6. Post-Excavation Treatment & Analysis

POST-EXCAVATION WORK involves three steps: preparation, analysis, and interpretation. All three steps, like all aspects of the project, are parts of the post-excavation process, which can be summarized under the rubric of "report production." If the report is the only tangible product of an archæological contract, it follows that all efforts under the contract should be directed toward producing the report.

This restricted objective, imposed by the realities of compliance, should prompt archæologists to re-examine certain procedures inherited from traditional academic or agency-supported archæology. The term "data recovery," which is used to describe this level of archæology, summarizes the kernel of the difference.

"Data recovery" refers to project-specific salvage work, but not to the regional and larger research programs typical of academic or agency research agendas. While a contractor must place his work in perspective, he does not enjoy the luxury of doing tangential research that will not appear in the data recovery report. Academic and other institutional researchers, by contrast, are traditionally expected to perform non-site-specific research as part of their job assignments.

Cecil B. DeMille once declared that all the millions he spent on his spectacular motion pictures should be readily apparent on the screen. In contract archæology, the analog would be a project designed so seamlessly that every step contributes directly and obviously to the final report.

Thus, while a consultant's procedures may lack the freedom to digress that characterizes academic pursuits, a contract report can focus on well-defined tasks and accomplish precisely specified objectives, drawing expertise from sources beyond the narrow confines of academic departments and disciplines.

At Blueberry Hill, the authors were able to operate under conditions that were nearly ideal. A combination of small crew size and lack of severe time constraints allowed the investigators to micro-manage all aspects of the project.

Preparation

The first step in post-excavation artifact handling is to prepare objects for examination. They are washed, marked, classified, and catalogued. Only after these preliminaries are finished can the finds be analysed and interpreted. Much of the preparation process appears to be clerical and manual labor, frequently delegated far down the line.

A respected manual summarized the common condescending attitude toward this function: "Washing should go on daily and can be done, under supervision, by unskilled workers of any age. It is an especially useful job for children and for those who would like to help but cannot dig or can spare only a few hours." This same manual suggests that the site director should "see the drying-rack or tray contents as part of his daily routine" (Alexander 1970:61).

Contradicting this not-uncommon line of thinking, the authors regard preparation as an indispensible first opportunity to observe materials and to adjust strategies while digging is still under way. All artifacts were washed by one of the authors immediately upon return from the field. On larger sites, principal investigators may not be physically able to personally wash each artifact, but the value of intimate contact with the material should not be underestimated.

As soon as the artifacts were washed, they were classified, described, and entered into the computer catalogue file by the other author. Artifacts to be illustrated in this report were set aside at this stage for the artist. The catalogue was seldom more than a few days behind fieldwork.

This assembly-line process afforded an opportunity for the supervisors to reflect on the day's finds, to formulate tentative interpretations, adjust techniques, and to discuss discoveries while units were still fresh.

Once they had been catalogued, artifacts were marked with their permanent Island Field Museum catalogue numbers. Standard reversible numbering was used. Each artifact was first painted with a clear or white base coat, followed by India ink, and covered with a clear lacquer. Marked artifacts were stored in perforated clear polyethylene bags.

NOMENCLATURE

All artifacts were classified by one individual, using computer "macro" programs to ensure internally consistent names. The nomenclature conforms, for the most part, to local practice and standard regional sources.

A ceramic analyst once stated flatly: "if any description of pottery could not be transferred effectively over the telephone, this would guarantee that the classification system based on that description was inadequate" (Celoria 1980).

Archæological classification would come to a screeching halt if this admirable standard were rigidly applied, but the warning should be heeded. Recognizing the inadequacies of human-based descriptive systems, the next-best practice is to assign the task of description to a single person and to establish a tightly-defined nomenclature in a machine.

ORGANIC AND SMALL ARTIFACTS

Another continuous process conducted during excavation was waterscreening, also known as wet-sieving. Since most of the site's soil was shoveled through quarter-inch hardware cloth, the record was in danger of being skewed in favor of large objects. Waterscreening was the remedy designed to correct this bias.

Roger Moeller (1986) has suggested three rules to guide waterscreen sample selection:

1. Never collect randomly or arbitrarily. Patterned collections are best.
2. Small sites, with relatively few artifacts and ecofacts, require larger samples. A minimum of 5% and a maximum of 50% was recommended.
3. Everything recovered needs to be analysed to determine the nature of the context being studied.

These three principles were applied to sample selection from Blueberry Hill project.

