

ANALECTA
PRAEHISTORICA
LEIDENSIA

28

PUBLICATIONS OF THE INSTITUTE OF PREHISTORY
UNIVERSITY OF LEIDEN

INTERFACING THE PAST

COMPUTER APPLICATIONS AND QUANTITATIVE
METHODS IN ARCHAEOLOGY CAA95 VOL. I

EDITED BY
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UNIVERSITY OF LEIDEN 1996

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Handling Excavation Maps in SYSAND

1 Introduction

SYSAND is a system to help archaeologists in processing and interpreting excavation data. It has been designed for the excavations of the Gallo-Roman town of Anderitum (now Javols in Lozère, France), but it could be easily adapted to handle data of other sites.

SYSAND records stratification unit (US) cards, checks consistency of physical relationships, and constructs and draws Harris matrices. The archaeologist can visit information related to each unit by navigating in the matrix representation (Maggiolo-Schettini *et al.* 1995a, Maggiolo-Schettini *et al.* 1995b).

To access pictorial and graphical information related to stratification units, SYSAND has been extended with the module SIGMA. In particular, SIGMA inputs maps digitized by means of a scanner. Maps (drawn during the excavation) are given to the scanner in portions. SIGMA reconstructs and stores each map in a stack related to a given year of excavation. The archaeologist has a complete view of the entire site, on a reduced scale, as resulting from the last excavation or from the excavation of a certain year. He can move in on such view, can move to the view related to another year, or can superimpose maps of the same part of excavation but related to different years.

The archaeologist has also at his disposal tools to modify maps by inserting or eliminating elements. For example, he may want to insert hypothetical elements or leave on the map only particular elements, such as walls, and, so store 'particular views' of excavated areas. Moreover, the archaeologist can associate to a line on a map the drawing of a section passing through that line, create links between the card of a stratification unit and maps containing that unit, and, vice versa, and create a link from a point on the map and the card of the related unit. Maps can also be consulted from the cadastral map of the area.

The described system runs on a portable Macintosh Powerbook. Both SYSAND and SIGMA are hypertexts realised in a HyperCard environment. Cadastral maps and sections which require a resolution higher than that of maps are manipulated by using the application Photoshop of SIGMA.

The requirement of being able to run the system on a portable computer at the excavation site, together with

economic limitations, made us opt for the HyperCard environment rather than other systems such as GIS, that are much more powerful but also require much more powerful machines and incur higher costs.

Two years experience at the Anderitum excavations have shown that the system is efficient and easy to use, also by inexperienced persons.

2 SIGMA

SIGMA (Sistema Iperestuale per la Gestione di Mappe Archeologiche, that is Hypertextual System for Handling Archaeological Maps) extends SYSAND with facilities to input and manipulate pictures from the excavation, such as maps and sections (drawn on the site) and photos. SIGMA is implemented in HyperTalk (the programming language of HyperCard), and HyperCard allows to establish links between images and textual information. A consequence of the choice of HyperCard is that images can be handled in two ways: on cards (basic elements of HyperCard for storing text and images) and on external windows. Images on cards may be only bitmap, may have a maximum resolution of 72 dpi, or may be manipulated automatically and manually with HyperCard tools. Images on external windows may be either bitmap or of vectorial type, have no resolution limits, and may be zoomed-in and zoomed-out, but can be modified only with specific graphical applications. We have therefore chosen to have excavation maps on cards, as they do not need a high resolution but may have to be manipulated frequently, whereas sections, photos or cadastral maps of the site are on external windows, as they need a greater resolution but no frequent manipulation.

To input excavation maps, the procedure consists of the following phases:

1. Manual decomposition of each given map into portions suitable for scanning. Maps, drawn by archaeologists, measure 50×50 cm (representing 10×10 m squares of the excavation). Each map is subdivided into six $16,6 \times 25$ cm portions.
2. Manual scanning of each portion. Each map is digitized with a resolution of 72 dpi and then saved on disk.

