SEARCHING AND EXPLORING MULTIMEDIA MUSEUM COLLECTIONS OVER THE WEB

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Over the last three years, the European Commission supported IST SCULPTEUR project (http://www.sculpteurweb.org) has developed novel ways to create, search, navigate, access, share, repurpose and use museum and gallery multimedia content over the Web. This paper will review the achievements of the project as a whole, as well as the challenges we faced in the process. We pay particular attention to the more recent developments of the project, including: new graphical approaches for exploring rich cultural heritage information spaces; integration into museum and gallery infrastructure; and advances in interoperability and delivery of multimedia content over the Web.

INTRODUCTION

SCULPTEUR involves the Uffizi in Florence; the National Gallery and the Victoria and Albert Museum in London; the Musee de Cherbourg and the Centre de Recherche et de Restauration des Musees de France (C2RMF). These museums and galleries are rich in digital information including images, 3-D models and videos together with rich textual descriptions and metadata. Despite drivers for increased Web accessibility, this content is often held in internal systems with non-standard schemas and descriptions. Exploring and exposing this rich source of information over the Web is particularly difficult due to lack of tools and standards. We address this problem by using ontologies (CIDOC CRM) and semantic web techniques for structuring and navigating museum collections. Machine-readable descriptions can be published on the Web, which, along with a search and retrieval service based on Z39.50 SRW, allows remote applications to access a museums multimedia content. This paper pays particular attention to the more recent developments of the project, including:

- Innovative graphical browsers that allow users unfamiliar to a museum collection to navigate, visualize and explore this rich source of cultural heritage information.

- Finding, accessing and using 3D content over the Web in applications that include virtual museums and interactive delivery of high-resolution models to low bandwidth devices.

- Use of a common ontological model for interoperability, in particular integration with legacy systems and methods for cross-collection searching.

GRAPHICALLY EXPLORING LARGE MULTIMEDIA COLLECTIONS

In the SCULPTEUR project we have developed a "Concept Browser", a graph based visualization that allows users to access the museum partners' metadata through a common ontology, the CIDOC CRM [1]. Due to the complexity of the ontology, a user customizable simplification of the ontology is displayed that only displays the concepts and relations present in the metadata structure being browsed. This simplification involves renaming and shortening the complex mapping chains, in some cases using terms from the original metadata schema to increase familiarity of the users with the interface.

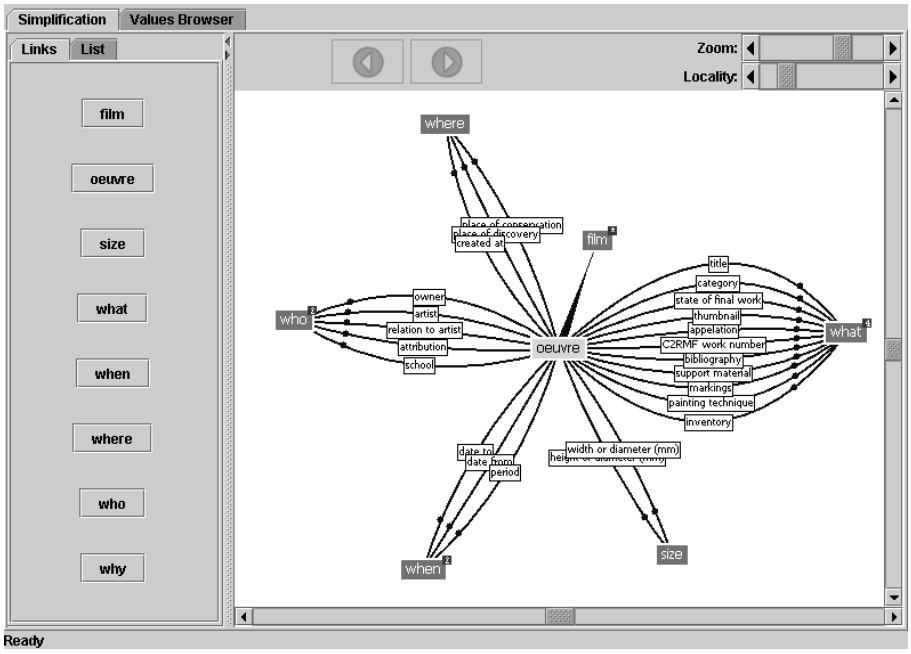

Figure 1 Concept Browser

The concept browser has based instance visualisation and query on mSpace interfaces [2]. mSpace is an interaction model designed to allow a user to navigate in a meaningful manner the multi-dimensional space that an ontology can provide.

