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The application of micro-electronics in the AM Lab

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ABSTRACT This report reviews those tasks in the Laboratory which are being, or could be, carried out with microelectronics. It was produced in response to a CRPU survey on the general and particular uses of microelectronics in DoE, and includes microcomputers, microprocessors and digital logic circuitry used data logging and process control.

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MICROPROCESSORS

THE APPLICATION OF MICROELECTRONICS IN THE ANCIENT MONUMENTS LABORATORY

I. Introduction

This paper reviews tasks in the laboratory which could be, or are being carried out, using micro-electronics. The term encompasses microcomputers used in the conventional computer sense, and microprocessors and digital circuiting used as circuit elements in data logging and process control.

In this laboratory, these applications fall into three broad categories:

1. Data processing

This is the execution of numerical routines for eg statistical and scientific processes; tabulation of data; preparation of textual reports; data retrieval. In short, all those activities normally carried out on conventional computers, within the limits imposed by the size and power of the microcomputer.

2. Data capture

Microprocessors or microcomputers may be connected directly with instrumentation for data capture. While some of the simpler data capture may be achieved with discrete logic, or analogue circuitry, a microprocessor allows considerable flexibility in constructing complex timing sequences or carrying out pre-ordained numerical routines on the data at the time of its collection.

The complexity of discrete circuitry has to be weighed against that of pre-programming and hard-wiring the microprocessor. Microcomputers offer a more flexible approach but their cost for such a relatively simple task may not be justified.

3. Process control

The same arguments apply here. Where frequent programming changes are required in process control, a microcomputer is preferable to a microprocessor or discrete circuitry. All that is required of the device is to test the process state, decide on appropriate action and take it.

The following objections apply:

a. Discrete circuitry is cheap in cost (relatively) but time consuming in design and construction, and inflexible.

b. The microprocessor chip and storage elements are cheap (£10-£200) and very compact but require considerable engineering effort to apply, and they lack input/output devices.

c. Microcomputers are not so cheap (£1000-£5000) and their use for too simple a task causes over-concentration of resources.

There have appeared several commercially available single circuit boards containing all the elements of a microcomputer with the exception of input/output devices. These are very cheap (£150) in relation to their power and offer an attractive solution to the objections. This is indicative of the current correlative trends of reduction in physical size and increase in computing power.

II. Current uses

At present the Laboratory possesses two Research Machines 380Z microcomputers. One is used by the Central Excavation Unit, but both users are sharing service programs and acquired expertise. There will eventually be a link between the two collections of data since they refer to different categories of archaeological material from the same sites.

The projects are:

1. Central Unit

This involves the recording, checking, assembly, statistical analysis, and cataloging of information on site structure and artefacts such as pottery. The catalogues are printed on a line printer and then microfiched, the overall intention being to establish an archival record of all CEU excavations.

Some work has been done on the establishment of the post-excavation record (for administrative purposes); and the eventual aim will be to put the archaeological data from each site on so compatible a basis that inter-site comparisons can be made. The Unit hopes to add a second machine for program development work and a hard, fixed disc-drive for enlarged file handling.

2. Animal Bones. (Environmental section).

Current work is in developing a package of programs sufficiently flexible to be able to carry out most of the work at present done (expensively) through the GEISCO bureau service.

When complete, the system will act as a flexible data-capture and processing device, allowing data checking and correction, sorting, statistical analysis, and ultimately, catalogue printing on a line printer. Some of the paper output will be microfiched for archival storage.

The system hardware in both cases is practically identical, comprising a central processor, floppy disc drive, visual display, cassette storage and line printer. The users of both systems expect the occasional need to connect their machines directly to the mini-computer for large-scale sorting and comparison tasks.

III. Further uses intended with the present apparatus (380Z)

Some of these have been listed above under II since they are under development at present.

Other projects envisaged on the Environmental machine include:

1. Keys. Setting up of dichotomous keys for identification of various specimen classes - seeds, pollen, plants, charcoal, etc. The advantages here arise from the machine's ability to keep track of the search path through a key and hence assist in restarting the search within the key rather than at the beginning, in the event of a false move, and in the machine's flexibility in expanding its data base with information returned from the bench. A typical example would be the immediate inclusion of newly recognised diagnostic features of, say, charcoal.

2. Data capture from eg the Atomic Absorption spectrophotometer or the X-ray diffraction apparatus. In the first case the machine would perform the necessary calibrations and recording for either a single determination or, in the event of its adoption, automatic sample processing. (A single computer board might be a better alternative). In the second instance the micro computer could carry this out and in addition, given a densitometer or diffractometer (neither are possessed at present), could compare the outputs with calibrated standards.

3. Text editor. This package offers the facility of using the microcomputer as word-processor. This will be used for glossary tabulation (eg for bone identification procedure), data tabulation, data listing, and for the textual edition needed in report writing. Text edition will also be available on the mini.

4. Data base work, apart from that in III.1. It is probable that the machine will be used for the establishment of small data bases for information retrieval of catalogued information. A typical example is that of collating the details of manufacturers of, say, teaching equipment, or power transistors. This is done through a manually indexed system at present, and although fairly efficient is tedious to update, and recording is long winded.