A graphic illustration of the value of wet screening through a fine mesh came from a site called Fuller's Hill in East Anglia. Meticulous hand sorting of clay sediments had produced evidence for only two relatively large fish species. Wet screening of the soil from the same deposits produced fifteen species of fish (Holden and Gerber-Parfitt 1992:429). While fish bones were not expected to be found at Blueberry Hill, it was just as necessary to retrieve any component that might consist largely of bits less than a quarter-inch across.

The purpose of the first stage of wet screening is not so much to recover artifacts as to reduce the bulk of the sample's matrix for later refinement. Since organic materials represent a very small fraction of the soil matrix, bulk reduction is a necessary first step; hand-sorting of an unreduced sample is expensive and less than accurate, as the Fuller's Hill experience had demonstrated.

Available extraction and consolidation methods include a variety of screening methods and flotation systems (Kenward, Hall and Jones 1980). Each soil presents unique mechanical difficulties; cement mixers have sometimes been found necessary to dilute clay soils, and graduated stacks of screens have been used effectively to sort samples containing abundant small organic materials.

Waterscreening, or wet-sieving, methods fall into two general categories: showering and flotation. In a flotation tank, the heavy fraction is caught by a screen below, while the light fraction is trapped in an overflow apparatus.

In the showering method, the sample is washed by running water through a fine screen; then the sample is then air-dried for flotation in a second step.

A comparative test of the two methods found that flotation tanks were more efficient, even though both methods produced comparable results in terms of the amount and diversity of material recovered (Jones 1983).

After some experiments, the authors determined that the shower method might be more effective for use by less-skilled workers. All samples were brought back to the laboratory for processing, since the construction of on-site facilities would have been impractical.

Screening Procedures

Given the assumption that waterscreening is superior to other available methods of mechanical disaggregation, it should follow that whole sites should be waterscreened, which has been done. One must seriously question the cost/benefit value to be derived from 100% waterscreening. Clearly plowsoil is too disturbed to deserve such treatment. Since waterscreening would be extremely time-consuming, it was necessary for us to strike a practical balance between field time and screen time.

A 25% sampling strategy was adopted during the Phase III project. In each five-centimeter level below the plowzone, the southeast quarter of each meter square was set aside for waterscreening. A ten-quart bucket was filled with earth from this quadrant, leaving only a small remainder to be included in the regular dry screened collection.

This strategy met Moeller's first two criteria of being uniform, and being between 5% and 50% of the total.

Each meter-square unit produced ten to fifteen buckets of sandy soil; at the excavation rate of one unit a day, the laboratory workspace soon became crowded with buckets. At least one day each week was devoted to waterscreening.

Ten-quart samples were washed through a modified five-gallon plastic bucket. The bottom was cut out and covered by screen with a mesh of about 20 openings to the inch, or about 1.25 millimeters (window screen). All floating materials, and heavier materials that would not pass through the screens, were bagged together for later examination.

The residue, consisting of coarse sand, stone artifacts, roots, organic trash and charcoal, was dried and then manually sorted to recover small lithic objects and then floated (or "flotated," as Moeller prefers to call it).

Flotation

Flotation of the entire dessicated sample for purposes of recovering pollen had been considered and rejected as unpromising, since the acidic sandy environment was unlikely to preserve organic materials that had not been carbonized.

After waterscreened samples had been dried, they were further reduced by flotation. The dried sample was dropped slowly into water, so that the lighter fraction floated. These lighter materials were skimmed off.

Roots, leaf fragments, and other intrusive materials, were manually sorted out of the flot. After carbonized material was isolated and weighed, identifiable carbonized seeds were isolated for specialist identification.

This two-step approach to water screening and flotation has been successfully employed on very large sites (Holden and Gerber-Parfitt 1992), where the sheer mass of the material caused logistical problems.

It worked well at Blueberry Hill, where the problem was similar but smaller. Charcoal was then weighed and mapped. Except for a sample from a feature, none of the charcoal was large enough for radiocarbon analysis.

Drawing as an Analytical Tool

Double-sized pen-and-ink drawings of artifacts were used as an analysis tool, in addition to their traditional role as an illustrative medium. This is consistent with a trend noted in other areas of the publishing trades, where critics have noted that the American public within the past few decades has become increasingly visually-oriented and more comfortable with pictorial evidence.

Cores, points, and other artifacts were selected and drawn *before* analysis began, rather than as part of report preparation. Double-size drawings were put in individual clear plastic bags with the artifacts, so that the analyst would be able to compare gross forms more easily than by direct observation.