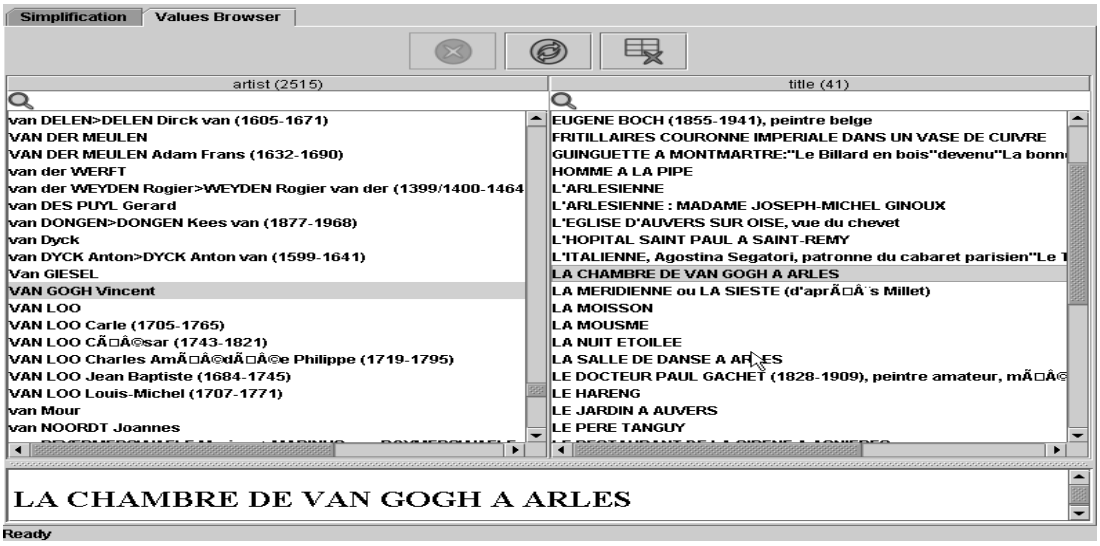

Figure 2 mSpaces interface of the Concept Browser

mSpace interfaces are based on slices through an ontological space, with each slice represented as a list of values; slices are presented as columns arranged from left to right. A selection in one slice will update the display so that the values displayed in the next slice are related to that value. For example, if there is a slice of artists and the next slice is painting titles, selecting an artist will display only that artist's paintings in the titles slice. Slices can be freely interchanged, removed and new slices can be added to the mSpace. The museum metadata being dealt with in SCULPTEUR is large and varied, so there are many possible slices as well as combinations of slices that users may be interested in. The ontology simplification interface, based on TouchGraph, allows users to browse and add the slices in which they are interested into the mSpace browser, where they can be arranged to suit the user's preference.

Multimodal queries

In addition to visualizing the structure and semantics of a collection, SCULPTEUR supports multimodal search and retrieval by allowing the user to search by a combination of content, textual metadata and ontological concepts. Searching by content allows the user to query and compare different aspects of 2D images and 3D models. For example, a user can find images that have a pattern or colour similar to an image that they supply, or they can find other objects in a collection that have a similar shape to a 3D model that they have already found. When the searching by textual metadata and content are combined, then new search scenarios can be supported and much better results are achieved. For example, a user might search for items of furniture that have upholstery of a particular pattern, search for religious oil paintings that used a pigment of a particular shade of blue, or search for vessels of a particular shape such as amphora urns.

An example content-based query is shown in Figure 3. A query VRML 3D model (inset image) defines the shape that the user is interested in. The first 3 results (main image) of the search clearly have a similar shape and are presented to the user in order of similarity.

