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Photo features Cromemco System 3 computer, 3101 VDU, and 3355 daisywheel printer.

C2

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Volume 3 No. 1 January 1980

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Guidelines for contributors
PCW welcomes articles of interest. Don't be put off if your style of writing is 'under developed'. . . true worth lies in the content, and shaping features comes naturally to us! Manuscripts should not exceed 3,000 words and authors are asked to use triple-spaced lines with a wide left-hand margin; diagrams, listings and/or photographs should be included wherever possible. Please enclose a stamped, self-addressed envelope if you would like your article returned.

Because of the foregoing, it is necessary to add that the views expressed in articles we publish are not necessarily those of *Personal Computer World*. Overall, however, the magazine will try to represent a balanced, though independent viewpoint.

Finally, before submitting an article, please check it through thoroughly for legibility and accuracy.

Subscription rates: Britain £8.00 for 12 issues, USA $20 for 12 issues (surface mail), Continent and elsewhere £9.80 for 12 issues. All prices include postage and packing. Supplies to specialist shops can be arranged by negotiation direct with the publishers.

EDITORIAL

PCW is acutely aware of the need for consumer protection in the microcomputer business. We try to advise and guide prospective buyers, often through the 'Interrupt' feature. Now we are delighted to report that the suppliers themselves have decided that the time has come for more positive action. To this end a Computer Retailers Association has been formed. At the time of going to press, 41 retailers have agreed to join the association and to abide by its strict code of conduct. This code is designed to protect the consumer and we think that it is in every readers interest to study the draft. In order that you may do this we publish it in full as part of the article 'Straight Dealing' on page 42 of this issue of PCW. Should you have any comments to make then write to PCW, marking your envelope CRA. As the code is still in draft form, this is your opportunity to influence the final product. PCW will pass all correspondence on this matter to the executive committee of the CRA.

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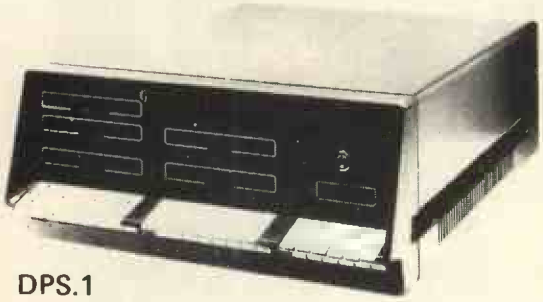

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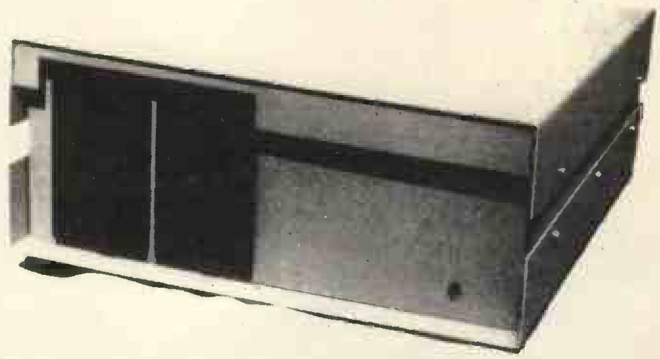

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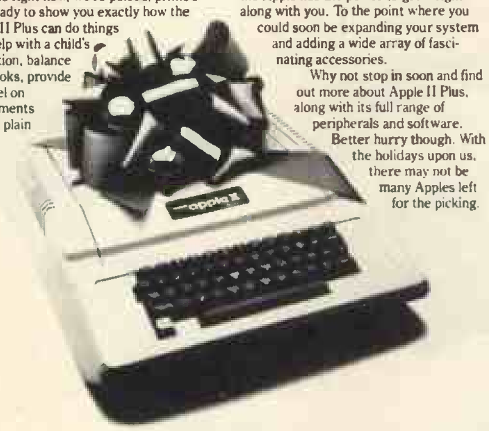

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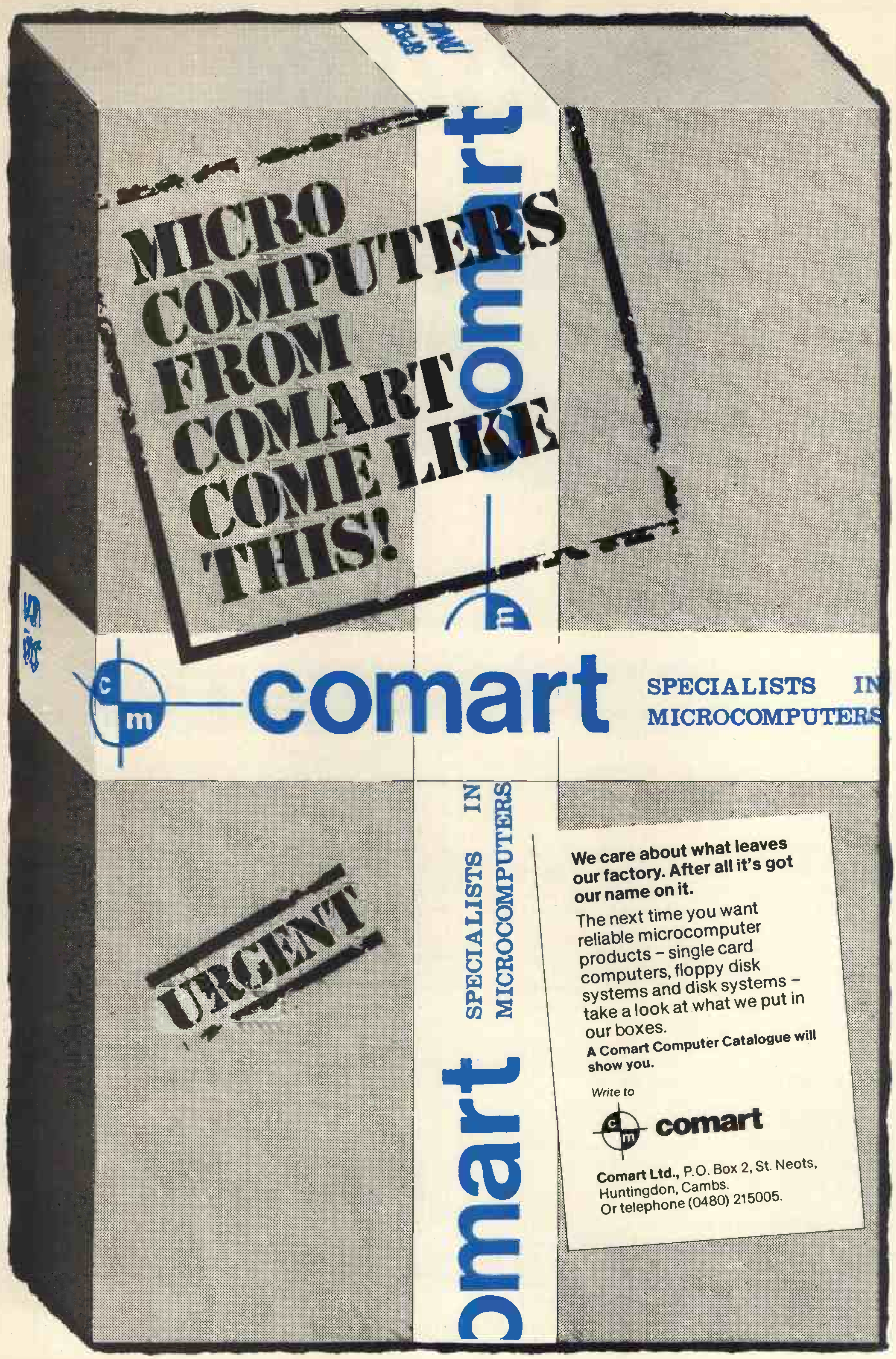
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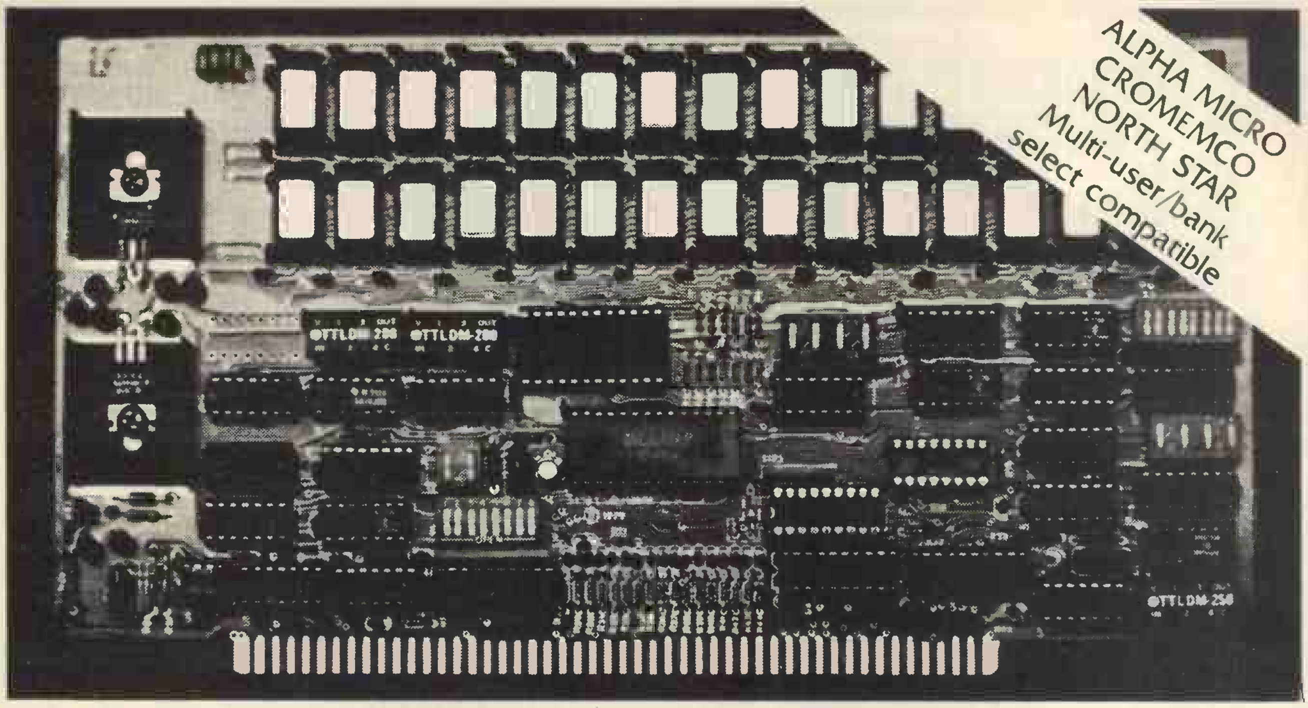

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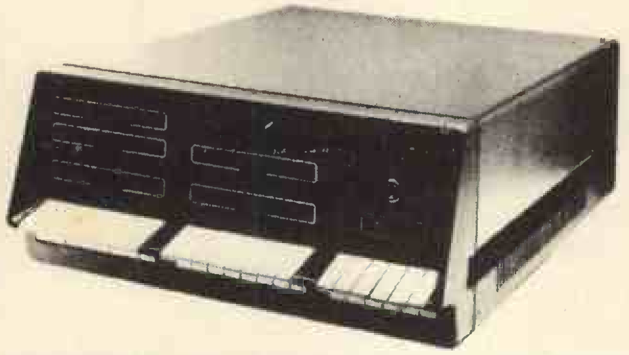

A MINI COMPUTER using MICRO technology at a ridiculous MICRO Price!!! The front panel with a backplane and power supply accepts S100 bus boards from many manufacturers.

InterSystems

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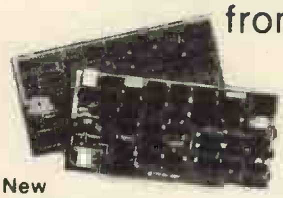

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THE RESEARCH MACHINES 380Z COMPUTER SYSTEM

THE RESEARCH MACHINES 380Z
A UNIQUE TOOL FOR RESEARCH AND EDUCATION

Microcomputers are extremely good value. The outright purchase price of a 380Z installation with dual mini floppy disk drives, digital I/O and a real-time clock, is about the same as the annual maintenance cost of a typical laboratory minicomputer. It is worth thinking about!

The **RESEARCH MACHINES 380Z** is an excellent microcomputer for on-line data logging and control. In university departments in general, it is also a very attractive alternative to a central mainframe. Having your own 380Z means an end to fighting the central operating system, immediate feedback of program bugs, no more queuing and a virtually unlimited computing budget. You can program in interactive BASIC or, using our unique Text Editor, run very large programs with a 380Z FORTRAN Compiler. If you already have a mini-computer, you can use your 380Z with a floppy disk system for data capture.

What about Schools and Colleges? You can purchase a 380Z for your Computer Science or Computer Studies department at about the same cost as a terminal. A 380Z has a performance equal to many minicomputers and is ideal for teaching BASIC and Cesil. For A Level machine language instruction, the 380Z has the best software front panel of any computer. This enables a teacher to single-step through programs and observe the effects on registers and memory, using a single keystroke.

WHAT OTHER FEATURES SET THE 380Z APART?

The 380Z with its professional keyboard is a robust, hardwearing piece of equipment that will endure continual handling for years. It has an integral VDU interface — you only have to plug a black and white television into the system in order to provide a display unit — you do not need to buy a separate terminal. The integral VDU interface gives you upper and *lower* case characters and low resolution graphics. Text and graphics can be mixed *anywhere* on the screen. The 380Z has an integral cassette interface, software and hardware, which uses *named* cassette files for both program and data storage. This means that it is easy to store more than one program per cassette.

Owners of a 380Z microcomputer can upgrade their system to include floppy (standard or mini) disk storage and take full advantage of a unique occurence in the history of computing — the CP/M™* industry standard disk operating system. The 380Z uses an 8080 family microprocessor — the Z80 — and this has enabled us to use CP/M. This means that the 380Z user has access to a growing body of CP/M based software, supplied from many independent sources.

380Z mini floppy disk systems are available with the drives mounted in the computer case itself, presenting a compact and tidy installation. The FDS-2 standard floppy disk system uses double-sided disk drives, providing 1 Megabyte of on-line storage.

**Trademark, Digital Research.*

Versions of BASIC are available with the 380Z which automatically provide controlled cassette data files, allow programs to be loaded from paper tape, mark sense card readers or from a mainframe. A disk BASIC is also available with serial and random access to disk files. Most BASICs are available in erasable ROM which will allow for periodic updating.

If you already have a teletype, the 380Z can use this for hard copy or for paper tape input. Alternatively, you can purchase a low cost 380Z compatible printer for under £300, or choose from a range of higher performance printers.

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RESEARCH MACHINES Computer Systems are distributed by RESEARCH MACHINES LTD., P.O. Box 75, Chapel Street, Oxford. Telephone: OXFORD (0865) 49792. Please send for the 380Z Information Leaflet. Prices do not include Carriage or VAT @ 15%.

interface components

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No more slaving over a hot soldering iron – the Nascom 1 is now supplied BUILT! Britain's biggest small system is available fully constructed for you to slot into your own housing for the ridiculously low price of £140 plus VAT (kit price still only £125 plus VAT).

nascom-1

12" x 8" PCB carrying 5LSI MOS packages, 16 1K MOS memory packages and 33 TTL packages. There is on-board interface for UHF or unmodulated video and cassette or teletype. The 4K memory block is assigned to the operating system, video display and EPROM option socket, leaving a 1K user RAM.

The MPU is the standard Z80 which is capable of executing 158 instructions including all 8080 code.

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NASCOM-2 + FREE 16K RAM

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NASCOM-2 + FREE 16 K RAM £295 + VAT + P&P £1.50

MEMORY
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- 2K NAS-SYS 1 monitor.
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- Main board sockets for the 8x4118s *or* 2708 EPROMS.

MICROPROCESSOR ● Z80A which will run at 4MHz but is selectable between 2/4 MHz.

HARDWARE ● Industrial standard 12" x 8" PCB, through hole plated, masked and screen printed. All bus lines are fully buffered on-board.

INTERFACES ● Licon 57 key solid state keyboard.
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- Kansas City cassette interface (300/1200 baud) or RS232/20mA teletype interface.

The Nascom 2 kit is supplied complete with construction article and extensive software manual for the monitor and BASIC.

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NEW

Fully built and housed in a stylish enclosure for just £325 plus VAT. Interfaces with all micro computers.

NASCOM IMP £325 + VAT + P&P £2.50

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MICRO MART

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BOMBING THE PRICES

Derek Rowe of Abacus can be sure that the hornets in the computer world are going to be very stirred up by his deal with Texas firm, Show Financial — and the hornets will call him the worst of all possible names. They will accuse him of Bombing the Price of terminals.

As an example of what bombing the price means, take a look at pricing on two devices: the Japanese NEC Spinwriter, and the American Texas Instruments 810 printer.

The Spinwriter is not easy to describe to somebody who hasn't seen one; as a test of the command of English it's far better than the old 'describe a spiral staircase without using your hands' we all learned at school. It is a typewriter, which makes its black marks on paper with a device about the size and shape of a small whisky tumbler. It doesn't look like a whisky tumbler, it looks like the vertical struts of a basket before the horizontal weaving is done.

In the centre of the cup-sized basket is a hammer, pointed at the paper. The 'struts' of the basket are spun past the hammer, and each strut has a letter moulded to the top of it. When the right letter gets between hammer and paper, the hammer bashes the strut onto the paper. If you are quick and put a typewriter ribbon in the way first, you will end up with a printed character. Got it?

As the market stands today, this device is a top quality electric typewriter, with the bonus feature of being usable as a terminal. Its official UK price of £2,600 reflects not only the many sophisticated safeguards that the builder has provided; it also reflects the fact that the IBM golf-ball typewriter sets the price standard, and that this machine can outperform the IBM one.

The crunch comes in that Derek Rowe has been taken over by Show Financial, and as a subsidiary, shares the terminal inventory of Show's US subsidiary, Computer Marketing Corporation. Rowe will import, at a figure he regards as being in line with prices charged to official NEC importers, but will sell for nearly £600 less.

NEC customers report a strange reaction from official sources when they query this. Rowe told me: "Some of my prospective customers have been told we only have a few, and that we won't get any more. In fact we have stocks, lots of stocks, and what's more ours run 50 Hz because we put our own power supply in".

And he ended: "Of course we could rock the boat less if we just charged the same as other people, but that would be making an immoral profit".

The direct relevance to the average micro user of this exciting squabble lies in the fact that terminals, like microcomputers, are sold in the UK for prices which bear little relation to their US price — a fact which Apple dealers find it hard to forgive us for mentioning.

Recently, Apple prices in the UK were cut, and in the process, some agents took the opportunity of observing that, compared to the terminal industry's mark-up, Apple importation pricing was very lenient on the customer.

"I can buy a Texas Instruments printer, the 810, from a store in New York, and import it, and pay duty and tax, and the one-off price; and it will cost me £730," raged one Apple mogul. "If I ask Texas in Bedford for a price, they won't offer me less than £840, and that's for very high volume. Why don't you print that, rather than going on about the $200 extra Apple charges on exported machines?"

As a matter of curiosity, I asked Texas in Bedford what a single 810 would cost: over £1,400, was the answer. Abacus will be importing the Texas 810, too, but Rowe wouldn't talk about pricing policy compared to Bedford. "We will be adding value", was all he would really say, "with a special character set option, and our price will be £1,200 or so; but we're not trying to compete with TI Bedford."