As an illustrative medium, drawings enjoy several advantages over photographs. An illustrator can, and should, emphasize or de-emphasize features of an artifact, which is frequently impossible in a photograph by all but the most skilled photographer. As useful as the process is, it requires careful control and editing (Brodribb 1971:45)

Karl Butzer and Leslie G. Freeman eloquently stated the case for drawings as the preferred lithic illustration medium: "Though good photographic documentation is necessary in some situations, properly drawn artifacts are invariably more informative than photographs in illustrating a prehistoric knapper's workmanship as well as an artifact's form and diagnostic features."(Butzer and Freeman 1986:ix).

Thus an illustrator can provide a picture of the human modifications on a piece of rock, rather than a nonselective picture of the rock that a camera would produce. This is particularly important when an artifact exhibits strong coloring or other visually distracting features.

By working with the drawings at the outset, the analyst was able to communicate with the illustrator, specifying changes and checking accuracy before the illustrations were finally dispersed into report illustrations.

Integrating Analysis and Fieldwork

Since the report is the ultimate objective of an archæological project, each step in the process should be designed in terms of its contribution to the final product. Modern computer and photoreproduction technology allows complete integration of the excavation, preparation, analysis, and publication processes into a single seamless whole. This seamlessness is both cost-efficient and intellectually beneficial.

Any project that is not integrated from start to finish risks inefficiency in its use of resources and deficiency in its ability to exploit available technologies to gain useful insights. Technology allows analyses to be designed so that initial data entry leads directly to publication-quality graphics without either re-entry or data file conversion. Thus, in the system used at Blueberry Hill, a field-assigned bag number is the only number an artifact will ever bear, and each cell in the site can be located and described in context, using computer-based catalogues that were generated as the artifacts were recovered.

Approach to the Analysis Phase

Ecological approaches to archæological interpretation require consideration of the entire human ecosystem, which is the context in which remains are interpreted (Butzer 1982:xi).

Analysis increases in complexity as the available evidence diminishes. Older sites contain less material evidence, prompting more complex, less direct, methods to extract maximum intellectual content from a minimum of data.

Traditional archæological analysis relies upon procedures in which the researcher examines the site or the artifact directly and reaches conclusions based upon direct observation.

Traditional analysis techniques have included artifact classification, mapping, and field recording. To these basic techniques, other disciplines have contributed such tools as floral analysis, blood residue analysis, radiocarbon dating, dendrochronology, geological and pedological interpretation, thermoluminescence, archæomagnetic dating, and radiocarbon dating. Such specialist techniques merely expand the archæologists' field of view, permitting him to see additional dimensions of finite remains.

Non-archæological technologies have also allowed archæologists to consider off-site phenomena that are proxies for missing archæological data. Proxy measures attempt to draw site-specific inferences from abstracted information.

In order to understand soil layers on the site, a geologist might examine deposits in the nearby floodplain. Pollen preserved in a nearby bog may be radiocarbon dated and geologically linked to climatic conditions that led to creation of on-site deposits where organic remains to provide dates do not exist.

Such proxy observations can increase a project's value, but there is a distinct danger that they might be misapplied, or might assume a life of their own, independent of the original archæological objective. It is incumbent upon a researcher to demonstrate exactly how a particular proxy measure is related to the on-site data it is supposed to explain.

If the connection is not clear, a proxy measure runs the risk of falling into the same category as a prophet who predicts stock market fluctuations by weighing the aluminum foil discarded into candy store trashcans. The connection might be real, but inferences are tenuous.

Once the various analysts have contributed their pieces to the puzzle, intepretation follows. If the specialists have done their jobs, interpretation is (or should be) straightforward. In an interdisciplinary project, it is the job of the archæologist to make sense of the various contributions.

All available technologies must be assessed. Some prove to be useful, and some are not. Blood-residue analysis was one promising technology that proved to be less than useful.

BLOOD-RESIDUE ANALYSIS

At the beginning of Phase III work, several artifacts were submitted to the laboratory of the University of Delaware Center for Archæological Research for blood-residue analysis.

The original research design called for edged tools and points to be tested for blood residues. This effort was dropped after the initial laboratory sample proved to be completely devoid of residues (Jay Custer, personal communication, December 4, 1991). Based on these unpromising results, no more artifacts were tested for blood residues.

We were not the only ones to be disappointed. At the nearby Dover Downs Site, Hill A, in similar æolian sandy soils, 115 tools and 207 pieces of debitage were tested with negative results (Riley, Custer, et al., 1994). Negative tests indicate only that blood residues are not now present on the artifacts, but do not indicate that the blood never was present.

