VIRTUAL RESEARCH ENVIRONMENT FOR THE MANAGEMENT AND THE VISUALIZATION OF COMPLEX ARCHAEOLOGICAL SITES

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Commission V/ 4 and 2

KEY WORDS: Information Systems, Data Management, Interactive Visualizations, Internet, Archaeology

ABSTRACT:

Virtual Research Environments are tools and technologies to enhance and support research. These online environments are dedicated to support collaboration whether in the management of a research activity, the discovery, analysis and curation of data or information, or in the communication and dissemination of research outputs. They are applicable to numerous domains, and they are particularly useful for Cultural Heritage purposes. Aim of this paper is to present a Virtual Research Environment (VRE) for archaeology and architecture. An Information System has been produced, which is based on open source software modules and works on the Internet. It permits to avoid users to be software driven and it makes possible for different persons to register and consult data from different places. The system will then improve the sharing of research and data between archaeologists working on dissimilar sites, and also between these professionals and the general public for the dissemination of the knowledge about the site. Our VRE has diverse objectives: digital archiving of archaeological and architectural datasets, data inquiry through different interfaces notably clickable plans and 3D models, attractive visualization and communication of information.
The Information System includes possibilities of thematic and interactive treatments. The thematic treatments are done from the history and the visit of the archaeological site, from diverse search engines and from views of the records. The interactive treatments are carried out on plans and on 3D models that are used as interactive interfaces to access the documents and objects. It allows doing an exploratory visit of the site and an inquiry of all the documents that have been gathered about it, according to the interests of each visitor. The tool proposed is usable for every kind of archaeological site, and allows managing and visualizing very diverse types of data. Our first experimentations and tests have been done on sites managed by the Service of the National Sites and Monuments of Luxembourg: the medieval castle of Vianden and the gallo-roman villa of Echternach.
In the system, data with metadata chosen by the expert are recorded in the XML format (standard of the W3C) and automatically integrated in a MySQL database. Afterwards, the registered information is made accessible through different interfaces, particularly interactive 2D and 3D representations, which permit queries at spatial and temporal levels. These clickable representations are 2D images or vectors created in SVG, and 3D models produced in VRML and X3D, for a full compliance with the W3C recommendations. The 3D models are principally historical models, which have been initially created from multiple data sources like texts, old paper plans, drawings, sections, etc., coming from the excavation work of the archaeologists. At the beginning they were in a particular modeler format. They have been exported in VRML and X3D afterwards, and then made interactive thanks to anchor processes. It is now possible to click on these models to access all the data from which they have been produced. In addition, the user of the system can generate his own 3D models and composition plans thanks to multi-criteria data entry forms. He has the choice to select for example one or several places and one or several historical phases, for which he wants to generate "on the fly" the 3D model to see the historical evolutions of the site. Approximately the same process is available to create synthesis 2D plans or photo-montage allowing for instance to superimpose the architectural arrangement of the castle today with its former configurations.
The proposed VRE offers also different possibilities to improve the visualization of archaeological and architectural data, which have sometimes been gathered for a long time, often without computerized means. This information is then highlighted in a new way, rather than being forgotten in a drawer with any means of further exploitations.

1 INTRODUCTION

Cultural heritage documentation induces the use of computerized techniques to handle and preserve the information produced. In archaeology as well as in architecture, numerous documents have been produced for years without computerized means and it is now necessary to conserve them numerically, to be able for instance to combine them with the new representations (3D models) of the monuments that can be done currently. In the archaeological domain particularly, data computerization gives solutions to specific problems in allowing inventory actions to save, represent or understand the features. Archaeology is an erudition discipline where the knowledge grows up in necessarily referencing the precious documents already gathered. The quantity of data produced during the working of a site can thus be quickly huge.

Moreover, archaeological datasets are made of primary information, concerning the archaeological realities themselves (objects or configurations), and of secondary information including documents that permit to know these realities, publications with artifacts descriptions and comments, or images collections. It is then required to develop systems allowing to create relationships between these numerous and heterogeneous data, for instance to retrieve immediately for a primary data like a ceramic, the diverse secondary data making its study easier. In architecture also, the development of systems permitting to link the 3D model of a building with the theoretical treaties having governed his construction can be valuable to understand or restore it.

2 PROPOSITION

To produce such systems it is necessary, first of all, to create a database permitting to record these data. The majority of the databases currently used in archaeology is relational, because the structure and the relationships of excavation data can be successfully modeled in this type of databases (Richards, 1998). These databases have to contain the totality of the characteristics generally used by the archaeologist in his interpretative reasoning, with in addition the characteristics which does not serve directly but allow to have a more precise view of the document, or for which we can think that they could be valuable one day. Therefore, the description of the feature that is recorded in the database is at least as rich as the report from traditional publications (Ginouves and Guimier-Sorbets, 1978). Then, to record the context or metadata of the data is as important as to record the data itself. The database that we propose for archaeological documentation allows then to record data and metadata in the XML (eXtensible Markup Language) format and to insert them automatically into a MySQL database. XML has been chosen because it is a standard of the W3C (WWW Consortium) for data description, and because it induces the registration of metadata about the data to preserve (to have secondary information about the primaries). The system is very flexible as it allows the user to choose the metadata he wants to attach (according to an archaeological standard for instance CIDOC-CRM (Doerr, 2003)).