My bet is that Texas will still accuse Abacus of 'bombing the price', which, if they do, will be an accusation that will bring wry smiles to the faces of that company's competitors.

Ace is high

A TV games machine called the Acetronic MPU 1000, selling at £90, has been launched by Advanced Consumer Electronics (ACE) with the Signetics 2650 microprocessor as its central intelligence. Managing director David Rurka included a 5-page sermon with the launch announcement, forecasting 'household financial planning and

The Acetronic MPU/1000, plus range of plug-in modules.

control, learning, recipe and shopping list storage and update programs' — all on plug-in modules. The sermon all but completely obscured the important announcement that a new ACE system would soon be introduced, again in the guise of a TV games system, but "capable of being enhanced to a highly sophisticated home computer".

I'll forgive him for his waffly sermon, for the sake of one snippet of metaphor: "The astronauts who landed on the moon in 1969 would not have known how to operate a digital watch, let alone have any idea of how it worked; such is the speed of micro technology." Egad, that's probably true!

Massmem and pi-mem

Unlucky readers of a local paper in Sheerness will believe that a British engineer has invented a computer memory that provides 128 million characters of storage without a disc or tape or semiconductor.

The truth, if less startling than that, is still good news for British micro users.

The local company, Courtest, believes it has found a way of using the fact that tape is generally cheaper than disc to offer a high speed tape drive that replaces disc.

On the face of it, this is not possible. Tape starts at one end and finishes at the other, so most tape data recorders are used to tie up data in a string as the computer winds it out. Discs, however, can yield any data written anywhere on their rotating surfaces in as little time as it takes to move the recording head to the right track.

Malcolm Joy at Courtest thinks he has beaten the problem technically, and, more important, has the money to turn his technical breakthrough into a product which Apple distributor Microsense has already agreed to distribute.

Courtest's general product, Massmem and Apple add-on product, Pi-mem (how do you make Apple pi?) use a Verbatim TC 4000 cartridge tape. It has nine heads built into the cartridge, together with the quarter inch wide tape — the result being that when the parallel heads are installed, it doesn't matter how accurately they are positioned, because there is no need for them to match the positions of the heads on a different drive.

Joy drives the tape with a stepper motor, at something like ten times the speed of normal tape — 240 inches per second, which gives him about ten seconds to cover the whole 128M bytes of data.

Using stepper motors is not normally possible on fast tape, because of the problem of keeping the tape flowing past the heads smoothly. The dots and dashes of binary code normally come at regular, predictable intervals; but on Joy's tape, they are there, or they are not there, at points defined by a 'clocking' channel which uses the ninth head. No need to synchronise watches, just watch for the synchronisation pulse and count the other eight heads.

A Pi-mem for Apple users would offer about eight million characters, and cost £1,450. It would fit onto the same interface card that Tim Keen of Keen Computers has announced with his diskette-sized hard disc memory.

As an alternative to disc, Joy thinks the tape system will work fine, as long as nobody writes a virtual storage system, putting programs from memory to disc and disc to memory, swapping the program that has just finished for the one that is just going to run. For the big 16-bit micro that Zilog is pushing into the market, the Z8000, Joy thinks his Mass-mem version of the tape, offering 128M bytes at £3,850 (discounted to £2,000 for builders of original mass produced systems) could provide a powerful associative memory, where data can be retrieved directly, rather than as a result of a search.

The price, he concedes, is not low "but we would rather start high and do a deal if necessary". What sort of 'deal' he won't say, naturally, but I can't see any reason for supposing that if the system works, it will cost much over £1,000 in a year or so's time.

The company behind this new idea, the Courtest Group, is also planning a word processor, various printer interfaces, and a consultancy service. Joy says it is backed up with £150,000 capital, has a factory and is making distribution deals — all of which could be more important than bright technology.

The name's the same

The computer revolution in Britain did not begin with the Mits Altair which Martin Underwood imported through his new company Compelec. It started with the Computer Workshop, which put a video display kit on the market, almost a year earlier; and the news that Computer Workshop is dropping out of the kit business probably marks the end of the revolution, and the fact of the New Establishment.

It doesn't mark the end of the Computer Workshop as a supplier of kits, however. This apparently magic trick — Workshop won't supply kits, but Workshop isn't dropping out of kits — is all done by mirrors, with the help of the clowns from the Business Register.

Computer Workshop in Manchester, and now in Leeds, has nothing to do with Computer Workshop of London and Peterborough, builder of South West Technical Products. The Northern Workshop is in fact part of Micro Computer Mart, which started selling SWTP, and used the 'workshop' title with the original Workshop's permission. It now sells Cromemco, Horizon, Apple, Pet and SWTP.

And as a result, the Original Workshop, (to avoid confusion) is changing its name to South West Technical Products. It is also planning a big announcement about how it will concentrate on the business and education market, and quietly pull out of hobbyist sales — something which its pricing policy had already brought about.

As a sign of the New Establishmentarianism in microcomputers, the Leeds shop was opened by an ex Cabinet Minister — Merlyn Rees, the Labour Home Secretary until this year.

Rees was attracted with the offer of a platform: he was asked to speak about computer technology and 'the role of the microcomputer in society and its future development.' His contribution was: a new social class will grow up in response to the micro, in the next decade.

Our picture shows him talking to an Apple micro, demonstrating the ability of the speech recognition circuitry and software to mistake 'seven' for 'end' and turn the whole program off just when it gets interesting. (No, I wasn't there, and for all I know, that didn't happen; but it did happen to me when I tried it.)

Ex Cabinet Minister, Merlyn Rees, willing-on Apple's speech recognition circuits at Computer Workshop in Leeds.

New courses

For the lost stranger to these pages, vaguely wondering whether a micro could help run a business, or whether perhaps an Official Minicomputer would be better, the idea of £27 for a one-day seminar to put the problems in context might seem cheap. Yes?

It is one of several 'beginners' seminars organised by the London Chamber of Commerce and Industry, and designed to make sure you only get fleeced if you are really overheated.

"Computer Bureaux vs Mini vs Micro Computers" runs on Tuesday March 18 next year from 2.00 to 5.00 pm. 'How to Negotiate Computer Contracts' runs on Thursday 21 February. A one-day training course 'Introduction to Computers and their Applications' costs more at £70 and there are several dates through to July next year. And finally, a two day 'Introduction to Microcomputer Programming' course — a BASIC course — at £127, runs on March 12 and 13, and again on June 11 and 12.

Contact; Ann Measures, training manager, at 69 Cannon St., London EC4N 5AB.

The money program

It isn't easy, giving away £800 to good software writers. Kent University has tried it, and last year, only 20 people were interested.

The £800 forms the prize money for the Kent Software Trophies. It is open to software writers in schools and colleges, and it would seem that software writers there just don't get to hear about it.

The problem, as explained by Dr. David Bateman, who works at the University of Kent computing laboratory, is simple. Either the £800 goes as prize money, or it gets spent advertising the competition.

This year, thanks to the foresight of the Government, the schools and colleges won't be able to distribute leaflets and entry forms about the competition, because local education authorities are having their budgets cut.

Well, if you want the money, you know what to do. You submit a computer program which you have written. The program must be of practical use in commerce or industry, not just for the school or college. It can be short — 20 lines of code would do, as long as it is 'imaginative', 'useful' and 'well documented'.

Two first prizes worth £300 will go to under 17 and under 19 year old winners, with up to 20 'merit' prizes of £10 each.

For details, entry forms are needed. Write to Dr David Bateman, Computing Laboratory, University of Kent at Canterbury, CT2 7NF. And be quick; entries must be in by February 16, 1980.

Micromotion

Adding to the list of computer shows outside London is the at first unlikely candidate of Computermarket '80. This travelling fair has in the past been an orthodox computer industry disaster, delightful for the visitor, who could be sure of respectful attention from a great many people on each exhibition stand, but rather less rewarding for the exhibitors themselves.

Now it is turning itself into the Travelling Micro Show, if not by that name. Exhibitors who are registered, according to organiser John Godley, include Comma Computers, Compshop, Computastore, Computer Workshop, Corner Computing Services, CPS (Data Systems) Digico, ITT Consumer Products (and Lovely Bottoms), Lyme Peripherals, Micro Centre, Micromedia Systems, Nascom Microcomputers, Robox, Rostronics. . . it reads like the headlines from the last four issues of PCW.

Orangisers are Couchmead; the theme of 'Taking the computer industry to the first time user' is obviously attracting the right people; dates in March are 4-6 in Birmingham, 11-13 in Manchester, 18-20 in Glasgow, and 25-27 in London; and details are on 01-437 4187.

Test trauma

A first-class row and a second-class scandal may be brewing over the servicing of personal computers. In the last two months, user associations, manufacturers, trade associations and all have pointed out the fact that not all users get trouble-free servicing of their equipment. What they have not concentrated on is the fact that the means for diagnosing microprocessor faults is still crude.

Illustrating the point pretty well is the announced specification of a new 'in-circuit analyser' which, it is claimed, will simplify microsystem diagnostics. The machine is available from BFI Electronics, for Intel's 8080 and 8085, and Zilog/Mostek's Z80 micros only.

It provides in effect a 'dual control' for a microcomputer system. The analyser has forty leads to attach to the forty pins of the micro on the board. It monitors the signals passing down the buses, and can over-ride them if certain pre-determined sequences of events occur.

For example, a particular memory location or stack location can be specified on

NEWSPRINT

Micro system diagnostics — from BFI Electronics.

the address bus for up to 16 times, before the analyser takes any action. Action then can include a halt, other memory examination, register adjustment, data adjustment, and so on.

Something like this diagnostic facility is available to designers of systems already, through the development systems with their in-circuit emulation abilities.

The question of how many dealers are designers or have micro development systems is less than moot, however. Many a problem has been overcome without the repairer ever having any real idea of why the cure has worked. Best known was the Nascom expansion memory board, which failed if the same memory loaction was accessed two or three times in succession, but only if one of the buffer chips was a Fairchild or Texas low-power Schottky device — not if it was made by National Semiconductor. Nobody has yet offered a convincing, detailed analysis of why this should have been so.

In the circumstances, the more test equipment available, the better. What about the people to operate it, though? Details from BFI on 01-941 4066.

Bubbles beat dust

A computer on a building site will probably need bubble memory instead of floppy discs, simply because of the heat and the dust. That is, assuming you can find a computer with bubbles. And now, you can, thanks to Sidney Schubert, in charge of his own company Dalestate. He has found an American microcomputer costing £3,400 in the UK which can take a bubble module of 128K byte capacity.

Included in the price are languages — Basic, Fortran and Cobol — and a floppy disc drive comes as standard. The system is portable, weighing 20lbs. It is made on the US West Coast by Findex, it runs the CP/M operating system on its Z80 processor, and the package includes screen, disc drive, keyboard and printer. The only snag is the cost of the bubble memory; £1,500 per 128K byte module. It can take eight of these, should you be able to afford it. But if you have problems with vibration, dust, heat or movement, then you probably can't afford not to. Schubert is on 01-660 9680.

Swings and roundabouts

When the country has two importers of the same computer, and each importer sells at a different price, look for the coolest sort of friendship between them. Thus it is between Comart, the big distributor of micro equipment, mainly based on the S100 bus; and its Scottish rival Micro Centre.

The two operations are very different in what they do, and in what they try to do. Norman Rouxell in Edinburgh sells at the lower price, direct to end-users. Comart has established a dealership chain, which includes all Byte Shops and Computerland retail stores, plus such other reputable dealers as Tim Moore of Newbear in Newbury. David Broad of Comart generally asks the end-user to pay rather more, most of the extra going on dealer support, which, he says, feeds back to the user. The incompatibility between two, equally valid approaches to the total market turned into something like rancour recently, when Rouxell announced the Cromemco hard disc system, and astonished the world by pricing it level with Comart.

He also astonished David Broad by announcing that maintenance would be done by the established repair firm, Computer Field Maintenance. CFM handles Comart maintenance, and the deal was supposed to be exclusive.

Claims and counter-claims aren't easily sorted out by simple phone calls, and until an angry user can put me right, I can only go on the intelligent guesses of non-combatants in the industry.

The intelligent guess is: on price, Comart is now a big enough customer on the more expensive Cromemco systems to pull some weight in California, and to get an undertaking that, on big systems at least, anybody selling below Comart prices will not be supplied.

On maintenance, rival stores tell me that there is no need to make a mystery out of it. Computer Field Maintenance, they say, makes money from fixing computers. If you ring the engineer up and ask him to fix a broken computer, it's quite possible he (or she) won't bother to ask who sold it to you before agreeing to send an invoice.

Intelligent guesses, however, aren't guarantees. Users should probably make their own investigations; and believe what you like, only make sure you get it in writing if you're paying for it.

Pet plug

To prove that Pet has become a world of its own, not just a character in the greater play, a new Pet magazine has started up. Obviously, it aims to balance the Commodore-oriented magazine put out by Commodore itself, by being independent. The fact that the Editor, Richard Pawson, is ex-Commodore himself need not mean that he will be biased pro-Commodore, either, as anybody who has ever met ex-Commodore man Derek Rowe of Abacus can testify. Printout, at £9.50 for ten issues in the UK, is available from Greenacre House, North Street, Theale, Berkshire RG7 5EX.

Now show me another magazine that will give publicity to a rival like this. Isn't PCW the greatest? We'll cut our own throats to bring you the news. . .

Pet printer

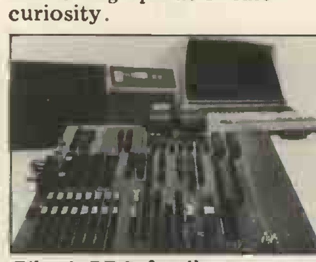
Printers for the Commodore Pet computer: at £550, a new range has been announced by Parameterised Computer Systems Ltd. Apart from the fact that this machine, called the X50, plugs direct into the universal plug port of the Pet, the IEEE interface, it doesn't appear to offer anything over cheaper machines such as the Oki, since it uses a roll of narrow paper — four inches wide. The German manufacturer claims that the matrix print head will last for 50 million characters.

Zilog range expands

Zilog has introduced a family of product development systems — all microcomputers with a Zilog chip as central processor on which to run and test software.

There is a big one based on the giant Z8000 chip, with up to 40 million characters of storage on hard discs, and smaller ones covering the established Z80 and the new single-chip Z8.

What will probably make the equipment, however, is the operating system, Zilog's RIO, which can link assembler source with high level modules written in PLZ/Sys and shunt them around the memory map on command. Sophistication like this is not, of course, for the user of a simple shop-bought system, but for the system builder who is making hundreds. Don't ring up out of idle curiosity.



Zilog's PDS family.

Heath-CP/M compatable

The vast bulk of software written for systems that used Digital Research's operating system, CP/M, will now run unchanged on the Heathkit micro, says CP/M's New York agent, Lifeboat.

At $145, the Heath version of CP/M includes a text editor, an assembler, debugger, and various other 'utility' items of software that give the user access to a system without having to toggle switches.

Steadmans bazaar

A bring-and-buy sale for electronics scraps is going to be by far the most exciting feature of the Great British Electronics Bazaar when whizzkid, Evan Steadman, puts it together next June.

Steadman is one of those amazing characters who is never at a loss for a comeback, no matter how rude the comment — and sometimes the comeback is better than his original idea. In the case of the bazaar, last time was the first show, and while it worked better than many 'first times', it was not above critical comment. The comment that seems to have stung was actually summed up in a letter of praise; "The atmosphere was very good and relaxed, unlike other exhibitions such as Breadboard which was too over crowded." There is, it seems, over crowded, and *too* overcrowded. In his blurb to exhibitors and possible exhibitors, Steadman observes: "You want lots of people to come to the Bazaar, agreed? Well, apart from the reduced admission if they write in for tickets in advance, we are now also offering a free bring-and-buy-sale for every visitor".

That, he explains, means that there will be benches, on which everyone "who has bits and pieces that they now don't require" can display their wares free of charge.

To get your cut-price ticket, write with stamp-addressed envelope enclosed to Evan Steadman, 34-36 High Street, Saffron Walden, Essex CB10 1EP. The Bazaar runs Friday, Saturday and Sunday, June 20 to 22 next year.

Glitch-free

Copying a tape with a program on it is simple; you borrow another tape recorder, play the program on yours and record it on the other. Getting the copy to load correctly is the problem, however. A tape copying service has been launched by Kansas City Systems. It runs on a non-profit basis and is for bona fide computer clubs only; and according to KCS boss Tom Crossley, the copies are guaranteed to load. Tom charges 50p a copy, including tape, for a minimum of five tapes. Details on Chesterfield (0246) 850357.

Fair success

A hobby computer fair in Stuttgart, Federal Germany, is reported successful enough to encourage the organisers to try again next year. The show, Eltro-Hobby 79, attracted Citizen's Band, ham radio, and television enthusiasts as well as microcomputing people; some 25,000 visitors arrived over the time from October 3 to October 7.

Next year's show will be September 10 to 14, and the venue will be the Killesberg exhibition grounds. Details from CES Overseas in London, on 01-236 0911.

Spiking the system

The worst thing you can do to your computer is turn it off: and the second worst thing is to turn the washing machine off.

As to the first, all you can do is put a notice on the machine, pointing out that it uses as little power as the fridge, and that it is supposed to have no moving parts. Turning it on and off makes the parts expand and contract and — literally — wear out.

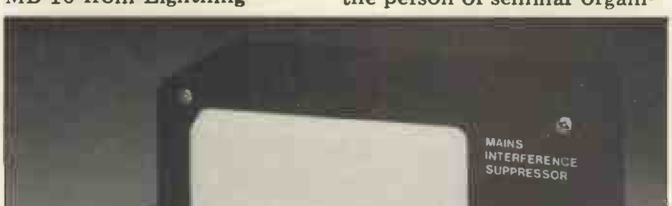
For the second, you could try filtering the Electricity Board's power supply. It's worth a try, because the voltages that can appear on the mains when a big coil like a washing machine motor is switched on or off can do dreadful things to a micro — both hardware and software. A mains 'spike' at our own PCW Show stopped the chess-playing Vega program's clock, blew three memory chips on a neighbouring stand, and, presumably, introduced uncounted random errors into storage, input and output, all around the hall.

Two products announced this month tackle the problem in different ways. Beyts Logic has announced a mains interference suppressor costing under £20, sold through Logic Box at 31 Palmer Street by Caxton Hall, London SW1.

Rather more costly at £105, but more ambitious in its attempt to clean up the mains noise is the LEA MB 10 from Lightning Elimination Associates, of Vine Cottage, Moreton, Oxon. It provides 13 Amp output, and has an impressive list of performance figures for its active filter.

Neither device, by the way, will stop your micro picking up the multi-million Amp spark that the typical electronic photographic flash generates when it stops flashing, and many are the systems that will execute an HCF (Halt and Catch Fire) instruction when they pick up that pulse.

Lighting Elimination will try to avoid this problem too — even to the point of advising you on what to do when lightning strikes next door. The company 'stresses' that it provides a total service, as well as supplying a product'.



The Beyts Logic mains interference suppressor.

Never mind maths

It is now officially true that you can program a computer without 'O' levels. The guardian of what is possible, the National Computing Centre, has produced figures from a survey of school levers who were trained as programmers.

The fact that startled the established computer industry is that the best sign of a potential programmer is a good grasp of English. After that, a test designed to measure general thinking ability showed a good correlation between those who scored well at it, and those who made successful programmers. But maths turned out to be no guide at all and neither did an interest in chess, bridge, or crossword puzzles.

