Computer Supported Cooperative Work in field archaeology: the Ade system

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Abstract

This paper describes Ade, a site object store, where objects with different attributes (textual, graphic, spatial) are kept as aggregates, inside larger units, like stratigraphic units and contexts. The same tool set may be used to produce documents, like reports to sponsor organizations, or e-mail to colleagues at Universities or museums, with various attachments, thus, improving fieldwork communication and cooperation possibilities.

Introduction

Since the duration of an excavation campaign is limited, and transportation costs could be relevant, it is important to be able to make the right decisions on the spot, accessing large archaeological databases and possibly, consulting specialists, who are at some, far away museum or university. In order to support such work, our group designed a hardware / software system based on two new technologies: wireless, mobile computing, and pen-based, man-machine interfaces.

We proposed to center field cataloging around a fixed workstation installed in some building, close to the excavation site, connected to the Internet by telephone cables or satellite. The task of the fixed station would be that, of integrating information, provided and collected in the field, into a unified database.

Each archaeological group in the site was provided with a mobile system, where input could be done, with an electronic pen, and which supported local, as well as remote, computations, resulting as transactions at the work station. The latter include data base queries, comparisons with previously entered data, contacts between mobile computers and scientists, in nearby, or remote areas, and anything else, which could be done by means of the Internet.

The software system was composed of Ade and Archeo, the latter, being executed on the mobile computers, used by field operators for data entry, either for drawings or textual data. These data could be immediately sent to the fixed work station, for data processing, or downloaded, at the end of each working day, into the site object store, managed by Ade.

This paper describes Ade, a software tool, functioning on a work station net, one or more of the stations, being connected, by radiofrequency, to the palm-top, mobile computers. Thus, Ade can be viewed as a site object store, managing objects with different attributes, accepting input of different types (textual, graphic, spatial) arriving from different hardware media, and being able to provide information on these objects, while also producing documents, like reports, in the form required by the sponsor organizations.

In the rest of the paper, we briefly introduce the features, which tools for supporting cooperative work (like, for example, Lotus Notes) are providing. Then we motivate the introduction of such tools into field work. A description of Ade features, and some concluding remarks on its present prototype, are finally given. Those wishing to get more details on software, being utilized on the mobile computer, are referred to our companion paper, regarding Archeo.

Tools for cooperative work

Progress, in computer and communication technologies, has now made it possible to develop novel tools, for supporting cooperative work, generally called *groupware*. These tools originate from interdisciplinary approaches, to coordinate working groups, within various activities, giving rise to new models of work organization, called Computer Supported Cooperative Work (CSCW).

A working group is a set of people, who cooperate towards a common goal, each group having possibly different information and responsibilities. We speak about a group, rather than a set of people, when we can identify, among them, specific patterns of work organization, by means of communication, cooperation, and coordination.

By work organization, we mean the identification of the various activities, necessary to reach a common goal, their partition among involved individuals, and the definition of rules to stick to. A group is naturally self-organizing, around the negotiation of work to be completed, which in turn, leads to a need for communication. Various languages for communication are being used, within a group, from formal letters, to e-mail messages, images, speech, and so on. As a result of communication, cooperation is achieved by sharing, accessing, and updating a common body of knowledge about group goals. Coordination of individual information exchange, within such an information repository, is then required, to ensure effective progress towards the common goals.

Groupware tools are then required to provide structures, where group knowledge can be stored. Rather than limiting information storage to files or data bases, we call the unit for information storage a document, which can be concurrently accessed by group members, in accordance with specific coordination rules. Access to documents can be selected, by only those group members, who have the right to knowspecific information, and information flow can be automated, in order to ensure specific flows of information, within the organization, as well as serialization, of selected group activities (workflow).

It is clear that some message exchanging facility, should be supported by groupware. Today's tools provide e-mail, scheduling, address books, form handling and document handling support. Within these features, control and security are an integral part of their design. Control is usually implemented by logging all events, like message sending or access to documents. Security is based on checks on the access rights of individual users for each document, even for selected parts of them.

Groupware tools should also allow users to customize the "basic" products. For instance, it is possible to insert specific "buttons" within forms, and to associate them, to the execution of given software, when they are clicked on; such software is often expressible as formulae or scripts. Another, very useful example, is that of an agent, which is activated, according to a given calendar, for periodic updates, reminder generation, and so on.

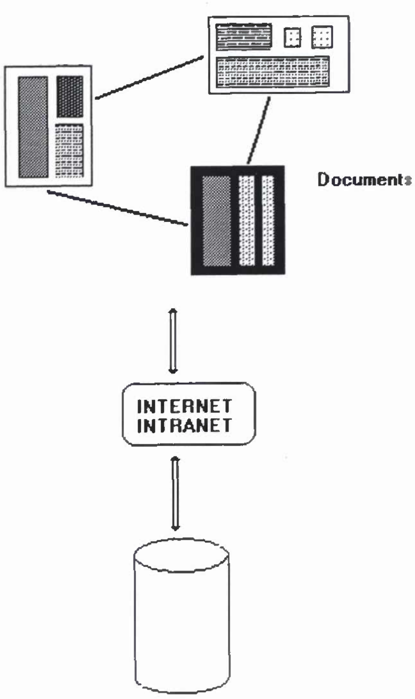

Figure 1. The Internet allows information sharing,

communication within the group, and with the outside world. As for communication media, the integration of groupware tools with the Internet is a straightforward extension of their potential. Information available on the net, thus, becomes available for the group, and conversely, group documents can be made available to the outside. This is achieved by groupware, client-server architecture, which already includes safety concerns, as opposed to what most current net browsers do, in order to make possible safe forms for electronic commerce or customer support (see fig.1).

