THE PLUTARCH SYSTEM

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Abstract

The paper describes the PLUTARCH system (Program Library Useful To ARCHaeologists), a fully-operational interactive graphics program implemented on the ICL 4130 at the University of Keele, and written in ALGOL 60. The system employs man-machine interaction using a light pen, function keys, keyboard and disc storage. The software is segmented and provides facilities of general use to archaeologists in the preparation of publications, viz. information retrieval, statistical analysis (pottery profiles, stone artefact analysis, MDSCAL, weighted pair-group agglomerative clustering, minimum spanning tree, etc.), graphics (3D perspective site diagrams, dendrograms, scalograms, histograms, piecharts, distribution maps, etc.) and miscellaneous features (reduction of proton gradiometer readings, pollen analysis, etc.), all interlinked.

1. Description of hardware.

The key piece of hardware for the PLUTARCH System is the line-drawing display unit. This has a light pen, a photosensitive device which detects light signals from the cathode ray tube screen, and which can be used to position points, activate light buttons (specific groups of characters on the screen which may be used to change the course of the software), etc. In addition the operator has a set of function keys, which have specific meanings to the software, and some models also provide an alphanumeric keyboard (in lieu of this a teletype keyboard is used). Thus the operator may influence the course taken by the software using the light pen, function switches or keyboard. The software is loaded in segments from disc storage as necessary.

Other hardware used by the PLUTARCH System includes a paper tape reader, card reader, magnetic tapes, line printer, paper tape punch and digital incremental plotter.

2. Software facilities.

Little attention has been paid in the past to the presentation of information for assessment by the archaeologist and for publication. The whole philosophy of the PLUTARCH System is that visual presentation is extremely important, and all facilities are designed with the end-product in mind: a hard-copy diagram in publishable form. Several illustrations are given in this paper. Lack of space prevents complete coverage, and a much fuller description will appear in Science and Archaeology 11.

A. Global Segment.

The philosophy of the system is to provide global communications between Information Retrieval, Statistics and Graphics functions. The Global Segment can enter, and be entered from, all other segments and provides overall control via the primary tree. It is permanently resident and contains global procedures and storage. When entered, it displays the primary tree (global segment menu) from which all other segments can be loaded using the light pen. The principle of segmentation allows a very large program to be executed in quite a small store area, the amount of core store required being equal to the size of the global segment plus the size of the largest remaining segment.

B. Diagrams Segment.

This is the most important segment in the system, and many other segments enter it automatically in order to 'finish' their diagram outputs for publication. The following facilities are available:

a) Standard frames; these are automatically generated and are designed to fit A4 sheets.

b) Non-standard frames may be generated by using the light pen to indicate the approximate positions of the frame corners. The corners are made true right angles despite the rough positioning given by the light pen.

c) Points may be specified explicitly in terms of x and y coordinates. A point, line or text line may be generated at the specified point.

d) The whole display may be deleted (this enables a restart if a mistake has been made).

e) A scalogram (multidimensional scaling output) may be plotted with labelled points; to these may be added circles to indicate group sizes (see Figures 3 and 4 in the paper in this issue - Allsworth Jones and Wilcock, 1974).

f) Circles of specified radius and centre may be plotted.

g) A dendrogram (clustering output) may be plotted with phenon scale and labelled branches (see ibid., Figure 1).

h) The sketching facility allows the light pen to be used to draw irregular curves.

j) On exit from this Segment, the plotting facility may be employed to produce any diagram at present displayed on the screen in permanent form for publication.

k) Points may be specified by the light pen. The point indicated is added to the point list. A previously-specified point may also be recalled from the point list.

l) A line may be generated between the last specified point and the point indicated by the light pen, or between two points already in the point list.

m) Any single item may be deleted from the display by using the light pen.

n) Text may be positioned at the place indicated by the light pen, or at some previously-specified point.

p) Site diagrams may be presented in simulated 3D by means of perspective. There are facilities for sketching, text, and switching the perspective on or off. This is useful for the portrayal of excavation block diagrams (see Figure 1, this paper). During generation of the diagram there are light button facilities for the rotation of geometrical axes, zooming in and out, panning right and left and 90^{o} rotation to obtain end sections.

q) Pottery profiles may be specified by reading a paper tape prepared on the d-Mac pencil follower, a device which produces x and y coordinates for any desired point on a diagram. Profiles are rotated to the true vertical, smoothed, and scaled to standard size. The pot is then drawn actual size on the display in conventional left-hand section and right-hand elevation. The pot may then be expanded or reduced in size as desired, to fit the diagram. Several different pots may be added to the diagram in this way (see example in Figure 2).

