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Theoretical Foundations and Enabling Technologies for Cultural Resources Management Systems

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Abstract

Cultural Resource Management (CRM) involves many activities, objects, relationships, and people, and a number of tasks, procedures, and conventions. All this work has been done until now manually, although many initiatives have been carried out to computerize, automate, or otherwise facilitate the everyday work. This paper presents the information technologies that have been adopted within the CRISys Project, funded by the Spanish Telematic Programme (project code TEL96-1386). This project is still in its first year, so the technologies described here are likely to change during the project's estimated life of three to five years. A sound theoretical basement is essential for any information system; we have chosen an approach to the archaeological record called the Valorative Sequence, and the object-oriented paradigm from the computer realm. Object-oriented modelling allows us to model the perceived world as a set of classes and relationships. In particular, the Fusion method by Coleman et al. offers a full lifecycle methodology for object-oriented software development. Also, an object-oriented database is required to store information in a convenient way. Almost every single object in CRM can be geographically located, so GIS (Geographic Information Systems) technology must be used to provide a geographic frame for everyday work. Two- and three-dimensional terrain models, capable of offering a number of views such as contours, sections, or human-eye perspectives are considered, and data geovisualization is used to gather information from computerized landscapes. Documents play a very important role in CRM, and a documental management system is crucial. Time-aware document versioning, intra- and inter-team workflow, and collaborative authoring are required functionality, and ISO-standard SGML (Standard Generalized Markup Language) has been adopted as a foundation. From a more technical viewpoint, the client/server architecture is necessary to achieve concurrent access and high performance. A flexible four-tiered schema, the WRAP model, has been adopted, decomposing the system into World, Representation, Application, and Presentation layers, which can be balanced between client and server endpoints as desired.

1 Introduction

Theoretical foundations are the conceptual bases that allow us to build an information system in a consistent, coherent way. Decisions and solutions must be traceable back to foundations in order to be explained and understood during system development. Enabling technologies are concrete pieces of commercially available knowledge, often in the form of products and/or services, which allow us to implement and use the aforementioned information systems.

2 Theoretical foundations

The *Valorative Sequence* is taken from the CRM (Cultural Resources Management) domain, specifically centred on archaeological practice, although it could be adapted for application to other fields.

Object-Oriented modelling is taken from the information technologies realm. It is a modern yet mature and well-documented paradigm on how to build information systems.

3 The valorative sequence

Archaeological practice can be viewed as a chain of assessments, each based on the result of the preceding one. The first assessment takes the physical evidence of past human action as its base. The ideas obtained in this process, namely the results of the assessment, are representations of the aforementioned physical evidence of human action. Thus, the concept of representation is the key to the Valorative Sequence. Representation has three main dimensions: contents, time, and subjectivity; they will be discussed in the context of document management.

Figure 1 shows the Valorative Sequence graphically. The original social being, through objectivation processes, creates effects and products by working and producing. The present-day social being, through archaeological practice, gets what we call the *archaeological record*.

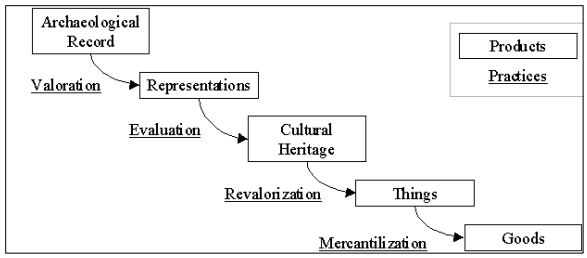

Figure 1: The Valorative Sequence, products and practices.

The *first valoration* immediately produced on that archaeological record, or *archaeological valoration*, creates the so-called *representations*.

The *second valoration*, which takes place on representations, is called *evaluation*, and is made from the heritage viewpoint. It creates what we call *cultural heritage*.

The *third valoration*, or revaluation, produced on cultural heritage, gives place to *things*.

The *fourth and last valoration*, which takes place on things, is called *mercantilization*, and creates *goods* that can be socially and economically exploited.

4 Object-oriented modelling

Similar objects can be classified into the same class. A class is the specification of the appearance and behaviour of each and every object that is an instance of the class.

Also, classes can be generalized; concrete classes with some common characteristics can be said to be specializations of a more abstract class. Objects that are instances of the first are also instances of the latter.

Classes show relationships among them. Some of these relationships are what we call aggregations, or composite classes. Others can be described as associations, or collaborations.

