SITUS
a web based information system for archaeological sites

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ABSTRACT
The paper presents the results of the project CORARC, funded by the Italian Ministry for University and Scientific Research, aimed at developing a Web based system, called SITUS, to support the management of information for archaeological sites.
The system supports, through a relational database and a GIS server, the archival and management of multimedia and cartographic data coming from a study of an archaeological site, and provides support functions for specialists.
The scalable architecture runs on a variety of configurations, from portable computers to a network with a data server and specialised clients for data acquisition and management, simulation, and modelling.
The architecture is fully Web based over Intranet/Internet and the standard client requires only the availability of a browser.
The application is designed to manage a large spectrum of archaeological sites (from small excavation campaigns to large sites) and has been validated both in the global context of the archaeological site at Pompeii and for a specific excavation campaign in the area of Pompei.

KEYWORDS: Archaeology, multimedia databases, web sites, geographic information systems, thematic maps, Pompeii.

THE CONTEXT: MANAGING ARCHAEOLOGICAL SITES INFORMATION

The management of data related to archaeological sites is a rather complex task, since it requires dealing with large amounts of heterogeneous data: texts, numerical data, drawings, pictures, movies, maps, 3D models.
Knowledge representation techniques and modern digital technologies can be useful, but designers must take into account that interesting data are already available for many archaeological sites on several media needing to be transformed into digital data.
Moreover, any automatic support tool should consider the relevance of time with reference to the management of archaeological data: proper dating of findings is a fundamental requirement for archaeological studies, and automatic tools for consistently dating sets of findings would be of great interest.

Eventually, georeferencing data might help archaeologists to define relationships among data and plan new excavation campaigns.
From these basic issues, the Italian Ministry for University and Scientific Research derived the requirements for an information system for the management of archaeological sites. Enel.Hydro (formerly ISMES SpA) was charged with the design and development of the system, which was requested to:

- acquire, store and manage multiple data types: written documents, numerical data, descriptions of sites and findings, drawings, pictures, movies;
- deal with multiple sites;
- deal with past data already stored on several supports, both digital and traditional;
- allow users to manipulate multimedia data;
- allow users to build three-dimensional models of the findings;
- provide cartographic support for georeferencing data on maps of the sites;
- support specialists to analyse data;
- allow easy delivery and exchange of data and knowledge among archaeologists and to inexperienced users;
- be easily accessible and usable.
- The system, which had to be initially developed for the Soprintendenza Archeologica di Pompeii (the local department of the Ministry of Culture), had to be used by four kinds of users:
- system managers, who manage and maintain the archives and deal with data related to users' management;
- local data administrators, who are responsible for inserting data, checking for inconsistencies and correcting errors, producing official documents;
- professionals, who use the system as a support for their studies and for producing new information from existent data;
- ordinary users, who want to get some information about some site, such as students who need it for educational purposes or tourists who plan a visit.

Moreover, the system had to be independent from the hardware architecture, and to be run on a variety of computer systems and configurations.

A WEB BASED ARCHITECTURE FOR MANAGING ARCHAEOLOGICAL DATA

From the requirements stated above, our analysis of the problem led us to propose a software architecture based on Internet technologies; therefore we built a system made of a server and several specialised clients, which are shortly described below. A more detailed description is given in a following chapter. The high-level software architecture is sketched in Figure 1.

The client-server structure includes a server, that provides most of the data

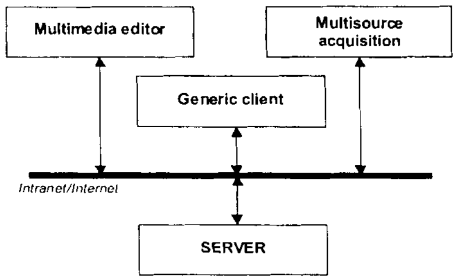

Figure 1 – High level architecture

and functions of the whole system, and some specialised clients that get data from outside, transform them and load them into the database managed by the server.

Two main functions are currently performed by specialised clients: the multi-source data acquisition, and the multimedia editing. Both have been built by integrating and extending some commercial products into a *virtual desktop* for managing data.

The multi-source data acquisition function allows users to import into the system documents of different types from many different devices, such as scanners, digital photo cameras and files. Other functions of this client allow users to manipulate these data, transform them (for instance to compose pictures taken moving a camera step by step along a road) and load them into the main database.