Afterwards, it is necessary to conceive an Information System, which can provide an enrichment of the information recorded in the database by allowing the immediate confrontation of the data. An Information System is a combination of the diverse types of data accessible through various interactive consultation systems. We propose an Information System based on open source software modules dedicated to the Internet, which aims notably (Meyer et al., 2006):

- to process graphically several information derived from very different kinds of surveys, because a selective superimposing could be a precious help for the interpretation;
- to combine elements selected in diverse graphs or models for the generation of visualizations in synthesis maps or 3D models, for example to be able to see in a new way the historical changes of the archaeological site;
- to present images and their connections with the concerned texts from the database, to lead to a complex system in which the process of texts and images would be possible simultaneously;
- to search in the dataset thanks to views of the data, or thanks to diverse search engines by data types, keywords or images.

Thematic and interactive treatments are then achievable, principally on spatial and temporal criteria.

These treatments provided by the Information System are necessarily combined with visualization systems that permit to see the results of the data extractions. The means of visualization of Cultural Heritage information are numerous to allow visual interpretation of data through representation, modeling, display of solids, surfaces, properties or animation, what is rarely possible in traditional paper publication. Visualization techniques are constantly evolving, but the most frequently they are based on 3D modeling used notably for museum presentations. The principal drawback of the types of 3D models used in archaeology nowadays is that these models are "empty". The idea in then to produce 3D models that can serve as research interfaces to access different kinds of information, notably in coupling them with web procedures (scripts). Our system has been carried out this way: we have produced interactive maps and 3D models that work like web interfaces to obtain views of the database records. It is linked to research work of P. Drap (Drap et al., 2005), who has notably developed a system integrating photogrammetric data and archaeological knowledge. The clickable representations are 2D images or vectors created in SVG (Scalable Vector Graphics) from scanned or vectorial drawings, and 3D models produced in VRML (Virtual Reality Modeling Language) or X3D (eXtensible 3D), for a full compliance with the W3C recommendations, from topographic, photogrammetric or laser scanning surveys.

Finally, the creation of a system working on the Web provides a tremendous opportunity to link distributed resources and to make unpublished material widely available (Ryan, 1995) (remarkably uncommon material like detailed fieldwork data, quantities of photos and archive drawings, vectorial graphs or 3D models). The division between publication and archive could thus be removed, even if there is still a big challenge to control the way in which the Internet is used (for the discoveries, quality controls or copyrights). The use of the World Wide Web network permits to communicate the archaeological data managed in a very complete way, more complete that traditional publication. Aims of the Web Information System are to assist the digital archiving of the documents, their inquiry and their processing by everyone, both the professionals (archaeologists, surveyors or architects) and the general public. Different types of access to the data are available depending on the user of the system. Representations adapted to museum displays (public attractive) have been done as well as interfaces permitting to update the data directly from the 3D models, for the needs of the site managers. Moreover, the development thanks to open source software modules allows accessibility and simplicity for all the users, and above all permits us to propose a system independent from any commercial software.

We propose a Virtual Research Environment[1], which has the following objectives:

- complete digital archiving of archaeological datasets,
- innovative data inquiry notably through clickable maps and 3D models,
- attractive visualization and communication of the site information thanks to thematic and interactive interfaces.

The tool notably combines survey, modeling and imagery data, and our purpose is to highlight how such a system can offer new possibilities for the management and the dissemination of these data, especially those coming from archaeological sites.

3 MODELING OF THE VRE

To describe an Information System in a generic way, it is possible to use modeling languages like UML (Unified Modeling Language). This permits to detail how the system works, independently of any programming language, in order to be able to implement it in different platforms but with the same ends. UML is based on an object approach of the system (in opposition with a functional approach) that consists in decomposing the system

[1] Term introduced by the Joint Information Systems Committee (JISC), which manages research and development programs in the use of ICT in teaching, learning and research to build knowledge. Particularly, it supports a project called virtual research environments program. A VRE is an online environment dedicated to support collaboration whether in the management of a research activity; the discovery, analysis and curation of data or information; or in the communication and dissemination of research outputs.

in terms of objects and interaction between these objects. Thus UML allows to do an object modeling of the system, which simplifies its understanding. It reduces the complexity of the system, permits to simulate or represent it, and to reproduce its behaviors. Diverse complementary views (the diagrams) are available to represent our VRE. They are graphical representations, each interested in a precise aspect of the model. In the following sections, we describe three essential steps of the modeling: the identification of the needs of the users, the study of the processes of the system developed to answer these requirements, and the definition of the entities and interfaces of the VRE.