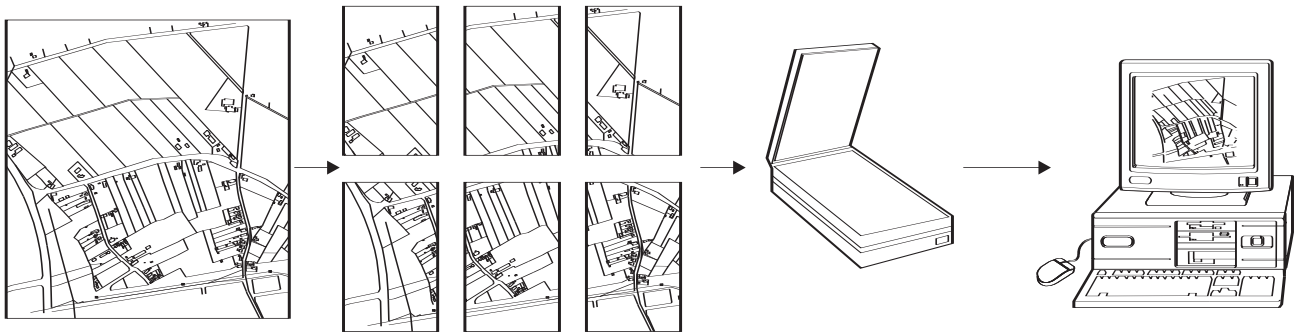


Figure 1. Phases of input procedure.

3. Automatic reconstruction of the original map with a 50% reduction. Such a map is stored in a sequential stack with information needed to view it in its real position in the planimetry.

The entire procedure is illustrated in figure 1.

Experiments suggest that 5 minutes are required to accomplish the first two phases. The third phase takes about 2 minutes (for a precise evaluation see Agresti/Saccoccio 1994).

With sections, photos and cadastral maps, phase 1 differs from the one described for excavation maps because sizes are variable, while in phase 2 a resolution of 300 dpi is chosen. Phase 3 is not automatic, the sections, photos and cadastral maps are reconstructed by the user, piece by piece, by means of a graphical application, such as Photoshop or Canvas.

3 Visualising and navigating in the excavation planimetry

Characteristic of hypertext is the possibility of linking pieces of information according to an ideal arrangement, possibly independent of how they are stored in reality. For excavation maps, the ideal arrangement is the planimetry of the site. One may therefore want to be able to move horizontally on the planimetry in a particular direction. As one has a planimetry for every excavation year, one may also want to move vertically from a map of a certain year to the corresponding map of another year.

Each excavation map has an associated map number. A map number is a sequence of integers: the last integer representing the position of the map in a 10×10 map array, the last but one representing the position of this array in an array whose elements are arrays like the one considered, and so on.

From the map number the system can compute numbers of adjacent maps (in four directions) in the planimetry, and

let the user view these maps (the user has a palette at his disposal to accomplish this).

Apart from the described horizontal navigation in the planimetry, a vertical navigation along excavation years is also offered. It may well be possible that the planimetry of a given excavation year is incomplete, for instance, the map for one particular square of one particular year may be missing. But as there are maps available of that square from different excavation years, the planimetry is automatically completed by inserting a map from a different year.

Single maps of the planimetry can be accessed in three ways (fig. 2):

1. going through the stack of map cards;
2. starting from the cadastral map;
3. through an 'interface', namely a reduced view of the most recently created planimetry.

Let us first describe the stack of map cards. Each card contains a reduced view of a single map, together with information such as among others the square number which identifies the map, the list of US numbers contained in the map itself, and a flag which is set on if there are drawings of sections of the represented square. From the map card one can access the related map, and may do a number of search operations; for instance, one can view, in a sequence, all maps containing a given stratification unit.

Secondly the cadastral map. It is a square, measuring 1×1 m, which offers a global view of the area comprising the excavation site. The archaeologist can inspect this cadastral map by exploring it continuously. By means of a single click he gets the number of the map of the selected location, by means of a double click he can visualise this map.

And finally, the 'interface' is a stack of cards, each containing a reduced view of fifty maps of the excavation (corresponding to 50×100 m in the real world). It is also possible to access one single map from the 'interface'. One can also go back and forth between the 'interface' and maps.