The multimedia editor comprises two main subtasks: the movie editor and the virtual reality manager.

The former allows editing digital movies or composing digital pictures to produce animated images, in order to show, for instance, the spatio-temporal evolution of a site during an excavation campaign.

The virtual reality manager allows building and managing three-dimensional views of monuments, findings, or 3D maps, so that users can visit the 3D objects, navigate through them, and look at them from different points of view.

Generic clients within the architecture are those which allow users connecting to the system or, in future releases, other specialised data processors.

Finally, the server is the core of the system. It comprises a database with its data management procedures, and special tools for interpreting data. The server is described in more detail in the next chapter.

THE CORE OF SITUS: THE SERVER

The central server comprises the multimedia database with its functions, a library of programs to interface SITUS services on the net, a cartographic tool for georeferencing data extracted from the database.

The database can host data related to more than one site. SITUS provides tools to manage the following main data types:

- archaeological site;
- phase of the site development, such as Etruscan phase, republican phase, ...;
- architectural monument (planimetric element), ranging from a single wall to the whole site; such objects can be graphically represented by SITUS on a geographic information system;
- decoration, that is strictly connected to a planimetric element;
- stratigraphic cut, that is the result of an excavation on a set

of contiguous stratigraphic units; stratigraphic cuts can be connected to planimetric elements;

- stratigraphic unit, the atomic element of a stratigraphic excavation; it represents a homogeneous physical unit, clearly different from the closest ones and related to them via *physical* and *chronological* links;
- physical and chronological links, such as *cuts*, *is over*, *is elder*, which describe relationships between stratigraphic units;
- diagnostic artefact, that is any object that can be used for dating purposes;
- archaeological finding, that is any object with archaeological relevance that is taken into account for filling a description form;
- drawing, picture, animated image, movie, 3D model, sound, text.

Privileged users can run management procedures, such as those for creating new users or for modifying passwords. Other functions are available for adding new data to the archives, modifying existing records or deleting them. Search procedures allow users specifying complex criteria to look for records within the database, and import/ export functions exchange data with Excel worksheets.

Moreover, SITUS provides the following special functions:

- statistics generation: the system provides reports on the data recorded;
- absolute time series: users can ask for the drawing of the distribution over time of some kind of finding;
- relative time series: users can also ask for representing the ratio of the number of findings of two classes of objects within a given time interval;
- Harris diagram: given a stratigraphic cut, the system can plot the Harris diagram for a set of stratigraphic units, on the ground of their relationships, as recorded within the database;
- congruency check: all the data which describe the physical relationships among stratigraphic units are compared, to verify the validity of their links;
- chronological consistency check: the system checks the dating of a stratigraphic unit against those of the artefacts found within that unit;
- thematic maps of planimetric objects: users can ask for plotting the map of a site, where only some kinds of planimetric objects are represented (for instance, shops and thermae);
- thematic maps of archaeological findings: users can ask for plotting the map of a site, where only some kinds of artefacts are represented (for instance, ceramics);
- special printouts, according to formats defined by the Italian Ministry of Culture.

The whole set of functions is available

through a user-friendly graphic interface, which is made of web pages that can be accessed from within a common Internet browser. These pages are built on the fly by SITUS libraries using some templates filled with data resulting from the current users' session: queries can be composed via graphical forms and sent to the server, which runs the proper functions according to users' commands, and builds as a result a new web page to be shown to users.

A DETAILED VIEW OF SITUS ARCHITECTURE

Figure 2 shows a detailed view of the architecture of the server that is the core of SITUS functionalities.

This architecture can be exploited both when SITUS runs in its minimal configuration, that is when a single user hosts on the same computer both the server and the clients, and when SITUS is used on a network, and clients and server can be hosted on different machines. In this case the server can be distributed on different nodes, since it includes several services which have been developed as separated servers.

A server hosts the archives and the functions to interpret clients' queries and provide them with answers. The multi-source acquisition system and the multimedia editor act as specialised clients, which communicate with the server for loading the data generated through them by users. Normal clients only require a web browser and the use of a computer network with the TCP/IP protocol.

The external man/machine interface layer, written in HTML and JavaScript, helps users build their queries and address them to the proper sub-server, since the server comprises three sub-servers. One of them has been built by embodying the public domain HTTP server Apache, and is used for directly managing textual and multimedia data. An other server, named CADMO, has been designed for building web interfaces of relational databases. Finally, a server called ATALANTA interfaces a cartographic database, and is used for georeferencing data extracted from the main archive, for instance to build thematic maps.

