

The Making of *Combe-Capelle on CD-ROM*

Harold L. Dibble

University of Pennsylvania
Philadelphia, Pennsylvania

Shannon P. McPherron

Bishop Museum
Honolulu, Hawaii

CD-ROM technology has tremendous potential for disseminating archaeological data and results both to the general public and within the professional community. Building on the authors' own experiences in producing a CD-ROM companion to a published site report, this article presents an overview of some of the issues that should be considered in developing standards for taking advantage of this new medium.

Introduction

As is true for all fields, computer technology has been making fundamental changes in how we do archaeology. Beginning about 30 years ago, the first areas to be significantly affected were in data analysis, as many archaeologists began to utilize mainframe statistical packages. With the development of microcomputers in the early 1980s, computerized database management became much more accessible. Since then, computerized techniques for data acquisition in the field and laboratory have been progressing rapidly due in part to the steady shrinking of computers down to laptop, notebook, subnotebook, and palmtop sizes, and in part to the development of more sophisticated instrumentation. Beginning in the late 1980s and into the 1990s, graphic presentation and analysis applications have enjoyed widespread use. Now, with the development of CD-ROM technology, archaeologists are faced with yet another potential application, the publishing of archaeological reports in computerized format.

This article describes our own attempts along these lines. *Combe-Capelle on CD-ROM* (Dibble and McPherron 1995) is a multimedia companion to the final report on that site published as a standard monograph (Dibble and Lenoir 1995). The CD-ROM contains over 400 megabytes (MB) of data, most of which are full-color images. There are about 900 images of artifacts recovered from the site (almost 10% of the total excavated assemblage) and over 100 "slide" images of techniques of excavation, artifact processing, stratigraphy, the area surrounding the site, project personnel, and more. It also contains all of the raw data generated by the project, including both

field contextual information (levels, x, y, z coordinates, etc.) and analytical information (measurements and other non-metric observations). Included with the CD-ROM are four programs, including their source codes, written by the authors: CCIMAGE, a Microsoft Windows program designed to browse through the color images; CCPLOT, a DOS program that accesses the data to produce color maps showing the positions and distributions of artifacts as they were excavated; ENTRER TROIS, a DOS data entry program that supports electronic calipers; and EDM, another DOS program written to work with electronic total stations for archaeological mapping or piece proveniencing. More information on the CD-ROM and site report is available (http://www.upenn.edu/museum_pubs/Prehistory.html) on the World Wide Web.

In developing this CD-ROM, we faced many issues. Some were technical, such as deciding on particular file formats and the nature of the user interface for the programs. Others were on a more philosophical level, such as trying to decide how this new medium should be exploited for the publication of these data and which aspects of the report should be left for a traditional book publication. The published CD-ROM reflects our decisions along these lines and it is now up to the archaeological community to evaluate the appropriateness of our decisions. In this paper we discuss some of these issues and present the reasons why, in an effort to contribute to the recent dialogue among archaeologists as to how this new technology can best serve our common needs, we produced the CD-ROM companion the way we did.

Background to the Development

Combe-Capelle Bas is a Middle Paleolithic site located in the Couze Valley of the Perigord region of southern France. Preliminary mapping of the site took place in 1985, and excavation began in 1987. It lasted for four seasons, producing an assemblage of approximately 12,000 lithic artifacts. This was followed by one full study season in 1991 and several shorter study periods in subsequent years. Throughout this time we actively developed several new computer applications to increase the efficiency and effectiveness of the work.

Not surprisingly, these new applications tended to mirror the progress of the project. When the excavation began our first concern was in the accurate recording of three-dimensional coordinates of the position of the artifacts, and so it was early on in the project that we developed programs to interact with total stations in a way that was more appropriate to excavation (versus general survey) applications (Dibble 1987), especially for dealing with problems of point proveniencing of artifacts and samples. This ultimately led to the EDM program supplied with the Combe-Capelle CD-ROM. Then, as we moved to the analysis phase, we began developing more user-friendly data acquisition programs. Many of these programs were written to interface easily with other devices, such as electronic calipers, scales, and video cameras. The final product, designed to address many of these needs, is the program *ENTRER TROIS*. Eventually it was necessary to integrate the several different kinds of data that we had acquired—field provenience data, analytical measures, and video images of the artifacts. The result was a program called *CCPLOT* (Dibble and McPherron 1988, 1992; McPherron and Dibble 1987). Finally, as we approached the production of the final publication of our work, we became increasingly concerned with the development of applications for presentation of those data. The result of these efforts is the CD-ROM itself as well as a traditional, comprehensive monograph (Dibble and Lenoir 1995). The monograph and CD-ROM differ in many important ways.