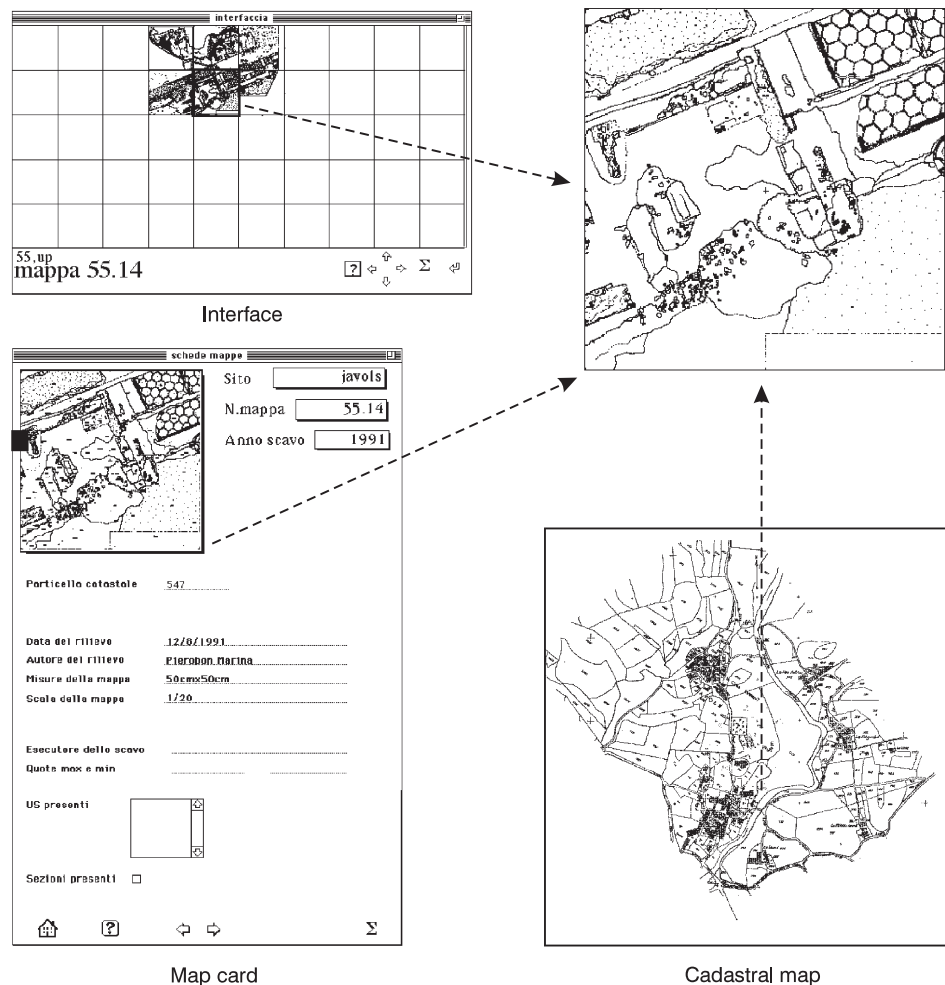


Figure 2. Ways of accessing planimetry.

The main difference between accessing maps through the cadastral map and accessing them via the 'interface', is that, in the latter case, one can also access non existing maps obtained by joining parts of the real maps. We call these 'intermediate maps' and we shall give more details about them later. Maps of the interface will also be automatically updated when a new map is added so that one always gets a view of the most recent map of an area, unless a particular excavation year is specified.

4 Tools for consulting and interpreting excavation maps

In the horizontal navigation in the planimetry one normally moves discretely with one map step. Thanks to the intermediate maps mentioned earlier, one can view a map consisting of pieces of scanned maps. Note that this map is obtained by patching maps belonging to different years if

maps of the same year are not found. The user should be warned that consulting intermediate maps is rather costly.

As an aid to archaeologists, the possibility is provided of superimposing either the altimeter curves or a grid on the maps. The archaeologist may also want to superimpose maps of different years for two purposes: joining parts that are complementary (thus giving an updated view of the entire area) and showing the temporal evolution of the excavation.

To a map the archaeologist can associate drawings of sections. A sign on the map indicates the existence of a section; by a single click on this sign the direction of the section is represented on the map, by a double click the section itself is shown.

The archaeologist may also want to zoom out maps in order to have a more comprehensive view. This is not possible if maps are stored in HyperCard cards, as in our