Two other possible uses being considered at present are the recording of a small quantity of Lab accounting details, and the Lab equipment inventory.

It must be emphasized that the mini will have (that is, at present is expected to have) input/output ports for data capture, a data base management system and a text editor, so that the apportionment of the workload between the machines, when and if made possible by available staff time, will have to be critically reviewed every time a new project is required to be started.

IV. Interaction with the mini

The microcomputers will interact when necessary through an electrical interface which has been specified in the mini's operational requirement. It is envisaged that interaction will only be necessary in those instances where the processing power of the micro would be insufficient. This would be for the collation of large data bases, large sorting jobs, complicated statistical work, and so on.

There will be other micro-mini interaction, some directly through previously described hardware, and the remainder through data transfer media such as magnetic cassettes and punched tape. These will derive directly from the data capture projects set out in the next section.

V. Other Laboratory Ideas

These fall into the three categories given in the Introduction:

Processing
Data capture
Process Control

In many instances the categories overlap so that a brief description of each project is given rather than a thematic list.

1. Geophysics

The ambition here is to develop a fully portable data capture system using discrete microprocessors with support logic. Data acquired would be unloaded at frequent intervals into a vehicle-based microcomputer for instant numerical treatment and display on an appropriate plotter (probably a VDU). Later, stored version on magnetic cassette would be entered into the mini for further treatment.

Another use would be in process control of, say, multiprobe apparatus (for which discrete microelectronics is used at present). A simple computer board built with the MkII version of this equipment would greatly increase its flexibility.

2. General purpose data logging

The current geophysics data-logging stock comprises three identical commercial digital loggers, which store data on cassette for subsequent translation into punched tape, and a prototype AM Lab-constructed analogue logger. The development of a microprocessor logger will free these (digital) loggers for use elsewhere, and it seems an attractive option to combine them with single computer boards also capable of recording alphanumeric data, making general purpose loggers available for use throughout the laboratory. This would ease the potential load on the 380Z for low intelligence data capture and, probably, solve the kiln control and recording problem.

3. Specific measurement logging.

Environment section have expressed interest in direct recording of information from optical microscopy. With a suitable transducer, data on, say, cell dimensions could be rapidly acquired in parallel with the examination. If a successful technique were evolved it would inevitably be extended to other sections whenever necessary.

They also have a need to record dimensional data on, eg eggshell thickness; they have undertaken sample statistics on a pilot project, and there is some enthusiasm to continue it.

Given suitable transducers, then any dimensional data could be recorded with the use of either this apparatus or the complete 380Z. Project assessment already in hand includes the measurement of tree rings, and the dimensions of artefacts such as flints. The attractiveness of micros in these applications is the combined independence of operation and ability to store comparative calibration standards.

4. Conservation section

The more practical suggestions are:

i. Recording the movement of finds;

ii. Recording the course of treatment of objects and associated information;

iii. Process control in freeze drying, electrolytic consolidation and reduction, and iron washing;

iv. Recording and instantaneous calibration of data from microscopy.

i will almost certainly be achieved through commercial data logging equipment (such as bar-code machinery) transferring the information onto the mini via magnetic cassette. There seems little advantage in using a micro as intermediary.

ii could be achieved either through a local microcomputer and block transfer to the main mini data base, or by direct entry to the mini.

iii would require microelectronics at the fairly basic level, probably no more than discrete logic hardware.

iv could be achieved through apparatus developed along the lines set out in V3.

Other conservation section suggestions are typified by the following:

- image enhancement, eg of X-ray plates

- sorting out and matching fragments for reconstruction

- environmental surveillance - recording of relative humidity and temperature in storage areas.

The first would definitely increase the information available from stored photographs and radiographs, and would probably be achieved through the purchase of very sophisticated purpose built equipment of the type currently being made available for medical work.

The second would involve high precision digitisation and very complex software. At present, no such software is available, and even if it were, it would require a powerful computer and specialist hardware, and each application, as seen from the present state of knowledge, would need to be approached on an individual and very specialised basis. This is therefore very similar to LERNIE as conceived by Mr L Biek.

The third type is a data logging need which presupposes extensive monitoring and control equipment.

VI. Conclusion

This paper has briefly reviewed the current use of microelectronics in the Ancient Monuments Laboratory, and indicated some of the thinking for the future. Inevitably, some of these ideas will be abandoned through lack of general resources or the changing spectrum of Laboratory activities.

As it was the explicit purpose to review deliberate and specific use of microelectronics, certain devices have not been included, such as the dedicated mini computer in the spinning magnetometer, or that built in to the X-ray fluorescence (Isoprobe) apparatus, both of which are shortly to arrive. There are many other instances, where, albeit in a simpler form, microelectronics is incorporated in apparatus for control, measurement conversion, numerical analysis, output driving etc. This is now very much an expanding trend in laboratory equipment.

Many of the straight forward data processing tasks will be mounted directly on the mini computer rather than be carried out with microelectronics as defined here. Nevertheless, there remain many projects which will continue to be, or will become, undertaken in this laboratory with microelectronics.

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