The average commercial data processing manager, however, remains convinced that home micros are a dream, because ordinary people will never be able to program them. That's my impression, by the way, not the NCC's. The NCC, in the person of seminar organiser Eric Bird, contents itself with the observation that data processing managers are exhibiting 'resistance to change'.

Plessy chip board

Fast memory for Z80 based systems: Plessey has announced a board of read-and-write memory chips that will keep up with this high speed micro. Considering that the board is nothing like S100, and that it costs £769, it is perhaps understandable that Plessey should call it 'the only memory board on the market for the 4 MHz Z80A' — but it isn't true. Cheaper 4 MHz boards are available from Comart, on the S100 bus and providing the same 64K bytes of memory.


The Plessy PSM 4463/Z

Program ADES

Since computers are ideal for tedious, boring, repetitive jobs, the first thing that the computer industry did with them was write programs to handle the tedious, boring, repetitive job of compiling program instructions. Hence the compiler, the interpreter and the assembler. The next logical move is the equally drawn-out task of teaching people to write programs, ready for compiling, interpreting or assembling by the computer. For £46 per tape, Pet, Apple and Tandy users can load a program that will do just that.

The supplying company is Applied Data education services, ADES and the programs are called Little Genius. Arrange a demonstration on 01-580 6361.

Mag tape loops

Serious magnetic tape systems for the low-cost microsystem are suddenly proliferating. The question of 'what took the tape drive makers so long to get realistic prices?' is answered by the largely new companies on the scene with a simple 'They had a captive market in data logging'.

With V&T Electronics showing an impressive drive using standard half-hour type cassettes at the PCW Show and Philips and Pelco showing a mini cassette drive on the Aim 65 system, the range of offerings is getting wider.

The latest idea, however,

is a £50 drive called the magnetic tape Wafer. It is unique in being a continuous loop, 50 feet long. With a microprocessor controlling a drive system, it costs £120, and individual Wafer tapes are £1.40.

The drive and the control are made by Micro Communications in the US, and the UK agent is Russet Instruments of Richmond.

Cheek

The Online micro show is moving to Wembley. This must be success, and since the organisers have asked me to speak at all three of the shows so far, I can only say that success is well deserved.

My totally unbiased opinion, then, is that from July 22 to 24, the exhibition, and the seminar, will go like mad. Unless, of course, they omit to book my speech, in which case, my unbiased opinion is, it will flop, OK?

Byte go soft

At the same time as he was turning a computer into a film producer in Glasgow, Bill Cannings of the Byte Shop chain was starting a new venture in software.

What he is producing is a whole series of business and accountancy packages for small users — and the pricing is strictly not retail. Cannings is having the software written by a professional software house. While this doesn't mean it will be foolproof, it does mean that there is somebody to kick if and when it goes wrong, as opposed to retail offerings which you can change yourself or throw out.

The computer film producer was in fact sold to a local film production company by Canning's new Computerland shop in Glasgow. The machine was an ITT 2020, and was due to be used to help titling video production for local commerce and industry.

Boss of the Computerland shop is Gordon Coventry; he can be contacted on 041 221 7409.

'16'-first sighting

The 16-bit micros are here, proclaims Bill Unsworth of U-Microcomputers — he has found a board with Intel's 8086 on it. The board is ready to slot into any S100 type system and with it comes CP/M software, and S100 support boards, all from Seattle Computer Products.

The specification of the board is very largely that of the 8086 micro. It will operate with 8-bit memory, or 16-bit memory, or mixed boards. Up to a million bytes of memory can be plugged in (at today's prices that would be somewhat under £8,000, but not much, so that figure must remain an indication of what the future holds — especially with memory chips still in short supply world wide). Unsworth is sole importer of the Seattle system.

Count on it

As an aid to servicing, a frequency counter that will measure signal frequencies between 20 Hz (slower than a Kansas City interface to tape) and 100 MHz (several times faster than any microsystem clock) is available from Continental Specialities. A detailed applications brochure included covers computer clock checks, video synch and scanning measurements, and general oscillator checking, as well as more typically 'audio' frequency counting tasks. The company says the device is suitable for the hobbyist.

The MAX-100 frequency counter.

Q.E.D.

Transdata claims this is the first 'portable 132 column printer terminal'. That presumably means that there are other printer terminals with 132 columns, but not portable; or portable printer terminals, but not with 132 columns; or portable 132 column terminals, but not printers. If low cost were the main selling point, Transdata would have quoted a price, and they didn't: so you'd better want 132 columns.


The Transdata portable 132 column printer terminal


Computerland Ltd., open for business in Glasgow.

Other bits

HB Computers have produced a beginners booklet — 'Microcomputers and The Smaller Business'. If you are completely new to the world of micro-computers you will find this a well written, simple explanation. Questions answered are: "What is a microcomputer?"; "How does it work?" and, "What happens if it goes wrong?". Anyone interested should send 50p to HB Computers Ltd., 22 Newland Street, Kettering, Northants.

Anyone want to write or list BASIC programs in French? L'Ordinateur Individuel (the French micro magazine) markets a tape called BASICOIS which enables you to do just this on PET, APPLE II integer, APPLESOFT and TRS-80. Their address is: 41, Rue de la Grange-Aux-Belles, 75483 Paris Cedex 10.

"If you want what's best for your PET, choose Commodore software."

Kit Spencer
General Manager
of Commodore Systems
360 Euston Road
London NW1 3BL

The Commodore PET is Britain's best selling micro-computer, with over 10,000 already installed in a wide range of fields, including Education, Business, Science and Industry.

This has led to a tremendous demand for high quality software.

And Commodore has met this demand by producing a first class range of programs, now available from the nationwide network of Commodore Dealers.

Commodore's support also includes training courses, a Users' Newsletter and Official Approval for compatible products of other manufacturers who reach agreed standards.

NEW BUSINESS SOFTWARE PROGRAMS ON DISK

Commodore's Floppy Disk Unit and high-speed Printer, combine with the PET to form a complete system (ideal for running a business) for under £2,500.

Commodore also produce a growing range of business software on disk available from Official Business Software Dealers.

Business Information System – COMBIS £150 + VAT
Combis facilitates the storage and instant retrieval of all kinds of company records, from personnel files to mailing lists and printed address labels.

Stock Control – COMSTOCK £150 + VAT
Comstock provides an accurate, up-to-the-second and comprehensive stock position for as many as 1,300 products.

Word Processor – COMWORD £75 + VAT
Comword turns the system into an excellent word processor.

Payroll – COMPAY £150 + VAT
Compay is a new, comprehensive payroll package.

COMMODORE PETPACS

Over 50 Petpacs of programs are available (mainly on cassette) from Commodore Dealers.

These cover such popular titles as Strathclyde Tutorial, Statistics pack 1, Assembler Development System, Stock Market Trends and the Treasure Trove Collection of game packs including the award winning Star Trek, which is packaged with Petopoly. Prices are from £5 to £50.

TRAINING COURSES AND SEMINARS

PET systems are simple to use and any normal advice or assistance you may need can be obtained from Commodore Dealers.

On the other hand, for rapid training on a basic or advanced level, you will certainly be interested in Commodore's intensive 2 and 3 day residential courses. We also run one day general appreciation seminars.

PET USERS' NEWSLETTER

This is Commodore's official method of sharing new information and ideas between the many thousands of PET users. The newsletter is published regularly and for an annual subscription of £10 you can start receiving copies now.

OFFICIALLY APPROVED BY COMMODORE

Look out for this sign. It tells you that compatible products of other manufacturers have met with our standards of approval.

(Tick the appropriate boxes)

To: Commodore Information Centre, 360 Euston Road, London NW1 3BL 01-388 5702

I am a PET owner ☐ Please put me in touch with my nearest dealer ☐
Please send me details of: Commodore PET Software ☐
Training Courses & Seminars ☐ I would like to receive the Users' Newsletter and enclose £10 annual subscription ☐

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COMMUNICATION

PCW welcomes correspondence from its readers. Be as brief and concise as possible and please add "not for publication" if your comments/questions are to be kept private.
Address letters to: "Communications", Personal Computer World, 14 Rathbone Place, London W1P 1DE.

Cromemco comments

The company for whom I work have just purchased a Cromemco System 3 microcomputer, so I read with interest Sue Eisenbach's Benchtest on this equipment. The only fault I could find with her report was with her comments on the RENUMBER command in BASIC. A bit of fiddling on her part would have shown that gaps left in the numbering sequence can be removed by first saving the program and then renumbering the saved program.

Incidentally, if any of your readers who have access to a similar system, and who understand the PEEK and POKE commands in BASIC, could explain these commands better than the documentation that comes with it, would they please contact me, I would be very grateful.
Contact Oliver St John at 263, Fosse Road, Leicester. Sue tells us that she knew about this rather clumsy way of renumbering but felt that there were other things more worthy of analysis in the space allocated for Benchtest.—Ed.

Pascal question mark

For many months, in many journals, I have been reading praise of Pascal, its speed, object code efficiency, power, structure etc. The only sour note has been 'another language to learn'. It seemed to be an ideal language with which to convert my main frame programs to micro.

Perhaps I have been reading your series too quickly, but the idol seems to have feet of clay.

In my main frame program the following split loop has been found ideal for fast execution of something that is used 100,000 to 1,000,000 times each run. It eliminates repeated IF statements and value allocations. The Pascal implementation seems to be very messy. Perhaps I have missed the point and a shorter solution is possible, without introducing machine code routines.

```
FOR L:= A TO X STEP 2 DO
    BEGIN
    END
FOR L:= L TO 19 STEP 2 DO.
    BEGIN
    END
```

"A is either 1 or 2. "X" is a random number between 0 and 19. The second loop start value is the overflow value of the first which may be X+1 or X+2 according to the values of X, and A. The STEP 2 is essential and the value of L is used inside the loop. How would Pascal implement this loop *efficiently*?
R.G. Silson,
Tring.
P.S: Second loop should be omitted if L outside range. Also omit first loop if X less than A.
Because loops contain steps requiring more testing in machine code, Wirth decided not to allow them. His aim was to maximise the efficiency of compilation and execution of Pascal programs. The following code will solve your problem in Pascal. Maybe I'm biased but it doesn't seem too messy to me:

```
L:=A;
WHILE X<=X DO
BEGIN
  .
  .
  .
  L:=L+2
END;
WHILE L<=19 DO
BEGIN
  .
  .
  .
L:=L+2
END
```

Sue Eisenbach

Yesterdays bugs

With reference to Malcolm Peltu's book review (*PCW* November '79) — Grace Hopper has played a very important role in the development of computing but she is not responsible for the very useful term 'bug' or its current application. Thomas Edison is noted in the supplement to the Oxford English Dictionary (Vol. 1 pp. 377) as using the expression in very much its present sense in the 1880s. Since then the word has had wide use, and even 'ironing out the bugs' was done before the last war, before the age of computers.
James F. Sullivan,
Bournemouth.

Back on hard times

Having read 'Hard Times' I found it quite interesting. There was one small point, though. The writer stated that the Horsley designed heads 'Winchester Head' were designed for the Piccolo, but in fact the Gulliver file (62GV) were the first to use it. The head gap (width of track) has now been reduced so that twice the number of tracks are available giving the first 62GV 5MB, 62TM 10MB and 62EH 14MB. The Piccolo file, as does the Gulliver, uses a voice-coil driven actuator — unlike the IMI file as far as I can see. The Piccolo file has a capacity of up to 64MB and the track seek time is far quicker than a stepper motor driven type, where the 330 tracks are covered by the system to give an exceedingly short access time of a few milliseconds. The cost of these files are expected to fall, though, for my money, as a home/club system user, I would stick to floppies until I could buy a voice coil accessed Hard Disc. Looking forward to the follow on.
Doug Thompson,
IBM Computer Club.

Unfair dismissal

Dick Pountain's dismissal of the Casio FX501/2P's music function (*PCW* November '79) was less than just. Whilst agreeing with him that the world doesn't need the Stylophone and/or Rolf Harris, there are at least a couple of valid uses for this 'robot Rolf Harris':
1. The non-musical can experiment and gain some insight of various musical aspects — time, rhythm, etc.
2. The musical, especially young learners, can have a near-perfect example of tempo against which to compare themselves.

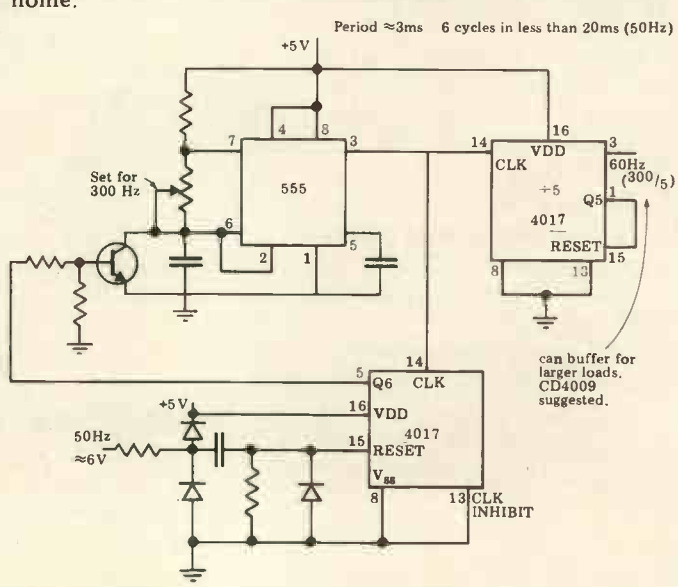
At the very least, the 501/2 plus FA-1 plus cassette can be used as an accurate, volume controllable metronome.

Having cast my lot for this disgusting noise, I do have a couple of gripes about the new Casio:
1. The 7-pin socket on the calculator is protected by a small, removable plastic clip — easily broken or lost. Surely, for a few pence more, Casio could have provided a slide or hinged device.
2. I really miss the displayed memory number of the 201/2. This was extremely useful for codifying input/output.

Obviously the programming method of the 501/2 cannot allow memory numbers to be displayed, but a plea to designers of future programmables — how about a 2 or 3 digit positive integer memory, accessible as a normal memory and displayed simultaneously with the X-register? This would double the calculator's potential.
Dave Barrow, Pontefract.
I accept your criticisms; my reaction was rather emotional since I love music. I doubt the value of the 501/2 as a metronome, however, since the calculator lacks direct sound output . . . everything must be taped and replayed, which is hopelessly cumbersome.
As to the displayed memory location, I feel that the 10 user definable keys more than make up for the lack of it—Dick Pountain.

Easy convert

I had a great time at your show! While I was there several people asked how to convert 50Hz to 60Hz for use with American/Canadian video stuff without having to 'butcher' a board; well, here's the answer (see below).
Les Solomon, Technical Director, *Popular Electronics*, New York.



Winning strategy?

Re. the advert by F.T. Chambers on page 83 of October *PCW*. Mr Chambers claims to have a winning strategy — "I certainly have not been beaten by man, woman, child or machine in the last few hundred games I have played". So I sent him £2.50 for this 'winning strategy' and the first paragraph of his replay reads "I have just received a copy of Petsoft's 'Super Othello' and, testing it against my strategy, I won 21 games out of 25 . . . I am satisfied that the games I lost were due to specific errors on my part".

I can beat most children and machines at chess — does anyone want to buy my winning strategy? I will admit that a few chess experts have beaten me but I made 'specific errors'. Even worse is Mr Chambers' apparent delusion that the 'winning strategy' applies to either side, ie if both sides play it then both sides will win. The final straw is that the strategy is well-known to the four or five people I know who have written Othello programs — it's a good 'rule of thumb' but you have to 'look ahead' to avoid traps and it's these tactical situations which decide who is going to win.
Alex G. Bell,
Sheffield University.

Homebrew for grown-ups

I have just returned from the Show and must congratulate you — it was the best I have been to this year. While I was there I overheard various comments which made me feel that the system I am now constructing may well be of interest to others, especially those that require a powerful, expandable system, which is not overpriced, but is readily interfaced to any peripheral. Some of the applications I have in mind are: high speed circuit design and analysis, real time check logging for amateur radio contests, amateur radio teletype, to name but a few, plus all the usual household functions. The spec' is as follows:
Demon 80A Mk1. Developed by I. Caplan and M. Buckland. CPU Z80A 4MHz; Memory 16K Dynamic RAM, expandable to 48K, 4K Monitor/Editor/Assembler 8K BASIC (optional), Inputs Standard ASCII Keyboard — interrupt driven plus up to 254 other ports; Outputs 256 x 256 B/W graphics display expandable to 8 or 16 colour graphics plus 256 ports; Mass Storage: Initially cassette, but floppies when cash callows; Power Supply: 240V AC with PSU 1. 12V DC for field use with PSU 2; Other Features: Real time clock, non-destructive 'Reset' and 'Break', full Z80 interrupt mode capability, full DMA capability, Nascom compatible monitor routines.

Although it is not intended as a beginner's system and the method of construction would be left entirely up to the builder, the basic circuitry can be simplified or expanded as required. My machine is built into a standard 3U 19" rack which contains the PSU (±5V, ±12V) and 9 card slots on a fully thru' hole plated backplane (very pretty but expensive). The backplane could be wirewrapped (not so pretty, but a lot cheaper) as it uses standard 43 way 0.1" double-sided edge connectors. Anybody interested may write to me and I will do my best to answer all letters. If sufficient interest is shown maybe *PCW* will print a few articles on this system. P.S: Anyone interested in a version of M5 for the RCA 1802?
Readers: Write direct to I. Caplan, 4 Minchenden Crescent, Southgate, London N14 7EL.—Ed.

Fax Flack

Congratulations on what generally is a much improved magazine. But, please, if you are going to publish op codes (Fax) could you check what you are doing more carefully — so far I've counted 3 basic errors in the Z80 chart.
D.E.Rogers, Radlett, Herts.
No excuses, but all is revealed in Blunders — Ed.

STRAIGHT DEALING

David Tebbutt reports on the setting up of the Computer Retailers Association.

The microcomputer business is, in the main, conducted ethically and conscientiously. Unfortunately, in common with most human enterprises, there are less savoury elements which are like to give the whole business a bad name.

In order to give the consumer a measure of protection, a Computer Retailers Association has been set up. Everyone joining pays £300 and agrees to abide by a strict code of conduct. A consumer who finds a member supplier in breach of this code can then inform the secretary of the CRA who will take up the complaint on the customer's behalf. If this fails, an independent arbitration panel will assess the situation. The consumer has the right to ensure that the panel is independent.

At present, anyone involved in the retail side of the microcomputer business is eligible to join the CRA. It is impossible at this stage to investigate the suitability of each applicant in great detail and therefore anyone prepared to be measured against the code of conduct may join. This means that membership of the association is by no means a cast-iron guarantee of satisfaction and, by the same token, neither is non-membership necessarily a passport to disappointment. As with all associations, maturity can only come with time.

Members of the association can benefit in a number of ways — they will receive a certain amount of publicity; consumers are more likely to put their faith in someone who is so clearly committed to such a code of conduct; they would be able to call on fellow association members for advice; and, if a customer's requirement is beyond their scope, they could be referred to a member more able to satisfy that customer's needs, knowing that the customer will get a fair deal.

