Comp. Appl. Arch. 13, 1985.

USING MICROCOMPUTERS IN ARCHAEOLOGY: SOME COMMENTS AND SUGGESTIONS

James McVicar

National Maritime Museum, Greenwich, London SE10 9NF

Abstract

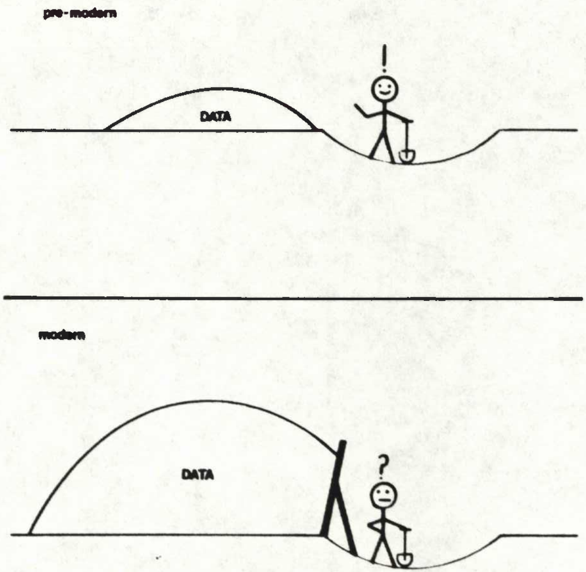
This paper points out that the real problem posed by microcomputers is how to use them most effectively. Current archaeological practice under-exploits this new technology in a questionable way. Consideration is then given to one area in which the particular strengths of microcomputers might be more fully used: the analysis of quantitative data on ceramics recovered during excavation. Two approaches are considered: the analysis of pottery fragmentation and of type diversity.

Computers in Archaeology

This paper has two starting points which, though distinct, are not unrelated. The first is an observation on modern professional excavations. Today's archaeologists labour under the intolerable moral burden that one of their principal methods of obtaining data simultaneously destroys that data. The force of the statement 'excavation is an unrepeatable experiment' is not diminished despite its status as something of a professional cliche. The response of most archaeologists to their burden has been to attempt to record during excavation everything in sight and as far as is possible everything beyond sight. As a result, modern excavations carried out under any but the most stringent rescue conditions generate a quite staggering quantity of data (Fig. 1). Of course, the reasoning behind such a catch-all approach is flawed. Excavation data is, of necessity, less factual and more interpretive than that obtained during laboratory experiments. The idea that we discharge our duty to posterity by recording every fact we can lay our hands on is patently a nonsense. It is in practice extremely difficult to reinterpret excavation data exactly because its gathering is an actively interpretive, and not passively observational, act.

The general response to this criticism, and it is by no means accepted as valid in all parts of the profession, has been an attempt to objectify excavation data and thus to render it more 'factual', most notably through quantification. Excavation archives now show an increasing amount of tabulated, numerical information. This does not, of course, do anything to answer the problem that all excavation data are by their nature subjective and those who quantify data simply with the aim of making it more objective are practising a naive self-delusion. However, this could be ignored were it not that the practice has some immediate side-effects. A great deal of effort is invested in the process of quantification, effort which is certainly one of the reasons why post-excavation analysis is presently such a lengthy and costly business. What is worrying is that little of this quantified data can currently be put to good use. Mercifully, it rarely appears in reports, but at the same time, it commonly contributes very little to the central aim of site interpretation. Unless something can be done to make quantified data more generally useful then the profession is guilty of self-indulgent hysteria.

Figure 1: The problem of archaeological data acquisition.