Queries to the database are managed by CADMO, which deals with the archives through the relational database management system (RDBMS) Access that exploits the ODBC protocol to interface a database. Any database accessible via ODBC can be linked to CADMO; for our purposes we have used both Access and SQLserver.

CADMO is a sort of state automaton, where each step of a user's session corresponds to a state and each user's choice implies a state transition. States are defined by Perl routines, which create queries for the RDBMS on the ground of users' choices and build on the fly the HTML pages to be served to the web client. The core of these pages is a skeleton HTML page related to the specific state, which is filled with the results of the query. Then some more generic HTML pages are merged into the skeleton to provide header and footer information with procedural hotwords for navigating through the system.

Each state is linked to a (meta)database record, which defines possible transitions, users' permissions, SQL queries that can be built from that state, headers and footers to be attached to the HTML skeleton of the state.

ATALANTA is a cartographic server, written in Perl, that implements a geographic information system. It exploits a program developed with Map

Objects, that manages cartographic information recorded on Shape Files and georeferences on them data extracted from the database. Resulting files are served via OLE in PNG format to ATALANTA, that delivers the results to the user.

CONCLUSIONS

This paper derives from a project aimed at developing an information system to support gathering, processing and distributing archaeological data.

The resulting system includes a large database that can store both new data resulting from new excavation activities, and old data, which are already recorded on several media and need to be transformed into digital data.

The database is fully interfaced by a library of programs, which enable the access to data over a network of computers, that can range from a local area network to the Internet.

The system includes also functions for georeferencing data on cartographic files, and processing tools to support interpretation of data.

Two specialised client programs may import multimedia data and virtual reality simulations into the database.

The system has been filled with a large set of real data derived from two excavation campaigns performed in Italy, in the archaeological area of Pompeii.

Data extracted from the database were also used to build a restricted set of web pages, which can be exploited as a public web site.

The advantages of the system, from the point of view of the management of archaeological data, are manifold:

- first of all, it stores into a single database data of different nature and related to different sites;
- then these data can be shared among the scientific community via the web architecture of the system;
- specialised subsystems provide functions to digitise old data recorded on paper, to manage multimedia sources and create 3D views, movies and virtual reality simulations, which are of great interest for displaying and analysing archaeological data;
- the system includes processing tools developed by gathering data interpretation knowledge from experts, such as those for drawing Harris diagrams or checking congruency and chronological consistency of stratigraphic units: these tools may be used as decision support systems, so that each user can profit from the knowledge embodied in the system.

From the information technology viewpoint, the system has been built as a general tool for developing multimedia distributed databases for a computer network, suitable to be extended through processing tools such as decision support systems and geographic information systems.

The core of the whole system is a state automaton implementing a server that manages users' queries, interfaces relational databases, builds web pages and serves them to users over the net.

This choice led us to build programs that are flexible enough to be easily adapted to different applications and extended according to specific users' requirements.

ACKNOWLEDGEMENTS

We wish to thank the Scientific Responsible of the CORARC Consortium and Superintendent of Pompeii, Prof. Pietro Giovanni Guzzo; the President of CORARC, Dr. Francesco Muzzi; Dr. Tiziana Rocco, who acted as application expert; Prof. Andrea Carandini and Dr. Maria Teresa D'Alessio of the Università La Sapienza di Roma and Prof. Paolo Carafa of the Università della Calabria who provided us with the data of their excavation campaigns; and Agostino Caffi, Alessandro Lussana, Marco Testa and Sergio Villa, who spent part of their life at Pompeii, developing and testing the system.

The multimedia editor has been developed by DIMA srl, the multi-source acquisition by SESM srl. Data acquisition and processing has been done in cooperation with TECMAV srl.

The project has been supported by MURST, Ministero dell'Università e della Ricerca Scientifica e Tecnologica (Rif. 179203-1354/494, Consorzio CORARC).

