR - CRM Harmonization. Paper presented at the Annual Meeting on CIDOC Conference (Gothenburg 2006).

Gangemi / Mika 2003

A. Gangemi / P. Mika, Understanding the Semantic Web through Descriptions and Situations. In: R. Meersman / Z. Tari / D. Schmidt (eds.), Proceedings of the DOA/CoopIS/ODBASE 2003 Confederated International Conferences (Berlin 2003) 689–706.

Hintze 1978

F. Hintze, The Meroitic Period. In: S. Wenig, Africa in Antiquity in Antiquity. The Art of Ancient Nubia and the Sudan II (Berlin 1978).

Hunter 2002

J. Hunter, Combining the CIDOC CRM and MPEG-7 to Describe Multimedia in Museums (Boston 2002).

Leclant 2000

J. Leclant, Répertoire d'Épigraphie Méroitique. Corpus des inscriptions publiées (Paris 2000).

Niccolucci / D'Andrea 2006

F. Niccolucci / A. D'Andrea, An Ontology for 3D Cultural Objects. In: M. Ioannides / D. Arnold / F. Niccolucci / F. Mania (eds.), 7th International Symposium on Virtual Reality, Archaeology and Cultural Heritage (Nicosia 2006) 203–210.

Török 1987

L. Török, The Royal Crowns of Kush. A study in Middle Nile Valley Regalia and Iconography in the 1st millennia B.C. and A.D. (Oxford 1987).

Török 1990

L. Török, The Costume of the ruler in Meroe: Remarks on its origins and significance. Archeologie du Nil Moyen 4, 1990, 151–202.

Török 1997

L. Török, The Kingdom of Kush: Handbook of Napatan-Meroitic Civilization (Leiden 1997)

Žabkar 1975

L. V. Žabkar, Apedemak, Lion God of Meroe: A study in Egyptian-Meroitic Syncretism (Warminister 1975).

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