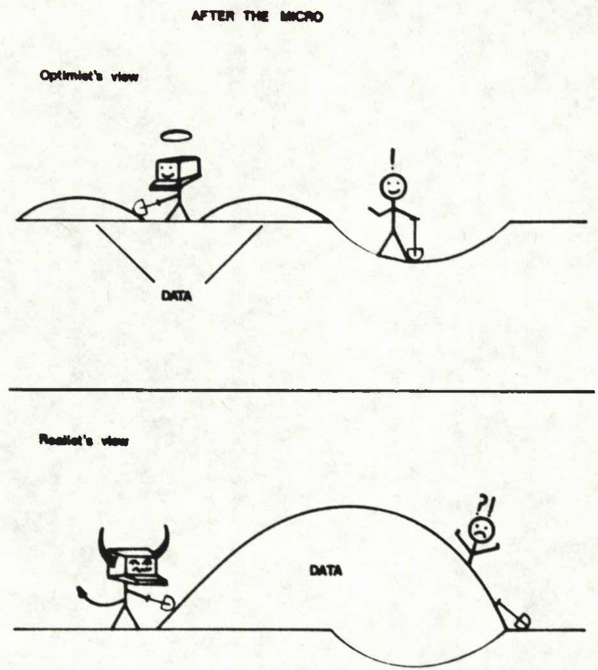


Figure 2: The same problem after the introduction of microcomputers.

This brings me to my other point which concerns the advent of microcomputers in Archaeology. Micros are, so we are told, an increasingly important tool for excavation. Indeed certain people would have us believe that we are incompetant to excavate unless we can make use of them, but why are they important? I think the answer to this question is very simple. Microcomputers are seen to be important because of the profession's increasingly fetishistic attachment to recording all the facts quantitatively. The main use to which micros have so far been put supports this view. Most applications I have seen have been directed towards the areas of data capture and retrieval. The micro would appear to have come along at exactly the right time to save archaeologists from the growing mountain of excavation data which they are now expected to collect; or has it? Personally, I am rather afraid that we are in great danger of digging ourselves a deeper pit (Fig. 2). Using micros may help us to record more data more efficiently. Indeed it may be seen positively to encourage the gathering of more information, but unless we are able to make sense of the growing mountain of quantitative data we are producing we will simply lapse into a self-defeating antiquarianism.

Micros will be the death of Archaeology if all they are used for is running database packages, banal statistics and graphics routines. If we are to escape the charge of mindless data acquisition and to exploit this new technology to our gain, then we shall have to start applying it to quantified excavation data with the aim of making that more interpretable and, hence, more useful. Only in this light will the use of micros to construct and manage excavation databases be justifiable. This does not mean, however, simply automating existing procedures. These have, in any case, largely proved inadequate to meet the challenge posed by an increasing amount of quantitative information. What is required is a serious look at new procedures and interpretive techniques, especially those now brought within our reach by the advent of microcomputers. If necessary we must acquire the courage to change our habits and approaches to excavation so that we may exploit new opportunities.

Pottery analysis

One area which might be used to illustrate this point is the quantification of ceramic data. Many excavations now record numerical data such as the total number of sherds recovered from a context, the weight or volume of the pottery and the number of formal or fabric types represented. However, the use to which these data are eventually put is rather unclear. It appears in many cases to have, in the end, only qualitative significance despite the effort spent on quantification. Why the effort should be expended in the first place is, in consequence, questionable. If it is to be at all justifiable, then some attempt must be made to make the information more useful.

To make quantified ceramic data more useful one needs to develop standard ways of exploring patterns in its structure. One route is to consider variation in the types and physical state of pottery recovered from contexts. There are two ways of doing this. One might explore patterns of overall association through some measure of similarity: this type of approach was tried by Redman at Qsar es-Seghir (1981) in an effort to identify functionally distinct areas within the walled settlement. The difficulty here is that a whole variety of possible patterns will be thrown up for consideration. Redman met this in some measure through the use of multivariate techniques. In the end the archaeologist may become lost in the sheer wealth of variability. Another more pragmatic approach is to take the line that the most interesting patterns are likely to be those which stand out from the general trend. This involves the analysis of residuals. I wish to discuss residual analysis with reference to two properties of ceramic assemblages: their degree of fragmentation and their overall type diversity.

The degree of fragmentation of the pottery recovered from a context reflects both its pre- and post-depositional history. A high degree of fragmentation may, for example, result from continued redeposition or may reflect an unusual use context from which the deposit originates. Of course, fragmentation necessarily must vary very considerably from site to site, but contexts from a particular site with unusually high or low degrees of fragmentation deserve special consideration. They may show a particular spatial configuration which reflects significant differences in deposition history, or functionally similar deposits, in different areas of the site.