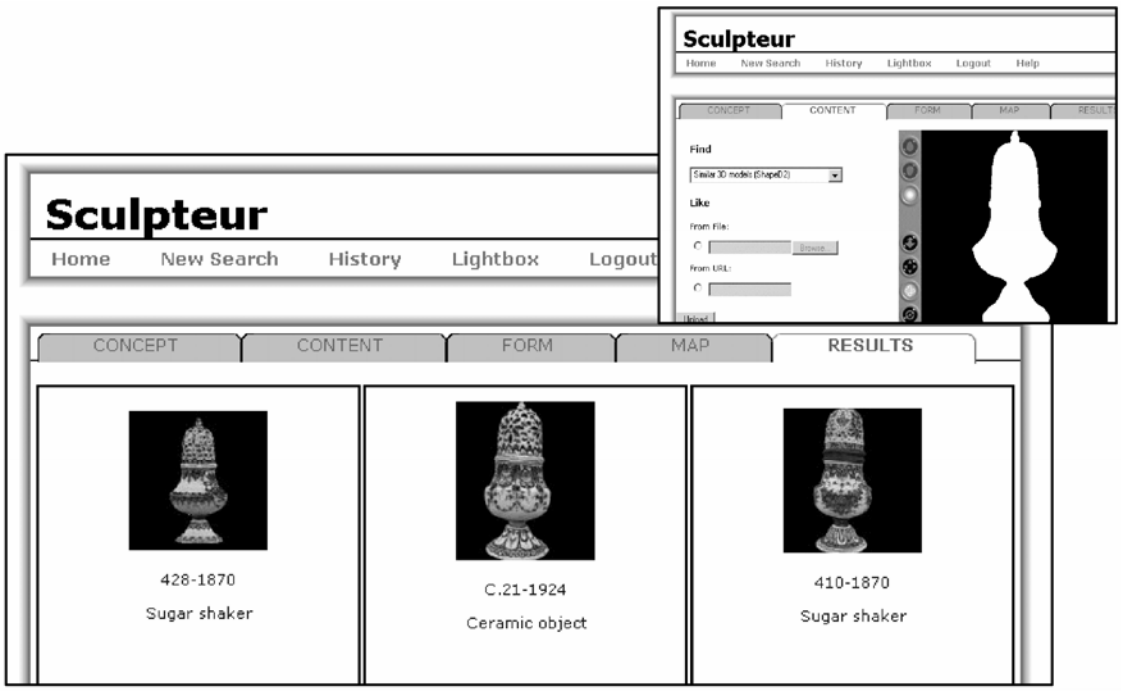

Figure 3: Example content searching using a 3D model as the query (inset) and the first three matches of a similar shape that are retrieved from the database (main image).

CRM MAPPING AND INTEROPERABILITY

In SCULPTEUR, we have approached semantic interoperability by mapping the different museum metadata systems to a common ontology, the CIDOC Conceptual Reference Model (CRM). The CRM, in the process of ISO standardization, has been in development for over ten years and is becoming increasingly used in the cultural heritage domain. It is capable of modelling the complex objects and relations within its scope, and can be extended to cover many specialisations. Although domain specific terminology can be modelled with the CRM, no vocabularies or thesauri are provided. Reliable sources of such information are required and in SCULPTEUR we have been investigating the use of controlled lists that are defined in the museum metadata.

To achieve semantic interoperability, mappings between the partner museums' legacy database systems to CRM are required. The efficiency of CRM at capturing and representing museum information had been demonstrated with attempts to map existing cultural systems [3], but our experiences in SCULPTEUR suggest that the mapping complex and time consuming. The CRM has a steep learning curve, and performing the mapping requires a good understanding of both ontological modelling as well as the source metadata system. Eventually the assistance of a CRM expert was required to complete and validate the mappings.

Database Field	Field Name	Mapping Chain		
object.period	Period	E84.Information Carrier	P8B.witnessed	E4.Period
		E4.Period	P1F.is identified by	E41.Appellation (value = "object.period"")

Table 1 Mapping a database field, Period, to the respective chain of CRM concepts and properties.

The result of the mapping process is a table linking the database fields to a chain of CRM concepts and relations. An example is shown in Table 1 for the object period field in the database. The object is mapped to the *"E84.Information"* concept in the CRM, and the period is mapped to the *"E4.Period"* concept. The relationship between the object and the period is indicated by the *"P8B.witnessed"* property. Note that the actual value from the database is mapped as an instance of the *"E41.Appellation"* concept, linked to the *"E4.Period"* concept by the *"P1F.is identified by"* property.

One of the main benefits of mapping to a common ontology is to achieve interoperability and cross-collection searching. We achieve this using a z39.50 SRW service [4]. The mappings to the CRM are published as an XML structure, which is available through the SRW 'explain' operation. The SRW is able to dynamically map CQL queries expressed in terms of these CRM mappings to the relevant legacy database fields, execute a combined metadata and content search, and then return the results as XML structured according to the CRM mappings. The user can explore the CRM ontology and then use the SRW to retrieve corresponding instances. These instances can then be displayed to the user, for example as slices in the mSpace viewer. In this way we leverage Semantic Web techniques to describe and visualize the complex space of cultural heritage information, whilst using XML and Web Service standards to provide an easy to use search and retrieval service to access this information. By using the CRM mappings and the common CRM ontology, a common result schema is achieved and cross-collection searching can be done across multiple art object collections.