Research on several other Delaware sites has indicated that blood residue analysis must be applied judiciously, under control. False positives, and the need to screen them out, are among the problems being addressed as the technique matures (Custer, Ilgenfritz, and Doms 1988).

In other areas, results of blood residue analysis have not been so disappointing or spotty. Since the first article on blood residue analysis appeared in *Science* a decade ago, a number of successes have been reported. In Northern Virginia, selected projectile points have yielded evidence of deer, bear, and human blood (Inashima 1992b).

Accumulated experience suggests that very old blood residues can be preserved archæologically on surfaces of artifacts buried in clay, or in dense bones (Smith and Wilson 1992). The sandy soils of Blueberry Hill and Dover Downs did not offer either of thse preservation conditions.

FLORAL ANALYSIS

Although pollen and blood residues could not be expected in the sandy matrix, there was a good possibility that burnt vegetable or animal matter had survived. Analysis of botanical remains can contribute significantly to interpreting the paleoenvironmental dimension of a site (McWeeney 1990).

Three tiny pieces of bone and many flecks of charcoal were found throughout the site, some in concentrations that appeared to betray the presence of leached-out features. Only one of the charcoal finds was so obviously related to a feature as to warrant radiocarbon dating.

There was not enough material to justify attempting to identify the species represented by the charcoal samples. Excellent, well-dated, floral materials from the bay-basin and the floodplain provided a robust body of proxy data for groundcover.

SOIL MORPHOLOGY

John Foss, of the University of Tennessee, visited the site several times during the excavation. His guidance during the Phase II work helped to develop the concept of five zones, which became the operational framework for the Phase III excavation.

Foss returned to the site after most of the Phase III units were opened and conducted further tests. His final report is an appendix to this report.

SOIL CHEMISTRY

Soil chemical analysis has been an archæological tool for more than fifty years. The first discovery relating soils to archæology was an observation by a German that man apparently increases the phosphorous content of soil, simply by living on it (Griffith and Mark 1978). Heavy metals have been accepted as an indicator of human activity that can be quantified even after thousands of years (Snodgrass and Bintliff 1991:90).

Foss subjected his profile to chemical analysis (Heite and Blume 1992:112-118). Certain heavy metals, including cadmium, lead, zinc, copper, and arsenic, in the A horizon were interpreted as indicating recent pollution.

Copper and zinc also were found in deeper layers, where Foss attributes them to recycling by vegetation on old surface layers. These findings helped the investigators determine how deep the units should be sunk. The ruddy ancient B horizon (Zone V), generally a meter or more below the modern surface, was selected as the stopping point for the dig because Foss determined that its creation predated man's arrival.

GEOLOGICAL SURVEY

James Pizzuto, of the University of Delaware geology department, was engaged to analyze the Holocene climatic and paleogeomorphic setting of the the site through a series of cores coordinated with radiocarbon and pollen analysis. The plan was to take cores from all the different environments in the locale: the bay/basin, the floodplain, and the site itself.

The original research design called for radiocarbon dating of samples from three different sources. First, it was assumed, there would be opportunities to date charcoal found in the site, directly contributing to information about specific deposits and the artifacts in them.

Geologists would use radiocarbon to date deposits that might be found in the cores of sediments produced by boring in the bay/basin or in the river valley.

POLLEN ANALYSIS

A third user of this dating technique would be the pollen analyst, who would seek dates for climate events reflected by changes in the local flora.

As the project proceeded, only one carbon date was obtained from the site itself, but the geologists' cores produced more dating material than had been anticipated.

Grace Brush of the Johns Hopkins University was engaged to analyse the pollen from cores provided by the geologists. Her analysis was intended to help reconstruct climate changes reflected in the geological profile.

DATABASE ANALYSIS

"Surprisingly, scholarship has survived for over two millenia without a computer. It is unlikely that new methods of learning will spring up overnight." That cautionary note was the first "basic assumption" in an article that examined new computer-based formats for archæological reporting (Rahtz, Carr and Hall 1989). Those particular authors advocated producing and keeping site reports in such hypertext systems as Apple's Hypercard®. that would allow unstructured or free-form access to site data.

Interactive compact digital video disk technology also has been put forward as another preferred future form of archæological report dissemination. This medium overcomes a major problem in archæological publishing, since it allows the author to display video images tied to the display of pertinent data. Interactive video users can be spared the tedium of leafing through reports to find cited pictures, and the cost of producing individual pictures is reduced. Unfortunately, multimedia computing is still machine-dependent and standards do not yet exist. For the time being, practical interactive video applications in archæology are restricted to teaching, reference, and museum applications (Lock and Dallas 1990).

