7. An experiment in electronic exchange and publication of archaeological field data

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7.1 Archaeology as rhetoric

Can archaeologists take advantage of new information technologies to exchange and publish information in electronic form? This question poses some concrete technical problems, but it is also a challenge to rethink the very nature of archaeological work. I would like to begin with a metaphor proposed in several recent theoretical discussions: that archaeology can be understood as a kind of rhetoric.[1]

In contrast to other theoretical perspectives stressing the relation of archaeologists to the physical remains of the past, the metaphor of archaeology as rhetoric insists that the ultimate goal of archaeology is to produce 'texts', to communicate with and persuade an audience of a particular point of view about archaeological subjects. Archaeology is a three-way interaction: archaeologists interpret archaeological material to an audience, which can interact both with the archaeologist's text and with the archaeologist's evidence.

If we take this emphasis on the social dimension of archaeology seriously, we must accept a conclusion that is equally essential to other theories: that material outside the dialogue of archaeologist and audience — unpublished material — is outside the realm of archaeology. In more polemical terms, unpublished information is not yet archaeological information, and arguments supported by unpublished information are not supported.

As new technologies change our understanding of communication, dissemination of information and publication, they imply changes in our notion of the fundamental activity of our discipline. The theoretical discussions of archaeology as a production of texts have to date conceived of 'texts' solely in terms of material printed on paper, but we need to adapt our archaeological rhetoric to current information technologies. This is an enormous undertaking. Indeed, it represents nothing less than rethinking the place of archaeology in a new world view: as the introduction of alphabetic writing in ancient Greece and of printing in early modern Europe gradually changed not only the ways people could record ideas, but also how they could organize and, ultimately, conceptualize ideas, so electronic information technologies today challenge us to ask how far our habits of thought have been adapted to technologies we were formerly dependent upon.[2] The problem deserves to be investigated fully, but this paper will focus on only one small aspect of publishing field results: the limitations of scale imposed by printed publication.

7.2 Publication of field research

Even the smallest field project generates far more documentation (primarily in the form of notebooks, photographs, and drawings) than can be printed. The physical capacity of a book is restricted to a few hundred pages; as the number of volumes is increased, and additional articles are scattered among various journals, it becomes increasingly impractical to work with the complete documentation. Above all, the expense of printing exerts a terrible pressure on archaeologists to select only some information for publication. Is it worth fighting for an extra appendix of tables with raw data, or an extra plate of photographs? Or, is it better to cut both in the hope of making the volume more affordable and so more widely accessible?

Such decisions determine what is included in or excluded from the archaeological record. Of course field archaeologists make such decisions whenever they choose what to record, but in that case they are defining the archaeological material that is relevant to the problem they wish to address. In choosing what subset of this material to publish, they are responding to a technologically imposed limit that has no archaeological relevance.

How do we reconcile our practice of archaeological observation and recording with our practice of publication? Typically, the field project relies on an unpublished archive to accommodate the difference in scale between documentation of the project and its printed publication. Higher level analysis will be published more fully, along with selections of supporting documentary material, but the bulk of the project's material (especially the drawings and photographs that are so costly to reproduce in print) remains in the archive. These unpublished documents may be cited in the published discussion, and in principle are accessible for consultation (although an archaeologist in the U.S. who wishes to consult the archive of a British excavation, for example, may consider this last point moot). Thus the principle function of the archive is to serve as an extension of the published record — an extension that can grow without the limitations of scale and daunting costs of the printed record. The unpublished archive is an artifact of inadequate technologies for disseminating information.

When the archive's system for managing information is modelled on the paper publication, identifying and retrieving information may become impossible. A printed volume delivers a comparatively small quantity of information; archaeologists using indexes, tables of contents and the other rough-and-ready organizational

1. Most forcefully developed in the two very similar works of Shanks and Tilley (1987a and 1987b).
2. This is implicit in Goody's studies of oral and literate societies, see above all Goody (1975). The idea is made explicit in Ong (1982); see also Bolter (1984).

aids that have evolved over the centuries since the invention of the printed book have at least some hope of locating information in a book without having to (re-)read it cover to cover. Extended to the scale of an archive, these paper-based techniques rapidly break down. How easily can an archaeologist identify contexts where a particular type of pottery was found, or locate photographs of architectural remains dated to a particular period?