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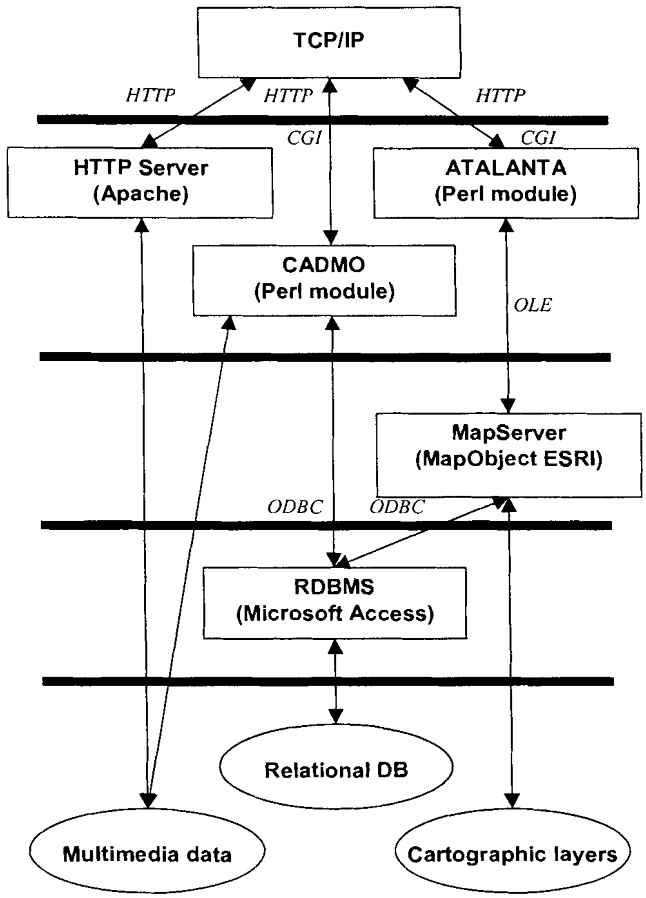