As long as computer report formats are machine-dependent, each user must employ compatible hardware and software. Even after three decades of computer applications in archæology, the common distribution medium continues to be the bound paper book-style report, such as you are holding.

Computers have not yet changed the form of archæological research so much as they have eased the drudgery and extended the quantities of data that researchers can comprehend and manipulate.

The stages of machine intervention into any process, physical or intellectual, are well understood. The first step is *mechanization*, in which a machine is used to amplify or enhance the quality or quantity of human effort. Invention of the lever extended a person's physical abilities and the typewriter extended our ability to put words on paper.

In the next stage, *automation*, a machine uses an outside energy source to reproduce a [usually repetetive] programmed process that otherwise would require human effort. An electric pump replaces a bucket in the well, and a stereo replaces an orchestra, but all the thought remains a function of the human brain.

In the final step, *cybernation*, the process is changed to accommodate the machines, so that a human brain could no longer be re-inserted. At this stage, a microchip is switching millions of phone calls, and no amount of manual switchboards could ever do the job. Logic at this level changes to accommodate the thought processes of machines, and the human becomes a mere bystander.

Effective cybernation depends upon such innovations as expert systems and artificial intelligence, wherein computers would be inserted into the decision-making process. At such a stage, the machine would not only conduct the appropriate tests, but would reach conclusions and prescribe further tests without human intervention.

Most archæological analysis remains at the mechanization level, or the very beginnings of automation. Relatively crude off-the-shelf analytical tools, such as graphic packages, word processors, relational databases, and spreadsheets, are the extent of most archæological computer applications.

Spreadsheet programs and statistical applications allow us to perform more complex numerical manipulation with less effort, but the thinking remains to be done by a human brain. Word processors simplify editing and eliminate retyping. Database systems make cataloguing simpler and more uniform. On the whole, archæologists have used computers primarily as machines to automate old manual procedures, rather than to create new procedures.

What formerly could only be imagined is now possible, but the previously unimagined seldom happens.

When computers were crude, users were obliged to modify their procedures to conform to the machine's limited capabilities. The history of computer development is an unbroken series of steps toward making computers behave in a more human fashion. Most computer applications used in offices and academic departments today merely mimic human procedures, at the automation stage of development. This is the "state of the art" in which the Blueberry Hill data was analysed, using the most user-friendly [i.e. human-like] of desktop computers, the Apple Macintosh®.

In the early days of computing, it was necessary to represent data in numerical form because computers were number-oriented and slow. A brief numerical code was easier and quicker to sort than a "string" of characters. Great effort was expended in "coding," or translating human-sensible data into machine-sensible numerical codes. The results of these excercises would be numerical values, which in turn needed to be translated and interpreted as quantities of whatever was being counted. Both translations required human interpreters to manually encode and decode the data.

This constraint no longer exists, since even the smallest desktop computer is fast enough, and has enough memory, to sort, parse, and otherwise manipulate "strings" of alphanumeric characters. Vestiges of such earlier practices remain embedded in established procedures that were formulated for earlier machines.

For Blueberry Hill artifact data, a full-text database system was used to keep the excavation register and to analyse its contents. Text databases, using character-string data, are easier for humans to manage than traditional numerical databases. They also produce more readily understandable results, but they require some re-learning of basic principles on the part of those who were previously exposed to old number-oriented computer systems.

Over many years, and partly because of old-style computer restraints, archæological practice has evolved a tradition of expressing intrasite distributions as numerical matrices. These matrices have become the preferred format for reporting classes of artifacts. Too frequently, valuable data has been obscured by being buried in mind-numbing tables that pad the appendices of reports.

Computer graphic technology now allows expression of these matrices as maps with column graphs or wire frame hills and valleys. Most reports today employ these graphic devices, which are employed in this report.

Tables, too, have become more readable. Whereas the old tables were produced on spreadsheets with cumbersome typewriter-style or dot-matrix characters, today's laser printers allow the same data to be expressed in a sixth of a page, and displayed next to the graphic that portrays it. Through typographical manipulation, the table can be highlighted to show important data or trends. Released from the appendical ghetto at the back of the book, tables can now become part of the main text with minimum monotony.

Dry grids of numbers can be brought to life and made intelligible through graphic representation. This transformation is known to information managers as the conversion of "data," or mere facts, into "information," which people can understand and use.

The next enhancement, which has been tried successfully in several forms, is three-dimensional graphic reporting. Simple enhancements of graphic output allow presentation of data in relief, using optical devices that have been available for more than a century. One method involves drawings split into red and green images, which are viewed through red-green spectacles.