7.3 The Southern Euboea Exploration Project

The Southern Euboea Exploration Project (or, inevitably, SEEP) has recently attempted to address just this kind of problem. The project grew out of Donald Keller's dissertation research,[3] which suggested unexpected patterns of rural settlement and land use in southwest Euboea in the classical period. When he planned his initial work, Keller had considered entering his data in a database, but reasonably concluded that the minicomputer-based systems available to him in the late 1970s were expensive, time consuming and not guaranteed to produce results he could not achieve with paper forms. From 1985 to 1988, an intensive survey of an area of around 25 square kilometres near Karystos extended Keller's original work; in this phase of the field work, project members recorded their observations on paper forms derived from those Keller had used. SEEP is now entering a new phase with quite different objectives: the project is attempting to develop appropriate field techniques to reveal routes of communication in a more extensive survey of southern Euboea.[4] As the project directors attempted to synthesize the results of the intensive survey and plan for the extensive survey, it became apparent that the difficulty of identifying material relevant to a particular question in the now sizable archive of photographs, drawings, notebooks and paper forms was a major obstacle. As a first step, they decided it was worth the effort to enter the structured information on the paper forms in a relational database system for a personal computer. As they began to plan the project's evolution from a paper-based recording system to an on-line recording system, they consulted with other archaeologists, including members of the Perseus project. These discussions raised further questions: what do changes in the recording system imply for the project's plans for publication? Is it possible to eliminate the unpublished archive altogether?

7.4 Perseus

The Perseus project is assembling a large interdisciplinary hypermedia system on classical Greece. This includes, for example, Greek texts in original and translation, philological tools and historical essays in addition to such archaeological material as catalogues of objects and contexts, an interactive atlas, satellite images, and an extensive photographic collection.[5] One goal of the project is to see how research and teaching can change when a rich collection of diverse resources can be brought to bear on a problem. From this point of view, the significance of Perseus is that it is creating a new kind of small on-line library, containing material that can be used for many different purposes by many different kinds of 'readers'.

Unlike a library, however, the Perseus discs are not simply repositories that collect and organize existing publications. Perseus also represents an experiment with a new medium of publication, one that permits us to redefine what information belongs in the archaeological record. Viewed in this way, the significance of Perseus is as a publication without the physical limitations of printed publications.

As archaeologists from Perseus and SEEP discussed SEEP's publication plans, therefore, they raised a further question: is the Perseus system capable of publishing SEEP's material more effectively and more completely than paper?

7.4a Electronic information interchange in Perseus

The Perseus project has addressed problems of archaeological information management that are not normally confronted by single research projects, and that are more closely analogous to the challenges faced by different archaeological projects that wish to exchange information. In addition to material assembled by project staff working with a variety of software, other information in Perseus derives from published work, when permission to republish has been granted by the copyright holder, and from other specialists in a particular content area who are not part of the project's full-time staff. Perseus has to cope with a large and challenging corpus: hundreds of megabytes of textual data, and thousands of images, ranging from photographs of coins to architectural plans to images derived from satellite data. With collaborators distributed across the U.S. from Brunswick, Maine, to Claremont, California, working with a wide variety of text editors, databases, hypermedia programs, and graphics applications as well as custom programs, interchange of information is a major challenge. The Perseus project chose a classic strategy: it attempts to isolate the definition of an object's structure from any assumptions about the kinds of analysis that can be performed on it.

This representation of archaeological objects has to satisfy two technological constraints: it has to be independent of any particular hardware or software platform, and capable of exchanging information with existing software with minimal effort. In short, it assumes a lowest common denominator for data types: ASCII data only for all textual information, and a restricted number of widespread data types for non-

3. Field work carried out from 1978-1981. Donald R. Keller, 1982, "Intensive archaeological survey in the region of Karystos, Euboea", *Program in Classical Archaeology*, Indiana University.
4. See most recently Keller and Wallace (1990), with previous bibliography in note 3.
5. As of the date of this publication, approximately 40 test sites are using beta versions of Perseus CD-ROMs and video discs. The first commercial version is to be distributed by Yale University beginning in December of 1991, with further issues planned annually. Inquiries about availability and pricing of the Perseus discs should be directed to Yale University Press.

textual material.

On the other hand, the representation must capture the full contents of a document. It must be:

- *Complete*. It must represent all the information recorded in the original system.
- *Flexible*. It must be able to accommodate modifications and additions to data structures, as well as data contents.
- *Open-ended*. The interchange format must be capable of recording multiple interpretations or versions of the same information within the context of the same document.

To satisfy the requirements of the Perseus project, therefore, a system for exchanging information must provide not simply a text-only method for encoding textual information in all its complexity, but also a text-only method for representing the rules defining the information's structure. The interchange system must provide not a common vocabulary for describing information, as has sometimes been proposed,[6] but a metalanguage — a communicable grammar for defining concepts and terminology.