The monograph is, in most respects, a standard site report. It contains chapters written by various specialists concerned with the overall research design of the project; descriptions of the archaeological levels and their associated industries (with many illustrations of the artifacts); geological descriptions and interpretations; discussions of site formation; and interpretations of the industries, focusing on current problems in Middle Paleolithic research. Like all site reports, it was designed to stand alone and present a comprehensive picture of how and why the site

was excavated, the nature of the assemblages in their geological context, and behavioral interpretations.

The CD-ROM was not intended to stand alone, but is instead a companion to the monograph. It presents no background to the site nor any interpretations. But it does contain material that would be virtually impossible to include in the monograph itself. It would have been prohibitively expensive, for instance, to print a large number of full-color photographs in the book, which would have helped in discussions of raw material variability. The large storage capacity and low costs of CD-ROM, however, make it possible to publish many more photographs than could be accommodated in the book (Martlew 1992). Similarly, while the publication of raw data in printed tabular format may be useful from an archival perspective, it is extremely expensive to recover these data in a format suitable for reanalysis. So, in deciding where to put different kinds of information relating to Combe-Capelle, we tried to identify those areas in which traditional publications and CD-ROM individually excel and exploit each appropriately (cf. Perkins 1994). Before comparing these two formats and outlining our approach, however, a more detailed discussion of the data included on the CD-ROM and the programs used to access those data is required.

Description of the CD-ROM

CCIMAGE

CCIMAGE is a Windows program that allows access to the more than 1000 full-color images of artifacts (FIG. 1) and the site during excavation (FIG. 2). Basically it displays one image at a time, accompanied by a caption and a list of keywords. The idea behind this program is to allow users to browse through the images in four different ways.

One way to browse through the images is through what we call "slide shows," a collection of images arranged in a particular order. The user can browse through the show forwards or backwards, go directly to the beginning or end, or browse quickly by pressing a "fast-forward" button. The program comes with seven predefined slide shows. One provides an overview of Combe-Capelle showing images concerned with the history of excavations there and some pictures of the surrounding area. The second show presents a brief introduction to the current project. Five other slide shows present examples of major classes of artifactual material, including Levallois flakes, scrapers, notched tools, and cores. The user is also able to create a slide show by choosing combinations of keywords. For example, one can create a slide show containing all of the scrapers from a particular level.

The second way to browse through the images is to use

a modified hypertext capability on either keywords or captions. By clicking on any word in a caption or any keyword in a keyword list, the program displays the next image that contains that word. Additional images can be displayed by clicking on the same or different keywords or caption words. The third form of access is to call up a specific image directly. This can be done either by requesting a specific file name (each image is stored in a different file), or, in the case of artifact images, by typing in the Square-ID number (i.e., the artifact number) itself. Finally, there are two site maps in the program, and by clicking on one of the highlighted areas the user can obtain a photograph of that area.

With the exception of the predefined slide shows, the program is designed to provide the user with a very fluid and flexible access to all of the images in the database. There is instant access to any particular image or any combination of images based on keywords, captions, or the Square-ID number. The use of hypertext allows the user to constantly change the criteria for selecting the next image to be viewed and thus explore the images in any order. This flexibility, of course, is a primary advantage of using computerized formats, which easily allow a number of pathways through a given collection. This approach represents a major departure from the viewing capabilities of a more traditional collection of photos organized according to the specific themes of the authors. The hypertext approach can be contrasted with, for example, the slide show format, which is designed to lead the user through a series of photos in order to tell a particular story, to develop a theme or series of themes, or to overview comprehensively major parts of a site or its materials. The primary advantage of the slide show approach is that it communicates to the user in a logical order what the author thinks is important. In a sense, it is arranged just as any published book of images would be. The primary disadvantage of this format, however, is that the access is sequential in nature and does not allow the user to pursue easily his or her own interests (Rahtz, Hall, and Allen 1992). A book can handle this problem by providing an index; hypertext is essentially a way of producing a number of different indexes automatically and with less effort.