Finally, let's remind ourselves of the reason for the association's existence — to give the consumer the protection he so badly needs in this business. *PCW* supports the aims and code of conduct of the CRA. Advertisements in *PCW* containing the CRA logo will be those of paid-up members of the CRA. Any members wishing to comment, be they suppliers, customers or just plain interested please write, see the editorial on the Contents page for details.

Extract from the CRA handbook

The CRA is a Trade Association that promotes professional standards in the sale of computing equipment, allied products and services.

Membership is open to companies with a significant interest in computer retailing and who are committed to the spirit of the CRA.

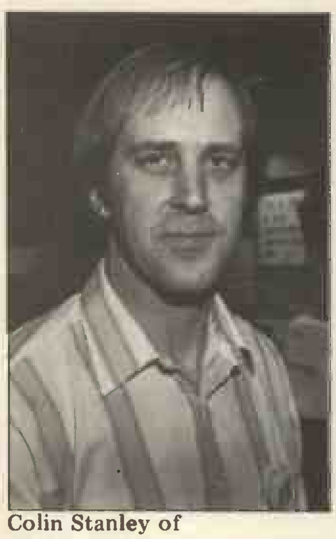
All members are obliged to comply with the CRA code of practice which aims to ensure that members shall conduct their business ethically and professionally.

Code of practice

1. Members will not misrepresent their experience or capabilities, and will carry out any work undertaken to the very best of their abilities.
2. Members will not deliberately advertise goods for sale which are not currently available and will avoid excessive claims as to the capabilities of the products offered. Terms that are likely to be misunderstood by the customer or that are not capable of exact definition should be avoided.
3. Whenever goods or services are offered for sale, a clear indication of the true retail price must be included, and every effort should be made to meet the date for delivery given.
4. Members will not knowingly trade upon the innocence of potential customers.
5. Order/sales acknowledgements should be used that help both parties by spelling out the terms and conditions on which business is being done. Such terms should be fair and reasonable and set out clearly, together with a statement of the circumstances under which they may be cancelled.
6. Mail order goods should be acknowledged within seven seven days. Where money is received with the order, if the goods cannot be delivered within 30 days the customer should have the right to cancel and to have complete reimbursement of that money.
7. Members will divulge to a prospective customer any vested interests they may have when recommending an alternative or additional service.
8. If any work is to be undertaken for a customer, then clear and precise terms must be agreed, in writing, before work commences.
9. Members will not offer any specialist services to a customer, where no 'in-house' skills are available, and where the work is to be subcontracted unless the customer is made fully aware of the intent to subcontract.
10. Members will take full responsibility for any work carried out by any subcontractors on their behalf.
11. Products commissioned and paid for by a client will not be offered to other clients without the full knowledge and consent of the original client.
12. Members will not disclose confidential information that they might gain of a client's business without permission and will not use a client's name as a reference without prior permission.
13. Products offered by members to clients will be subject to a 12-month warranty unless a specific statement to the contrary is included in the contract. This warranty must not adversely affect the customer's remedies against the seller under the Sale of Good Act.
14. The warranty will not cover any defects caused by misuse and/or maltreatment of the equipment by the customer and will be based on a reasonable use.
15. Members will take all reasonable steps to ensure that services undertaken for a client reach an agreed conclusion.
16. Members will agree to submit disputes with clients to arbitration by a panel appointed by the executive committee of the CRA being acceptable to the client. The subject member should abide by the decision of the arbitration panel who will report its findings to each of the parties in writing.
17. The CRA code of practice should be displayed prominently in the trading premises of a CRA member. A copy should be available to the customer on request.

The Executive Committee comprises: Dr. Tim Keen, Keen Computers Ltd; Colin Stanley, HB Computers Ltd; Tim Moore, Newbear.

Tim Moore of Newbear Computing Store



Colin Stanley of H.B. Computers

Tim Keen of Keen Computers

LUXOR ABC 80

If you were to hear of a personal computer manufactured by a television and hi-fi company that sells through its own retail outlets and which consists of a monitor, a separate cassette deck and a single board computer boxed under its keyboard, the chances are the Tandy TRS-80 would spring to mind. If you were Swedish, however, you'd probably think of the ABC-80, a personal computer with the quality of finish, attention to detail and price that we've come to expect from Swedish products. Luxor, the northern European electrical chain which sells the ABC-80, is also the manufacturer, while the designer is Swedish firm Dataindustruir AB; that company has also evolved a modular development system called the Databoard 4680 which it manufactures. The ABC-80 and the Databoard 4680 are mutually compatible and, therefore, even though Luxor only manufactures a small system, there is a large range of products available to hang onto it. The review machine was an ABC-80 microcomputer with a Databoard 4680 floppy disc unit, plus Datadisc 80 dual drive.

BY SUE EISENBACH

The ABC 80 is based on a single board computer. It contains a Z80A CPU, BASIC in 16K of ROM, 16K user RAM (dynamic), 1K Video RAM, a real time clock, a USART and a PIO. This board is within the keyboard case. On the back of the case there is room to connect a cable to a Databoard 4680 bus, an RS232 port, a reset button, and cables to both the cassette and monitor. The keyboard box is well ventilated and solid.

The keyboard was designed with great attention to detail. There are fifty-five keys which are nicely shaped and have a solid feel. Upper and lower case letters, numbers and 32 other characters can be accessed from the keyboard. Both £ and $ are provided as well as ¼, ½, ¾, the division symbol and the more standard characters. There is an upper case shift lock key (with a light) that only turns the alphabetic keys into upper case. So when you switch into upper case you don't have to remember to unshift in order to type line numbers and commas. There are two cursor control keys (left and right) for screen editing. Unfortunately there are no cursor control keys for up and down (however, in BASIC there is an edit facility that compensates for this lack). Any character can be repeated by holding the relevant key down. When listing a BASIC program only one screenful is listed. To see more pressing any character and keeping it down brings up one line at a time.

The character generator chip is Texas

Instruments' Viewdata chip and is therefore compatible with Prestel, Ceefax and Viewdata. The 12" screen can hold 24 lines of 40 characters or can be divided into 72 by 80 pixels. Next to the screen there is a loudspeaker which is connected to a sound generator. When a line is typed in incorrectly a 'peep' is output. There is a real time clock that can be set and interrogated from the terminal.

The cassette is a digital unit with the surprisingly slow transfer rate of 700 baud. It has a tape counter with a RESET button so that the tape can be set near the program or data required. The cassette runs for about five seconds before any storage is completed. If the ABC 80 does not find any information within ten seconds it stops the tape and displays an error message stating that the program or data isn't on the tape. So if there is a fifteen second gap in the tape, searching will stop at that gap with a (possibly false) error message. Fortunately when transferring data with the loudspeaker's volume up you can hear programs and data being loaded or stored. If there is silence the tape can manually be moved forward and the search continued. Normally turning the cassette on or off is under program control.

The minifloppy system DataDisc 80 was also provided; it had two BASF 80K Byte discs. DataDisc 80 contains a floppy disc controller with two (yes, two!) Z80s. There is an EPROM-board which contains the 4K DDS and some free sockets (suitable for the IEEE-488 interface PROM and a fast printer PROM). The DataDisc 80 unit has space for two memory cards (static) — those were present in the review machine — and three I/O cards. All cards are of Eurocard specifications and attach to a Databoard 4680 bus. The box, a standard 19" rack, is quite substantial and contains a power supply and filtered fan.

BASIC

ABC 80 BASIC occupies the lowest 16K of memory and is reasonably sophisticated. Not written by Microsoft it does not have exactly the same features commonly available. If a user finds it inadequate it can be expanded to 24K Databoard 4680 BASIC. The benchmarks show that it is quite fast. I could not run any tests on the discs through having insufficient free disc space (CCS didn't have any spare discs). The speed of the BASIC is in part due to each statement being translated during program input. If an instruction is not understood an error message appears as soon as the return key is pressed. The message is either an error number which can be easily decoded by looking at a chart attached to the keyboard, or when there is a disc in drive 0, a message rather than a number appears. I found the messages more helpful than the Microsoft variety.

The special features of ABC 80 BASIC include a graphics mode and audio programming. From the keyboard one cannot access the graphics. However the ABC 80 can be put into graphics mode with each screen character position being interpreted as 6 graphic points. Points on the screen can be turned on with SETDOT R, C, turned off with CLRDOT R, C and tested with DOT(R, C).

There is a sound generator that can be accessed as an output port. There are 128 different possible sounds that can be output. The section of the manual describing the sounds was confusing, but it was easy to write a program to play them all. There are a variety of pure pitch sounds, a siren, a bird chirping, as well as a range of noises that reminded me of electrical interference.

The full power of the language can be seen from the list of BASIC reserved words. The features of particular interest include:

1 LIST will list from or to a given line.
2 ED uses the cursor keys.
3 DEF FN can take several parameters.
4 INPUTLINE will read a whole line including CR/LF.
5 CHAIN allows you to divide programs. Unfortunately there is no COMMON so variables have to be POKED.
6 MERGE allows the user to read two programs into memory.
7 PREPARE U$ AS FILE N opens a file for writing.
8 INSTR (X%, A$, B$) searches for B$ in A$ and gives X% its starting position.
9 + concatenates strings e.g. A$ = B$ + C$ + "?".
10 ASCII arithmetic works on strings interpreted as numbers.
11 CALL links machine code routines into BASIC programs.
12 IMP is implication. That is X IMP Y is false only when X is true and Y is false.
13 There are both integers and reals.

Commands

NEW	RUN	SAVE	MERGE
SCR	REN	UNSAVE	CHAIN
CLEAR	ED	KILL	PREPARE. . AS FILE. .
LIST	LOAD	NAME. . AS. .	TRACE
			NOTRACE

Program Statements

REM	GOTO	END	POKE
LET	GOSUB	ON. . GOTO	CALL
DIM	RETURN	ON. . GOSUB	
FOR. . NEXT	DEF FN	ON ERROR GOTO	
IF. . THEN. . ELSE	STOP	PEEK	

I/O Statements and Functions

PRINT	GET	OPEN. . . AS FILE	INP
TAB	READ	CLOSE	OUT
CUR	DATA	SETDOT	
INPUT	RESTORE	CLRDOT	
INPUTLINE		DOT	

Arithmetic and String Functions

SWAP%	COMP%	LEN	NUM$	ATN	FIX	OR
ERRCODE	RND	ASC	VAL	LOG	ABS	XOR
ADD$	RANDOMIZE	CHR$	+	LOG10	SGN	IMP
SUB$	LEFT	INSTR	SIN	EXP	PI	EQN
MUL$	MID$	SPACE$	COS	SQR	NOT	
DIV$	RIGHT$	STRING$	TAN	INT	AND	

Technical Data

CPU	Z80A 3.5MHz
Memory	2K Monitor in ROM, 1K Video RAM, 16K BASIC in ROM, 16-40K user RAM
Keyboard	55 keys
Screen	12", 24 lines of 40 characters, Viewdata format
Cassette	Digital with tape counter, 700 baud
Disc Drives	Twin 5" discs, single density
Printer	n/a
Bus	edge connector to Databoard 4680 bus expansion unit
Ports	RS232 serial port, V24 jack
System Software	4K DOS in ROM
Language	16K BASIC

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14 Variable names are at most two characters.
15 A real time clock is accessible in BASIC.
16 Sequential access files are implemented on both cassette and floppy discs and random access (rather obtusely implemented) files on disc.

System software

The ABC 80 uses three operating systems: Cassette BASIC; Disc BASIC; and DOS. To enter cassette BASIC one presses RESET once: to enter Disc BASIC, RESET is pressed twice: to enter DOS it's necessary to enter DISC basic and then to type BYE. A useful feature of the disc systems is that they refer to both discs when loading and saving files.

The two BASIC systems (disc and cassette) are very similar, most commands being common. For example, LOAD, SAVE, and KILL are identical, except that on the Disc BASIC, if they refer to cassette operation, they are suffixed with CAS. The Disc BASIC system has a directory facility whereas the cassette system does not, not even a screen listing of files and programs encountered while searching is in progress. Error messages appear as numbers on the cassette system and as full messages on the disc system. Both BASICs were quite good.

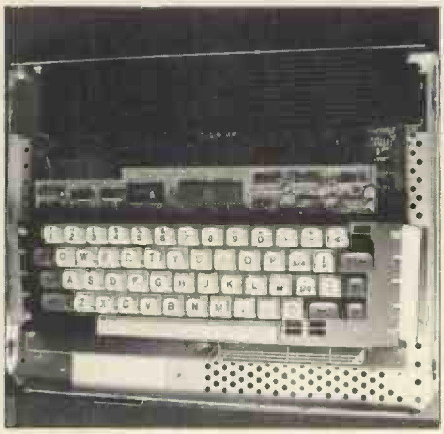
Moving on to the DOS system, it again is straightforward and simple to use. In addition, it includes the following facilities:
SPACE gives the amount of free space on discs.
MAP gives a memory map.
DOSGEN used to generate a new version of DOS and to format discs.
COPY used to copy files and to remove them if necessary.
COPYLIB copies all or part of disc.

A number of utilities that I would have liked to use were missing, although apparently more advanced facilities are available when different disc drives are attached.

Business and industrial potential

For a user who wants to purchase a packaged system the ABC 80 is not the answer because, unfortunately there are no business packages yet written specifically for this machine. As the BASIC is slightly different from other personal computer BASICs, packages written for another machine will need alteration to run on the ABC 80.

The ABC 80 does however have potential as a word processing system. There are two packages available, one of which is Runoff, a good text formatting program (available on DEC machines and very similar to Texwriter). The sturdy keyboard, uncluttered by any 'funny' graphics characters is more likely to suit a typist than several of the other lower priced word processing systems. On the back of the keyboard there is a socket suitable for a golfball or daisywheel typewriter.



The large selection of boards, built by Dataindustriur AB, that can be attached to an ABC 80 make it most suitable for process control. The IEEE 488 interface (which is accessible from BASIC) can be purchased either as a chip to plug into the disc controller card or a card to slot into the expansion box. The PET therefore has lost its unique position as the only personal computer with this interface. The facility for sound enables a programmer to use sound to signal completion of a task, error conditions, etc.

The ABC 80 is suitable for use as a Prestel terminal provided that you have a Post Office approved modem with which to connect it. There is a modem board for the ABC 80 but the Post Office cannot consider licensing this system until they receive an application.

Educational potential

Personal computers are applicable for several different educational contexts. They are used for teaching programming, computer science theory and in laboratories. For all of these applications a level of robustness and portability is required. The ABC 80 seems robust and well made, though it does have a reset button on the back of the keyboard box which is probably undesirable for teaching in school. As far as being portable the ABC 80 is quite light but, like the TRS 80, it is in several sections and would need a trolley if it's going to be moved around regularly.

The ABC 80 is a very nice machine for teaching BASIC. The 16K BASIC, being ROM based, is very easy to use. It is more powerful than any other BASIC in ROM that I've seen. It has line by line syntax checking which is helpful for novice programmers. To teach languages other than BASIC, a substantial investment in hardware and expensive software is required. A disc subsystem must be purchased to run all other languages including the Z80 assembler. In addition, before being able to run Fortran or Pascal the BASIC ROM must be replaced with RAM.

A book is provided that covers an introduction to computers from circuit level to BASIC programming based on the ABC 80. The machine, in conjunction with the book, should provide an edifying entry into computer science. For use in the laboratory, the ABC 80 can be purchased with a wide variety of controller and interfacing equipment.

Homes and games

The straightforward graphics, sound and ability to program the cursor all make the ABC 80 a good machine for recreational computing. The review machine came with a variety of games (most still with Swedish messages). They included chess, Othello, maze games and arcade paddle ball games. The cursor control keys were used as joysticks. Both the graphics and sound are used to good effect. The arcade type games were challenging but neither chess nor Othello were as well designed. Chess accepted illegal moves while Othello did not fend its sides or corners.

Documentation

I was provided with three types of documentation: English manuals for most of the Databoard 4680 modular development system, preliminary English manuals for the ABC 80 and Swedish documentation. The Databoard manuals seem quite reasonable, clearly written with comprehensive tables of contents. Not having the system described, I cannot say how helpful they actually are. The data sheets on all the Databoard 4680 boards looked sufficiently comprehensive to aid in the selection of new boards.

There were two preliminary documents for the ABC 80. The first, a

Personal Computer World

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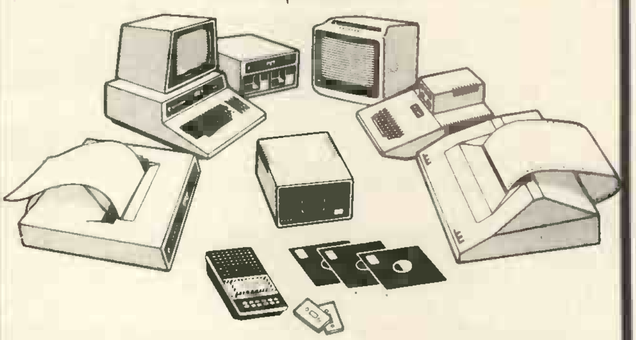


manual for the ABC 80, was translated into reasonably good English (not quite perfect but understandable). This manual was divided into two parts. The first section was a straightforward, informative general description and instructions for using the ABC 80. The second section described ABC 80 BASIC. It did not go into enough detail but referred the reader to a book called *ABC 80 BASIC*. As this book is unlikely to be published in English, the User Manual should be expanded.

The second preliminary document supplied was a first translation of the book *Mikrodations ABC* by Gunnar Markesjo called *The ABC of Microcomputers*. This book is an introduction to computers from logic circuit level to programming with all examples based on the ABC 80. The book was most thorough and would make a straightforward introduction to computers. Unfortunately the book was not translated by a technical writer, so jargon when it was translated at all, was badly translated. For instance 'capsule' is used when unit, chip, subroutine or module is required. I was told that this version would not be published but I hope a reasonable version is published soon as I thought the book would prove most informative to the new computer user.

The Swedish ABC 80 books were provided to indicate to me the quality of the final versions of these books. They were softcover with nice size print and plenty of pictures and diagrams. The books were paginated and had detailed tables of contents.

Expandability

Besides the monitor and cassette there are sockets for a printer and a connector to the Databoard 4680 bus, so that with the exception of a printer, all expansion must be through the Databoard 4680 development system. If a disc system is needed, there is the Datadisc 80 Dual Disc Unit which has slots in its backplane for five boards, in addition to the disc controller board. There are spare sockets on this DOS card for an IEEE 488 interface PROM as well as for a high speed print PROM. If a larger disc system is needed, there is an 8" floppy disc system.

If a user wants to expand an ABC 80 system without adding a disc subsystem, there are several expansion boxes that hold from 6 to 20 cards. An IEEE 488 card is available for users with an expansion box. The other cards that can be slotted into a Databoard 4680 include a variety of RAM and EPROM cards (including a colour video RAM card). There are a large number of I/O cards including ones for parallel I/O, relay outputs, opto-inputs, transistor outputs, UART, USART, floppy interface card reader interface, relays and numerous A/D. and D/A convertors. For development there is a control panel, PROM programming board, extension board and prototype boards.

The software announced is for the DataDisc 80 system, and includes a Real Time Operating System, an editor, a text formatter, a Z80 assembler, FORTRAN, Extended (24K) BASIC and PASCAL. The PASCAL and the FORTRAN will not be available until April.

Conclusion

The ABC 80 is a recent entry to the 'under £1,000 for a complete system' class of personal computers. As such it is in competition with PET, APPLE, TANDY, SHARP and SORCERER. When choosing a machine in this class the price, packaging, software and expandibility are all important considerations.