7.4b Standard Generalized Markup Language

The need for a metalanguage to define object structure is not unique to archaeologists. In fact, it is sufficiently broad that the International Standards Organization (ISO) recently defined a standard for such a metalanguage, the Standard Generalized Markup Language, or SGML.[7] SGML is the descendent of earlier markup languages that were developed for publishing applications. In different typesetting programs or on different computers, completely unrelated codes might be used to indicate various formatting functions (a familiar problem to many users of more than one word processing program). With a markup language, the author can specify content, rather than formatting, so that instead of formatting an article's title with instructions to centre the title in italic type of a certain point size, for example, the author might simply identify the chosen text as a 'title' element. In SGML, that might appear bracketed with start- and end-tags as:

<TITLE>An Experiment in Electronic Exchange and Publication of Archaeological Field Data</TITLE>

The typesetting program could print this centred in italic type, or however the editors chose to display titles. Indeed, the author's word processor could display it that way on the computer screen as well: it is not necessary that the author ever see the SGML codes.

The critical insight in this trivial example is that specification of structure can be isolated from processing instructions of whatever kind. The text file might be interpreted by a typesetter for printing, but the tags could just as easily define fields for an archaeological database, or identify the structure of a hypermedia network. The SGML of today's ISO standard lives up to its name: it is a very generalized language for describing the structure of a document.

At the Perseus project, we have therefore added yet another type of program to the collection of software for working with archaeological information: the SGML-intelligent editor.[8] It may seem perverse to add another piece of software to deal with the proliferation of programs already in use, but consider the number of import/export utilities necessary to guarantee that information from any program can be transferred to any other program in the collection. Increase the number of programs, and the number of utilities grows geometrically. Define the SGML file as the common intermediary, and each program needs only one utility set: import from and export to SGML format.

SGML provides the means for formalizing the structure of archaeological information in Perseus, and verifying that the structure is coherent. It can also check that a given document adheres to those definitions. Before importing information into an application, or after exporting new information from an application, therefore, SGML can guarantee that the information is correctly structured. SGML can *not*, in and of itself, verify the contents of a structure. That job, like any other analysis of contents, must be carried out with other applications.

Used carefully, formal structures in SGML open up some interesting possibilities. Most obviously, a single document can be implemented in many different ways. SGML can even provide an application-independent absolute system of reference. Indexes of terms to SGML elements, or of sub-elements to elements can remain stable across implementations in a particular application, as can cross references to other SGML-defined elements.

As archaeological information systems reach the level of complexity that results from the field data of more than one project, these benefits more than compensate for the overhead of working with an additional piece of software strictly concerned with structure.

7.5 Example of implementations

For this discussion, a brief example will illustrate some of the issues that arise when material from a relational database system like SEEP's is transferred to a hypermedia system like Perseus.

The principle data structures recorded by SEEP had been defined in some detail before the project ever considered computerizing its recording system. Team members working in the field or recording pottery and other finds in the museum complete forms with a

6. For example, most recently, at the Second World Archaeological Congress, Wilcock (forthcoming). I have seen only the conference pre-publication papers, but the reader should refer to the final publication of the WAC.

7. For a good discussion of some of the broader implications of content markup, see Coombs *et al.* (1987). For a readable introduction to and description of SGML, see Bryan (1988), with references to the impenetrable ISO document.

8. Very early in the development of the Perseus project, Elli Mylonas had begun structuring Greek literary texts with SGML; her success suggested that SGML could apply equally well to documentary texts.

combination of 'check-off' type data, and space for free comments on particular subjects. A detailed 'user's manual' explains the forms, and defines terms, listing all possibilities for the controlled vocabulary to be used for some entries on the forms.

Both visually and structurally, the SEEP relational database is closely modelled on the existing forms, but automates links among the different types of documents. Fig. 7.1 illustrates the equivalent in the database system of the first page of a form that is filled out in the field for every find spot. In the database system, a separate form automatically produces an inventory of all the objects found there, and is linked to the individual descriptions of each object (Fig. 7.2).

These descriptions are initially recorded in the local museum for every object recovered, while particularly significant objects are later catalogued more fully. With the relational database, these records, separated on paper, can be unified. It is also possible to track links such as sherds that were recorded separately and then found to join.

In SEEP, the observations at the find spots and above all the assemblages of material recovered from the find spots are the primary evidence for interpreting a find spot as a site.