3.1 Needs of the system users

The object modeling of an Information System is guided by the needs of the different actors of the system. Indeed, the aim of the conceptualization of a system is to understand and to structure the needs of the users, because these needs define the outlines of the system to be modeled (to make clear the objectives to reach) and because they allow to identify the main functionalities that the system must have.
The actors are the external entities (users, files) that interact with the system. An actor can consult or modify the state of the system, and in answer to the action of the actor, the system supplies a service that correspond to his need. For our VRE, we have identified the following actors:
Files and software:

- system administration
- application software
- data
- archaeological site

Physical users:

- administrator
- member (user who has rights to act on the data)
- visitor

The physical actors are the users of the VRE, of whom we can identify and structure the needs. These needs are finally what the archaeologists can expect from a system dedicated to the online and easy management and dissemination of datasets coming from the working of archaeological sites. They make the detailed counterpart of the objectives of the VRE quoted before.
From a simple visitor (data consumer) point of view, the expectations are:

- to visualize the data in different ways: in catalogs, by reaching directly the data connected, in views aggregating different attributes, from the metadata corpus, in thematic and interactive interfaces (clickable maps and models);
- to do flexible search across the diverse data: by data types, by keywords or by images;
- to combine elements selected in diverse graphs or models to generate visualizations in synthesis maps or 3D models, in order to see historical changes of the site;
- to configure the use of the system (language...), to have access to help files, simple schemes of the VRE functioning or answers to frequently asked questions, to contact the support.

From the point of view of a site manager (data provider), the needs are:

- to access the system in a secure way (login and password to be able to do modifications on the data);
- to administer his archaeological site: to add a site (from existing files or not), to generate standard exchange files of the data (to collaborate with other teams for instance), to make global saving of all data files, to delete the site;
- to store his data on a server (upload of images, maps, models, videos...);
- to generate new interactive data from his initial 3D models or maps (automatized anchor processes);
- to manage his data: addition of a data, addition of existing types of data or of new types (originals or imported), modification of the structure of the metadata, definition of default values for the metadata, suppression of data types;
- to access the data in different ways (in catalogs, by reaching directly the data connected, in views aggregating different attributes, from the metadata corpus, in thematic and interactive interfaces (clickable maps and models)), in order to edit them for update or to rename, duplicate, delete them;
- to do flexible search across the diverse data: by data types, by keywords or by images;
- to combine elements selected in diverse graphs or models for the generation of visualizations in synthesis maps or 3D models, in order to see historical changes of the site;
- to configure the use of the system (language, configuration of the pages...), to have access to help files, simple schemes of the VRE functioning or answers to frequently asked questions, to contact the support;

And finally the administrator needs to:

- administer the Information System and his applications (thematic and interactive interfaces, search engines, views, etc.);
- administer the server parameters and the databases;
- administer the rights and roles of the users.

The formulation of these needs is essential to conceive a system really dedicated to the users, in our case the archaeologists or site managers. Indeed, they have particular expectations regarding a system for the management and the dissemination of their very specific data, and they are not necessarily experts in computing (the simplicity of use is thus very important). As we know henceforth which functionalities the VRE has to offer, we can do the conceptual model of the system.

3.2 Processes of the Information System

A conceptual model of the system has to be done for a better understanding. It serves as an interface between the actors of the project, and in UML it is represented thanks to ”use cases” diagrams. These diagrams shows the processes of the system regarding the actors. The processes are all the internal activities of the system, which aims to answer the actors’ needs. Considering the actors and the needs quoted before, the processes are represented in the following diagrams (Figures 1, 2, 3, 4).

The first one shows the different processes of the VRE considering its use by a simple visitor. These processes reflect the needs of the visitor identified in the last section.

The second one is more complete and implies more actors of the system, because it concerns a member having rights when using the VRE. Thus, the Figure 2 shows how a member can act on the data or on the site(s) that he has to manage.

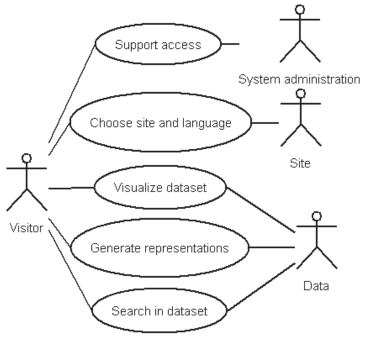

Figure 1: Diagram linking the visitor, the site, the data and the system administration.

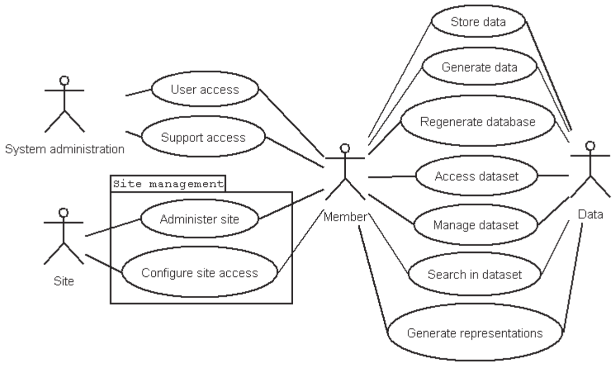

Figure 2: Diagram linking the member, the site, the data and the system administration.

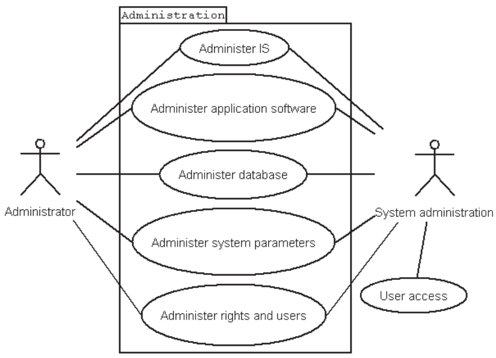

Figure 3: Diagram linking the administrator and the system administration.