Figure 2 – Detailed architecture

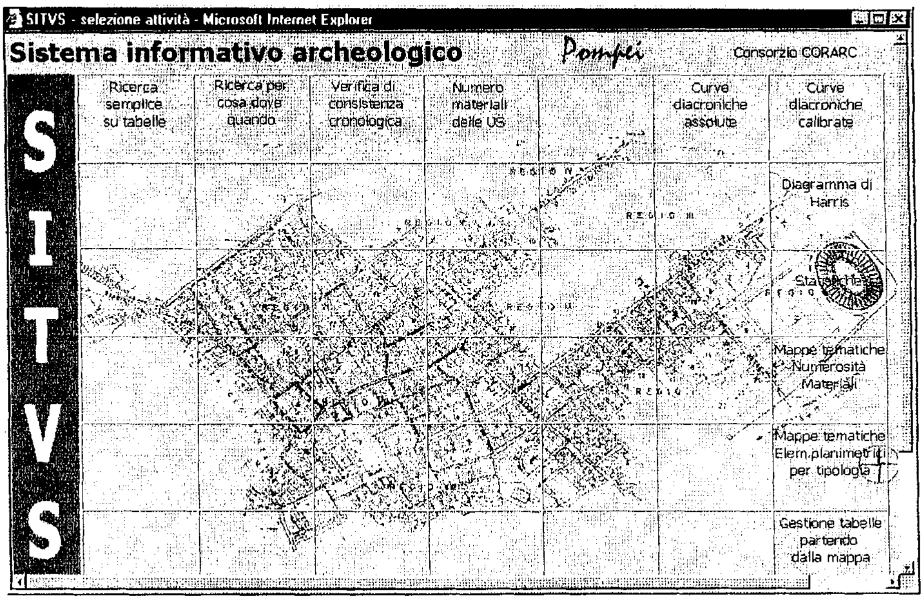

Figure 3 – High level functions for professionals

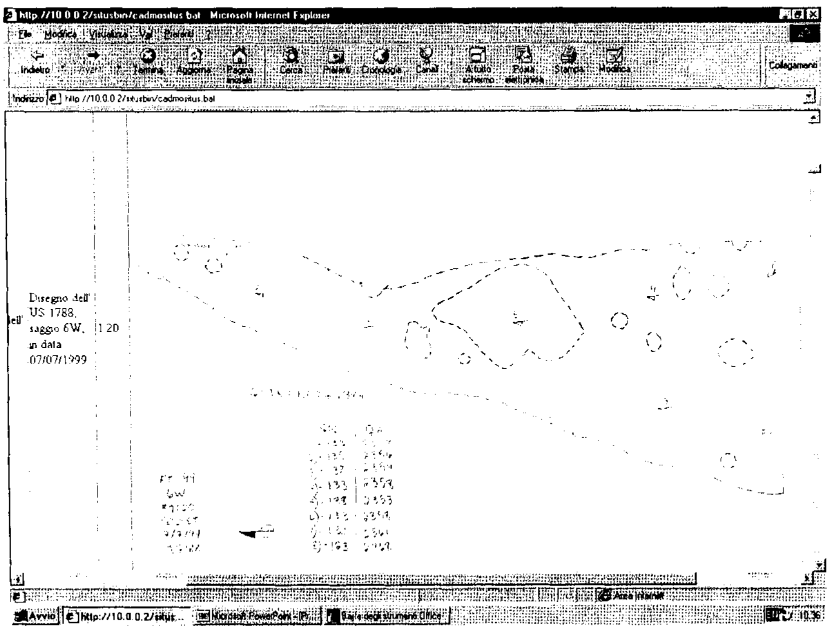

Figure 4 – Plotting a stratigraphic unit

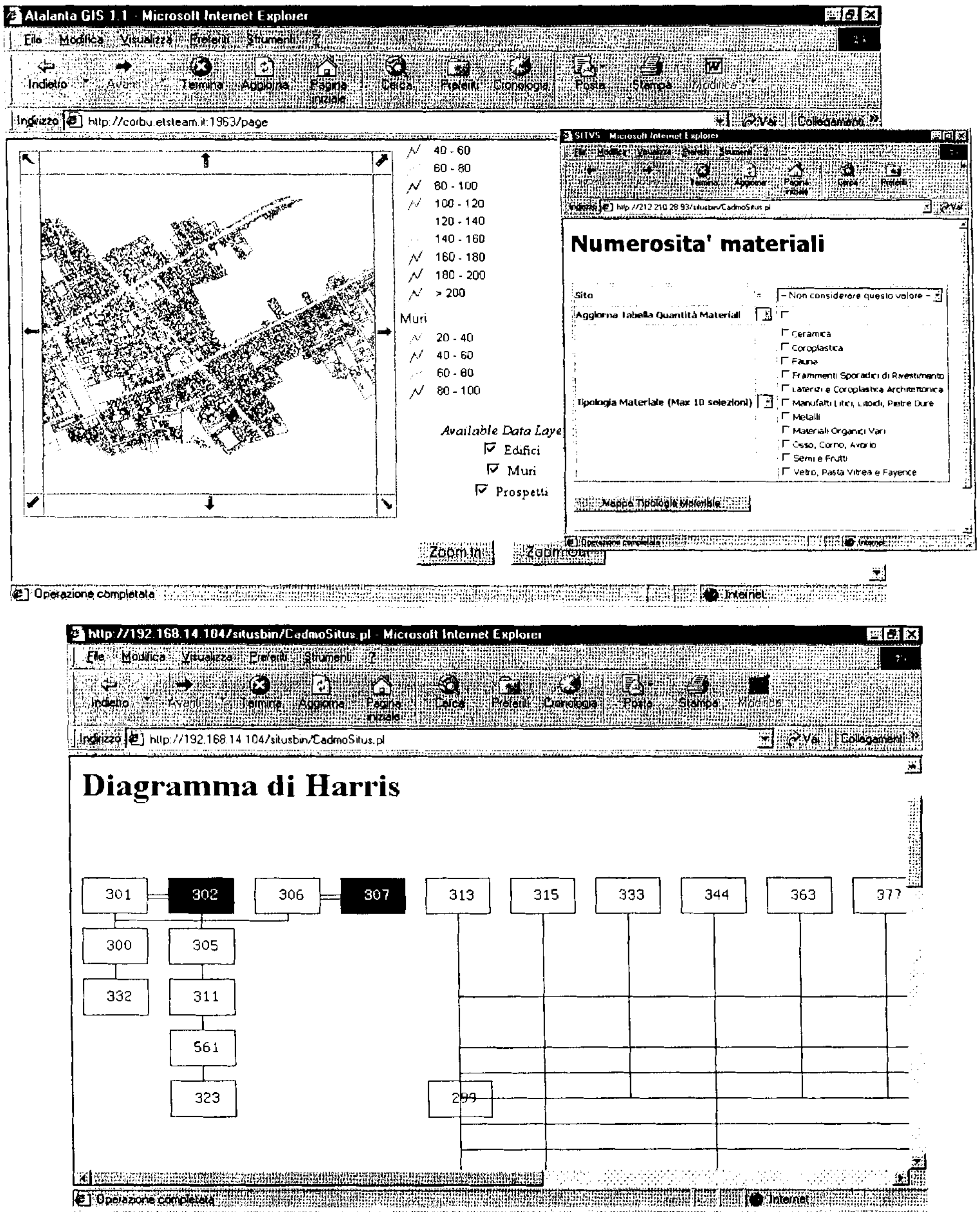

Figure 7 — Decision support tools: Harris diagram for a set of stratigraphics units