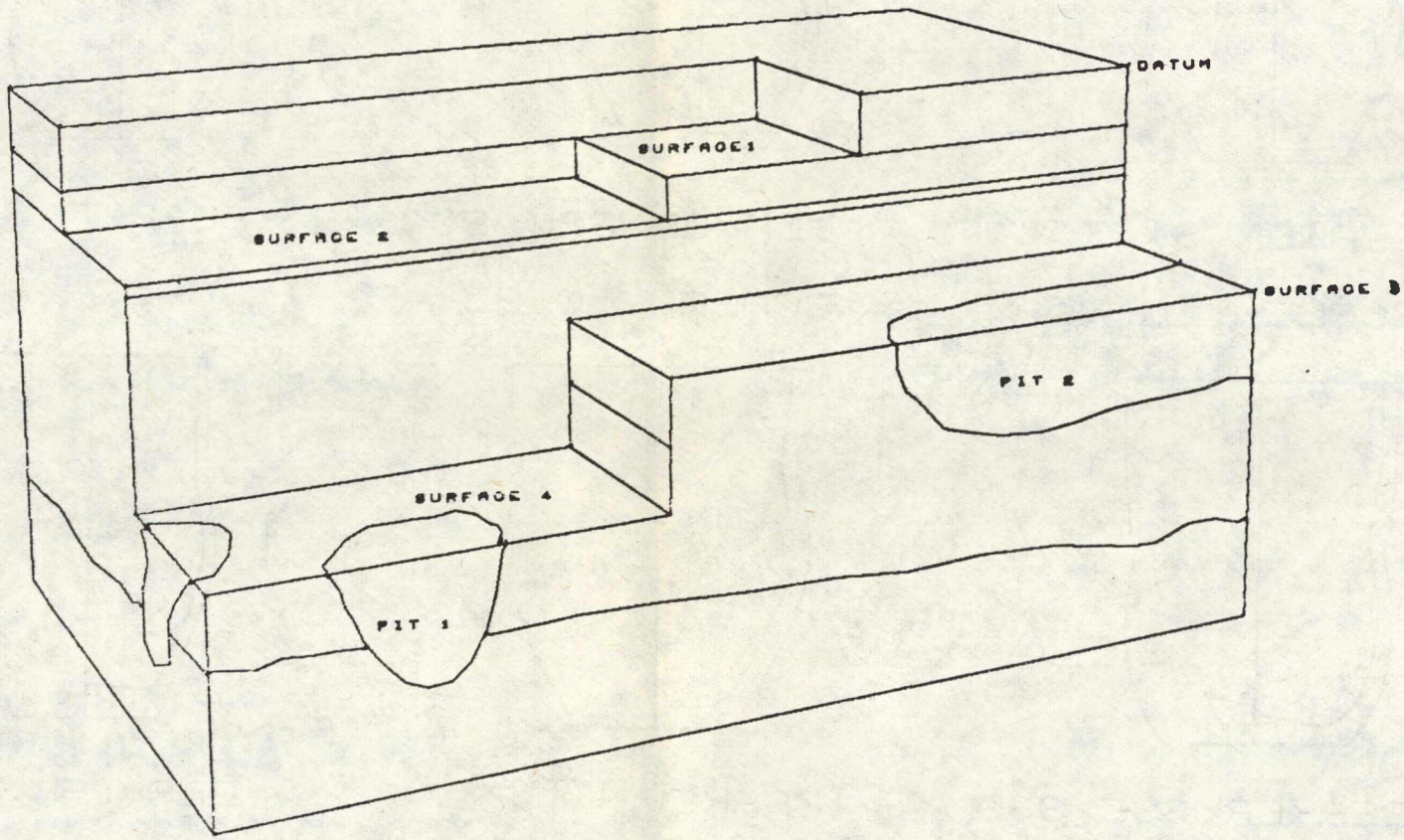
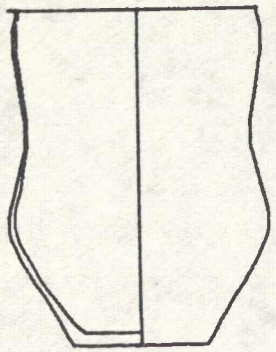


Figure 1 Perspective block diagram with sketch and text facilities

BRITISH BEAKER POTTERY - CLARKE CLASSIFICATION



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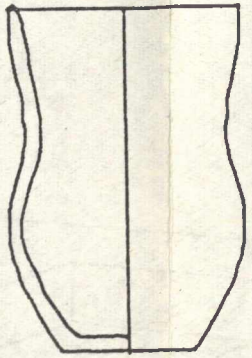

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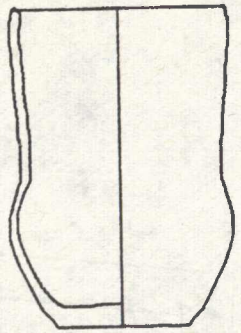