7.6 Perseus site catalogue

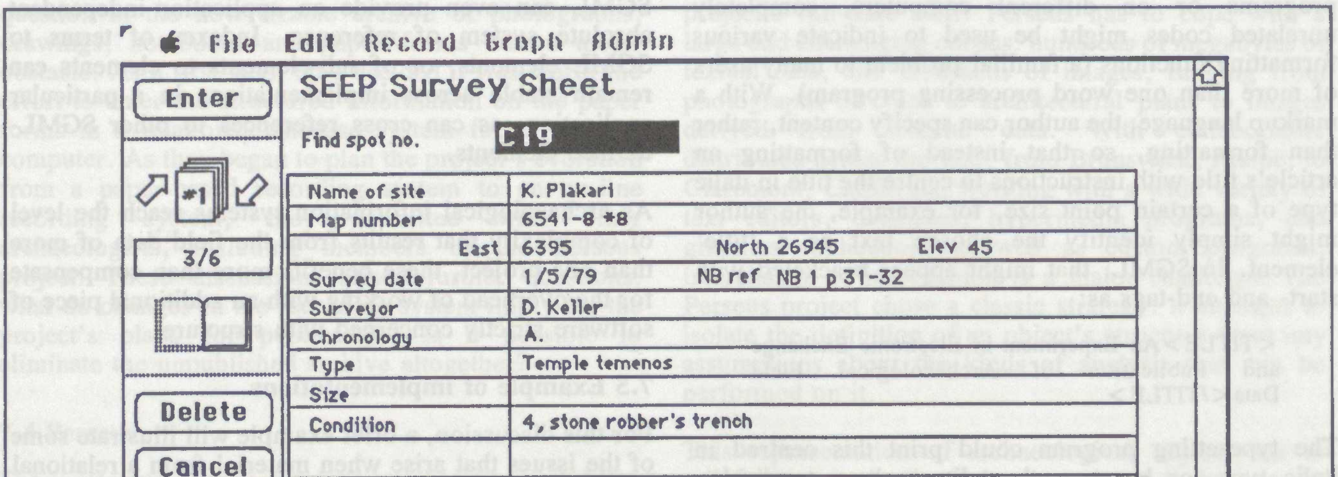
In Perseus, a site is presented to the user in a very different manner (see Fig. 7.3). Textual description of the site is linked to plans of the site, which can display the approximate location and point of view of digitized photographs in the collection, permitting a simple sort of 'pseudo-travel'. Longitude/latitude coordinates can be plotted on an interactive atlas, and architectural monuments or other objects from the site in the Perseus catalogues are linked to the site record.

7.7 SEEP material in Perseus

Although these visualizations of a site are quite different, they are largely complementary rather than contradictory. Some elements between the two systems overlap; for example, in both Perseus and SEEP, the authorship and version history of a document is carefully traced. In such cases, data from fields of the SEEP database could be translated directly into SGML structures already defined for Perseus. Much of the information in SEEP had no directly corresponding element in Perseus, however. An SGML module containing definitions of all the remaining material in SEEP was created, and the basic Perseus definition of such elements as an archaeological site was modified to make the SEEP material an optional addition.

The SGML rules define the relations of SEEP material with pre-existing Perseus material, so that when this SGML file is translated into Perseus' HyperCard-based front end, the ensemble can be treated as a whole. Thus if references in the SEEP database identify objects in the Perseus system, Perseus' system of dynamic links can be put into play. This is illustrated in Fig. 7.4, showing a site from the SEEP database that has been

Figure 7.1: Part of the SEEP site form as implemented in the relational database system. The form closely follows the appearance of the paper forms that team members fill out on-site.