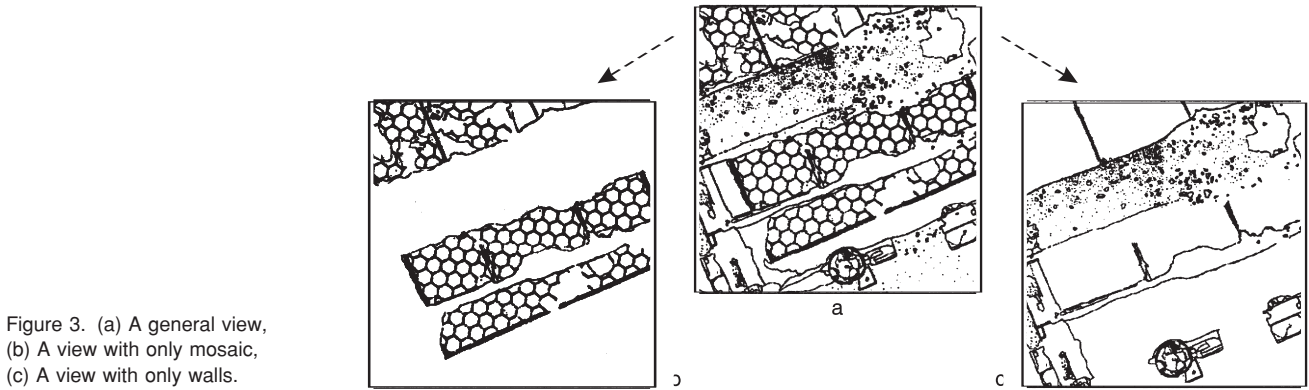


Figure 3. (a) A general view, (b) A view with only mosaic, (c) A view with only walls.

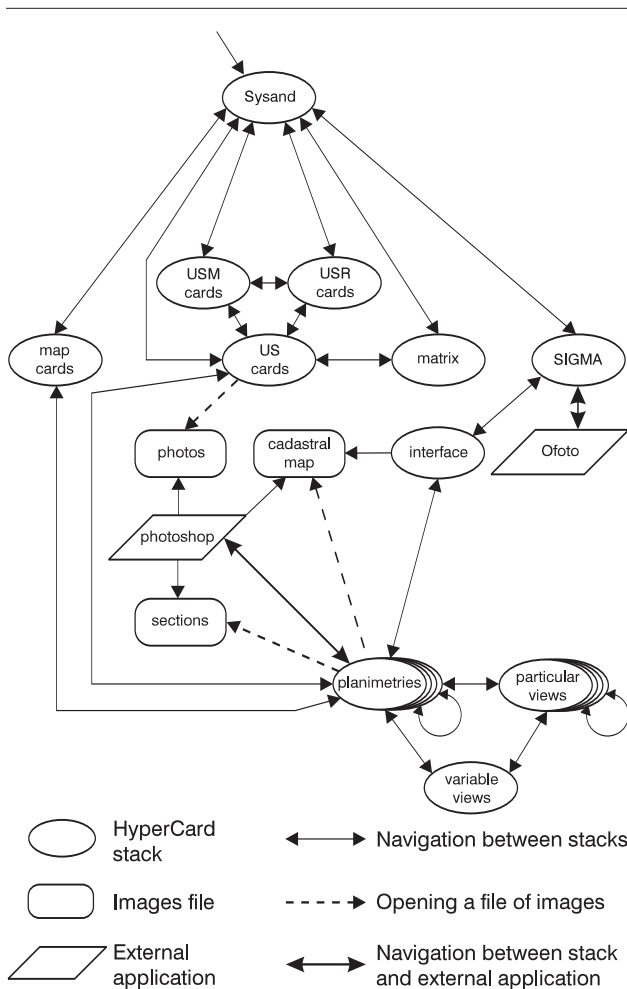


Figure 4. Scheme of links.

case, but it can be simulated. The archaeologist may wish to view m times n maps together, with m being an integer up to 10 and n an integer up to 5. This requires the creation of a card in which the desired maps, suitably reduced, are patched together. Once created, these cards, called ‘variable view’, can be stored for future consultation.

As an aid to interpretation, it may be useful to add information to or remove information from a given map. For instance, one may want to leave on a map only information representing walls, or one may want to complete a map with hypothetical elements. This is achieved by supplying the archaeologist with tools for modifying a map, that, once modified, can be stored as a ‘particular view’. A planimetry of these particular views can be created and navigated upon (fig. 3). All facilities for such a navigation are also supplied.

5 Moving around in SYSAND

In previous sections we have described the modules of the system. By modules we mean stacks of programs, such as SYSAND and SIGMA, stacks of US cards, USM cards (cards that detail information of the US cards when the stratigraphic units are walls), USR cards (cards that detail information of the US cards when the stratigraphic units are pavements of tiles, mosaic, etc. or plasters, frescoes, mosaics, etc.), map cards, map ‘interface’, planimetries, particular views, variable views, files of images such as pictures, sections, and cadastral maps, and, finally, external applications such as Ofoto and Photoshop.

We have already mentioned a number of links created between cards in a stack (such as those that allow the visualisation of excavation maps as a planimetry) or between stacks, like those between planimetries.