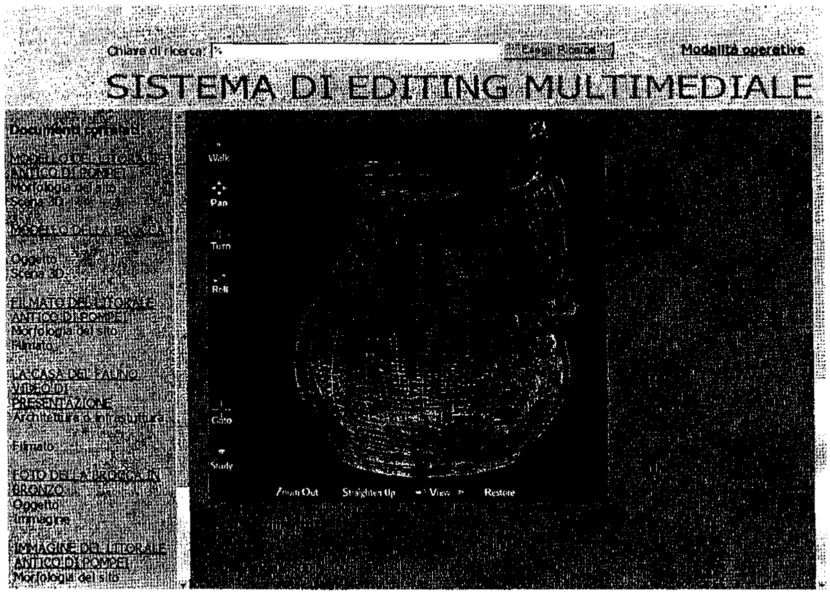

Figure 8 – Virtual reality through the multimedia editor

Figure 9 – Importing old drawings via the multi-source acquisition system

Figure 10 – The public web: accessing multimedia data

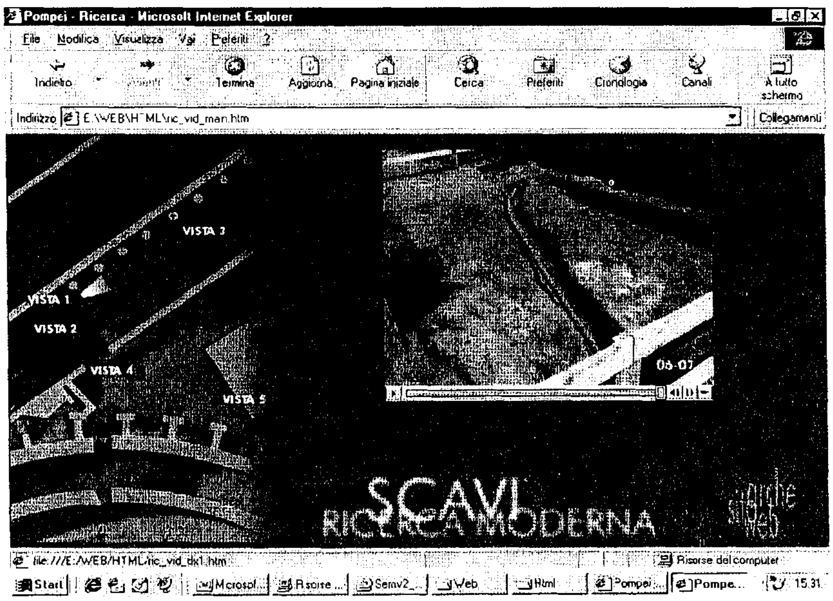

Figure 11 – The public web: five movies show different views of an excavation campaign