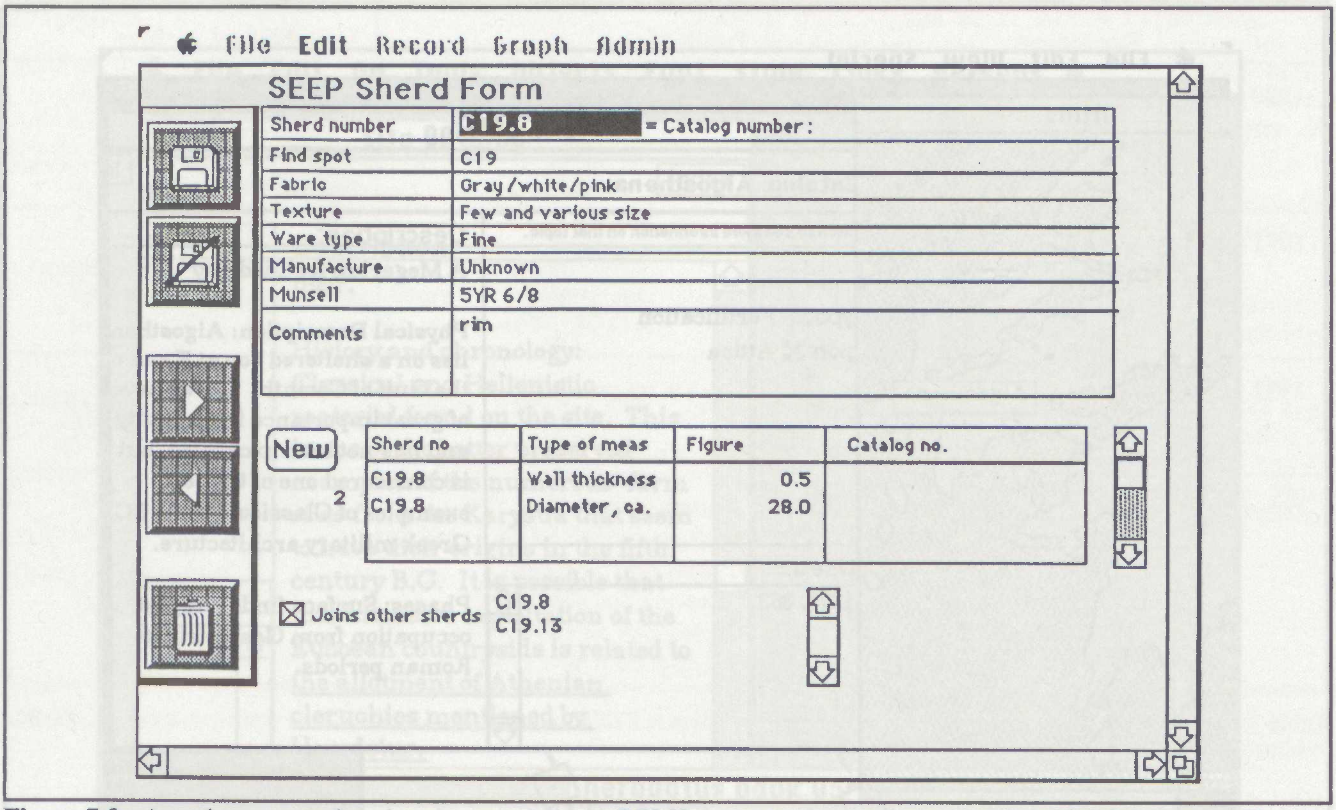


Figure 7.2: A major reason for choosing a relational DBMS is to track associations such as joining sherds. Here an uncatalogued sherd joins two previously recorded sherds.

imported via SGML into the Perseus environment. In HyperCard, most of the elements from the SEEP database have been interpreted as discrete HyperCard fields or labelled sections of longer HyperCard scrolling fields, but a cross reference to a passage of Herodotus is instead attached to a section of the author's comments on history and chronology of the site, and indicated only by underlining. The user can pop up a menu here to establish a dynamic link with this passage. In Fig. 7.4, we see the screen just after this action: part of the basic site description appears in the rear window, while the front window displays the text of Herodotus.

This is a small example, but it illustrates an important principle: different applications may interpret the same information structures in dramatically different ways. By attempting to define information structure abstractly with a tool like SGML, we leave open the possibility that another user or another program might exploit that information in unforeseen ways.

7.8 Structures underlying implementations

A very brief selection from the common Perseus and SEEP SGML rule set (or 'document type description', usually reduced to DTD in SGMLese) will give a general idea of this process even to readers unfamiliar with SGML. The greater part of the DTD defines relations among archaeological constructs: sites, locations in various systems such as longitude/latitude or grid systems, and the like. In the documentation of a site, an optional element is defined for commentary on history and chronology. This commentary is composed of 'paragraph' elements, which are defined as being composed of raw character data, footnotes or cross references, as follows:

```
<!ELEMENT para    - - ( #PCDATA | note | xref)+ >
```

The cross reference is made up of two parts, a source span of text, and a typed reference to an object elsewhere in the Perseus system:

```
<!ELEMENT  xref  - - (source.span, &ref;)        >
<!ELEMENT  source.span        - - (#PCDATA )     >
```

The types of the object are listed at the very beginning of the Perseus DTD, while the names of the objects themselves are simply character data:

```
<!-- This is the identifier used elsewhere in the system to
refer to this object. -->

<!ENTITY  %  ref  "(biblio.ref   publication.ref |
image.ref | artefact.ref | context.ref | inscr.ref | gktxt.ref
| other)" >

<!ELEMENT &ref; - - ((#PCDATA )   >
```

Thus the last sentence from the paragraph in Fig. 7.4 would appear like this in the SGML source document:

```
<para>...
It is possible that this intensive exploitation of the
Euboean countryside is related to
<xref><source.span>the allotment of Athenian
cleruchies mentioned by Herodotus. </source.span>
<gktxt.ref>Herodotus book 5,77
</gktxt.ref> </xref>
```

In other words, the object referred to is named 'Herodotus book 5,77' and is of type gktxt.ref. It is tied to the span of text 'the allotment of Athenian cleruchies mentioned by Herodotus'.