The *Fusion* method (Coleman et al. 1994) offers a mature and well-proved methodology for object-oriented information modelling and computer program design. It is a free and open specification.

5 Enabling technologies

The client/server architecture is a concrete way of deploying computerized infrastructures, in which one or more *server computers* perform the heaviest workloads while *client computers* send them requests and wait for the answers.

Object-oriented databases are information stores in which *objects* are stored according to their class, and relationships between objects are also maintained.

Landscape models allow us to present to the archaeologist a simulation of the spatial context of archaeological finds or structures.

Finally, document management is key to the good function of any modern organization.

6 The client/server architecture and the WRAP model

The WRAP model defines the basic architecture of a computerized client/server application for CRM. Each letter in the word WRAP designates a different conceptual layer, and these layers, stacked each on top of the other, arrange the structure of the tool. The four layers are described in turn.

1. World (W layer). Captures and describes the real-world entities and the relationships among them, avoiding a posteriori interpretations, judgements, and further constructions. This layer only considers the entities and relationships given by the very structure of reality, which should become unveiled through intense research. Each one of such entities becomes an object managed by the system.
2. Representation (R layer). Includes the representations through which the entities and relationships in the previous layer will be managed. It is possible to consider several different representations for the same object, depending on purpose or time flow; it is also possible to deal with a single representation regarding more than one object from reality. Each of these representations makes up a new object into the system.
3. Application (A layer). Involves objects and relationships specific to the intended application for the tool. These objects and relationships are defined taking the previous representations as a base.

4. Presentation (P layer). Includes the objects and relationships needed to present the contents of the previous layer to the user of the tool, be a person or just another computerized system.

7 Object-oriented databases

Object-oriented databases differ from relational ones in that the unit of data ddefinition is the *class*object, not the record (Kim 1993). Different kinds of relationships among classes can be also stored.

Generalization is a kind of relationship that enables the user of an object-oriented database to deal with objects at the required level of abstraction. For example, a pottery piece could be treated as such by a finds specialist, but as a valuable archaeological object by a heritage manager.

Also, the use of metainformation that object-oriented databases can perform allows us to build user interfaces that guide and assist the user when designing queries or navigating the network of relationships.

8 Landscape models

Conventional Geographic Information Systems are two-layered, meaning that they store (first layer) and display (second layer) graphical data such as points, labels, arcs, and surfaces. These systems should be called Cartographic Information Systems instead, because they take as input the pre-prepared cartographic information and not real geographic data.

A three-layered GIS would store (first layer) the representations of real things such as rivers, roads, hills and houses. A representation engine (second layer) would build appropriate representations of these objects, taking into account working scale, user preferences, and output intent. Finally, a display layer (third one) would show these representations as usual.

Human perspective is the viewpoint that human beings use to look at their environment. This concept could appear in a number of places along this presentation, but maybe the most significant one comes up when dealing with the archaeological record: the strongly spatial-dominated mind of humans is notably helped by human-eye landscape perspectives in addition to contour maps or other conventional displaying techniques.

9 Document management

Documents reflect the thoughts and processes resulting from everyday work, and therefore must support change and evolution just as real life does. Usually, the only documental dimension taken into account is the contents dimension. Documents are different because their contents are different. Nevertheless, time and subjectivity can also provoke changes in documents: time makes contents evolve and change, reflecting the chain of thought of the authors. On the other hand, subjectivity can result in different documents talking about the same matter, due to the different opinions or viewpoints of the authors or groups of authors.

Documents should be stored in a database that could offer powerful full-text search and report capabilities, as well as document presentation and formatting utilities. Documents should be authored in a format-free fashion, centring efforts on structure and contents. The Standard Generalized Mark-up Language (SGML), an ISO standard, was conceived for this purpose.

Also, documents flow among people and organizations, being necessary a workflow engine that could take decisions and trigger actions as dictated by pre-defined business rules and procedures.

10 Key concepts summary

Representation enables us to deal with objects indirectly, taking into account time and subjectivity issues.

Assessment is the mechanism we use to produce new representations from existing ones.

Objects and *classes* are the way to model the perceived reality, using abstraction to treat objects at the convenient level of detail depending on context.

Human perspective is the key to let the human mind concentrate on gathering information from data instead of imagining how to interpret displays.

Finally, facilities for *co-operative work* are necessary in a collaborative environment where no one can achieve good results in isolation.

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