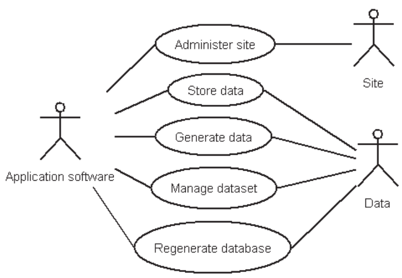

Figure 4: Diagram linking the application software, the site and the data.

The third one illustrates the work of the administrator.

And finally the Figure 4 is a ”use case” diagram representing the links between internal actors of the systems. It shows the applications that has to be done to manage the sites and the data within the system.

All these ”use cases” diagrams constitute the conceptual model of the VRE, which has permitted to structure the needs of the users and the corresponding objectives of the system. Afterwards, to implement the VRE, the processes (written in the bubbles) must be able to be executed by the workers of the system.

3.3 Entities and interfaces

The workers of the VRE are those who interact, communicate and work together to execute the system processes. In our case, the physical workers are:

- the administrator
- the member (expert user)
- the visitor

These workers process the objects of the VRE: these are the entities of the system. We have identified the following entities according to the system processes:

- the data
- the user
- the database
- the archaeological site
- the support

The entities are considered as the diverse study classes of the VRE that permit the execution of the processes of the Information System. A class is an abstract type characterized by properties (attributes and methods) common to a set of objects. It also permits to create objects having these properties through a process named instantiation. The classes of our system can be divided in three categories:
The entity (data):

- place
- period
- document
- object

The internal worker:

- site
- database

The external worker or ”interface worker”:

- user
- support (administrator)

To sum up, a class is the addition of attributes, methods and instantiation. The attributes can be considered as the columns of the tables of a database or as the nodes of an XML file, they are for instance the metadata about the entities. The methods ensue from the processes of the VRE that we have identified previously, they are what the worker can do and what can be done on the entities. The example of the class ”Document” with one of its sub-class ”3D Model” is given in Figure 5. A sub-class extends the properties of a class, it is more specific and inherits of the attributes and of the method of the class.

To end with, the interfaces necessary to access the information managed by the VRE have been defined.

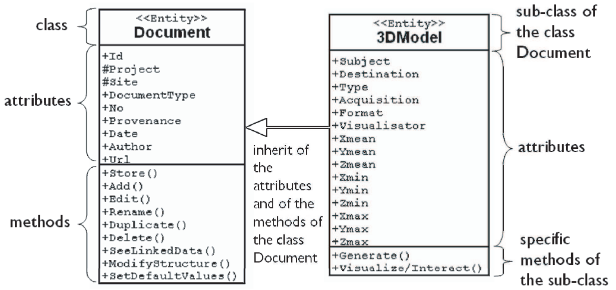

Figure 5: Class "Document" with one of its sub-class "3D Model".

They are of different types:

- list (catalog of the data)
- thematic (places and periods)
- interactive (in 2D and 3D)
- views (creation of tables views, display of corpus)
- search (by data types, keywords, images)
- generation (combination of elements selected in diverse graphs or models for visualizations in synthesis 2D maps or 3D models)

This allows to represent the global diagram of the classes of the VRE, showing also these diverse interfaces (Figure 6). This schema represents the structure of the VRE for archaeological data management that we have developed. It is flexible and allows modifications to add new functionalities in the system or to insert new classes or sub-classes of the already existing entities for instance.

As shown in this diagram, the system permits to manage very different kinds of documents and archaeological objects. The types given here are examples, we can imagine to manage documents or objects of any nature. Likewise, the proposed interfaces answers the needs of the archaeologists quoted before, but they can be completed by others to offer new possibilities of visualization or communication of the data managed.
We can now explain how the VRE described by the previous diagrams has been implemented and how it works, particularly the visualization tools.

4 IMPLEMENTATION AND FUNCTIONING

For the simplicity of implementation, because we are not computer specialists, we have chosen to base our developments on a web server infrastructure allowing to interpret PHP programs. We use a set of free software programs commonly employed together to run dynamic websites or servers, called LAMP for:
- Linux, the operating system (Microsoft Windows (WAMP) or Macintosh (MAMP));
- Apache, the Web server;
- MySQL, the DBMS (DataBase Management System or database server);
- PHP (Sometimes Perl or Python), the programming language.
The combination of these technologies is primarily used to define a web server infrastructure, to characterize a programming paradigm of developing software, and to establish a software distribution package. It is a middleware, i.e. a software that connects two otherwise separate applications. In our case, the middleware product WAMP links a database system to a Web server.