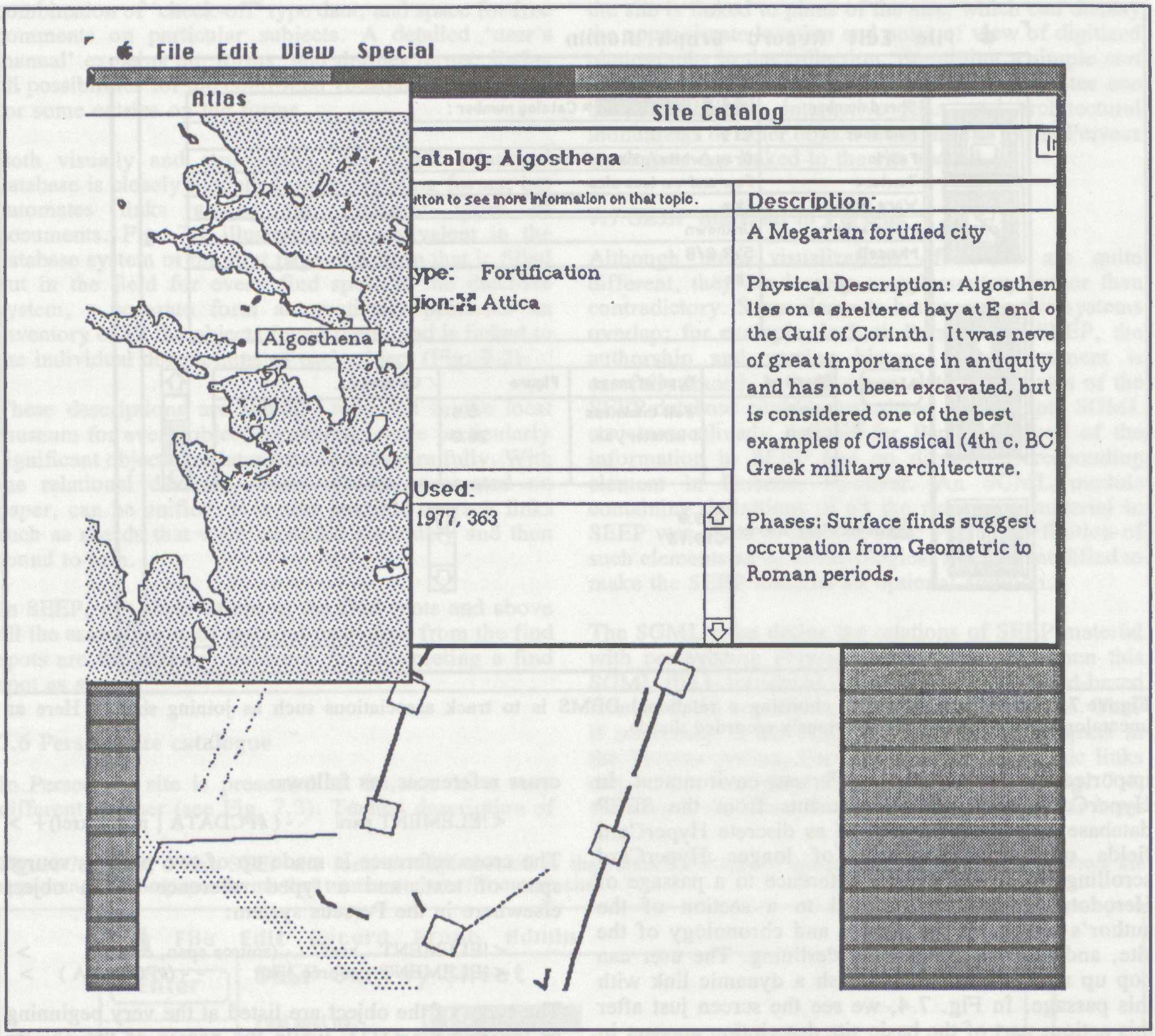


Figure 7.3: An example site showing how Perseus' HyperCard interface associates textual description, longitude/latitude data in an interactive atlas and site plans.