CCPLOT and the Analytical Data

Beyond the images, one of the primary purposes of publishing this CD-ROM was to distribute the raw data generated by the project and to provide a means of accessing it graphically. The program that accomplishes this is CCPLOT. CCPLOT provides the user with three menus. One presents all of the archaeological levels of the site; the second shows the excavation units; and the third is a

selection of predefined subsets of major artifact classes. The user may select one or more of the choices simultaneously from any or all of these menus. The program then accesses the database and draws schematic representations of the artifacts in either plan or side view according to their positions indicated in their x, y, and z coordinate values. Objects are color-coded either by artifact class or level (see Dibble and McPherron 1988). Once the artifacts are plotted, the user may click on an individual object to obtain other details concerning it and, if available, a black and white photo (FIG. 3). The data themselves are also accessible through any commercial graphics or statistical package.

The advantages of distributing the data and this program on CD-ROM format are very clear. While some maps of artifact distributions could be printed in the monograph, it would be impossible to present more than a selection of them and it would be very expensive to print them in color. Furthermore, the primary access to artifact photos in this program is not according to their attributes (as in CCIMAGE), but rather by provenience, which would not be possible in the written report.

CD-ROM versus Printed Monograph

It should be clear from the preceding discussion that the publication of data and images offers significant benefits that cannot be achieved with traditional printed site reports. Nonetheless, there are also very clear limitations inherent to this medium. The principal advantage of the CD-ROM relates to the kinds of access to both data and images that are possible in this format. The images of artifacts is a good case in point. In the Combe-Capelle monograph, the basic artifact descriptions are presented by level, since stratigraphy represents the primary organization for the excavation, description, and analysis of the site. Accompanying the description of each level are several illustrations of artifacts from the level. In this format the reader can easily see examples of particular tool types—scrapers, for example—from a given level. It would be more difficult, however, to see all of the scrapers together, or all of the scrapers made on Levallois flakes, regardless of what level they were found in. The CCIMAGE program manages this problem easily, however; by using hypertext or multiple keyword searches, any image or group of images can be found quickly.

On the other hand, when the only access to a photo collection is through hypertext, it is almost impossible to develop and communicate certain themes that are thought to be important to the author. A hypertext format is not particularly useful, for example, in communicating a specific interpretation. Interpretations are, after all, based on arguments, and arguments are essentially linear in form.

One simply cannot make a coherent argument by presenting all of its necessary premises, steps, and relations in a random order. This distinction in terms of access to the material is essentially the same distinction made by Rahtz, Hall, and Allen (1992) between a cognitive approach to learning, wherein the reader assembles facts together to form a conclusion, versus a procedural approach, wherein facts are presented to the reader in a particular order with inferences linking one to the next. The cognitive approach is far more suited to hypertext or hypermedia publication on CD-ROM, while the procedural approach is not. It is not a question of what kind of medium is used (CD-ROM or in a book), but rather the kind of access that is made available to the user.

This difference in access capabilities is one major reason why CD-ROM was not developed as a stand-alone product, but was instead designed to be used in conjunction with the published monograph. The monograph, which is written to be read in a sequential order, is the more logical place to present background, basic descriptions, arguments, and interpretations. To the extent desired, the images on the CD-ROM can be accessed in an order that follows directly the order of discussion in the book and thus help supplement those discussions with additional figures. But the CD-ROM goes well beyond the book itself by providing the user with the opportunity to explore the material in an independent manner. By publishing both the CD-ROM and the monograph together, we are in a much better position to exploit the primary advantages of both kinds of media to facilitate different kinds of learning.

To some extent, this discussion creates an artificial distinction between the hypertext access available with CD-ROMs and the sequential access typical of books. While it is very difficult to make a printed book work as a hypertext document, there is no reason why the contents of a CD-ROM cannot be accessed in a sequential manner. This raises the question of why we decided against publishing the entire monograph on CD-ROM, as a kind of "coherent archive" that Ryan (1992) argues should be the final product of any excavation. Our reasons for not doing this were all practical ones. In the first place, not all archaeologists have access to computers or computers with CD-ROM drives. Thus, a CD-ROM as the sole publication medium would significantly limit the potential readership of the report. Second, there are still significant problems with hardware and software compatibility. Although the raw data and image files on this CD-ROM are accessible with Macintoshes, the programs themselves will only run on PCs, and some of them will run only under a Windows environment. Third, even for those who have the necessary hardware, it is probably not as comfortable to read a

350-page report on a computer screen as it is to read it in printed format. Fourth, as we just discussed, there are no real advantages to publishing the straight text on CD-ROM because the arguments or themes developed in the text are not improved by hypertext access capability.