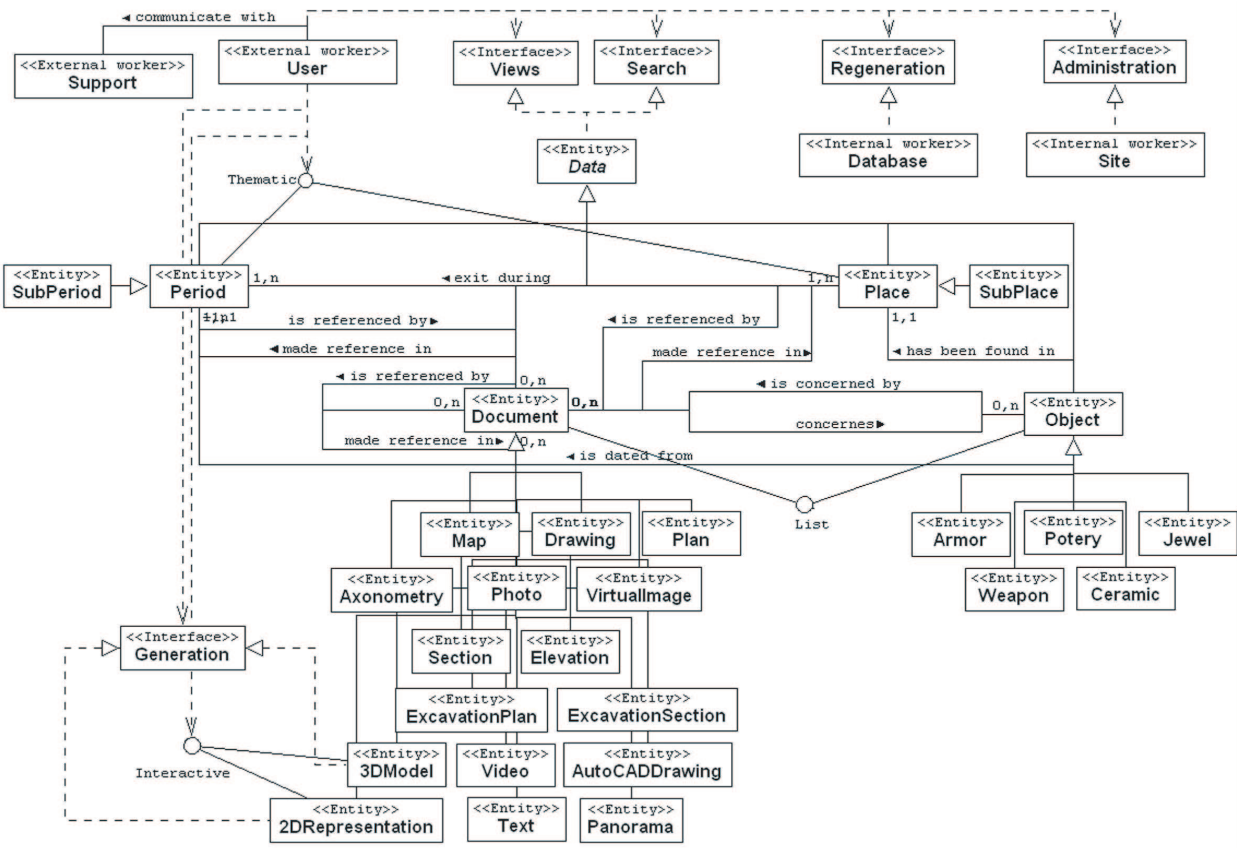

Figure 6: Global structure of the Information System developed.

It allows users to request data from the database using forms displayed on a Web browser, and it enables the Web server to return dynamic Web pages based on the user's requests and profile[2].

To sum up, the data are recorded in a MySQL database and accessed thanks to scripts written in the PHP language. The documents and objects are then recorded in tables of a relational MySQL database but also as XML files. These two record possibilities allow to have standardized data written in XML (for simple information exchanges with other institutions for instance) and a classic form of data that can be retrieved through SQL queries in the DBMS MySQL. The metadata (attributes of the classes) are recorded as columns of the tables and as nodes of the XML files.

Technically, to insert data in the system, after having integrated a first time the corpus of each data type in the form of an XML file generated by the system (a data entry form is available to choose the metadata structure), all the metadata is recorded through other data entry forms. The data itself is attached thanks to an URL link. Figure 7 gives an example of the HTML (HyperText Markup Language) representation of an XML 3DModel file (data and metadata) thanks to an external XSL document. When the user clicks on the miniature of the image, he has access to a screenshot of the 3D model. By comparing Figure 7 and 5, it is possible to see that the nodes of the XML file correspond to the attributes of the sub-class 3DModel added with those of the class Document from whom it has inherited. This form also contains the lists of the places, subplaces, periods, 2D representations and 3D models to which the considered model make reference (links between the tables).