The bracketed markup makes the structure of the cross reference explicit, but difficult to read. In the Perseus interface, the reader sees only the underlined section of text. For display purposes in the SEEP database, the sentence is shown in a more legible form that still provides sufficient indication of the underlying structure to be translated back to SGML without any loss of information:

> It is possible that this intensive exploitation of the Euboean countryside is related to *the allotment of Athenian cleruchies mentioned by Herodotus.*[text: Herodotus book 5,77]

7.9 A possible evolution away from the unpublished archive

For SEEP, the definition of application-independent object structures in SGML specifies a system for exchanging information with external projects like Perseus, but it also means that within the context of SEEP, it is now easier to consider multiple uses of the same information base. For analysis of the intensive survey, tracking information with a relational database was the highest priority, and will certainly simplify the production of the promised study. But once this information is on-line in a structured and flexible form, we can rethink the relation of the report and the information behind the report. The database might as well be published electronically; and, if it is to be published, it might as well be meaningfully related to the analysis. Future reports will continue to be published on paper, but perhaps simultaneously electronic versions of the reports may take on the appearance of a hypermedia network as they automate access to other parts of the project's documentation.[9] A relational database model would not by itself support such publication plans, and therefore would not tend to suggest the possibility. The formal definition provided by SGML helps free us to think abstractly.

9. For an experiment along these lines, see Rahtz *et al.* (forthcoming).

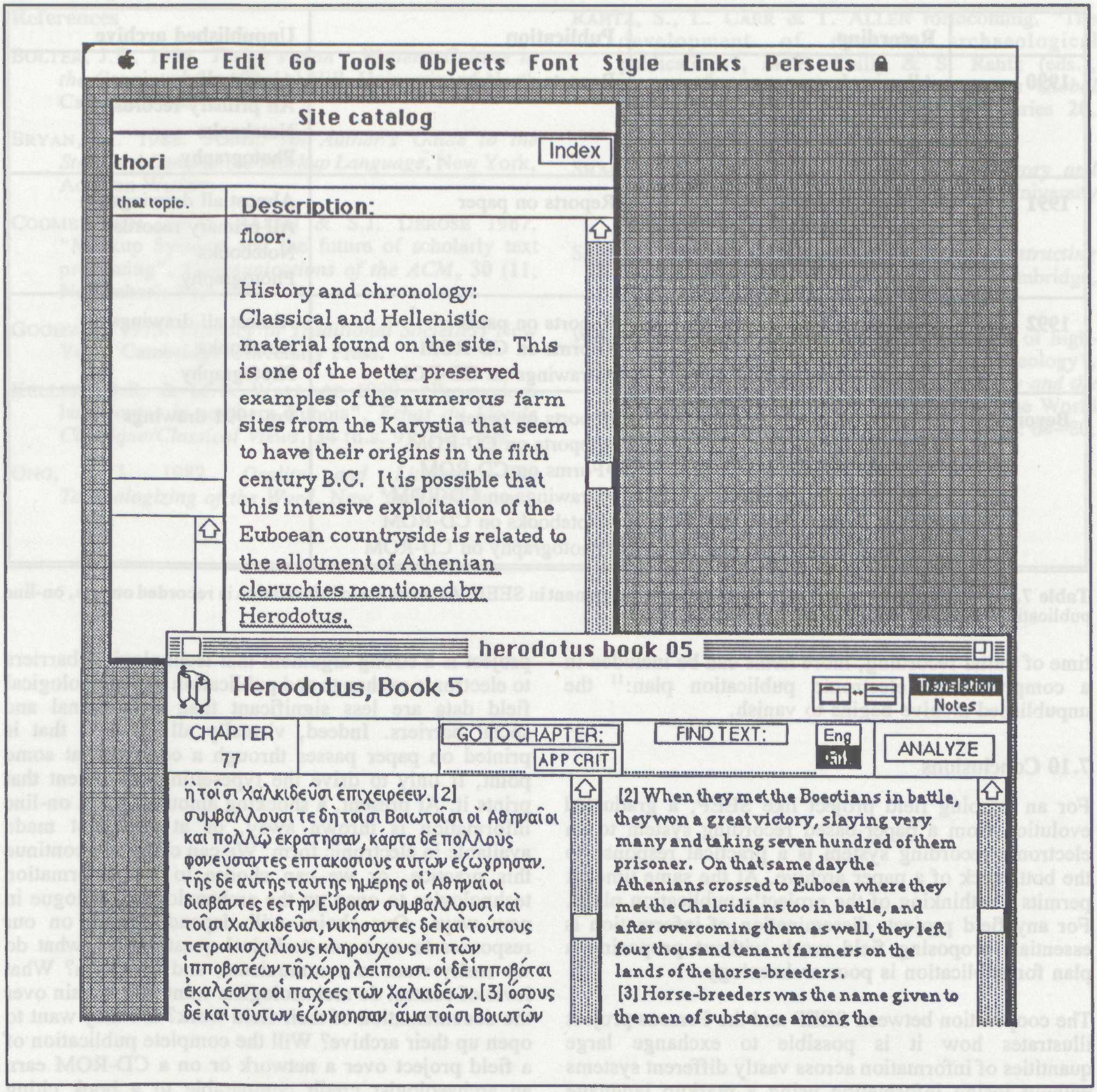


Figure 7.4: The same document may be visualized in radically different ways in different applications. Here in the Perseus interface, a reference to an object already in the system (the text of Herodotus) is implemented as a hypertext link. The front window presents the text that is related to the underlined phrase in the rear window.