At £790 for the basic system the ABC 80 is near the top of the market in starting price. This is because the minimal system is larger than those of its competitors including a 16K BASIC, 16K RAM and a monitor. Turning to the packaging, the ABC 80 is a robust system, even though it isn't a single unit. The 16K BASIC is both fast and powerful but at present there is no other system software available for a cassette based system; neither is there a library of packages on tape written for an English market, that can be loaded and run. Since the ABC 80 can be plugged into a Databoard 4680 bus there are a wide variety of boards and two types of disc units that can be attached in a straightforward manner. Unfortunately the user is locked into one supplier as the Databoard 4680 bus isn't an S100 bus. This fault is shared with most of its competitors.

FIRST IMPRESSIONS	
Looks	***
Setting Up	**
Ease of Use	****
HIGH LEVEL LANGUAGES	
BASIC	****
COBOL	n/a
FORTRAN	n/a
PASCAL	n/a
SYSTEM SOFTWARE	***
PACKAGES	
Business	n/a
Education	n/a
Home	****
PERFORMANCE	
Processor	****
Cassette	***
Disc	**
Bus	**
COMPATIBILITY	
Hardware	***
Software	**
DOCUMENTATION	***
VALUE FOR MONEY	***

*****	excellent
****	very good
***	good
**	fair
*	poor

Prices

Included in the price list, as well as the ABC 80 system, is a variety of Databoard 4680 components likely to be of interest to an ABC 80 owner. All prices are exclusive of VAT. As much of the system has never been sold in the U.K. prices are not firm.

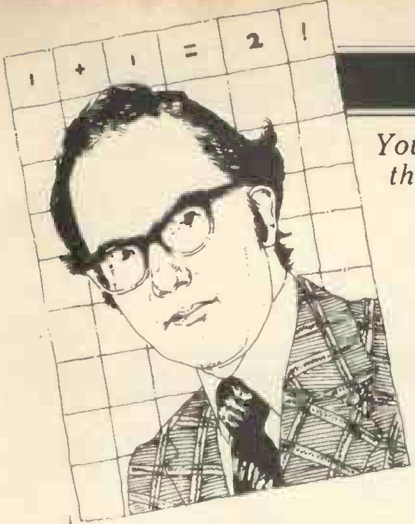
ABC 80 Microcomputer	£ 790
Datadisc 80 Dual Disc Unit	1190
Expansion Box	295
8908 PROM Programmer	280
9701 Hi-Speed Printer PROM	55
9702 IEEE 488 interface PROM	25
Z80 Assembler	109
8K Static RAM	170
3061 8/16/32K EPROM board	127
4025 IEEE 488 interface board	196
4084 8 bit D/A 4 channels	250
4087UART board	196
5001 Prototype board	32
5070 Prototype board with I/O	91
5023 Bus Expansion board	107
7900 Dual 8" floppy disc	2764
8021 Control panel	777
9400 Fortran	1053
9500 Extended BASIC	448
9600 Pascal	527

Benchmarks	
BM1	1.1
BM2	2.3
BM3	11.1
BM4	12.1
BM5	12.6
BM6	17.7
BM7	23.9
BM8	13.6

Memory Map

Address	
FFFF	
	16K User RAM (on CPU board)
C000	
	16K User RAM
8000	
	ROM for fast printer
7800	
	ROM or RAM
7400	
	ROM IEEE 488 interface
7000	
	ROM DOS
6000	
	Free ROM space
4000	
	ROM BASIC interpreter

Minimum configuration 0-4000 & C000-FFFF



YOUNG COMPUTER WORLD

Young Computer World is the place where, each month, John Coll highlights the thoughts, ideas and contributions of PCW's younger readers.

Firstly, a Star Wars game, written by Simon Ainsworth of Croft near Warrington. There are two sections; the main program and a set of instructions. As usual the dialect of BASIC has its oddities; among them being the use of the suffix % to indicate a decimal real constant. 'If in doubt just leave it out' should work on most microcomputers. (See page 93 for the program listing.)

A couple of months ago I asked for suggestions of problems that need solving — for passing on to people looking for projects. Tom Boyd of Holmbury St. Mary has written in to request a device that will record data from a variety of sources in a machine readable format.

In outline he suggests the use of an ordinary audio cassette recorder to record the data for later playback to the computer. The input should be an analogue voltage, say up to 1 volt. The sampling rate need not be high — say two readings a minute — and the whole device should be easily portable and thus probably run off batteries. It would be convenient if the data were to be recorded in a standard format (such as the Kansas City tape standard) but I can see problems there when starting and stopping the tape. I suppose that one could store up 20 or 30 readings in memory and then dump them out as a single block once every 15 minutes or so. At the other end one needs a simple program to load the data into memory from the cassette. That shouldn't be too difficult.

The whole machine would take quite a time to develop but I would be glad to hear from anyone who would like to have a go at it. Perhaps we could pool ideas. One variation that Tom didn't mention is that a similar device could be used to record someone typing into a computer. This is only worth doing if the system saves input until a whole line has been typed in, before dumping it to cassette. It would enable pupils to prepare programs off-line onto a cassette which they could then run on a computer later. A good cheap system like that really would be useful.

The TRS-80 waveform generator is a straightforward design giving 6 outputs which can each be switched between 0V and 6V. My only worry is that it provides no isolation and if anyone were to connect mains up to the outputs (yes, people do that sort of thing!!) then you could easily blow up the whole computer. Still, they're so cheap these days! David Goodman, who supplied the idea, is in the Lower Sixth at Paddington College, London.

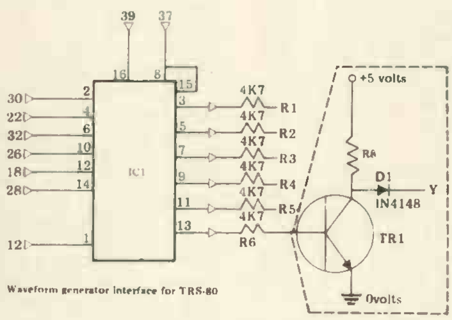
Waveform interface

The following circuit allows the connection of an oscilloscope to the TRS-80, via its expansion ports on the edge card at the rear. Any waveform can be programmed into the machine and when it is 'run', a trace will be viewable on the screen of the scope.

The circuit utilises the special signal available at the rear of the machine called 'OUT'. This is used as a sync signal since it can be pre-programmed. The heart of the interface is the 'tri-state hex buffer' which buffers the data signals. The chip also contains a dual input gate of which one input is tied to ground and the other is connected to the out signal. This allows the data to be turned on and off at the output of the buffer and thus the output of the analogue section can be controlled as well.

The remaining part of the circuit is the analogue interface between the output of the buffer and the scope. This is designed to allow the output voltage to be pre-programmed and the voltage is in relation to the logic states of the buffers. This consists of a 4K7 resistor, a transistor, a diode and another resistor acting as an attenuator. One of these sections is needed for each of the six data lines from the buffer. The outputs labeled 'Y' are connected to the 'Y' plates of an oscilloscope.

One further point of application interest is that this circuit can be connected to a voltage controlled oscillator and a simple synthesiser can be made.



Waveform generator interface for TRS-80

D1 - D6 = IN4148
R1 - R6 = 4K7
TR1 - TR6 = BC109C
IC1 = 74LS365

R8-R13 = values up to approx 15K with linear steps

example R8 — 2K
R9 — 4K
R10 — 6K
R11 — 8K
R12 — 10K
R13 — 12K

The circuit

When the 74LS365 receives an out signal from the TRS-80 it goes low at pin one and data present on the data bus appears at the output of the buffers. The logic signal is fed to the transistors via current limiting resistors (4K7). As each transistor is turned a voltage is apparent at point 'Y', after a diode, which is related to the value of the resistor chosen for the attenuator between the collector and the positive rail. If R8 to R13 step in linear increments then the final waveform will have better characteristics. The diodes are used because when all points 'Y' are connected together it prevents feedback to the transistors of each channel.

The power can be supplied by the TRS-80 expansion port but if a separate power supply is used then the ground rails of the supply and the TRS-80 must be tied together. The supply must also be smoothed and regulated.

Data

The edge card on the TRS-80 is double sided and there are twenty contacts each way, with a spacing of 1 mm

A suitable program to turn on the transistors in turn is as follows:

```
10 PRINT"WAVE FORM GENERA-
   TOR PROGRAM"
20 OUT 254,1
30 OUT 254,2
40 OUT 254,4
50 OUT 254,8
60 OUT 254,16
70 OUT 254,32
80 GOTO 20
90 END
```

The Program

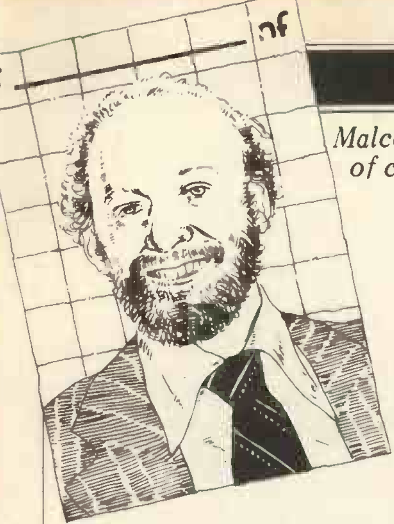
This command puts the binary value of 'Y' into the binary value of address 'X'. The number 'X' can be anywhere between 0 and 255 as the TRS-80 can access up to 256 ports. We are not interested in the address but only in the data value 'Y'. The desired waveform can be pre-programmed by working out binary equivalents of 'Y'. Using this theory, waveforms can be pre-programmed with good resolution.

Lastly, this month, is a short program for the TI-57 from Simon Walton (13) of Bournemouth. The idea of the game is to finish the series of numbers which are presented. When the display stops enter the number which you think is next in the series. If you are right the program presents another series, if wrong it pauses to display the correct answer. It looks fun.

Loc	Key		
00	6	21	RST
01	STO 0	22	LBL 9
02	SBR 9	23	RCL 2
03	STO 1	24	+
04	SBR 9	25	π
05	LBL 4	26	=
06	+	27	Yˣ
07	RCL 1	28	8
08	=	29	=
09	PAUSE	30	INV INT
10	STO 3	31	STO 2
11	DSZ	32	X
12	GTO 4	33	1
13	R/S	34	4
14	STO 7	35	+
15	RCL 3	36	6
15	+	37	=
17	RCL 1	38	INT
18	=	39	INV SER
19	INV x=t		
20	PAUSE		

Most of the suggestions for getting a function, such as X=SIN(Y), into a running basic program involve saving the function to another disc file and then CHAINING that file in. True that is the obvious way and it will work on most computers but since on many microcomputers one can not APPEND a line from a separate file, the whole program has therefore to be saved as a single chunk before being CHAINED back in. A pretty clumsy method. Perhaps before too long Microsoft will incorporate a feature to make that process easier.

I was glad to meet some of you at the PCW show and trust that I have sufficiently twisted a few arms to encourage the ideas to keep flowing in.



BOOKFARE

Malcolm Peltu has made his name writing and lecturing about the nature and impact of computer-related technologies.

All our tomorrows

H.G. Wells in 1905 looked forward towards a modern Utopia in which a universal registration and identification system would be an essential feature of social regulation. He dismissed fears of bureaucratic threats to human freedom as "mental habits acquired in an evil time". But that was before the real evils of the World Wars and the bloodlines of greater and lesser Hitlers turned such Utopias into the nightmares of Aldous Huxley's Brave New World and George Orwell's 1984. The imaginary futures pre-dated the computer but the poetic visions of their authors are likely to provide better insights into the shape of tomorrow's worlds than the megawords of prognostications with which the new decade is about to be launched.

In *The Conquest of Will*, *Abbe Mowshowitz* analyses in about three hundred *closely reasoned* pages the practical nature and impact of information processing technology. Then he uses the last chapter to place a 'literary perspective on the machine'. Here he summarises his fears through the words of science 'faction' author Christopher Hodder-Williams in his novel Fistful of Digits which concludes: "Eventually the mechanical interlock of technology must conquer all individual will. You might conceivably postpone it, but it could only be postponement; because for as long as man could not stand by himself and rely on himself. . . then eventually he would wind up handing over the mastery of his own wits. . ."

Mowshowitz comments on this and other literature of the future: "Questioning the beneficence of scientific rationality and technological progress is almost as heretical as denigrating patriotism. Poets are held of little account in our society, so their licence is free for the asking. Operating without poetic licence, however, opens one to a variety of charges, ranging from lack of objectivity to muddled mysticism".

Braving such charges, he continues, "The belief in the social necessity and inevitability of computer utilities, databanks, management information systems and sundry computer applications is not based on reason alone. It is the reflection of a political faith built into the scheme of modern history, with an internal logic akin to that portrayed in the Theatre of the Absurd. If the past is any guide to the future, we cannot afford to acquiece in moral bankruptcy. There are always other choices so long as the paralysis of will is not complete".

Mowshowitz followed up this theme of holding up a poetic mirror to see ourselves and the future in *Inside Information*, an analysis of the role of computers in fiction that is an essential reference for anyone, like myself, fascinated by the interrelation between science fact and perceptive fantasy.

There are over thirty extracts from novels and short stories in *Inside Information*, grouped into sections such as 'Clockwork Society' and 'Broken Promises'. Each section begins with an introduction ranging far and wide for literary references as well as placing the extracts in context. There is also an extensive bibliography.

The Broken Promises section contains two particular gems in Moxon's Master, written in 1893 by Ambrose Bierce, and Ms Fnd in a Lbry, a 1961 short story by Hal Draper. Bierce follows the potential of computer chess players to an emotionally horrifying conclusion while Draper humorously pokes cataclysmic fun at the obsession with creating ever larger data banks using ever smaller microelectronic media.

With remarkable insight for the pre-micro times in which the story was written, Draper creates the wonderful notion of punched molecules, chipped quantum and supermicros as the storage media for vast catalogues to catalogues of indexes to indexes to indexes etc, etc, which culminates in the ultimate information explosion.

Mowshowitz calls this section 'Broken Promises' because he believes that "modern technology has indeed conjured up a miracle (in the computer) but in the final analysis it is a great disappointment. . . The computer emerges as yet another god that is not likely to succeed". He traces the rise of expectation of scientific optimism, such as Francis Bacon's comment three centuries ago that science and technology held the promise of providing: "the knowledge of causes and secret motion of things; and the enlarging of the bounds of Human empire, to the effecting of all things possible".

A disillusionment in the achievements of science and technology has been expressed by many 'poets with licences' from Mary Shelley in *Frankenstein* to Solzhenitsyn in his play, 'Candle in the Wind', which draws a sharp contrast between the humanitarian pretensions of scientific progress and the amoral actions of the scientist.

The magazine *Omni* (which comes out of the Penthouse stable) strives every month to blend fact and fiction to monitor new developments and future trends. Generally I find *Omni* as superficially pretentious as the editorials by its Editor *Bob Guccione*. In the first anniversary issue last October he reached pinnacles of macho absurdity with phrases like ". . . the Carter administration and/or the delicate sensibilities of Wall Street not withstanding, man will reach into the future with the same implacable determination with which his seed rose from the primeval slime."

Although each issue of *Omni* is likely to contain at least an article or story of interest, to me it lacks any real excitement and vision of the kind which enthused sci-fi magazines like Astounding Science Fiction and others of that ilk, while the factual articles (at least in the realm of computer technology) follow pretty predictable lines.

Life, of course, isn't all rising seeds and primeval slime and nor is it (yet, at least) totally under the control of Big Brother and the punched molecule. *Take My Computer. . . PLEASE!* by *Steven Ciarcia* is an example of an entertaining new trend towards what could be called computer soap operas. Using his own experiences with a personal computer, *Ciarcia* weaves some whimsical stories in the style of James Thurber with tales about the day the computer alarm did *not* ring and the feverish and misguided attempts to use a computer to win a fortune on the stock market. *Ciarcia's* world is very American, from the strange gambling game Jai-Alai to the huge hospital bills. Nevertheless, as a portent of personal times to come, it is a pleasant read.

Now, all that's needed for facing the future is *The Hitch-Hiker's Guide to the Galaxy* by *Douglas Adams*. Marvin is one of the wild and wonderful cast of characters in this BBC radio hit, turned novel (soon to be TV-ised and, no doubt, cultified). Marvin is also my third most favourite robot because he is so humanly neurotic, with more than a touch of Woody Allen (and Allen it was who created my two most favourite robots — the Jewish automated tailors in Sleeper). Marvin's philisphy is: 'Life — loathe it or ignore it, you can't like it'. He has a brain 'the size of a planet' but spends much of his time shepherding bumbling humanoids and having his irony circuits irritated by doors. He has a cheerful and sunny disposition, expressing sighs of gratification each time someone — or thing — walks through.

Aboard the Heart of Gold Starship, powered by the Improbability Drive, is Eddie the computer who sings during count down. Elsewhere, Deep Thought, the second most powerful computer ever built , grapples with The Big Question about the meaning of life; it takes a mere seven and a half million years to compute.

Adams' cybernetic inventions and his playing about with ideas like probability theory have a manic illogicality of their own; there is a similar dreamlike aura to that pervading *The Cyberiad* by Stanislaw Lem, reviewed previously. The whole book — and the radio and TV series — exist (and will exist) in a private time dimension where anything is possible.

The story zaps across time and space linked by Earthling Arthur Dent and Ford Prefect (from a small planet near Betelgeuse) who has with him the book for which he was doing research — The Hitch Hiker's Guide to the Galaxy — a speaking electronic book with the words DONT PANIC on the cover.

With its all-embracing funky information, the Guide sells far better than the boring Encyclopedia Glactica. The difference between the books can be guaged from the entries on robots.

According to the Encyclopedia, "a robot is a mechanical apparatus designed to do the work of a man". and it comments, "The marketing division of the Sirius Cybernetics Corporation defines a

Continued on page 99

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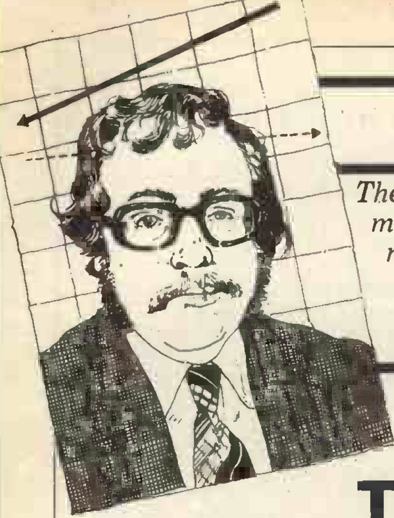


ON THE LINE

The role of any telecommunications authority such as the UK Post Office is not merely to provide the minimum level of public service which will avoid an undue number of 'Carter Committees' and questions in the house. Rather than just attempting to meet demand, the Post Office should act positively and imaginatively to encourage the growth of communications and to stimulate the free flow of information.

The Post Office connection

I am not against the monopoly supply of telecommunications services; on the contrary, I believe that (done properly) it is superior to the alternative of unregulated private-sector common-carriers fighting it out for the most lucrative market sectors.

What I *am* against is the abuse of what the Post Office Act describes as the monopoly *privilege* and the unnecessary extension of the monopoly into areas which can much better be fulfilled by responsible private companies under the generous supervision of the Post Office.

A good case in point is the supply of modems. The average PO modem is a good five years behind equivalent products from the private sector. That applies to functionality, quality and availability. I have never been able to see any good reason why the PO should supply modems; it neither makes a good job of it nor makes any money from it.