Communication in the field and outside: the fixed station

We have already remarked that field data is collected in a data base, which takes the form of an object store, as a result of collecting finds, from mobile units in the various tests. Storage, retrieval, and analysis of archaeological data should not be thought of as a simple man-machine interaction, but rather as a distributed system, where different data is kept on different machines, for various purposes.

In this respect, the role of the site object store is close to that of corporate, workflow manipulation tools. In fact, various objects with different attributes (textual, graphic, location, and other relationships, based on possible interpretations) should be stored and aggregated inside larger units (stratigraphic units and contexts) as excavation work proceeds; they should also be "viewed" at different detail levels, by various people in the organization. There is usually no concern for security, among scientists; the reason is rather that of filtering irrelevant details once an interpretation has been given to the finds.

Data in such an object store is considered to be experimental evidence, and its aggregations are subject to updates, as excavations proceed. Thus, tentative interpretations can be made, and later discarded, if further data becomes available, which contradicts initial hypotheses. This flexibility, and the possibility of keeping several such tentative interpretations, at the same time, until a final choice is made, are implicit in the tools structure.

Once some or all of the data is settled, the same tool should also be used, to derive documents, like reports to be given to sponsor organizations, or even, just e-mails to colleagues with non-textual information as attachments (Soprintendenze or the Ministry of Cultural Heritage, in Italy, use a standard format, on paper; the Italian National Research Council has provisions for computer-based input in various formats). Again, workflow manipulation tools already support such organization, as part of their usual specifications; interfacing to more traditional databases is also supported, once the analysis phase is completed, and no further information is to be generated.

Thus, a tool supporting the Cooperative Work, in the archaeological field, must at least exhibit the following features:

1. Since number of data collected during an archaeological campaign is very high (excavation field grid descriptions, find drawings and attributes, explanatory documents, and so on). This means that heterogeneous data must be recorded and managed efficiently.
2. Extreme security is not mandatory, due to the non-strategic features of archaeological finds. However, the system could be used by non expert personnel, and

possible erroneous operations could delete data as a side effect. Thus, robustness is required.
3. Since the end-user is not usually experienced in computer science, a friendly interface must be provided to induce the user, to use the tool. Ease of use is one of the most important reason, for the success of an application.
4. The tool should be easily portable, on different hardware platforms, either to allow the use of already owned work stations, or to be able to be executed on new targets.
5. Since Ade is used by a working group having different purposes, and possibly interacting, at the same time with other working groups,, resources must be accessible concurrently, and data consistency must be preserved.

Ade may be implemented, bearing these principles in mind:

Other archaeological data repositories have been developed. As an example, we mention the system, Syslat[7], an archeological information system, developed in France, and widely used for excavations in Lattes and near Nimes (1994). Syslat allows the subdivision of the field, in excavation areas, and also allows finds cataloging, and the integration of textual and graphical information.

We remark that Syslat meets some of the previously listed requirements, while others are lacking, due to the different aims, for which Syslat was designed.

Its ability to manage a wide, heterogeneous data base was verified, in the field. However, graphic representation is limited to the finds repository, since Syslat does not allow internal image generation. For this last reason, interaction with the archaeologist, from the excavation site, has not been considered.

This system exhibits a high data security; it does not allow any unforeseen operation to be executed, to such a point, that it has been considered, by the end-users to be lacking in flexibility; moreover, the interface is not really friendly, for non-expert users.

The tool was built on top of Apple Hypercard, and uses several, separate tools for text and image management, so that the program only manages files, concerning excavation cards. It only works on Apple Macintosh, thus, it is hardly portable, on different and more recent platforms.

Finally, Syslat was created as a centralized system, and could not be adapted to distributed cooperative work, without substantial interventions; for example, concurrency and synchronization control systems, for data base access operations, must be added.

The system is globally, well conceived; it can be viewed as a set of functions, able to answer to the archaeologist's different needs; the search functions, for example, are flexible enough to provide not only key word queries, but also data statistics completed with the related graphics.

These features have also been considered in the design of Ade, which has additionally been enriched, with those functions, required to support cooperative work. The most important and decisive factor, was the choice regarding the software platform, on top of which Ade would be implemented.

The choice of which tool should be used for workflow support [6] fell on Lotus Notes, for the following reasons:

- It was a multi-platform tool, which could be run on different work stations; it could also be loaded, on the mobile computer, if sufficiently configured with disks and RAM space.
- It was designed for cooperative work, so it was possible to interface it, immediately, with several mobile systems, at the same time.
- Access to Internet and e-mail are available, at no additional cost (actually, it was originally designed, for such purpose).