Table 7.1 summarizes one possible evolution of information management in SEEP.[10] The initial step proposed for 1991 is well underway. The backlog of paper forms is being entered, and SGML structures for interrelating SEEP reports with this database have been defined, based on the experience of sharing material with Perseus. Our hope is to include this material on a future Perseus CD-ROM.

For 1992, the major innovation proposed will be to begin on-line recording in Euboea. If this step is funded, we plan to enter material in the SEEP database daily, so that as we plan how to deploy teams in the field, we can have a clear, up-to-date view of the material recorded. This step will also permit us to enter pottery profiles on-line, so that our published database can include all drawings done in the museum during the season.

Beyond 1992, the plan is more speculative, but the general pattern is clear enough. Bulleted items highlight on-line material. As more items are put on-line at the

10. The timetable in Table 7.1 represents the author's proposed migration of paper-based information to electronic form in SEEP. Obviously, many timetables differing in detail could be proposed, but the general movement away from paper recording systems is clear in any case. SEEP is currently seeking funding to support its development of information management. Any implementation of a timetable will depend on funding, on developments in technology, and on the project's priorities as determined by the directors of the project.

	Recording	Publication	Unpublished archive
1990	All records on paper only	Reports on paper	Almost all drawings All primary records Notebooks Photography
1991	•Forms on line Drawings on paper Notebooks on paper	Reports on paper	Almost all drawings All primary records Notebooks Photography
1992	•Forms on line •Drawings on line Notebooks on paper	Reports on paper •Forms on CD-ROM •Drawings on CD-ROM	Almost all drawings Notebooks Photography
Beyond	•Forms on line •Drawings on line •Notebooks on line •Photography on line	Reports on paper •Reports on CD-ROM •Forms on CD-ROM •Drawings on CD-ROM •Notebooks on CD-ROM •Photography on CD-ROM	Pre-1991 drawings

Table 7.1: One possible evolution for information management in SEEP. As more basic information is recorded on line, on-line publication begins to eliminate the unpublished archive.

time of initial recording, more items can be included in a comprehensive electronic publication plan:[11] the unpublished archive begins to vanish.

7.10 Conclusions

For an ongoing field project like SEEP, a graduated evolution from a paper-based recording system to an electronic recording system is a practical response to the bottleneck of a paper archive. At the same time, it permits a rethinking of the project's publication plans. For any field project, dissemination of information is essential; proposing field work without proposing a plan for publication is poor archaeology.

The cooperation between SEEP and the Perseus project illustrates how it is possible to exchange large quantities of information across vastly different systems without losing information using a markup language like SGML. Different kinds of systems will provide different analytical tools for working with the same source document, and may even implement the same relations among objects in radically different ways, as in the hypertext example discussed above. The richer the information in a document, the more probable it becomes that no single program will provide the means to analyze it exhaustively, but using SGML, the archaeologist working with a variety of programs or collaborating with other archaeologists using different software can guarantee that all programs work with a data source that adheres to a formally defined structure.

To return to the theoretical perspective that began this article, the collaboration between SEEP and the Perseus project is a strong argument that technological barriers to electronic exchange and publication of archaeological field data are less significant than institutional and social barriers. Indeed, virtually all material that is printed on paper passes through a computer at some point, if only to drive the typesetting equipment that prints it. At present, a shocking amount of that on-line information is thrown away, or at least not made available in electronic form. We can choose to continue this practice, or we can choose to use information technologies to open up the archaeological dialogue in new ways. Our choice will depend largely on our responses to such non-technical questions as, what do we really want to communicate, and to whom? What level of control do archaeologists want to maintain over the documentation of their field work? Do they want to open up their archive? Will the complete publication of a field project over a network or on a CD-ROM earn an archaeologist credit comparable to a book citing unpublished material?

The answers to such questions may or may not seem obvious, but they are questions that we should evaluate on their own merits, rather than anachronistically assuming answers suggested by the technology of printing on paper.

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11. Table 7.1 suggests CD-ROM as the medium for SEEP's publication. One attraction of CD-ROM is that production costs for a full disc (up to 650 Mbytes of storage, depending on the file system) are no greater than for a partially full disc. However, one of the major advantages of on-line information management is precisely that it does not restrict you to one medium of publication. As international networks improve, publication over a network might be equally attractive for parts or all of the SEEP material. Here too, a single source file could support many kinds of implementations.

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