The other method uses black-and-white stereopticon pairs published side-by-side, which are viewed through a device that could be as simple as a card held perpendicular to the page (Spicer 1985). Since three-dimensional representation enhances the "feeling" of depth, it has proven useful for conveying information about intrasite distribution.

For two-dimensional reports, such as the present effort, however, the reader must be satisfied with viewing a two-dimensional computer-generated approximation of a three-dimensional image.

Since computer graphics are so easy to create, there is naturally a desire to make more of them, which means that the body of data is often sliced different ways to produce new ways of looking at it. Here the traditional numeric matrices can become a hindrance rather than a tool, unless they can be reformatted.

If one depends upon fixed tables of numbers, it becomes difficult to rearrange the numbers without going back to the database from which they were derived. A quick, sure, and easy way to create new tables is by using context-sensitive search features of a full-text database.

Full-text databases allow objects to be catalogued without conversion to numerical codes. However, since a search through a text file requires precisely matching a character string, rather than numerical comparisons, care must be taken to ensure that similar objects are described with identical terminology. The process of entering the correct terminology can be automated.

Database Implementation

The most important advantage of a full-text database is intelligibility for both humans and machines. This mutual intelligibility allows a researcher to move freely into the data file at any time without recourse to decoding or reference to symbol tables. The operational superiority of full-text databases without encoding will be apparent to anyone who has used a cataloguing system based on encoded data, such as the notoriously cumbersome National Park Service ANCS program.

Artifact and site data from Blueberry Hill was first entered into a word-processor file in the form of a detailed excavation register. The first column was the register number; the second column was site identification data; the third column identified the deposit within the site; and the fourth column contained a description of the artifacts from that deposit.

Data was entered into a Macintosh® personal computer, using Microsoft Word™ (in several versions culminating with 5.1a) word-processing software in table format. To ensure consistency, artifact identifications were entered using the QuickWord™ macro program by EnterSet™ software package, which stores a table of "boilerplate" words for insertion through keyboard "macro" commands. The computer's need for consistent terminology proved to be a useful discipline for the cataloguer as well.

Word processor input is by far the most accurate and cost-efficient way to enter data into any spreadsheet or database. Editing features of word processors are generally simpler and faster than the text editors embedded in databases or spreadsheets, and data can be formatted for publication much more easily through a word processor. Virtually any word processor can write files for virtually any spreadsheet or database, which is important in view of the fact that several application programs may use the same data in the course of a project.

Formatted Microsoft Word™ files were saved for publication and submission with the final report. Copies were made for conversion into database format. From this point, two versions of the data existed, albeit for different purposes.

Once data has been copied, it is important to remember that there is no such thing as two identical data files. From the instant they are created, duplicated files begin to diverge. Cosmetic and editorial changes may be made to the publication (word processor) version alone if they do not affect the data-manipulation process. But substantive changes must be made to all versions. This difficulty did not exist in the world of manual databases, but it becomes critical in the environment of microcomputers that can support multiple copies of the same data files in different formats.

For database manipulation purposes, the file was converted into an unformatted tab-delimited plain text file. This file was then read into a three-field database for use in Microsoft File™ flat-file database program, which was used to conduct searches and compile matrices.

The decision to use a flat filer rather than a more technologically sophisticated relational database was prompted by two factors. Since a flat filer uses tab-delimited fields, it is possible to confine searches to single fields, reducing the number of comparisons the CPU must execute. Although flat filers lack the manipulative abilities of relational databases, it is easier to move files between flat files and word processors or spreadsheets. In fact, the integrated system, Microsoft Works™, contains all three types of program as modules capable of manipulating the same data file.

More sophisticated searches could have been accomplished with a relational database on a faster processor, but this was not deemed necessary. Relational databases, such as dBase, have severe limitations, not least of which is a data format that is difficult to transport to and from word processors.

Each archæological cell, usually a quadrant of a five-centimeter level within a meter-square unit, was represented by a record in the database. The finished file contained 4,471 records.

Wildcard and field-specific search routines of the file program were used to isolate records with specific characteristics, such as all Zone V cells containing chert, or all cells containing Townsend pottery. Searches using several criteria could take more time, but most searches were accomplished in a few minutes, even on the relatively slow Macintosh® Classic® computer.

After appropriate records were selected, a report was printed. This report contained all the information in the register for each cell containing an occurrence of the keyword. For example, a report listed each occurrence of chert in Zone V, in full context that the analyst could readily understand without reference to any other document.

