THE AUTOMATED ARCHAEOLOGIST

A review of new personal computing and office automation methods of relevance to site recording, retrieval, analysis and publication

by

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Abstract

The paper is intended as a "state of the art" review of hardware developments in "word processing" equipments and microcomputers, and is aimed at archaeologists who do not have daily contact with technical computing literature.

Introduction

Recent developments in microprocessors have made it possible for a personal computing system to be bought for less than the cost of a new car. These systems are rugged, do not require a dust-free or air-conditioned environment, and are more than just toys (i.e. they are capable of carrying a real work-load). Such systems can be used in a site office or vehicle (see, for example, the work of Graham on the Zilog Z80), and make it feasible for on-site recording to take place as excavation proceeds. Archaeological data files so created may be used to produce phase diagrams automatically; to perform statistical studies which may, for example, influence the conduct of the excavation; to collate, analyse and classify information; and to produce lists and diagrams as an aid to publication. Microprocessors now also form part of "word processing" equipments in business and office automation. The archaeologist can use these equipments to advantage, which are basically text editors and retrievers with a video screen and associated magnetic backing storage (cassette tapes or "floppy" discs). The equipments may be linked to an automatic typewriter or film-setter which produce the final print master for direct publication.

This paper is intended as a "state of the art" review for archaeologists who do not have daily contact with computer developments. In microprocessors the situation continues to change rapidly, and new implementations are announced every week. The paper will introduce a number of jargon or "buzz-words", and no particular originality is claimed.

Microcomputer Components

A *microcomputer* consists of a number of components. Central to the system is the *microprocessor*, which is a development of the electronics industry, not the computer industry, and is certainly the most important electronics invention of the last decade. With the development of silicon integrated circuits it has become possible to cram tens (small-scale), hundreds (medium-scale) and now thousands (large-scale integration) of transistors, resistors, capacitors and their associated circuitry onto a piece of silicon semiconductor material about 1 cm square. Such circuits have long

been in use for conventional purposes in radio and television sets. But unfortunately the more components a circuit contains, the more specialised the circuit becomes, and the smaller its potential market (hence it is more expensive). The microprocessor was introduced to meet the need for a universal large-scale integrated circuit of general application. The large market makes it cheap (less than £30 at 1977 rates), and it can be programmed to perform a wide variety of functions. It has about the power of a first generation (electronic valve) computer of the 1950s. Unfortunately, however, because the development did not come through the computer industry, high-level language availability is not very good; many systems are still most efficient if programmed in binary, and the best one can expect is an implementation of the BASIC language, and perhaps FORTRAN, but the situation is changing rapidly.

The microprocessor cannot work in isolation. First of all it needs some associated storage, which comes in two main varieties, the *read-only memory* (ROM) and *random-access memory* (RAM). Here the situation is just the opposite of that in a conventional computer (where the data can be considered permanently stored, and the programs transient in the sense of only being in the store when under execution) - a microcomputer has permanent program storage in the ROM, which is preserved at all times, and transient data storage in the RAM, which is "volatile" i.e. lost when the power is switched off. In some read-only memories the stored program is permanent, while in others the program may be erased by ultra-violet light and rewritten, although rather slowly (this version is called an eraseable programmable read-only memory, ePROM, or a read-mostly memory, RMM). Both ROM and RAM are semiconductor stores rather than ferrite core or plated wire memories.

To communicate with the outside world the microprocessor needs input/output or peripheral devices. Here there is a snag, for these devices are still relatively expensive, accounting for most of the cost of a microcomputer system. Information is transferred to and from the peripherals via special *programmable interface adapters* (PIAs), usually treated as special memory locations and addressed in the same way as any other ROM or RAM address, i.e. a "store" operation to a PIA location causes an output operation to the peripheral, and a "fetch" operation similarly causes an input. Peripherals may generate *interrupts* for service by the microprocessor. Also some high-speed input/output applications may require direct memory access (DMA) which bypasses the microprocessor.

Typical peripherals which are currently available for microcomputer systems are as follows:

Teletype, or other automatic typewriter (see below)
Video screen, often a converted TV set
Low cost printers
Audio-style magnetic cassettes
Flexible ("floppy") magnetic discs, or "mini-floppies"
Keyboard
Papertape reader

The peripherals communicate via the "*buses*" or sets of communication wires connected to all parts of the microcomputer system. There are three main buses:

a) the address bus, which carries store and PIA addresses
b) the data bus, which moves information around the machine
and c) the control bus, which carries control signals. Buses are now being standardised (e.g. the S-100 bus) and a wide variety of devices may be attached to these standard buses, including even speech recognition and synthesis systems.