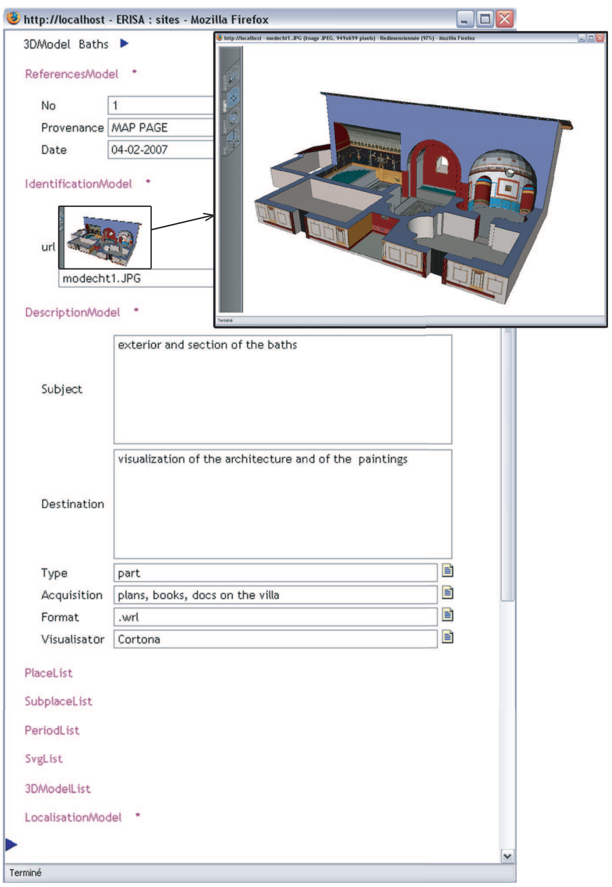

Figure 7: Descriptive form of a 3D model recorded in the system. Case of a 3D model of the Echternach villa (Luxembourg).

[2]http://www.vapartners.com/Software/middleware.html (Accessed April 2007)

This form can be accessed by very different means in the VRE. Figure 8 shows the interface of the VRE where the menu "Interactive representations / 3D" has been chosen to see the list of 3D models recorded for the Echternach villa. This is the easiest way to obtain informations about a 3D model, by clicking on the "Edit" button. The diverse methods (cf. Figure 5) which apply on this model are available through buttons, for instance to open it for visualization and interaction purposes (see 4.1) or to see the other data that are linked with it. In this Figure, we can also see all the interfaces permitting to access the data and all the methods that can be applied on them, through the general and administration menus: access to the catalogs of data, generation of original representations, creation of views, management or storage of the data, and so on.

Figure 8: Interface of the Information System. Case of the access to information about the 3D models of the Echternach site.

To go further in details about the visualization processes, we will explain the functioning of the 3D interactive representations, and the principle with permits the "on the fly" generation of original models.

4.1 3D models as privileged interfaces to reach the data

There are several types of formats to provide 3D models on the Internet. The most used are VRML (Virtual Reality Modeling Language, the oldest), X3D (eXtensible 3D) and COLLADA (COLLAborative Design Activity). X3D is the successor to VRML, ISO standard for real-time 3D computer graphics that offers the ability to encode the 3D scenes using an XML syntax (according to the W3C recommendations). COLLADA aims to establish an interchange file format for interactive 3D applications, and defines an open standard XML schema for exchanging digital assets among various graphics software applications. For the simplicity of visualization we have created and we display our models in VRML, because the plug-in Cortona VRML Client (ParallelGraphics) is the most flexible to use (in HTML frames for instance) in comparison with those for X3D for instance. However, to obtain models compliant to the standard of the W3C, the VRML code has just to be rewritten with XML conventions and descriptive elements to convert it to X3D format (converters are available).

The 3D models included in the VRE have been produced from historical documents (for the models of the past phases of the site) or from surveys (notably laser scanning). The modeling can be done in any software permitting to export in VRML or X3D (for instance Maya or SketchUp). Afterwards, processes to make these models interactive have been programmed in PHP, in order to put anchors in the models that allow to click on diverse elements to access data through an URL link. The clicked elements are highlighted thanks to scripts in JavaScript and VRMLScript with "routes", which permit for instance to change the color of the chosen part of the model.

Thus, the user can navigate freely in the model, zoom in, choose viewpoints, and so on, to see the parts in which he is interested, and in addition, he can click on a place of the modeled site, to access all the documents and objects that have been recorded in the database and that concern the place he has chosen. The queries that are achievable through the clicks on a 3D model are then spatial queries, but if we navigate in a historical model (model of the site during a given period), we will access only the data making reference both to the place chosen and to the period of the model. Spatio-temporal queries are then also available, to find specific information recorded in the VRE through the navigation in the 3D models.

Figure 9 gives the example of a 3D model corresponding to the historical reconstruction of the Vianden castle during the 1200s. It has been done by the MAP-CRAI laboratory of Nancy (France). This model is mainly accessible through the "Open" button available on the interface corresponding to the Figure 8 but for the Vianden site. On this model, a place called "Byzantine gallery" can be seen and clicked. This example shows the possibility of a query on a combination of period and place: here, the click on the place "Byzantine gallery" on the model of the year 1200 gives only the documents referencing this place and this period simultaneously. Afterwards, these documents can be edited or manipulated thanks to the same buttons than those available in the main interfaces. This leads to work in the direction of updating or modifying the data directly from their 3D representations.