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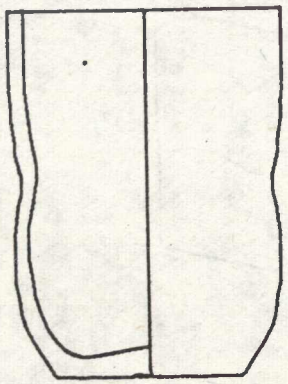

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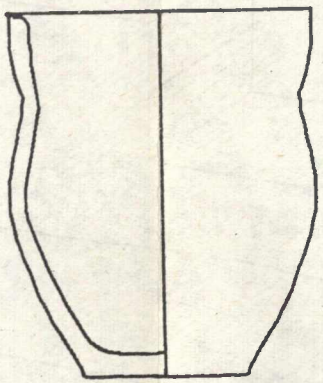

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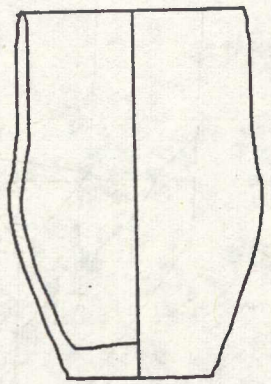


BEAKER S4 977

SCALE 0.25

Figure 2

C. Histogram and Piechart Segment.

This segment automatically plots histograms, piecharts and pollen diagrams. It is only necessary for the archaeologist to supply a list of numbers to be analysed and an end-of-file marker. The computer finds the range of the items and automatically allocates step sizes. The histogram is plotted with a horizontal scale indicating the values of the items and a vertical scale for the counts in each step. The piechart has automatically drawn and labelled segments for the same steps. A percentage figure is calculated for each segment. Pollen diagrams are a special form of histogram, and are plotted with the aid of an analysis program for pollen counts located in the Input Segment. The horizontal axis is a depth scale showing the depths at which pollen counts were taken, and the vertical scale expresses percentages of the 'total pollen count'. Each species is plotted on a separate diagram, labelled automatically with the species name; these may be viewed in sequence on the display, and plotted if desired.

D. Maps Segment.

This segment uses the Input Segment to read a magnetic tape containing the master map outlines (produced by d-Mac pencil follower), then draws the map on the display complete with scale, north point and border. Points may be plotted on the map with a variety of symbols, using grid references. Finally the Diagrams Segment is entered for addition of titles etc. An example of a map drawn in this way is illustrated in Figure 3.

E. Instrument Plot Segment.

This segment draws a dot-density plot of survey data (usually from magnetic instruments such as the proton gradiometer). The readings are manipulated to enhance anomalies using a simple filtering process. The four corners of the square are outlined. For each reading a random scatter of dots is used to illustrate the strength of the anomaly. The square is automatically labelled with the name of the site and the square number. The Diagrams Segment is automatically loaded at the conclusion.

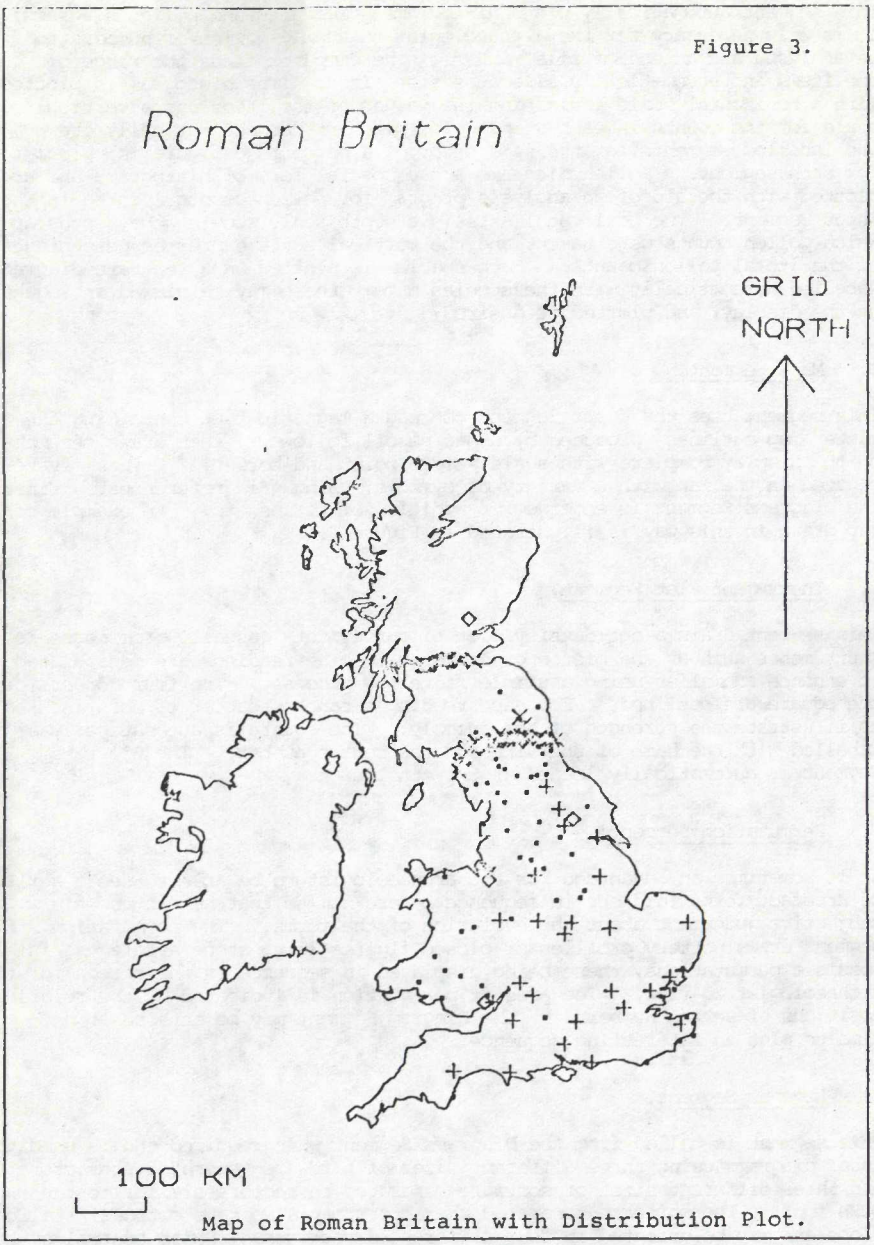
F. Permutation Segment.