The Archaeologist's Use of Microcomputers

In a personal archaeological microcomputer, the programs will generally be written in the BASIC language and carried on a cassette or floppy disc. The programs will originally have been typed in (or read in from punched paper tape produced off-line on a teletype) and edited on the video screen or teletype using an operating system supplied by the microcomputer manufacturer. Prior to this the microcomputer will have been switched on, the loader program read from ROM, and the manufacturer's software read from paper tape, cassette or floppy disc. Once the relevant archaeological program is loaded, the archaeologist is free to type in data items as required. These may be edited on the screen, then written to cassette or disc when correct. The information is generally entered in a "prompt" or question-answer format, which obviates omission of data. As the information is recorded a label may be simultaneously printed for attachment to the find. Subsequent analysis may be carried out on site using the microcomputer, and this may influence the conduct of the excavation, but many archaeologists may wish the records to be subsequently transferred to a main frame computer of superior statistical capability and more elaborate peripherals, e.g. plotters, graphics displays with light pens, etc. This can be done by sending the cassette or disc through the post to a colleague at the computer centre, or by using telephone-line transmission for transfer of the data.

It is of interest to note that the recently-launched Micral V is a computer-in-a-suitcase. It is based on the Zilog Z80 microprocessor and has 32K bytes of memory, a display screen, keyboard, minifloppy disc, and a small thermal printer which is able to make hard copies of anything displayed on the screen. The whole weighs 14 Kg and can run on a car battery.

Word Processing Equipments

Word processing is a way of handling paperwork of all kinds, and especially letters, documents, summary lists and reports. The basic system consists of a video screen, a keyboard, cassette or floppy disc storage and some form of printer, all controlled by a minicomputer or microprocessor; it therefore differs from the more general microcomputer described above only in the applications software or programs. The operator types information or text on the standard typewriter keyboard and the material appears on the screen. The text may be edited immediately by making corrections, insertions and deletions of single characters, words, sentences and whole paragraphs without committing anything to paper. The perfect text is recorded on the cassette or floppy disc. When required the text may be printed in as many copies as desired. High-speed automatic typewriters can produce one page every 30 seconds, may have upper and lower case characters, variable spacing both horizontal and vertical, and can produce right-justified text if desired. The printing head is commonly a "*golf ball*" or "*daisy wheel*" and the printing is done in both directions - conventionally left to right, then right to left as the carriage returns. An added facility is the possibility of transmission of text at high speed over telephone lines, a form of electronic mail. But developments in printing technology have gone far beyond the typewriter or electromechanical impact line printer; there are now non-impact printers (electrostatic, electromagnetic), filmsetters (which produce letterpress-style print on a continuous roll of photographic paper) and microfilm systems. Microfilm is of particular use to archaeologists. The frames may be produced by direct computer output (at a rate of about 10 frames per second) or by conventional photography, and colour is available as well as black-and-white. The format may be continuous roll film, jackets which

accept short lengths of film, microfiche, 80-column size aperture cards with transparent windows for pieces of film and space for notations as well, and film folios which are a cross between jackets and aperture cards and of standard microfiche size. Storage of microfilm stock is much easier than for files of paper, and speed of retrieval can be as low as a few seconds for any one of a million frames. Valuable man-hours can be freed from sorting, filing, locating and copying paper records. The microfilms may be easily copied for security and publication. The cost is so economical (a few pence per microfiche) and the size and weight so suited to transmission by normal letter mail, that every interested archaeologist can have his own copy of any lengthy report which would be beyond his personal means in conventionally printed format. Microfiche readers are now common in reference libraries and academic institutions, and if a paper copy of any frame is ever required, it can be obtained as a Xerox copy.

A View of the Future

Within a few years microprocessors will be commonly used in domestic equipment such as cookers, washing machines and cars. The biggest impact will probably be the incorporation of a microprocessor into the television set, which will make it capable of operating as a computer terminal, transmitting and receiving information via the telephone. The CEEFAX, ORACLE and VIEWDATA teletext systems are available now. Is it too much to hope that these will form a basis for archaeological data systems in due course? No doubt microcomputers, word processing and teletext will be used by a few dedicated computer archaeologists. But the technology is still too formidable for any archaeologist who has trouble, for example, in tuning a television set, typing a letter without mistakes, or correctly adding a column of figures; these will continue to see the computer more as an enemy and a threat to their reputation.