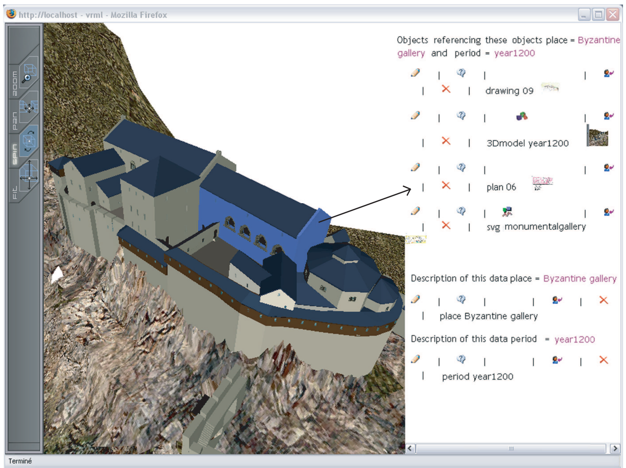

Figure 9: 3D interactive interface allowing access to the data linked with the chosen place. Example of the Vianden castle site.

The same principle is available to access the information recorded in the VRE through 2D representations. The system allows the user to examine deeply and to interact with 2D maps generated in the SVG format (Scalable Vector Graphics), which is the XML formulation of 2D vector graphics. It includes drawing of vector data, displaying of image data, interaction and animation. Structure and appearance of graphic elements is separated by using stylesheets. Applying a SVG viewer as a plug-in for the web browser enables zooming and panning in the graphic area. Furthermore sophisticated design possibilities like pattern filling, shading, insertion of symbols and others are provided by SVG.

So, interactive maps in SVG have been done in the open-source software Inkscape, from digitized plans of the site or from graphs coming from AutoCAD or ArcView. We have used the potentialities of SVG by building a representation, which gives quick access to the dataset by means of templates defined by the user: archaeological templates, photographic templates or typological templates. The PHP interpreter allows access to the file system of the server and a JavaScript program permits the interactivity between the SVG graphic and the Information System. Like for the 3D models, we give the possibility to the user to make his map interactive thanks to programs written in PHP that put anchors on the places drawn by the user on the map. Thus, by clicking on different zones defined in the SVG drawing (corresponding to the places of the site recorded in the database), we access the corresponding form showing the documents and objects that refers to the clicked zone.

The possibility to create 2D interfaces is useful to complete the 3D interfaces, because often archaeologists are more used to work on 2D representations than on 3D models. Therefore the proposed VRE gives the possibility to create and to exploit both 2D interactive graphics and 3D interactive models, to permit diverse visualizations and multiple types of navigation in the information.

4.2 Generation of original models from the initial data

For an other type of data visualization and for more interactivity, the user of the VRE can generate his own models and composition plans through multi-criteria data entry forms written in PHP. He has the choice to select for example one or several places, and one or several historical phases for which he wants to generate "on the fly" the 3D model, to see the evolutions of the site in time. For the VRML models, the principle of generation of an original model, according to the choices of the user, is based on the fact that a VRML file is composed of different fragments permitting to cut it in distinct parts. For instance, a geometric form (sphere) can be described by the fraction of computer code shown below:

```
Shape (
geometry DEF e2-Chateau:pSphere115-0Geo
IndexedFaceSet ( convex FALSE solid FALSE
coord DEF e2-Chateau:pSphere115GeoPoints
Coordinate ( point [ 0.008 -0.099 -0.029,
-0.017 -0.119 -0.024,
-0.011 -0.112 0.011,
0.015 -0.108 0.005,
-0.025 -0.118 -0.001,
-0.023 -0.091 0.034,
0.019 -0.085 0.031,])
)
)
```

This allows to divide the initial models in several parts, each of them containing the code corresponding to the places of interest (during a given period). Then, when the user makes his choices (places and periods in the data entry form), the PHP program crosses the file containing the fragments of VRML codes and rebuilds a new model by assembling the different parts selected by the user (that had formerly been separated from the initial model). This is possible notably because the type of result file aimed by the user can be chosen in the header of a PHP program. Thus, instead of producing a HTML file (most popular use), it is possible to produce a VRML or a SVG file.

The procedure for an original 3D model of the Vianden castle is to see in Figure 10. The resulting model presents different parts of the castle (yard, chapel and hall) in two different periods (year 1150 and 1200). We can see in this figure the architectural changes that have been done during the 50 years considered (building of a tower, displacement of the hall...).