Artifact distributions were manually interpreted and hand-transcribed from the reports onto worksheet maps of the site, from which spreadsheets were created for plotting in the DeltaGraph® Professional graphic software. The resulting maps provided a visual guide to clusters of artifact types, lithic materials, charcoal, and fire-cracked rock.

Working from these graphic outputs, analysts were able to quickly define artifact concentrations that might represent features or activity areas. Once the graphic software had helped to identify a cluster, the context could be studied by reference to the selected database elements.

The entire process preserved an audit trail *in context,* including the identity and all the contents of each cell even when entries were being abstracted and lumped together into spreadsheet tables.

Since analysis ultimately depends upon a human working in context, the prolix products of a full-text database enjoy significant advantages over columnar spreadsheets and numerically coded data that are alien to the human way of conceiving data.

NATURE OF THE STRATA

Few recognizable deposits on the site were cultural in origin. Instead, stratification here was almost entirely a geological phenomenon.

Harris has emphasized inherent differences between man-made strata and "natural" or geological, generally horizontal, strata (1979:36). Stratigraphic evidence is useful because of the law of superposition, but a site's history may confound the simple layered model. Man-made strata, as Harris points out, seldom are strictly horizontal.

At Blueberry Hill, the natural geological stratification of the site was expressed as the five æolian soil zones defined by Foss. These zones were strikingly different in color and texture. Undulations of old ground surfaces, such as gullies, may or may not be obvious in the soil layers.

There were also man-made "units of stratification" enveloped in the geological strata. These scattered artifact deposits could be detected in the database as clusters of similar materials in adjacent cells.

Some of the clusters would ultimately be defined as features through data manipulation.

PARSING ZONES II AND III: A SANDWICH

Zone III posed a special problem. Soil evidence indicated that this apparently homogenous light-colored sand had been deposited rapidly, and there was no sign of soil development within it. During excavation, the field crew noticed apparent clusters of artifacts within this zone, separated both vertically and horizontally by substantial amounts of sterile sand.

Since there were no observable strata within the zone, it would be necessary to develop a statistically defensible method for detecting vertical and horizontal clustering, based solely upon evidence drawn from the excavation register.

Obviously, a sand deposit this thick and extensive is not likely to be a uniform layer, like a coat of paint, across the site. In some places, it had been deposited more thickly than in others. Some surfaces had been lost to erosion, either during or after deposition. We could appreciate its probable complexity, even though the layer appeared uniform when examined in small profile segments.

In order to distinguish the passage of time in the archæological record, the researchers decided to arbitrarily assume that Zone III was deposited as *at least* three layers, to be known as bottom, middle, and top.