The most significant reason, however, is future accessibility. Here we are concerned with two issues. First, the archival life of CD-ROMs is simply not known. This issue is little discussed within the CD-ROM industry and most industry claims lack independent confirmation (Bouley 1992; Stielow 1992). Currently, it seems safe to assume an archival life of at least 10 years and perhaps even 25, but no one knows for sure. The longevity of acid-free paper, on the other hand, is well understood and far exceeds these estimates for CD-ROMs. Second, the very rapid changes in computer hardware and software make it unlikely that any computerized format will remain readable for more than a short period of time, regardless of the longevity of the physical medium. This problem was made clear recently when a colleague of ours tried to access his data collected in the 1970s and stored "permanently" on computer tape. The tape itself was fine, but there was only one remaining person in the university computer center who still knew how to access the data!

In a similar example, we would pity the person who has all of his or her data stored on a 8-inch floppy diskette. In fact, some of the first CDs printed in the mid-1980s are no longer readable, not because the medium failed but because of changing software and hardware standards (Stielow 1992). Given these concerns, it is simply unrealistic to assume that CD-ROMs produced today will be readable in a decade. Institutional efforts to protect and preserve archaeological data in the face of these issues are clearly needed (see Eiteljorg 1994). In addition, any software included on the CD-ROM will also be affected by future changes in operating systems. For the near future, CD-ROM technology is not likely to replace printed site reports, although it should be admitted that it can enhance considerably traditional methods of publication. In particular, the ability of CD-ROM to publish raw data—the provenience and analytical observations of the artifacts as well as the artifact and slide images—has several implications.

First, for research, the availability of the analytical data will facilitate more productive research on the existing material. At the most basic level, access to the original data will enable independent evaluation of the published analyses, not just by checking the author's calculations but also through exploring different implications of the data or alternative hypotheses. Even more important, it will enable others to use those data to address research questions not

posed by the original author. In effect, this will considerably extend the use life or research value of many excavated collections. Even when certain observations were not made on the material in the original study, new studies of the artifacts can be carried out and, where relevant, these new data linked directly to existing data, thus minimizing the expense of supplemental studies. Not only would this greatly reduce the cost of basic research, but it may also have the effect of conserving archaeological sites by making existing data more readily available and thereby minimizing the need to acquire new data through excavation.

Moreover, and to a large extent, the publication of raw data reduces some of the burden of the original investigator. It is generally felt, and with good reason, that a final site report should represent the most comprehensive set of results possible within the current intellectual and methodological context. In a sense, it should present everything that could be learned about the site because the excavation of a site effectively destroys it. But the unfortunate reality is that a site report will always reflect primarily the interests of the excavator and many questions that may be posed of those data by others are never addressed. By their very nature, the summaries of information presented in many site reports are often not adequate for others who wish to explore different lines of thought. The best way around this dilemma is to distribute the raw data in conjunction with the summaries and interpretations of the excavator, which allows the original excavator to concentrate on those issues of most interest to him or her, while at the same time making it possible for others to investigate different questions.

A second major implication of publishing data on CD-ROM is that it greatly enhances their use for education. Through the slide images students can get much more of a feel for how archaeology is actually done and excavation techniques can be more thoroughly described. An abundance of color artifact images allows students to understand more the nature of the recovered assemblages. And the access to the analytical data allows students a much greater opportunity to engage in meaningful research.

Technical Issues and Costs

In designing the Combe-Capelle CD-ROM, we faced a number of technical problems. Perhaps the most difficult of these was the issue of Macintosh versus PC compatibility. We have always operated in the PC world and know very little about Macintosh software and hardware. We realized, however, that if we were to meet our primary goal of making the Combe-Capelle data truly available to archaeologists, we would have to publish in a format that could be accessed by both types of systems.