The PO have always had a policy of *type approval* for products which are to be connected to telephone lines (either directly or through some other approved product). This approval addresses two questions:

1 Is the equipment electrically safe and unlikely to damage telephone plant or engineers?

2 Does the equipment put any extraneous signalling on the line which might affect the efficient operation of the network?

A form of provisional approval could sometimes be obtained by using a 'barrier device' to protect the lines. Until recently this procedure applied only to business equipment and could take up to six months or more to complete and cost up to £1000 in PO fees. I say that it applied only to business equipment because no-one had come up with home products which the PO would permit to be connected to telephone lines.

It was with some trepidation, therefore, that we started 'On the Line' at the beginning of 1979; there was a distinct danger that the PO would require all home built computers to be type approved. Just to make this quite clear, anyone using a non type approved system (such as Apple II) would be breaking PO regulations and the same would apply to home-built systems. In November 1978 I wrote to the Post Office to ask them if they would waive type approval requirements for microcomputers and terminals working through approved acoustic couplers. The use of couplers would avoid direct electrical connection with the telephone line. The PO refused to make such a waiver.

What follows is a resume of how we managed to persuade the PO to change their minds.

Please bear with me if I go through the history of this in strict chronological sequence; I do not want to give you the impression that the Post Office comes to such minor decisions hastily. I am quoting from the Post Office's letters to avoid any suggestions that I am mis-interpreting them. I will not, however, identify the individual concerned in the Post Office Service Department because the problem lies more with the structure of the Post Office and its traditional attitudes to the monopoly privilege and the attachment of non-Post Office equipment. So here goes; it all started before this column did, back in 1978.

5th October 1978

I wrote to the Post Office Service Department saying that many personal computer users were interested in data transmission on the Public Switched Telephone Network (PSTN) for the purpose of program exchange, game-playing, file transfer and so on. The letter suggested that ". . . within some regulatory constraints and guidelines the Post Office should encourage such traffic. The large proportion of calls would be made during off-peak periods i.e. 'after six and at weekends'. Call duration would be relatively long compared with speech calls. Clearly there is a means here whereby the Post Office can increase revenues from existing plant". It then went on to ask three questions.

"1 Assuming that operation is via an approved acoustic coupler will it be necessary to obtain type-approval for the micro? If so, how would the approval procedure operate for, say, home-brew systems?

2 Would the use of some form of barrier kit be an acceptable alternative to full type-approval? In any case, are barrier devices relevant when using an acoustic coupler?

3 What other regulatory guidelines would the Post Office wish to specify for home users wishing to transmit on the PSTN?

I look forward to your reply."

9th October 1978

Received acknowledgment of my letter.

3rd January 1979

Wrote to Post Office:

"I wonder if you are yet in a position to give me the Post Office's views"

11th January 1979

Reply from the Post Office apologising for the delay and continuing:

"1 Post Office policy regarding the connection of modems to the PSTN is that such requirements should normally be met by a modem supplied, installed and maintained by the Post Office. Exceptions are, however, made and, for example, privately supplied acoustically coupled modems are permitted in applications where there is need to move the modem from one point of application to another from time to time. In these circumstances it would, of course, be unusual for acoustically coupled modems to be used at both ends of the transmission link.

2 As regards the connection of private equipment (e.g. a personal computer system) to Post Office plant via an acoustically coupled modem, we are concerned with

two main considerations namely:
(a) Electrical safety; the highest voltage occuring within or connected to the terminal must not exceed 250V AC or equivalent DC.
(b) The maximum power level of signals (intended or otherwise) connected to the Post Office line; this is of particular concern because recent experience has shown that interference can be significant especially if certain types of high frequency mains transformers are used in the terminal equipment. For this reason we have recently reviewed the policy and have decided that acoustic couplers will not be evaluated in isolation unless they have the ability to allow only those frequencies which are within the limits laid down. . . to be transmitted to the Post Office line regardless of the frequencies and levels fed electrically to the coupler from any attachment to it. (I am not aware of an acoustic coupler, however, which currently meets these requirements).

3 Therefore, unless the acoustic coupler to be used as a separate stand-alone modem with the personal computer systems conforms to the above specifications (para. 2b), it will be necessary for all the systems to undergo a technical evaluation in association with the acoustically coupled modem with which they will be used. (The use of a barrier unit as you suggest would not in fact prove a feasible solution as problems other than safety exist).

The Post Office evaluation of the computer systems, for which charges to cover the cost of Post Office resources used are raised, would be done on a general or one-off basis as follows:
(a) Pre-built systems
(i) With integral acoustically coupled modem. Suppliers of these systems would need to apply for a type-evaluation of their equipment. If this proved satisfactory a PO/Supplier Agreement for their supply could be drawn up and local Telephone Area Offices (Sales) would then be able to deal with applications for their use without further reference to Telecommunications Headquarters.
(ii) With separate stand-alone acoustically coupled modem. Suppliers of these systems would need to submit their computer system *and* the acoustic coupler with which it is to be used for type evaluation. If this proved satisfactory a PO/Supplier Agreement for the supply of both the computer system and the acoustically coupled modem could be drawn up as in a (i). If the modem is not to be supplied by the same supplier as the computer system, it will be necessary for PO/Supplier Agreements to be taken out with all companies concerned.
(b) Kit and Home-Brew Systems
Individual constructors of these systems would need to submit their equipment and the acoustically coupled modem (either separate or integral) with which it was to be used to THQ Service Department for a one-off evaluation of their individual installation.

4 When a PO subscriber wishes to use an acoustically coupled modem (with or without an integral input/output device) in connection with his telephone installation, he must first obtain the written consent of his local Telephone Area (Sales) Office. The conditions under which telephone service is supplied and private attachments may be used are as laid down in the Post Office Telecommunication Scheme 1979 (and amendments) a copy of which can be consulted at any local Telephone Area (Sales) Office.

I trust that the above information proves helpful to you".

Needless to say it didn't!

14th Feburary 1979
Letter to the Post Office.

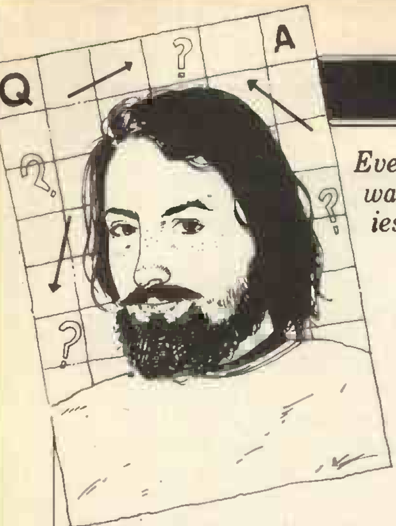
"I was surprised and disappointed to read of your plan to impose on these products type approval procedures originally conceived for business equipment. I would like to return to this but first of all, perhaps I could respond to your letter point-by-point.

1 I agree that it is unusual for acoustic couplers to be used at both ends of a data transmission link. Clearly, such an arrangement would involve the use of a computer which could receive on Channel 1. We are aware of this requirement and are encouraging the development of a switchable acoustic coupler which can be used for both the origination *and* reception of calls on the public network.

2(a) Even as someone who is not an electrical engineer, I find it difficult to understand how an excessively high voltage in a terminal device can transfer itself across a connection insulated by plastic, air and foam rubber to a PO exchange line. But just to be sure, I checked on this with three highly-qualified electrical engineers who confirmed, that in their opinion, this was impossible. I have these opinions in writing if you care to inspect them. In any case, paragraph 3.3 of Technical Guide No. 32 does require that 'It must not be possible for the metal framework of the equipment to come into contact with any metalic part of PO telephone installations'.
(b) It took me a little time to determine what you meant by the statement that 'recent experience has shown that interference can be significant especially if certain types of high frequency mains transformers are used in the terminal equipment. . . ' I believe that you are referring to the high kHz/low MHz radiation caused by the types of power supply needed to operate the bubble memory systems employed in certain models of the Texas Instruments Silent 700. In view of the fact that this problem is not caused by acoustic couplers, it would seem to be unfair to require the problem to be solved in the coupler. Does the problem not also occur with directly-connected modems? Indeed, are the Post Office's own modems protected against such radio-frequency emanations?

3 Assuming that there is no real electrical danger and that the 'problem' with respect to acoustic couplers can be overcome, would it still be necessary for full type approval procedures to be followed? If it really were necessary, a number of specific issues concern me.
(a) Is it not possible that the PO Service Department will be 'swamped' by developers of kit and 'home brew' systems? At present the department is set up to handle the (relatively few) business applicants for type approval and the addition of a large number of personal users to this queue could cause unacceptable delays for all concerned. The extension of the lead time to some two years would not be unexpected (at least, not by me).
(b) Is the level of charges made going to be acceptable to developers of personal computer systems? When one considers that it is possible to build a kit system for less than £200 the possible PO charge of more than £1,000 would seem to be rather high. In addition to the fees levied by the PO, the user must add the cost of getting himself and his equipment to Tenter House to participate in the evaluation exercise.
(c) If the regulations and type approval procedures as presently

Continued on Page 81



COMPUTER ANSWERS

Every month in PCW, Sheridan Williams assists readers with their hardware, software and systems difficulties. Some questions he deals with himself, other enquiries are directed towards members of his consultancy panel.

Long distance information

I've noticed that component prices in America are cheaper than over here. How easy is it to buy components from there?

If you have a credit card then the simple answer is "easy". First, look through the adverts in any American computing magazine (Byte is generally the best) and compare prices for those items that you want. Send the order on an airmail letter and print your order and address clearly. If you want the order quickly then ask them to air-freight it (which will cost you a bit more). If the shop accepts either VISA or BANK AMERICA then quote your Barclaycard number and expiry date — for MASTER-CHARGE read Access. A few shops take other credit cards such as American Express. ON NO ACCOUNT SEND YOUR CARD. Ask them to mark the customs declaration 'Computer parts' and don't forget to keep a copy of your order and the date that it was sent.

Remember though the state of the IC market is permanently chaotic with items regularly becoming in short supply. Last month it was LS TTL, the month before, 4116 dynamics and 2708 s the month before that. If the item is out of stock then most shops will 'back order' those items and send them out later on — some shops will charge you separately for any back-orders, others will charge you for them on the original invoice. If you don't want to 'back-order' then say so in the order. Similarly, prices may be up or down on those quoted in the advert — some LS devices have tripled in price due to the supply and demand situation. Delivery times vary even with air-freight — it took 2 months for some SMART 1 components to travel from California to here and yet only a fortnight for other similar orders.

When your order arrives in this country, duty will be levied at a rate of approximately 7%. The actual amount that you pay will depend on the 'declared value' on the Customs Declaration that the shop filled in; don't be tempted to ask the shop to 'mark down' the value — HM Customs are not that stupid! VAT will then be charged on the total but sometimes if the value of the order is small, then you'll pay nowt! All of this is done automatically and you don't need to worry about import licences etc. The first you will know about it is when the postman asks you for £x before he'll hand over the package. In due course, the sterling equivalent will appear on your statement just as other goods do. The current rate of exchange seems to be about $2.10 = £1.00. That is all there is to it.

If the component is faulty (unusual) then that's tough luck I'm afraid, as in practical terms it's going to take a long time to sort it out. However, it's the exception rather than the rule. Good firms that I have dealt with are: Quest, Advanced Computer Products, Californian Digital, Micros and Page Digital. And don't forget, it doesn't cost *that* much to telephone them directly should the need arise. Why not organise a bulk order with your local group and ask for some discount?

Mike Dennis

Bolting-on a disc

How easy is it to add a floppy disc to my home-brew system?

This is both a major hardware and software design problem. You need the hardware to interface your micro to the floppy disc electronics, generate the correct control signals (eg head load) for the drive, and record and retrieve the data in an acceptable and reliable format. The software required operates at two levels — one, to control the disc drive and the other, to manage allocation and cataloguing of the data.

To design it all yourself from scratch using, say, the Western Digital FD1781 or 1791 will be quite an undertaking — alternatively there are S-100 products (eg Versafloppy) available but you would then be faced with the problem of generating the necessary S-100 bus control signals from your own system. As far as the software is concerned, the most common is CP/M but again some modification to suit your system is inevitable.

Mike Dennis

Essential validation

I came across the term 'Validation' the other day, does it have a special meaning in programming or is it just common sense?

Suppose that you asked someone their age and they replied one hundred and twenty nine, you would probably not believe them. You have validated their age in your brain and would probably ask them the question again. This is the technique that must be applied to *all* good programs. None of the data should be allowed to be processed without having been thoroughly validated. In BASIC this is not often easy, but as an example we could validate the answer to the question "How many children do you have?" as follows:—

```
10  INPUT"HOW MANY CHILDREN DO YOU HAVE",C$
20  C=VAL(C$):D$=LEFT$(C$,1)
30  IF D$<"0" OR D$>"9" THEN 100
40  IF C<0 OR C>20 OR C<>INT(C) THEN 100
50  PRINT"THANK YOU": STOP
100 PRINT"I THINK YOU'VE MADE A MISTAKE":GOTO 10
```

Notice that serious programmers always input data into a string variable so that at least some errors are trapped and the message ILLEGAL QUANTITY ERROR does not come up.

Most validation techniques are fairly straight forward and common sense. Check the following when inputting data:—

SIZE — the data contains the correct number of characters
PRESENCE — that there is some data present
RANGE — check that numbers and codes are within a reasonable range
CHARACTER CHECK — check that data contains only permitted characters. . .ie names contain only letters, etc.
REASONABLENESS — quantities are checked for abnormally high or low values.
FORMAT — that a code contains numbers and letters in the correct sequence.

Two other techniques that require further reading, but are of the utmost importance when validating data are Batch/Control/Hash total and 'Check Digits'. These techniques would take too long to describe here but are worthy of further reading.

To summarise — all programs should validate the input to trap erroneous data before it is processed. The validation section of a program is usually quite long, but is essential.

Sheridan Williams

Menu options

In advertisements and articles about business software I've seen the words 'menu driven software'. What does this mean?

From the operator's point of view it means that he or she is presented with a list of options — usually on the VDU screen. Each option would have an associated code. For example, O = Order entry, I = Invoicing and so on. All the operator need do to select a program or an option within a program is to enter the appropriate code. The benefit of this approach is not restricted to the operator alone, the programmer prefers to develop several small programs because they are easier to debug and test and he can concentrate his efforts on one task at a time.

To link all the small programs together a 'menu' program is written which is responsible for displaying the options available, accepting the choice and calling the appropriate program — usually from disc. At the end of each program, control is returned to the menu program. In this way the package is self sustaining; this technique can also be thought of as 'chaining'.

Sheridan Williams

Good advice

As a businessman I need advice on how to define whether I can benefit from a microcomputer. Unfortunately, from where I am, all I see is vested interest. Software houses want to sell their packages or services, some are even tied to particular machines. Shops obviously want to sell their machines. Maybe I'm just a suspicious old sod, but I really can't see how to get truly objective advice. Can you help?

I've covered this type of question before, but it's such a common one that I will go over the points mentioned again. You will *never* get truly unbiased advice. I like to think that I am unbiased but my view of business computers is limited. It may be far greater than average, but my advice is still limited to those machines that I have tried, tested, and surveyed; hence I too am biased. Look at it this way:- if you require legal advice then you go to a solicitor; if you require financial advice then you go to an accountant or bank manager — they are all biased, but less so than most.

So if you require advice on microcomputers do *not* go to a shop for unbiased advice, approach a microcomputer consultant. There are several ways in which you can find a consultant. Look through PCW. . .there are several who advertise there; ask to see the Microskill register compiled by Digitus; write directly to me and I can put you in touch with a consultant who specialises in your field. The National Computing Centre (NCC) are doing a feasibility study of a microcomputer consultancy bureau — good news, I must say that there is a great need for one. Finally I do suggest that the consultant you choose should be able to show either relevant qualifications or references, as there are a great many 'cowboys' around.

As for your question on whether you can benefit from a microcomputer, don't be surprised if a consultant tells you that aspects of your business are better off staying as they are. It *is* possible that these will run more efficiently as they stand — don't look at microcomputers as some sort of universal panacea.
Sheridan Williams

The real business

How long do you think it will be before a pukka business machine comes on the market? Up to now all the business stuff gives me the impression that only a dedicated hobbyist/businessman should attempt using it.

I am not quite sure that I understand your question. Do you mean that all the systems you've seen have had wires and cables trailing all over the place, with naked printed circuit boards abounding? Maybe you see micros for around £2,000 upwards and refuse to believe that they can be any good, because you've been told that computers cost upwards of £50,000.

There have been pukka business machines on the market for some time now — and even the hobbyist micros are capable of performing simple business tasks. I suggest that you take a look around one or two shows or exhibitions. . .I feel sure you'll be surprised. If you are still sceptical then please write back and I will endeavour to prove my case.
Sheridan Williams

Plotting Lissajous

How do I plot Lissajous figures on my micro? I have seen them done but have no idea how to program them myself. Do I need a great knowledge of mathematics and physics?

Lissajous figures are nothing more than two mutually acting simple harmonic motions. An example might be the pattern formed when a pendulum swings in two planes (not just backwards and forwards, but from side to side as well), and has sand pouring out of the pendulum's bob. The trace made by the sand on the floor will be a Lissajous figure. They are fairly simple to plot provided that you don't want them plotted on a teleprinter. If you have direct cursor addressing on a VDU then you will find the task easy. Here is a program for the Research Machines 380Z, plus suitable mods for other machines like Apple and PET.

```
10 INPUT"SCREEN WIDTH"
;W
20 INPUT"SCREEN
HEIGHT";H
30 W=W/2: H=H/2
40 INPUT"TWO PARA-
METERS";A,B
50 GRAPH 1
60 FOR T=0 TO 9999 STEP
0.01
70 X=W*SIN(A*T)+W
80 Y=H*COS(B*T)+H
90 PLOT X,Y,2
100 NEXT
```

For the Apple change 50 HGR and 90 PLOTX,Y. For machines like the PET with no plotting command you will have to calculate the screen address and use 90 POKE V+2*W*Y+X,46 where V is the screen base (top left hand corner) address, and the ASCII code for a dot is 46. I won't do any more for you as half the fun is making the program work; please, no letters saying that the program doesn't work — make it work!

Lissajous figures can be stated parametrically as x=sin at, y=cos bt; and t can have any value (although it is convenient to use the values in line 60 above). Values of *a* and *b* will give differing forms of pattern, choose simple small integer values to begin with. Have fun.

I included this question as I was asked at the PCW show to cater for those with a scientific interest too. Please send in more scientific questions as I'd like to include at least one per month.
Sheridan Williams

BREW-IT-YOURSELF

Martin Lea outlines his own design Z-80 microcomputer.

There have been many circuits for microprocessor systems published in the various hobby magazines. These range from simple LED and switch operated designs to sophisticated microcomputers with resident BASIC interpreter, VDU, tape interface etc. Most of the simpler systems have suffered from several drawbacks.

Firstly many of them have been designed with very little thought of expansion. One of the results of this is minimum memory decoding and thus, to add further memory the circuit may have to be modified, in some cases quite extensively. Also, almost without exception such systems have used the SC/MP (or SC/MP II) microprocessor. The main reasons given for the use of this micro are that it is cheap, and easy to understand and use. Now, however, other micros are available which are far more sophisticated than the SC/MP in both hardware and software, while being almost as cheap and just as simple to use.