Thus, our system provides novel features, with respect to other archaeological information systems, due to its different attitudes, towards archaeological data manipulation, deriving from groupware activities. In fact, Notes allows multiple copies to be kept, even incomplete ones, for each object repository, called *replicas*, which are stored on different client computers. In our example, we might filter data, belonging to a specific test in the whole site, or objects, belonging to a certain period of time for all of the site, or, even, stratigraphic units, at the same level in selected tests.

A specific user, either mobile or stationary, or, even a user connected via the Internet from the University labs, may independently retrieve, update off-line, and then send back to the server, a selected data subset, including some contextual interpretation. Consistency of multiple, independent replicas, even when simultaneously updating the same object, is kept by Notes, itself: in fact, it contains proprietary synchronization software, to such purpose; conflicts on the same piece of information are solved by accepting the latest update.

Ade operations: a brief description

Let us consider the features of Ade. System interconnectivity is shown in Figure 2. Note that the database can be entirely or partially replicated, on different stations and servers, depending on user needs.

The Notes network is composed of a coordinator/archive, which receives input in a structured way, from both mobile units, and a collection of clients and servers, cooperating on the archaeological data analysis and elaboration. The system has two bridges, towards the external world:

- an interface to receive standard, flat files from mobile units, and
- an Internet interface.

The data base is an object store, implemented on top of Lotus Notes; thus, the net data consistency problem is solved, using the Notes synchronization mechanism, the efficiency and robustness of which, has been proved, even in the case of concurrent accesses. Thus, Ade cannot be restrictively viewed as a simple operator / machine pair, instead it must be viewd as a distributed system, where data are recorded at different sites (such as Museums and Universities).

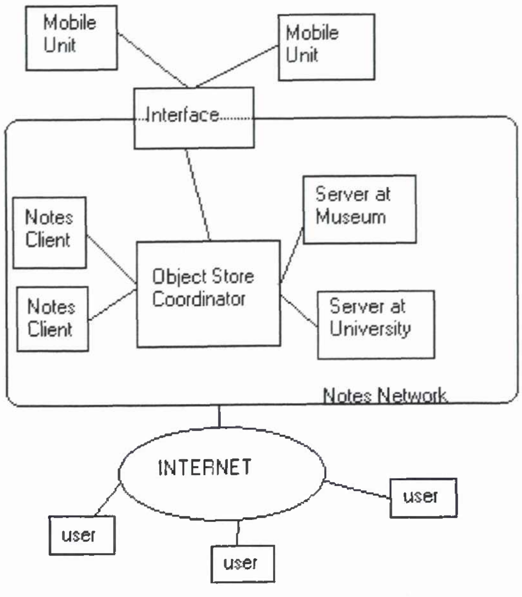

Figure 2. Systems interconnectivity.

The archaeological data base is organized into:

- Forms
- Navigator
- Views

The basis of the Ade design is a constant adherence to cataloging and reporting, of archaeological data, as prescribed by the Italian Ministry of Cultural Heritage. Thus, the forms managed by the system, with the exception of the context form, have been designed following these cataloging rules, so that documents required by sponsor agencies can be easily printed. The description of the excavation area is obtained, by means of four forms, called in Italian, Sito, Saggio, Unita' Stratigrafica and Contesto, each one corresponding to well defined archaeological entities respectively called Site, Test, Stratigraphic Unit and Context. The key point for field data handling is the Stratigraphic Unit form, where a stratigraphic unit may be any excavation region, of variable size, containing some interesting finds. The attributes definition, of these finds, is better described in a companion paper about Archeo, the drawing tool. Once a definition of a find is passed on to Ade, archaeologists may as well update such descriptions, in accordance with the excavation progress, as soon as new evidence is collected. Thus, the stratigraphic unit is the building block, in the site finds hierarchy.

Each of the above forms is straightforwardly implemented, using a Notes form. In Figure A (stored in a separate file) part of the "scheda di sito" form is shown, as an example. Several hot spots are included (such as "Localizzazione", "Informazioni catastali" and, so on), which can be clicked on. If so, each one recalls a layout region, useful for including related data ("Localizzazione" has been opened, in the figure).

Data are reached using different views, used to divide documents, in accordance with the type of form, which originated it. Thus Ade has four kinds of views, containing the related data base.

Ade user is provided with a Navigator, to simplify query operations, on the views. Part of the Navigator and a selected view are shown in Figure B (see the separate file).

Conclusions

This project is the result of the cooperation between DISI, the Department of Computer Science of the University of Genova, and ISA, the Institute for Archaeology and History of Ancient Arts in the College of Humanities, headed by Professor Santo Tine'. Researchers from both institutions have been investigating the feasibility of an information system for field archaeology; as a result, the system described above was prototyped. The end-user for such a system is the Italian Archaeological School in Athens, which has been responsible for more than 60 years of campaigns at Poliochni aerchaeological site, in the Greek island of Lemnos (see [6] for archaeological references). In the 1997 summer campaign, an almost complete version of the drawing tool was already field tested, on the site, by the archaeological team.

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