Fortunately, CD-ROMs are written in a standard format that allows both Macintosh and PC computers to view their contents. The contents of our CD-ROM are composed of two basic file types: program files and data files. Due to differences in the operating systems of Macintosh and PC computers, program files are incompatible, meaning that the same program will not operate on both types of computers. Aside from newer, more powerful Macintosh computers that are able to emulate PCs, the only solution to this problem is to write separate versions of each program. In our case, however, this was not possible since we are not capable of writing programs for both types of computer. Since four of the five programs included on the CD were already written for PCs, we decided to stay with PC compatibility for the program files.

Data files are easier to access on different platforms since compatibility is dictated not so much by the computer's operating system but by the programs used to access the data. When the data are written in a highly standardized format, many Macintosh and PC programs will be able to access the same data files. From the beginning of the Combe-Capelle project, we made a special effort to store our data in commercially standardized formats. Thus our data are stored in dBase III (DBF) files and our initial images stored in Targa (TGA) files, which were industry standards at the time the project was initially developed. While the former is still recognized by nearly all database and spreadsheet applications in the Macintosh and PC world, we decided to also include an ASCII copy of the data on the CD-ROM to ensure access to the data (cf. Eiteljorg 1994). As for images, Targa files are now not as widely recognized. As a result, for the CD-ROM project, we converted all of our images to Windows bitmap (BMP), files which are the standard on PC computers running under Windows and, while not the most popular standard for Macintosh computers, are nonetheless recognized by most Macintosh graphics programs.

The choice of image format was not entirely driven by the issue of Macintosh and PC compatibility, but was also influenced by concerns about image quality, storage requirements, and display speed. Those who have worked with any computer graphics program know that there are at least a half-dozen popular image formats and probably a dozen more less popular ones. The basic differences among these formats lie in the image quality and in how the data are compressed when stored on disk. Image quality is primarily determined both by the number of pixels (dots) making up the image and by the number of colors used, though presentation quality can also be affected by the type and degree of compression. The storage requirements for an image are a combination of its size

(width by height in pixels), the number of allowable colors, and type of compression. Lastly, the display speed is affected by both the type of compression and the computer's graphics card.

Obviously, it would be best to optimize image quality and access speed within the constraints of the available storage space. The best quality images are those based on a format that allows up to 16 million colors. Using an uncompressed format also enhances image quality as well as offering the highest access speeds. With this format, which is maximally expensive in terms of space, the individual image files take up from 200–500 KB each, or about 300 MB altogether. This is well below the limits of the CD-ROM, which holds about 600 MB. The raw data (in two formats) take up just over 9 MB total; the black and white images accessible in CCLOT occupy 21 MB, and the remaining program files take up approximately 5 MB.

The major constraint on image format, however, was not related to these considerations, but rather to differences in computer capability, since not all computers can adequately deal with 16 million colors or with higher-resolution images. Higher resolutions require more pixels. But different screen formats, which are limited by the quality of the monitor and video card and by the software video drivers, will affect the number of pixels that can be displayed in a given area of the screen. In other words, a 640×480 resolution displays 640 pixels horizontally and 480 vertically. If an image has a resolution of 800×600 pixels, it simply cannot fit on a 640×480 screen. Second, if a computer is equipped to handle a maximum of only 256 colors, then it must reduce the number of colors itself, which can take an enormous amount of time (up to several seconds per image).

The solution to these problems required two different approaches. In order to minimize access time for machines that can handle fewer colors, a second 256-color BMP format was included for every image. Each of these takes up between 100 and 200 KB, or just over 100 MB total, but even on low-end machines access time is very fast. The best solution to the screen resolution problem was to size the images so that their maximum resolution was one that would be compatible with the lowest resolution screen. When those same images are displayed on screens with a higher resolution they simply take up less room, although they also appear as being sharper.

All of our images were thus modified so that they would be optimized in both size and quality for the lowest possible screen format— 640×480 resolution and 256 colors. When displayed on a higher quality system, the images appear smaller, but better. If they had been optimized for the higher quality system, then their quality would markedly diminish on a low-end system.