This circuit (fig. 1) is designed to overcome these problems. It features the powerful Z-80 microprocessor and is designed for easy expansion. It may at first seem strange to use a micro such as the Z-80 in such a simple environment but there are good reasons for this.

1 It is straightforward to use from the hardware point of view. It only needs a single +5V supply and a single phase TTL clock; also no demultiplexing of control signals or addresses is necessary.

2 It provides automatic refresh for dynamic RAM. While this is not used in the basic version, it means that cheap dynamic RAM can be added without external refresh controllers (which are expensive, and slow the processor down). All that is needed to interface 16K of dynamic memory is an address multiplexer.

3 It has a very powerful instruction set and a large number of internal registers. This means programs can be written which are faster, smaller and easier to understand (due to less shuffling of data from memory to micro etc.) than the simpler micros (SC/MP).

4 There is quite a bit of software available for it.

Despite these advantages it is now not very expensive. The Z-80 can be bought for £10/£12 for the 4MHz version.

The system

The system is almost as basic as you can get. The memory is 1K bytes (using 2102s 1K is only slightly more expensive than 256 bytes of 2112s). As there is no firmware, address and data switches are provided for loading programs and data into the memory. The data switches can also be read by programs as input. Output from programs is through the eight data LEDs. A switch is provided to interrupt programs via the $\overline{INT}$ pin. This is useful for such things as signalling to the computer that data has been set-up on the switches, and can be read in.

The circuit includes a PIO consisting of two eight bit ports. Each one can be configured either as an input or output or, in the bit mode, each bit may be separately defined as an input or output. This is a very useful IC as it allows many things (D/A converters, Keyboards and other peripherals) to be connected to the computer with little or no external circuitry.

Also available as outputs from the circuit are sixteen memory block enable lines (1K blocks) and eleven I/O port enable lines. The other five of the sixteen decoded port enables are used on the board, one for the LEDs and switches, and four for the PIO. All the outputs are fully buffered to drive up to twenty LS TTL loads. (Some lines have a slightly lower drive capability as they already drive inputs on the board.)

The circuit

There is nothing particularly revolutionary about the circuit (Fig.1). The heart of the circuit is of course IC1, the Z-80 CPU. This is clocked at 2.5MHz by a simple crystal oscillator built around N1, N2 and N3. As already mentioned, direct memory access is used to load and examine the memory. In the DMA mode the address, data and deposit switches effectively replace the MPU as a source of address, data and control signals. The circuit contains data selectors to select between the MPU and the switches. (The data switches are connected via a tri-state buffer because they are also used as a data input peripheral).

The PGM/LINE switch (S1) is used to select between the two modes.

With S1 on LINE, $\overline{BURSQ}$ is held high, allowing the MPU to have control of the busses. This is acknowledged by $\overline{BUSAK}$ being high. This signal is used to control the five data selectors (IC2 to IC6). As it is high the data selectors are switched to channel B. Four of these (IC2 to IC5) connect and buffer the MPU address bus onto the system address bus; IC6 connects $\overline{IORQ}$, $\overline{MREQ}$, $\overline{RD}$ and $\overline{WR}$ control signals onto the appropriate system control lines.

IC8 decodes the high order address bits and MREQ to provide the sixteen 1K page enable outputs ($\overline{P0}$ to $\overline{P15}$). Only $\overline{P0}$ is used in the basic system but the others are very useful for system expansion, especially adding ROMs. $\overline{P0}$ will go low whenever a location in the bottom 1K of memory is addressed. This signal is therefore used to enable the 1K block of RAM (IC13 to IC20). When $\overline{P0}$ and $\overline{RD}$ are both low, ie. a read from the RAM block is being performed, IC12 is enabled, putting the data from memory onto the data bus. The memory decoding is not quite complete, so P0 occurs again at 8000 – 83FF, as well as 0000 – 03FF. Memory expansion above 32K will therefore require additional decoding. For this reason it is suggested that A14 should be connected to IC8 by an external jumper to allow easy modification.

This also applies to IC9; the I/O port decoder, A4, should be connected to IC9 by a jumper. IC9 works in the same way as IC8 but it decodes the low order address bits as the I/O port address appears on the low byte of the address bus during IORQ time. IC9 is of course enabled by IORQ not MREQ. In the basic system, port 0 is used to enable the LEDs and switches. Ports 4 to 7 are gated together by N19 — N21 to select the PIO. The B/A and C/D select lines of the PIO are connected to A0 and A1 respectively. The result of this is the port allocation shown in Fig. 2.

	INPUT	OUTPUT	
0	switches	LEDs	
1	unused		
2	unused		
3	unused		
4	PORT A DATA		PIO
5	PORT B DATA		PIO
6	PORT A CONTROL		PIO
7	PORT B CONTROL		PIO
8	unused		

Fig. 2
I/O PORT ALLOCATION

When reading from port 0, both RD and IO will be low. N7 will therefore go low, thus enabling tri-state buffer IC11 via N11 and N12. The data from the data switches is thus enabled onto the data bus to be read in by the MPU. When data is written to port 0, WR and IO will both be low. The output of N9 goes low, enabling IC10 via N10. The data from the data bus is latched into IC10 and thus put on the LEDs.

IC7 is a bi-directional tri-state buffer. The direction is controlled by RD and it is enabled by BUSAK. Its function is to increase the drive capability of the data bus. It's not necessary in the basic version and as it seems very hard to obtain at the time of writing, it may be omitted. It must be replaced by a direct wire connection between the MPU data bus and the system data bus. If expansion over the drive capacity of the data bus (four LS TTL loads) is incorporated, it will have to be included.

DMA mode

When S1 is switched to PGM, BUSRQ is pulled low. This informs the MPU that an external device (in this case the human operator) wants control of the busses. The Z-80 finishes execution of the current instruction (or cycle of a block transfer, search or I/O instruction) and then releases control of the busses. The data address and control busses go tri-state, and BUSAK goes low to indicate that the bus is available.

The BUSAK disables IC7 and switches the data selectors to channel A. This connects address switches S11 to S22 via the data selectors to the system address bus. The high order nibble is wired to zero which limits the switches to 4K of memory. This is no hardship, however, as it is impractical to address more than 4K of memory with switches. Via IC6, MREQ is held low and IORQ is held high. With S2 (deposit) not pressed, RD and WR are held low and high respectively.

Assuming that the address on the switches is in the bottom 1K of memory (less than 400), the RAM will be enabled just as in the LINE mode. As RD is low, IC12 is enabled so the data from the selected RAM location is enabled onto the data bus. IC10 is held open by the BUSAK signal via N10. The LEDs will therefore follow the data bus and thus display the contents of the selected memory location. Any memory location may be examined in this way, simply by setting up the address on the address switches.

If S2 is now pressed RD is sent high and WR is sent low. This enables IC11 via N8 and N11/N12, and disables IC12. The data bus will therefore contain the data set-up on the data switches. The RAM is in the write mode as pins 3 are held low by WR; the data from the switches is thus written into the RAM location. When S2 is released the system returns to the read mode so the LEDs will continue to display the new contents of the memory location. This checks that the data has been written correctly.

Interrupts and reset

A computer is not much use if you cannot run the programs you have entered. To start programs with the Z-80 it is necessary to apply a low pulse to the RESET pin. This is achieved by S3. The switch is debounced by a standard RS flip-flop (N22 and N23). This is to ensure that only one reset pulse is applied which is important for some programs. Capacitor C1 differentiates the output and applies it to the RESET pin of IC1. This has two effects: firstly, with S3 off, RESET is effectively floating so other circuitry (with open-collector outputs) can be connected to it, and secondly, C1 also produces only a short (about 1ms) pulse to IC1 to ensure that refresh to any dynamic RAM which may have been added is not lost for long enough to corrupt the data.

S4 is connected in just the same way as S3 but to the INT pin of IC1. Pressing S4 thus causes an interrupt of the current program. The use of this will be explained later.

N15, N16 and N17 buffer HALT, RFSH and M1 respectively. HALT also drives LED D1 which lights to indicate that the system has halted. LED D2 is connected to BUSAK and thus lights when the system is in the PGM mode. This is necessary as sometimes on switch-on, with S1 on PGM, the system will not enter the PGM mode until RESET is pressed. All the control inputs (RESET, NMI, INT, WAIT, BUSRQ) have pullup resistors, so external open collector circuitry can be connected to them direct.

Construction

The prototype drew a current of about 700mA with all LEDs on, so the simple power supply of Fig. 3 will suffice. The 7805 regulator should be provided with a heatsink. This supply allows little room for expansion; in that case it's worth using a higher current supply. An alternative and preferable approach is to mount a simple regulator as shown in Fig. 3 (with a smaller reservoir capacitor) on the board and on each expansion board; you can then power the whole lot from a smoothed but unregulated 8V DC supply.

It is advisable to use the low power schottky TTL for all TTL ICs, to reduce power consumption. In some cases this is unavoidable (DM81LS95 and 74LS373 are only available in LS), and in some cases virtually impossible (try getting a 74LS154). The only ICs for which standard TTL may not be used are IC21, IC23, IC25 and IC26. All of these have more than one input driven from a single Z-80 output and the fanout of a Z-80 is only one to standard TTL (four to LS TTL).

The 2102s can be 250ns or 450ns access time. The minimum time available for a memory access is during an M1 cycle (op-code fetch). The allowed access time for the memory is three clock half-cycles, less about 40ns.

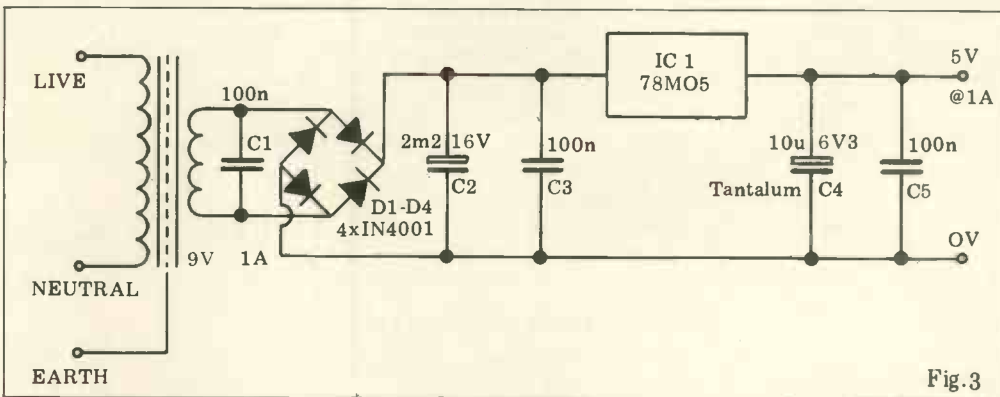


Fig.3

PROGRAM 1.

ADDRESS	DATA	INSTRUCTION
ØØØØ	3E ØØ	LD A,ØØ
ØØØ2	D3 ØØ	OUT (ØØ),A
ØØØ4	3C	INC A
ØØØ5	Ø6 ØØ	LD B,ØØ
ØØØ7	48	LD C,B
ØØØ8	Ø6 ØØ	LD B,ØØ
ØØØA	1Ø FE	DJNZ -2
ØØØC	41	LD B,C
ØØØD	1Ø F8	DJNZ -8
ØØØF	18 F1	JR -F

PROGRAM 2.

ADDRESS	DATA	INSTRUCTION
ØØØØ	31 ØØ Ø4	LD SP,Ø4ØØ
ØØØ3	ED 56	IM 1
ØØØ5	FB	EI
ØØØ6	76	HALT
ØØØ7	DB ØØ	IN A,(ØØ)
ØØØ9	D3ØØ	OUT (ØØ),A
ØØØB	4F	LD C,A
ØØØC	76	HALT
ØØØD	DB ØØ	IN A,(ØØ)
ØØØF	81	ADD A,C
ØØ1Ø	D3 ØØ	OUT (ØØ),A
ØØ12	76	HALT
ØØ13	18 FD	JR -3
⋮	⋮	⋮
ØØ38	Ø6 ØØ	LD B,ØØ
ØØ3A	1Ø FE	DJNZ -2
ØØ3C	FB	EI
ØØ3D	ED 4D	RETI

At 2.5MHz this is 560ns. If we allow about 100ns delay of $\overline{MREQ}$ through IC6 and IC8, and of the data through IC12 and IC7, (a fairly pessimistic estimate) this leaves 460ns for memory access time. There are therefore no problems in using 450ns RAMs.

It is possible to use the Z-80A at 4MHz in this circuit (the prototype used it). I would in fact advise it as it is not much more expensive (about £3 for the CPU and PIO) than the 2.5MHz version, and you get nearly twice the processing speed. The only other change necessary is to use 250ns memories. You could add wait states etc. to get away with the 450ns memories but it is really not worth it as 250ns 2102s are not much more than 450ns ones and they can be got for about £1.10 (HM).

Construction of the microcomputer is not very critical; the prototype was built on a single sided PCB with no problems (except for mistakes in the PCB). The main thing is to keep everything neat and any interconnections fairly short (problems may be encountered with christmas tree construction methods). About ten 0.1uF decoupling capacitors should be distributed around the circuit, across the power rails, especially near the Z-80.

Operation and programming

Operation of the system is extremely simple. At power-up, if S1 is on PGM, LED D2 should come on. If it doesn't then press RESET and it will. (If it still remains off, something is wrong.) The LEDs will now be displaying the contents of whatever memory location is selected by the address switches. At this stage the RAM will of course just contain rubbish from power-up. (In my system it always seems to power-up with alternating 00 and FE.) To load correct data or instructions into a location, the data is set up on the data switches, the address where the data is to go is set up on the address switches, and deposit pressed. The LEDs will now display the new contents of that location. Continuing in this way the whole program can be entered into memory. Once entered it is always worth checking that the program is loaded correctly as incorrect programs have a nasty habit of wiping themselves out. Z-80 programs must always be written to start execution at location 0000.

To start the program, press $\overline{RESET}$ ($\overline{RESET}$ over-rides $\overline{BUSRQ}$ so the Z-80 will reset with S1 on PGM). This causes the Z-80 to fetch and execute the first instruction and then return to the PGM mode. If S1 is now moved to LINE the program will continue execution until a HALT instruction is met. Putting S1 to PGM at any time will stop the program, allowing memory to be examined and/or modified. Moving S1 back to LINE continues from where the program left off.

It is not possible to do justice to the software capabilities of any microprocessor system in a short article but here are a couple of simple examples.

Counting

The program shown (Program 1) is a simple binary count program. It will count in binary on the LEDs at about 3Hz. The count rate can be varied by changing the contents of locations 0006 or 0009.

Addition

It is unusual to have interrupt available on a switch as in this circuit but it's a very useful feature in simple systems. One handy application is to signal to the computer that data has been set up on the data switches and can be read in. This is demonstrated in Program 2.

Before using the INT switch it is necessary to load the stack pointer with a convenient location to hold the interrupt return address. The Z-80 must then be set to interrupt mode 1.

In this mode an interrupt causes a jump to 0038. . . the interrupt system is then enabled with an EI instruction. Program 2 simply adds two numbers which are input from the switches, and displays the result. When each number is required, the input instruction is preceded with a halt instruction. When this halt is executed D1 will light to indicate that the MPU is waiting for data. When the data has been set-up on the data switches, INT is pressed. This causes a jump to 0038. Here there is a delay of about 1.3ms before the interrupt is re-enabled, thus ensuring that the INT pulse from the debouncing circuit will be over when interrupts are re-enabled, preventing multiple interrupts. After enabling the interrupt, the RETI instruction returns to the instruction after the halt, which in this case reads in the data.

Using the PIO

The Z-80 PIO (IC21) is a fairly sophisticated LSI circuit. It provides two eight bit input/output ports with handshake control, and is fully compatible with the Z-80 vectored priority interrupt system. Despite this it is not hard to use. For simple applications the handshake and interrupt facilities may be ignored. Before using the PIO, a program must set it up. This involves outputting various control bytes to the control port of the required channel (port 6 for channel A, port 7 for channel B). This information includes setting the mode (input, output, bit or bidirectional); in the bit mode a byte must also be sent to define which bits are inputs and which are outputs. If interrupts are being used, additional information must be provided about interrupt modes, interrupt vectors and bit mask (in the bit mode only). There is no room in an article of this type to explain the device fully and I would advise those interested to obtain the Z-80 PIO technical manual.

Parts list

RESISTORS	
R1-8, R12-26, R35-42	1kx31
R9, R10	680Rx2
R11	330R
R27-34	180Rx8
CAPACITORS	
C1,C2	100nx2
C3	82p
C4	10n
SEMICONDUCTORS	
IC1	Z-80 CPU
IC2-6	74LS157x5
IC7	74LS245 (optional)
IC8, IC9	74154x2
IC10	74LS373
IC11, IC12	DM81LS95x2
IC13-20	21L02x8
IC21	Z-80 PIO
N1-6 = IC22	74LS04
N7-9 = IC23	74LS32
N10-13 = IC24	74LS00
N14-17 = IC25	74LS08
N18-21 = IC26	74LS08
N22-25 = IC27	74LS00
MISCELLANEOUS	
S1, S5-S24	21xminiature slide switch
S2-4	3xminiature push switch
D1,D2	.2" LED (one red, one green)
D3-10	8xTIL209
X1	2.5MHz crystal
2 x40pin	
2 x24pin	DIL IC socket
4 x20pin	these may be omitted but their
13x16pin	use makes testing etc much easier
6 x14pin	