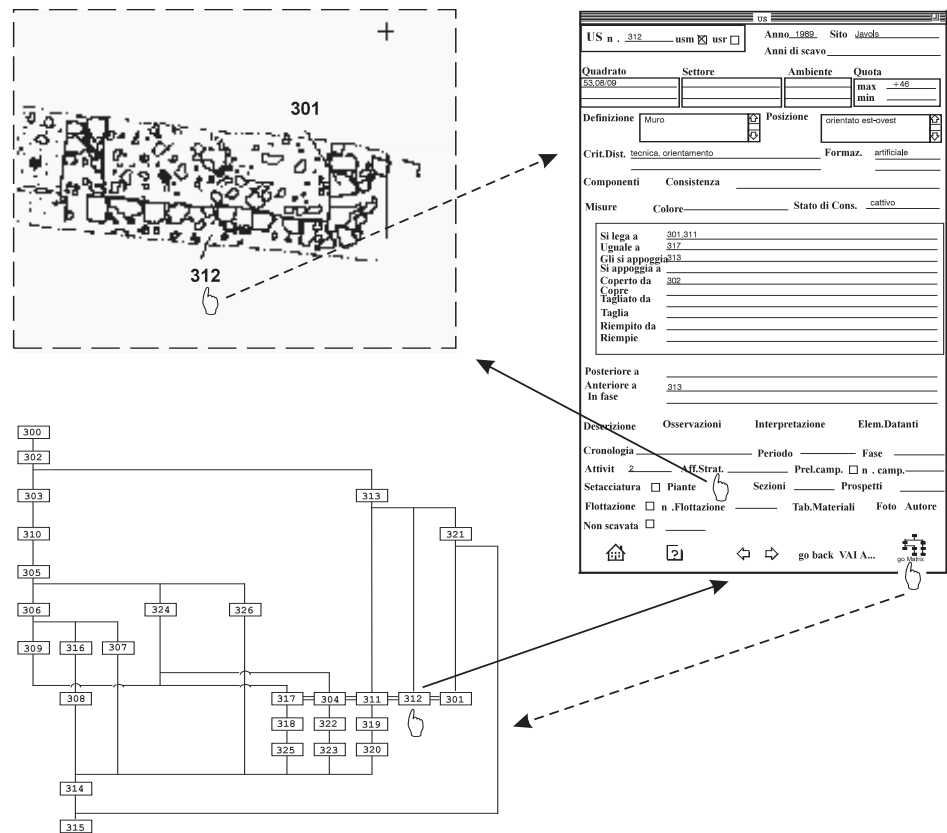


Figure 5. Navigating among US card, matrix and map.

We will now describe other links, both static ones, which are established by the programmer, and dynamic ones, which are created by the user.

Such links appear in the picture in figure 4. Circles denote HyperCard stacks (e.g., SYSAND, US cards), squares denote images files (e.g., photos, sections), and rhomboids are external applications (e.g., Ofoto). Double arrows between two modules indicate that one can navigate between the two; we distinguish navigation between stacks of HyperCard, represented by a double thin arrow, and between navigation between a stack of HyperCard and an external application, represented by a boldface double arrow. Simple dotted arrows represent the possibility of opening a file of images from an external application or from a stack (e.g. a cadastral map either from a planimetry or from Photoshop). Note that this case differs from that of navigation between, for instance, a planimetry and ‘interface’, where the stack of a planimetry is left to go into the interface stack. When opening the cadastral map from a planimetry, the stack of the planimetry is not left, the cadastral map is only consulted and can be used to navigate between the cards of the planimetry.

The usual way to access the system is from SYSAND. One can also enter US, USR, USM stacks and either consult them or introduce new cards. In this case one may reconstruct the new stratigraphy. The already computed stratigraphy may be viewed either starting from SYSAND or from any US (USR, USM) card. From SYSAND one may also consult map cards (that are created by SIGMA when maps are inserted into the system).

With SIGMA one can digitise a new map, calling Ofoto, reconstruct the map from the digitized portions, and consult planimetries via ‘interface’.

One has the possibility of opening a US card from the related node of the matrix, and, from the US card, consult maps, photos and cards of materials found in that US (to be done) (fig. 5, the path indicated by dotted links). Links between US cards and maps are established by the archaeologist, who has a suitable tool to sensitise an area on the map to which the US number is associated, so that by clicking on this area the relative card is opened. One can, therefore, also go from a map to a US card and from this card to the matrix (fig. 5, the path indicated by solid links).

6 Future work

At present, our work is concentrated on integrating into SYSAND a relational data base system of material found on the excavation site.

For each stratification unit a card gives a general description of Common pottery, Fine pottery, Small objects,

Miscellaneous material, all associated with the unit. To each such card, detail cards will be associated with a precise description of each piece. The archaeologist should be able to query the data base, to ask for statistics and to create thematic maps.

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