Having decided on the content and format, there remained the tasks of organizing it, transferring it to the CD-ROM, and finally testing it. One of the disadvantages of CD-ROMs is that data can be written to them only once, which means that the programs and structure must be worked out before a CD-ROM is pressed. Fortunately, one can now purchase a hard disk even twice the size of a CD-ROM for no more than a few hundred dollars. With a hard disk of this size, it was possible to lay out, organize, and test the programs and structure of the CD-ROM without actually pressing a master copy of it. Once satisfied with the structure, the contents of the hard disk were transferred to the University of Pennsylvania's Social Science Computing Center across the Internet and test CD-ROMs were printed by them for a minimal cost (\$30 per disk). Low costs at this stage were particularly important because the process of testing and debugging resulted in the need to print several iterations before we achieved a master disk suitable for publication.

The most serious problem that arose during the debugging and testing phase had its source in the relatively slow access times of CD-ROMs versus hard disks. While our programs CCLOT and CCIMAGE functioned smoothly on our test hard disk, they were unacceptably sluggish once they were transferred to CD-ROM. The problem was most acute during database searches. In some cases, we were able to address this problem by refining the program code and by switching to indexed searches of the databases. In the end, however, we realized that the full potential could only be achieved if some of the databases were transferred from the CD-ROM to a hard disk. This decreased access time to the CD-ROM, but with a cost, since the databases take up approximately 3 MB of disk space on the user's system. Assuming that there would be some users who would not want to give up this much space on their disk, we decided to retain the option to run the programs directly off of the CD-ROM with decreased access time.

The total cost of pressing the test versions of the CD-ROM was approximately \$250. Copies made from this master, produced in lots of 500, cost \$6.00. The only program written specifically for the CD-ROM was CCIMAGE, which took approximately one year to develop, although CCLOT was slightly modified for the CD-ROM. The artifact images were captured in TGA format with a program written by ourselves over the course of the project. The images were then translated to the two BMP formats with Paint Shop Pro (by JASC Inc.) and edited with Adobe Photoshop (by Adobe Systems, Inc.). The slide images were digitized with a slide scanner and the images then edited with Photoshop. Of course, we were considerably aided by the fact that most of the

indirect costs of program development and data acquisition were spread out over the duration of the entire project.

Final Comments

CD-ROM technology offers considerable potential for archaeological reporting, although it will not completely replace written reports in the immediate future. The unknown and potentially quite limited archival quality of CD-ROMs, coupled with the fast pace of advances—and therefore changes—in computer technology represent major limitations in the useful life of these projects. On the other hand, having data and images in computer format greatly facilitates interactive use in ways that are not achievable in standard publications. Archaeologists should try to exploit the advantages of both media at the same time.

There are still some issues to be faced, however. One of these is publication standards. Traditional published reports follow standards that have been developed over many years but equivalent standards are generally lacking for CD-ROM publications. We have already discussed some of the issues relating to standards in computerized data and image formats and cross-platform capability. There are also issues relating to the nature of user interfaces and content. Another important consideration is that while computer technology has significantly enhanced the flexibility of producing everything from written reports, CD-ROMs, and Internet web sites, such personal desktop publishing also allows one to bypass any sort of peer review process, which is essential to maintain standards of quality and integrity of academic reporting. It is important, therefore, to consider what new standards might be appropriate and how they might be enforced. There is also the serious issue of how these products are to be used in evaluating an individual's scholarly production.

Another important issue is the degree to which these products can be supported. With computer software and computerized data, product support can become a serious problem. There is an almost unimaginable array of computer configurations in use by archaeologists, and it is unlikely that a single application can run correctly on all of them—“bugs” are always another possibility. Supporting software applications can be more expensive and time-consuming than developing them, but there is a legal, if not moral, obligation to make sure that someone who has purchased an application will be able to use it. In the past, we have dealt with this issue by simply giving away the programs and source code we develop, following the philosophy that the user gets what he or she pays for: if it works, fine, but if it does not then one cannot complain. It is largely for this reason that the Combe-Capelle CD-ROM is priced so inexpensively (about \$20.00). This price

reflects only the actual direct costs of copying and distributing the raw data; the programs are included only for the convenience of the user and we do not assume any liability for their functioning. Obviously, this is not an ideal solution, but it is the only option available to us at this time. We have also included the source code of all of our programs on the CD-ROM so that others can modify them to suit their own purposes and hopefully build on our work.