Fragmentation can be assessed by taking the ratio of the total weight of pottery to the number of sherds for a given context to produce a fragmentation index. In itself this index is meaningless but in the light of the overall trend for a particular group of contexts it may be significant. The overall trend can conveniently be summarised by fitting a linear function to the data for a given group of contexts using normal regression techniques (Fig. 3). The regression function represents the norm. The difference between the observed fragmentation index for a context and the expected value as given by the function represents the deviation from the norm of that context. Contexts with positive deviations imply lower fragmentation, while negative deviations imply greater fragmentation, than was expected. Of course, in practice one expects all contexts to deviate to some extent from the overall trend. It is only when they deviate significantly that there may be something worth pursuing. Significance is assessed by how large the deviation is in absolute terms. A useful approach here is to standardise the deviations by dividing by the standard deviation for the regression function. Contexts can then be classed by whether they fall within one standard deviation, within two standard deviations or outside that range. Contexts falling outside the two standard deviation range are highly deviant, but amount to less than 5% of all observations.

A number of approaches can then be followed. The contexts can be mapped and shaded to reflect the error bracket into which they fall. The resultant pattern can then be inspected for any obvious spatial structure. Surface smoothing techniques might also be used at this point to identify trends across wider areas. A more rigorous approach would be to test the spatial distribution of the residuals for patterning, by subjecting them to a test of spatial autocorrelation. However, the point to be made is that the whole approach is eminently suited to microcomputers. Regression techniques are very well understood and easily prorammable. Indeed, most standard statistical packages for microcomputers include suitable routines. The computational power required is also, except in the case of very large sites, appropriate to a small machine. Moreover, it is feasible to consider running such analyses during the excavation phase so that patterning which would not otherwise be recognised until after the excavation was completed can be used as part of the process of day-to-day site evaluation and thus made available in time to allow a change in excavation strategy where appropriate.

A similar approach can be taken with pottery type diversity. Depending upon the pre- and post-depositional history of a context, the diversity of pottery types, both formal and technical, recovered from it is likely to vary. Frequently redeposited material will for example commonly show high diversity. It should also show a higher than normal fragmentation index. Marked differences in

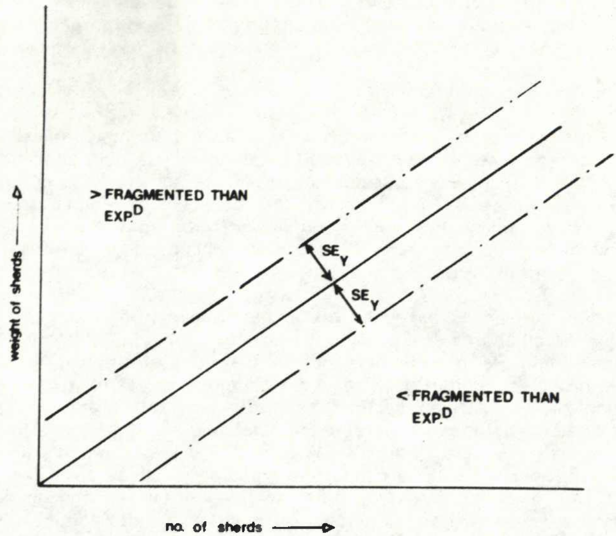


Figure 3: Degree of sherd fragmentation fitted to a normal regression function.

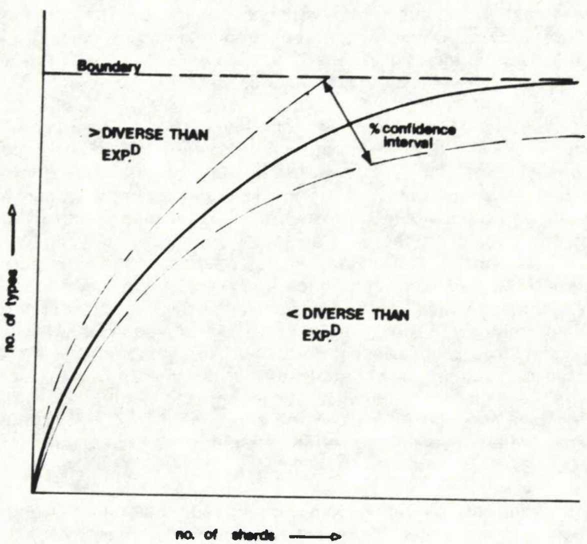


Figure 4: Probability prediction of the degree of type diversity in a given deposit.

diversity within a particular phase might reflect various contexts under which deposits were formed. This in turn could suggest functional or symbolic subdivisions within a site.