DELIVERY AND USE OF 3D MODELS OVER THE WEB

Evidence in the education and learning domain suggests that interaction and exploration enforces learning objectives and improves knowledge retention [5]. Giunti Interactive Labs exploited the SRW interface to integrate their Learning Content Management System (LCMS), Learn eXact [6] into the SCULPTEUR system in order to retrieve 2D and 3D objects and use these media objects to build virtual learning environments. The immersive virtual worlds (virtual museum exhibitions in case of SCULPTEUR), for example as shown in Figure 5, are simply created through the developed intuitive graphical user interface. Selected cultural resources and educational materials are positioned in the virtual scene with drag and drop operations. Finally, the virtual exhibition is packaged according to the e-learning specification IMS CP and ADL SCORM.

Figure 5: Creating a virtual learning environment: example the sequence of operations

For accessing 3D models on low-bandwidth devices such as palmtops and mobiles, as well as boost usability on "home" hardware, Centrica has developed XL3D. This is a 3Dbrowser following the approach of XLimage® [7], which requires no client-side software installation. The tool can be used in standard Internet browsers, and has been designed to allow easy integration within existing web sites and layouts. All image and model rendering, colorization and final generation are done server side to ensure full customizability of access and interface (based on client capabilities, location, resource availability, or identity). It is possible to integrate digital rights management (DRM); and prevent the original data being "downloaded" to the client. For very low bandwidth environments, resolution decimation, color space simplification ("posterization"), and progressive image display, allow a satisfactory user experience even on slow mobile terminals (see Figure 6.)

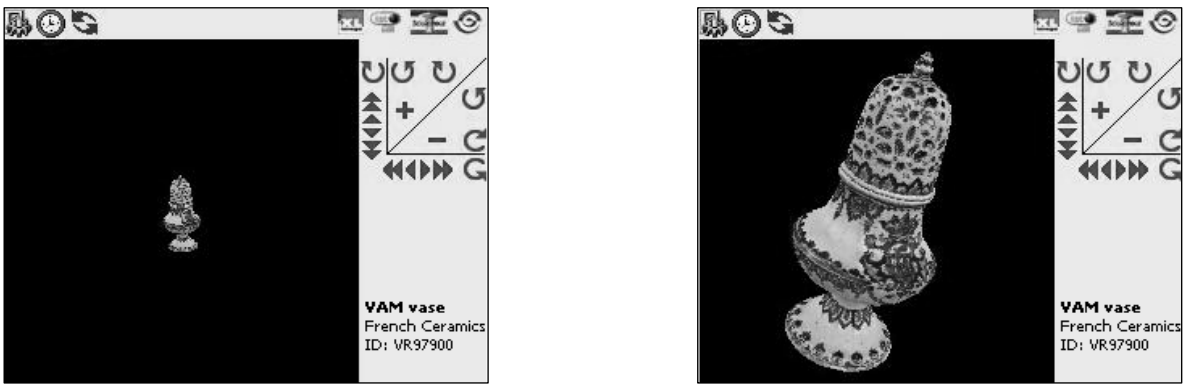

Figure 6: XL3D access to a V&A vase in the interface for mobile users (300x240) - at the left the initial state, at the right the state after several zoom and rotation actions.

MUSEUMS AND GALLERY EVALUATION

Much of the SCULPTEUR system is composed of novel technology where it is difficult for many existing browsers of image archives to recognize its full potential. When users are given the opportunity to try them in real situations then surprising uses occur. Though SCULPTEUR has been created with general picture researchers in mind, digital archive managers will probably be the first group to adopt its unique features. These managers have issues with retrospective management, data cleaning and trying to catalogue individual records where text data is absent. SCULPTEUR provides new tools to make this possible in an efficient way. The collective combination SCULPTEUR technology also provides new techniques to enrich the creativity of both the visitor and the museum professional. All of the major museums in the project have high figures for virtual website visits. As museums develop their digital media holdings these will naturally include media types that are not 2D images. SCULPTEUR allows the digital librarian to add these new media types such as QT movies, 3d virtual models, flash elements etc, to their databases with the confidence that they can search, query and find them with the same degree of accuracy as they would for 2D images. Traditional searching of image databases by text only is restricting and frustrating to many searchers. SCULPTEUR liberates these restrictions by the ability to add content based searching. This potentially opens up image databases to the illiterate, to the non-native language speaker, and to the searcher whose knowledge of the particular terminology used in the database is limited. The SCULPTEUR consortium is keen to see the reaction of creative professionals, such as designers and artists, when they query museum multimedia collections and observe if they become freed from the restrictions of text and metadata.

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