It is likely that both of these issues—publication standards and support—will be solved as major publishing houses move into this new arena of multimedia publication. While computers allow a great deal of individual expression and innovation, this freedom must be balanced by rigorous controls on quality. The enforcement of standards, primarily through peer review and editing, has been one of the traditional roles of publishers, and they are also in the best position to take on the responsibility of product support.

While CD-ROM technology has tremendous potential for archaeological reporting, it is clear that it will not replace standard publications. Besides the issues surrounding quality, accessibility, and support, the most important problem is the lack of compatibility among existing computer systems and especially future ones. For now, the best solution appears to take advantage of the best that each media has to offer.

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Harold L. Dibble is Professor of Anthropology at the University of Pennsylvania. His main research is on the Middle Paleolithic of Europe and the Near East, and he has directed several excavations in France. Mailing address: Department of Anthropology, University of Pennsylvania, Philadelphia, PA 19104.

Shannon Patrick McPherron (PhD, University of Pennsylvania 1994) is currently an Associate Archaeologist with the Bishop Museum in Honolulu, applying GIS technologies to Hawaiian settlement systems. Both Dibble and McPherron have written and co-authored many articles

on archaeological computer applications and both are currently working at the site of Fontéchevade, France. Mailing address: Bishop Museum, Department of Anthropology, P.O. Box 19000A, Honolulu, HI 96817

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Figure 1. Screen image of CCIMAGE program showing an artifact. Note that the keyword list contains other information about the artifact and can be used to search for more images with the same characteristics.

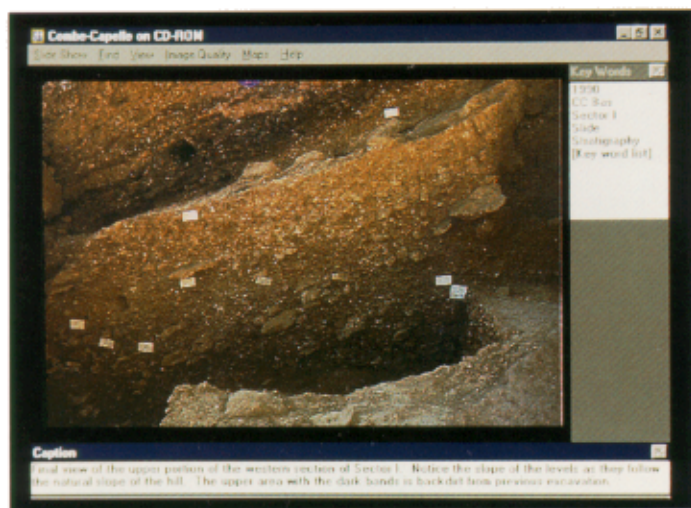


Figure 2. Screen image taken from a 35 mm slide and displayed in the CCIMAGE program.

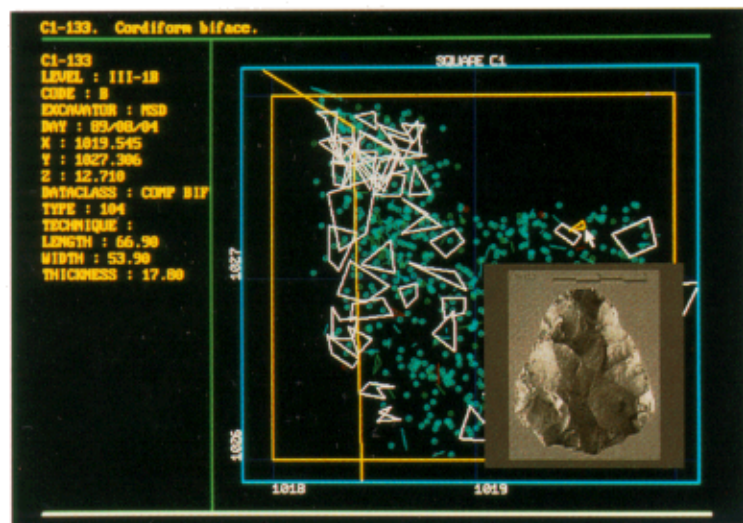


Figure 3. Screen image from the CC PLOT program. The black and white image is of the artifact shown next to the mouse arrow in the plotted area. The data on the left of the screen correspond to other information on that object.