Type diversity is measured by the ratio of the sherd count to the number of types observed. This immediately raises a problem: the diversity ratio is extremely sensitive to the fragmentation index of a context. Contexts which have an unusually high or low index will thus produce spurious results. This kind of problem is normally solved by quantifying pottery in terms of its weight or volume. However, such an approach cannot be taken here. The appropriate statistical techniques preclude the use of modifiable units. One possibility might be to exclude from the analysis those contexts which showed highly deviant fragmentation indices, but this is simply a waste of information. A practical alternative is to correct the sherd count for each context against the overall trend obtaining between sherd count and weight.

Given a working diversity measure, interest then focusses on the extent to which a context deviates from the normal trend obtaining between the number of sherds and the number of types represented. At first sight this trend might appear to be suitable for regression analysis but reflection suggests otherwise. While it is true that as the number of sherds from a context increases so the number of types represented will rise, the relationship between the two variables is closed. Given that there is a strictly limited number of types available for inclusion in deposits so that the graph for diversity looks something like that shown in Figure 4. The question then arises: how does one model the overall trend so that highly deviant contexts can be pinpointed?

One solution is to use a simulation approach which attempts to model the probabilistic nature of the relationship. A fairly suitable algorithm for this was discussed recently by Kintigh and Ammerman (1982). The procedure generates for each sherd count a corresponding type count value and a probability bracket. The graphed results typically produce a figure similar to Figure 4 with which the particular diversity ratio for a context can be compared. The probability bracket provides a confidence interval which acts very much like the standard error interval in regression analysis. It provides a measure of just how deviant a particular context is. Given this information, the residuals to the simulated trend can then be treated by a variety of techniques in much the same way as fragmentation indices.

The point about both fragmentation and diversity analysis is that they systematise in a rigorous fashion techniques already used in an informal occasional way by many archaeologists. Gross differences in the spread of different pottery types or in the extent of sherd fragmentation, have frequently proved of major interpretive value, but more subtle trends have rarely been looked for or explored. The reason for this is not so much that such trends are not potentially important as that they have been effectively impossible to detect without extremely time-consuming analysis. No one wants to spend hours in calculation just to explore for statistical trends which may turn out to be of no particular significance.

Conclusions

However, the advent of microcomputers throws open the possibility of undertaking this kind of analysis as a matter of routine. Micros are particularly suited to applications which are processor intensive. One can give a micro a single task to perform, go away for the night and allow it the 10 hours it will need to complete the task, without paying enormous computing bills or degrading the performance of a multi-user system. Microcomputers are also, in many respects, better adapted to the production of graphical output than non-specialist mini or mainframe computers. These strengths are not well exploited by the use of microcomputers simply as data capture devices. Such usage also significantly under-exploits their processing potential. On the other hand, routine data analysis along the lines discussed here does take advantageof the particular strengths of the microcomputer while, at the same time, helping to make some sense out of the growing mass of quantitative data gathered during an excavation. If we are to take on the challenge of the microcomputer and also to save ourselves from being buried under a mountain of increasingly intractable numerical data, then it is the use of micros for these kinds of routine analyses which we should be exploring.

References

KINTIGH, K.W. & AMMERMAN, A.J. 1982 Heuristic approaches to spatial analysis in Archaeology. American Antiquity 47: 31-63.

REDMAN, C.L. & MYERS, J.E. 1981 Interpretation, classification and ceramic productio: a Mediaeval North African case study. in Howard, H. & Morris, E.L. (eds) Production and distribution: a ceramic viewpoint, pp 285-307. British Archaeological Reports International Series S120, Oxford