It is sometimes an advantage for the archaeologist to be able to see a series of artefact forms laid out in sequence before him so that he can use his subjective judgement about the evolution of the forms. The permutation segment draws pottery profiles or closed figures (e.g. stone artefacts) in all possible permutations, these being displayed in sequence on the screen for the archaeologist to view. The present permutation is indicated by the relative positions of serial numbers. The Diagram Segment may be entered at any time to plot an interesting sequence.

G. Legends Segment.

This segment is called from the Diagrams Segment when required and is used to label diagrams using three different sizes of hardware-generated characters and three different sizes of software-generated characters similar to the OCRB font. The software-generated characters may also have optional italic slope and may be oriented in four different directions. Shift control symbols are used to obtain both upper and lower case. A "newline" facility is included so that lines of text may be assembled, and the size of the line shift depends on the size of the characters to be written in the next line. Computer lettering of this type adds style to a computer-generated diagram and saves time in Letraset application for the archaeologist.

Figure 3.



Map of Roman Britain with Distribution Plot.

H. Inputs Segment.

The inputs segment is used to read pollen data and map outlines from magnetic tape. A request for the correct tape is presented to the operator and the routine does not continue until this tape is mounted on a tape handler. After the required information is loaded, another segment is automatically entered. The inputs segment also contains temporary paper tape loading routines for data which is not yet on magnetic tape.

J. Statistics Segment.

This segment contains analysis routines to produce profile statistics and other details for pottery, and for stone artefacts. A weighted pair-group agglomerative clustering procedure is also available which can be applied to either pottery or stone artefacts. This application is fully described in the above-mentioned paper in this publication (Allsworth Jones and Wilcock, 1974). Plans are well advanced for the inclusion of multidimensional scaling and k-means divisive algorithms in this segment. The data for these statistics programs is communicated from the information retrieval segment, and parameters are passed to the diagrams segment for the generation of dendrograms and scalograms.

K. Information Retrieval Segment.

This segment contains routine file-building and editing programs, for the transcription of punched cards to magnetic tape and for the amendment, insertion and deletion of records. Data validation is currently being implemented. Databases may be scanned using a nesting-store principle for the generation of Boolean expressions. The process is fully described in another paper in this publication (Shackley and Wilcock, 1974). The information retrieval segment communicates data to the statistics segment for the generation of classifications, to the histogram and piechart segment for the generation of routine statistical diagrams, and to the maps segment for the plotting of distribution maps.

3. Conclusion.

It can be seen from the above that the PLUTARCH System provides interlinked facilities for information retrieval, statistics and graphics for the general use of archaeologists. The system is segmented and therefore flexible, i.e., new segments can be added and interlinked as necessary. Some of the diversity of its possible applications can be seen from the two associated papers in this publication, treating stone artefacts and sediments respectively. Archaeologists wishing to use the facilities of the PLUTARCH System or to see it demonstrated at the University of Keele are welcome to contact the author.