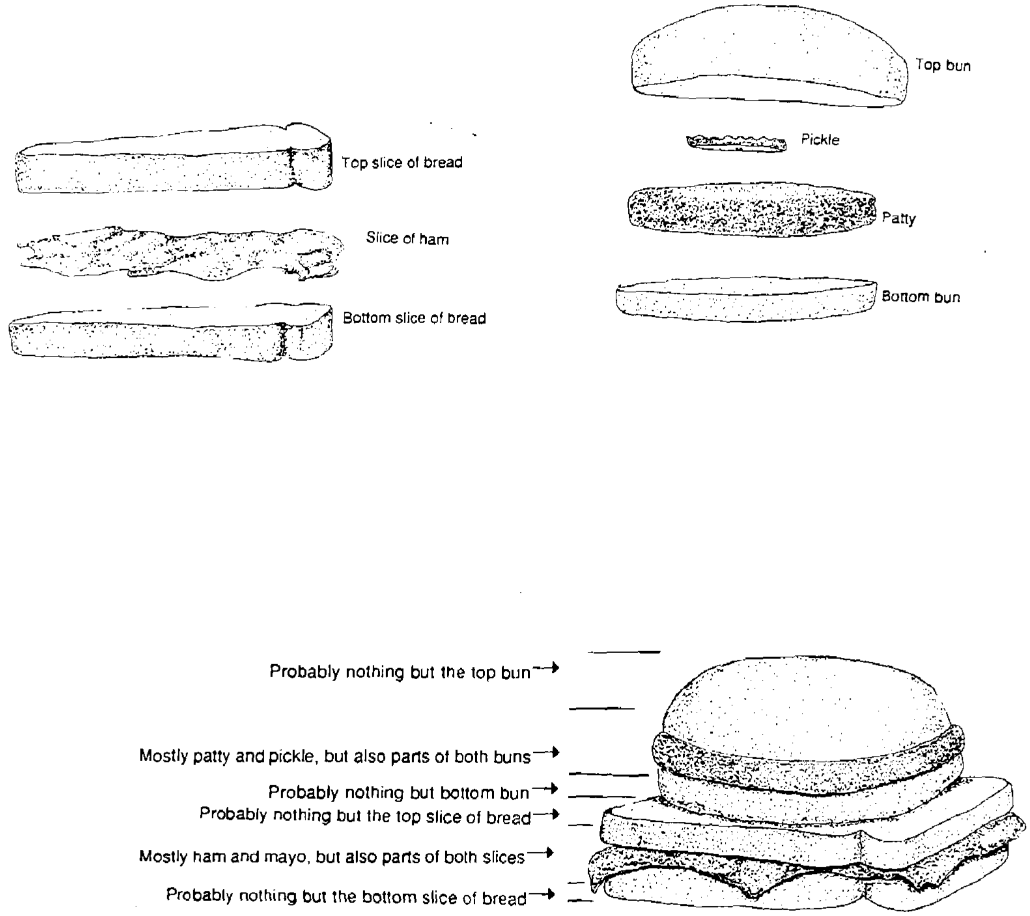

Figure 27
The school-lunch sandwich analogy:
How to identify bread after everything gets smashed together.

When the sandwiches are made, slices of bread, buns, and fillings are easy to identify. After the sandwiches have been sitting a while, the parts may become inseparable. In order to obtain a valid sample of the bread, one can assume that the layer adjacent to the crust is bread on both top and bottom. By the same reasoning, one is assured that most of the ham will be found between these two layers.

It was apparent that in some places the top surviving layer was actually the middle, because the original top layer had been lost to erosion. In other places, the surviving bottom layer could actually be the original middle layer, deposited in a place where the bottom layer had not existed, or where the bottom had been eroded away before the middle was deposited.

Overall, however, we assumed that the original top, bottom, and middle survived pretty much intact over the whole site. Exceptions could be considered statistically insignificant unless proved otherwise.For purposes of sorting layers, Zone III could be visualized as a ham sandwich. We want to analyse the ham and the two slices of bread, but we do not know the thickness of each. If we can assume that the top and bottom surfaces are most likely to be bread, we can assume that the ham lies between those surfaces. If the bread is missing in some parts of the sandwich, ham will show through, but it will look just like the ham in the middle and we will be able to identify it.

Pursuant to the logic of this analogy, the zone was divided into three layers and the contents were plotted separately. The uppermost ten centimeters were mapped as "top," and the lowest ten centimeters were mapped as "bottom." Everything between those layers was called the "middle," regardless of its actual thickness. The exercise proved successful, and different patterns of clusters could be observed in all three levels. Features that penetrated two or more layers could also be identified by the same means.

Returning to the ham sandwich analogy, the top and bottom slices of bread are described, however thinly, by their surface layers, and the ham is somewhere in the middle. Observed clusters in each of these layers could be identified for examination and related to the other materials in their contexts.

The ham sandwich worked so well as a conceptual framework for parsing Zone III that we decided to visualize Zone II as a burger (with pickle, plain white bun, hold the mayo). Again, it worked.

Spatial and Regional Analysis

No site exists in a vacuum; the site is part and parcel with its environment, just as features and artifacts within the site are interrelated. This notion of *context* defines and distinguishes archæology as a discipline (Hodder 1986:120).

As a component of a settlement system, each site is related to all other sites in a large area. Even when it was not occupied, the fact of its vacancy was a component of the regional system.

Well-tested settlement models have described the environments in which each type of prehistoric activity will have occurred during each period. The project area is relatively unusual because it lies in an area where the paleoenvironmental models have been refined by tightly-controlled surveys that minimize the risk of subjective interpretation (Custer and Galasso 1983). Subsequent work in the immediate area has strengthened the credibility of the surveys.

Site distribution across the landscape is determined first by resource availability and location within a human group's range. Repeated use of the same sites, indicated by cached tools and other evidences of intent to return, may be taken as evidence that seasonal migrations to specific stations were fixed in tradition.

Geographers will recognize these patterns as expressions of spatial relationships found in many cultures around the world. In northern Europe, prehistoric site distributions have been interpreted by the tested geographers' technique of superimposing hive-like patterns of hexagons over site-location maps from which physical geographical features have been eliminated (Hodder and Orton 1976:7).

Such displays measure human space, as distinct from aspects of settlement patterns imposed by resource distribution. People have been shown to distribute themselves across the landscape in relationship to one another as well as in relationship to environmental factors.

Now that well-dated sites have been mapped or predicted in much of central Kent County, it should be possible to place Blueberry Hill in a spatial context at different times in its history by applying techniques of both geography and archæology.