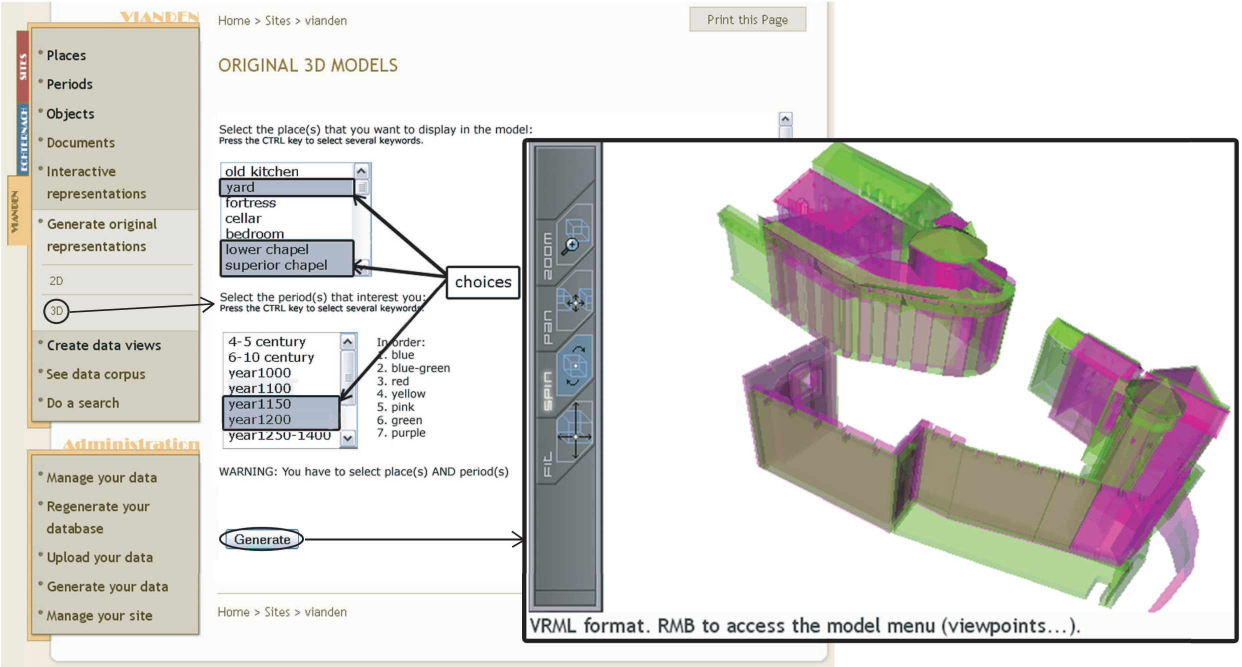

Figure 10: Process to generate 3D models ”on the fly”. Example of a part of the Vianden castle.

Approximately the same principle is available to generate synthesis plans or photo-montage in SVG, allowing for instance to superimpose the architectural arrangement of the castle today with its former configurations. These possibilities of interactions between the user and the system give him the opportunity to generate his own visualizations according to his particular interests or research.

5 CONCLUSION

After having set our propositions for a system dedicated to the online management and dissemination of datasets coming from the working of archaeological sites, we have carried out the conceptual modeling of the Virtual Research Environment that we have created. This modeling allows to see in a generic way how the VRE works and how it is possible to implement it on different platforms. The essential point in this state is the listing of the needs of the different users to whom the VRE is dedicated, and the processes that we have carried out in the system to answer them. For the moment, the VRE is dedicated to the management and the visualization of archaeological datasets, but it is also usable for architecture for instance. Thanks to the flexible behavior of the system, it can be easily adapted to the needs of any person involved in Cultural Heritage preservation, not only the archaeologists.
Thus, the Web Information System described in this paper allows recording, making use and representing data of any Cultural Heritage site. This VRE has been made to offer solutions to the sites managers and to avoid them to be software-driven for their conservation and communication work. The full XML choice for textual and graphical representations permits relevant interactions. The use of 2D graphics and 3D models as user-interfaces to the data permits to link purely documentary data and metadata to geometric representations. We connect very different types of data to emphasize new research possibilities and new information exchanges between diverse sites, to be able to draw conclusions by crosschecking for instance.

Moreover, the data are available through the Internet what allows to work in the direction of visualizing and communicating them in an innovative and interactive way.
Our final aim is to create a simple and everywhere accessible tool for all the sites managers, who wish to be able both to manage efficiently the quantity of data produced, and to represent them in order to make use of this VRE as a virtual storefront for the communication and the e-publication of their findings.

REFERENCES

Doerr, M., 2003. The CIDOC CRM - An ontological approach to semantic interoperability of metadata. AI Magazine 24(3).

Drap, P., Durand, A., Seinturier, J., Vannini, G. and Nucciotti, M., 2005. Full XML documentation from photogrammetric survey to 3D visualization. The case study of shawbak castle in Jordan. The ISPRS International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences XXXVI-5/C34, pp. 771–777. ISSN 1682-1750.

Ginouves, R. and Guimier-Sorbets, A.-M., 1978. La constitution des donnees en archeologie classique. CNRS Ed, Paris.

Meyer, E., Grussenmeyer, P., Perrin, J.-P., Durand, A. and Drap, P., 2006. Intra-site level cultural heritage documentation: Combination of survey, modeling and imagery data in a web information system. Short papers from the joint event CIPA / VAST / EG / EuroMed 2006, 30 October - 4 November 2006, Nicosia, Cyprus. Edited by M. Ioannides, D. Arnold, F. Niccolucci, K. Mania, EPOCH Publication. ISBN-10: 963 8046 74 0. pp. 129–134.

Richards, J. D., 1998. Recent trends in computer applications in archaeology. Journal of Archaeological Research 6, pp. 331–382. DOI 10.1023/A:1022879819064, http://dx.doi.org/10.1023/A:1022879819064.

Ryan, N. S., 1995. The excavation archive as hypertext document? Computer Applications and Quantitative Methods in Archaeology 1994, Huggett J. and Ryan N., eds., Oxford: BAR International Series 600, pp. 211–219.