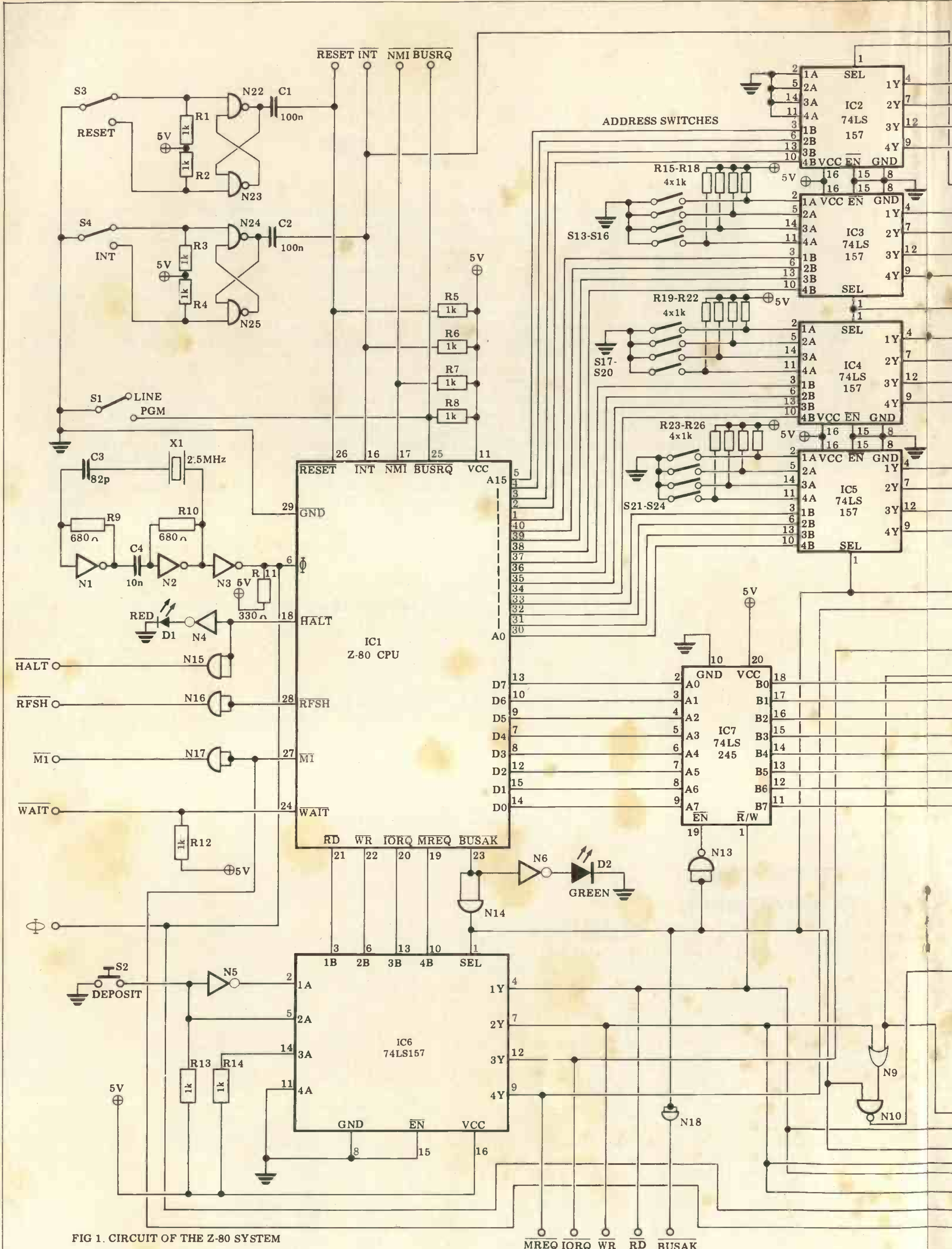
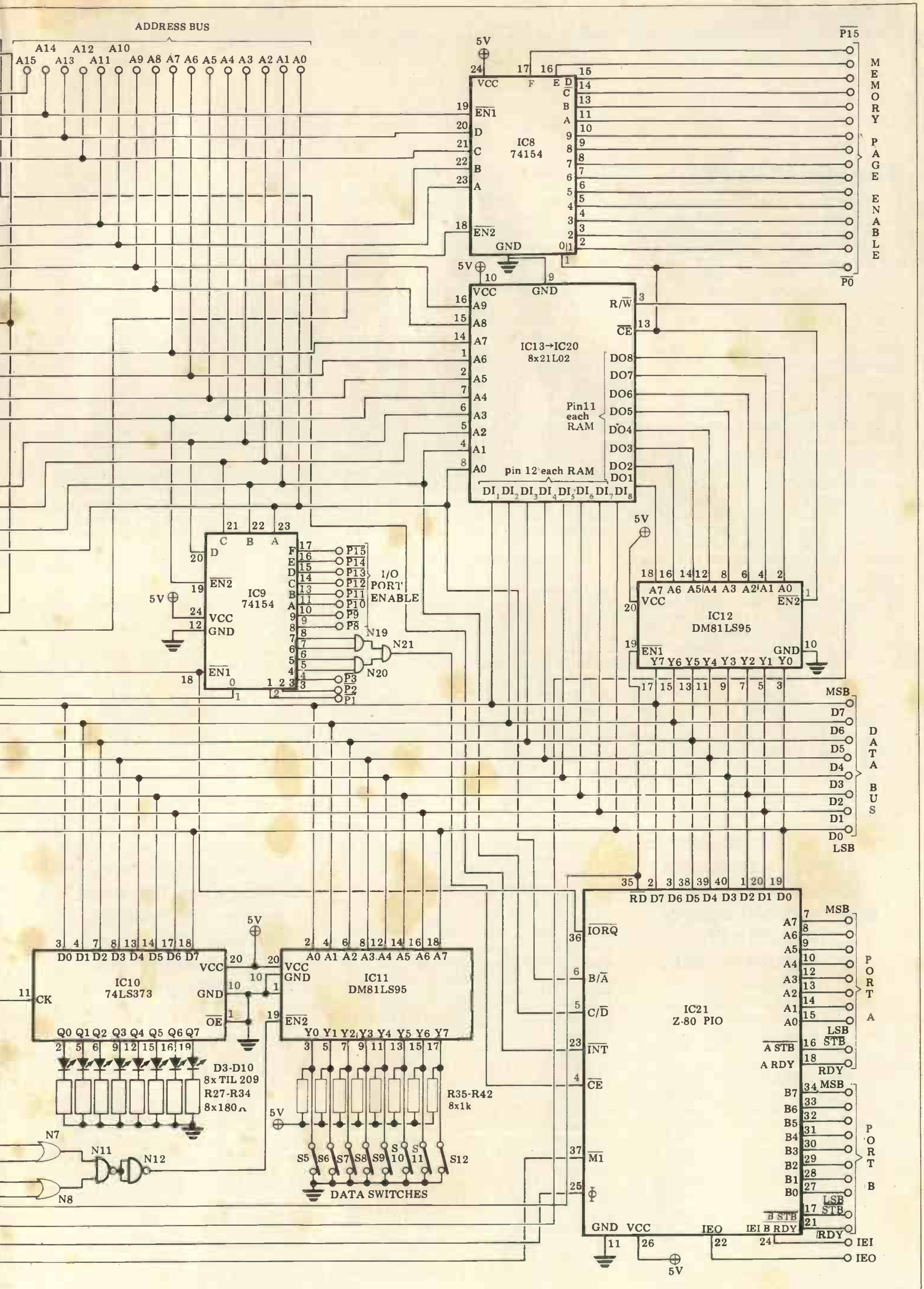


FIG 1. CIRCUIT OF THE Z-80 SYSTEM


ADDRESS BUS
A15 A14 A13 A12 A11 A10 A9 A8 A7 A6 A5 A4 A3 A2 A1 A0
5V
IC8
74154
MEMORY PAGE ENABLE
P15
P0
IC13→IC20
8x21L02
Pin11 each RAM
pin 12 each RAM
IC9
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An abridged version of the talk given by Lord Avebury at the University of Sussex, November 1st, 1979

The end of work?

"Following a personal initiative by Her Majesty the Queen, the Government is to launch a huge programme with the aim of getting the public engaged in a debate on informatics and society. There will be computer film festivals, programming contests, and an international conference at which computer experts will be thinly diluted with trade unionists, social scientists, natural scientists and journalists. The doors of hundreds of government establishments where computers are used will be thrown open to the public, and staff will be on hand to talk about their work. The idea is to make the people aware of the potential benefits of information technology, and to stimulate the flow of new suggestions on how to tackle the problems which may arise from it".

Of course, nothing of the kind is actually happening on this side of the Channel. The description is of the scheme put into action in France at the behest of President Giscard d'Estaing. Presumably there must be a far greater awareness among politicians in France of the revolution just beginning. In Germany, too, one of the principal aims of the Government's new £250 million programme for the years 1980 to 1983 is to 'encourage a two-way flow of ideas between the information technology industry and society so that the technology meets the needs of people rather than developing in isolation'.

Here in the UK, although substantial help is being given towards microelectronics applications, and towards the training of users in industry, there does not seem to be any consciousness of a need to explain these advances to the consumer or the trade unionist, nor to encourage them to participate in the discussion, let alone the management, of the changes that will so profoundly affect them.

"There is a danger of Britain becoming polarised into a fairly small elite of professionals and managers...

The trade unionists have had to work out their own attitudes independently of the rest of the community, while the consumer, who is virtually unorganised, has no say in the matter at all. There is a danger that Britain may on the one hand become polarised into a fairly small elite of professionals and managers who are keen to apply the available technology, and on the other, the mass of the people for whom the word microelectronics conjures up only images of Big Brother and the dole queue.

In practice, as long as we remain part of the free world we have very little choice but to use microprocessors in mechanical and electromechanical devices, because we are bound to face irresistible competition from other manufacturers who will do so. The alternative would be a society of almost total isolation; full-blooded socialism including state-owned trading enterprises with complete control over imports and exports, or enormously high tariff walls to protect inefficient and stagnant home industries.

It's from now onwards that we can expect the jobs to vanish at an ever increasing rate, if prophets like Dr. Chris Evans are to be believed. He forecasts ultra-intelligent machines (UIMs) taking over not only the repetitive and boring work now having to be done by human beings, but also the highly skilled and professional jobs. He envisages computers sitting as judges in courts of law, for instance, and the total replacement of the printed word by electronic communication.

One dearly wants to believe the picture of a 16 to 20 hour working week by the end of the century, diminishing thereafter to zero. But to get there it is necessary to pass through an era of radical adjustment in our attitude to work, and to find ways of occupying people's time and energy that will satisfy them.

During the next 20 years, occupations will be deskilled one by one. Information handling will be transformed out of all recognition, sweeping into oblivion most of the clerical jobs now available. Logica has estimated that one word processor can produce the same output as 3½ to 5 traditional typewriters, and ASTMS has forecast that by 1991, as many as 3.9 million 'information workers' — a term meant to include secretaries, managers and supervisors as well as accounting and stock control clerks — will have lost their jobs.

Text processing systems communicating with each other through the telephone network will first lead to a drop in the letter post. This in turn will necessitate steep increases in postal charges, thus encouraging more users to hook up to the electronic postal network. It is doubtful whether the conventional letter post could survive at all in twenty years' time, displacing 172,000 workers.

Since fewer people will be employed in offices, there will be less demand for office space, and other industries will feel the pinch. It it not hard to think of secondary effects, such as a fall in demand for office furniture, carpeting, manual filing systems and paper.

The industrial sector will not be immune either. It has been estimated that the System X telephone system will eliminate 90% of the workers now engaged in TXE4 production, and when in operation, it will result in a 75% reduction in the labour needed in fault finding, maintenance, repairs and installation work. And one major consequence of the spread of viewdata in the eighties will be a sharp fall in demand for other sources of information. Newspapers are likely to feel the brunt of this trend, and although news *gathering* obviously will not be affected, its dissemination, increasingly, will be.

There can no longer be any doubt that a job famine of unprecedented size is about to hit the world and politicians who suggest or imply that with minor changes of economic policy there could be a return to full employment are practising a cruel deception trick on their voters.

With persuasion more workers might do some of the jobs that are at present so unpopular. Not many people want to be mortuary attendants or waiters, yet few of these unpleasant or unfashionable jobs are likely to be eliminated by automation. In speaking of the role of human beings in the silicon age, there is a tendency to overlook this kind of work, and to concentrate on the way informatics can enhance the power of individuals whose jobs are already attractive, relatively speaking.

There is a very real danger, if we are not careful, of creating new and worse class divisions in society than we had in the past. On the one hand would be the information-rich, a small elite with interesting jobs and a stimulating, varied leisure life; on the other would be the mass of the information-poor, either unemployed or performing tasks that give them no satisfaction, and ill-equipped to make best use of their plentiful spare time. The contrast between the two groups would be stark, because the range of skilled and semi-skilled activities in between would have virtually disappeared. This would be a prescription for extreme social unrest, perhaps disintegration; yet the social engineering needed to reconcile the new Helots to an existence of unchallenging rigidity would be incompatible with a free society.

... and where for the mass of the people the word micro-electronics conjures up only images of Big Brother and the dole queue".

Another approach is the TUC's formula for spreading the available work round more thinly. The package consists of: the 35 hour week; a reduction in systematic overtime; longer holidays; better provision for time off for public and trade union duties; substantial leave; and early retirement for older workers on improved pensions.

Clearly if the proposals could be introduced without an increase in unit labour costs, they would be effective. But when the trade unions argue for a shorter working week, for instance, they naturally expect to get there without any loss of basic pay. This puts up our costs, makes Britain even less competitive and stimulates the export of jobs to Europe, America and Japan. If full employment was of supreme importance, the TUC's measures would be implemented without any change in hourly rates, and with increased social security contributions to pay for early retirement and better pensions. That is not a practical possibility, however, and the best that can be hoped for is a trade-off between the various forms of work-sharing and the need to contain inflation.

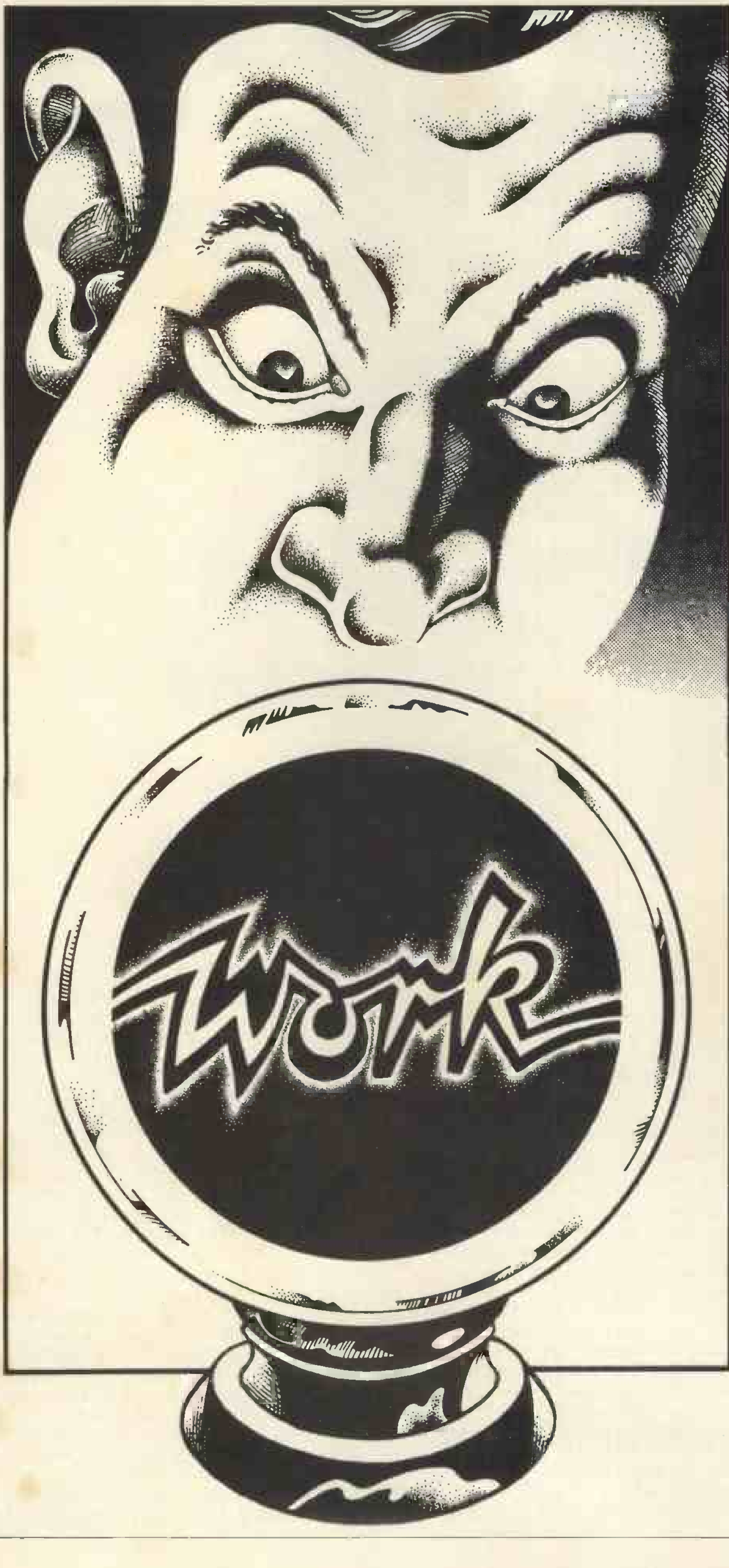

Illustration by John Storey

In everything that has been said up to now it has beem implied that man has a right to work, and that he suffers deprivation if he is without a job, quite apart from any economic hardship he may endure. This is indeed a widely held and deep rooted belief. And today the virulence displayed towards alleged social security scroungers indicates that many people still think it is morally wicked to abstain voluntarily from paid employment, even when the effect of doing so may be to leave open a job for someone who really wants it.

Herman Kahn was speculating, 12 years ago, on the question of whether or not in the postindustrial society people could adapt to the idea that work is an interruption of normal life. Some of the benefits of work, he thought, could be derived from other forms of activity, provided they were available and, preferably, institutionalised. The sense of participating in an important activity, the exercise or mastery of gratifying skills, and the establishment of personal identity, for instance, are among the values sought.

More important than any of these, surely, and more difficult to realise, is the absence of guilt feelings, caused by the way society views the unemployed. The man or woman on the dole is either an object of sympathy, to be relieved by alms or charity — which is in fact the original meaning of the word — or he/she is seen as a failure, lacking the skills and ability to compete in a harsh world.

The transition to a steady state economy is now a matter of absolute necessity, if economic discontinuities — and hence political and social discontinuities also — are to be avoided. This is not yet generally accepted, but when it dawns on opinion leaders, attitudes to productive work are bound to shift accordingly. If society ceases to consider economic growth as the goal of paramount importance but rather, as a policy bound to lead to catastrophic failure, then the contribution of the individual to the general good must be evaluated by some other yardstick than the quantity of resources he processes or converts.

The end of work? Clearly not, but it will shrink in importance, as part of a far reaching transformation that can only be dimly perceived. The uses made of information technology in this process could be wholly beneficial, contrary to the image people have been given by the media. Indeed they will be, if, instead of abdicating their power to influence the course of events by concentrating entirely on the microeconomic effects at the work place or within a particular industry, the trade unions and the political parties would begin to think about the institutions needed to provide and control the silicon revolution for the benefit of mankind as a whole.

Eric Avebury
House of Lords

COMPUTER GAMES

Chess master, David Levy, begins a series of articles on the principles behind programming computers to play games.

Games are fun, but some games are more fun than others, depending on your taste. It's long been recognized that the type of mind required to play good chess, bridge, backgammon or poker, is also likely to be adept at solving crossword puzzles and writing computer programs. Hence it is hardly surprising that many programmers derive enormous satisfaction from programming intelligent games.

In this series of articles I shall discuss the principles of programming a computer to play games, placing special emphasis on the particular problems posed by running these programs on a micro. My aim will be to acquaint the reader with the techniques of games programming so that (s)he will have the confidence and ability to program any intelligent game for a personal computer. Although I shall use a limited number of games in my examples, the same general principles can be applied to any game in which the computer competes against the user or users.

The series will be divided into three parts. The first part will cover all the general principles, giving examples and suggesting interesting programming tasks for the more enthusiastic reader who wishes to test his understanding of a particular topic. In part two I shall discuss some specific games in more detail and describe what work has been done in these areas so that the reader who is interested in a particular game need not re-invent the wheel. I shall also invite readers to write to me with their questions and ideas, and I shall publish the most interesting letters together with my comments (though I regret that no personal replies can be given). The third part of the series will begin when the most interesting games have already been discussed in detail, and it will be possible for me to devote most of each article to the readers' forum.

I very much hope that these articles will be interesting and informative for all of you who are 'into', or would like to be into, computer games.

Input/output

I/O on a personal computer is often largely a matter of taste, though certain points are worth bearing in mind when writing a game playing program:

1 The output should be easy to follow. You may not think this important, and many programmers take the attitude that if they can understand their output nothing else matters; but how about someone else? If you want to show your program off to a friend it will be so much better received if the output is clear, concise and unambiguous. Remember to output any information that may be helpful, for example in a chess program you should always announce check, checkmate and stalemate. These little touches take hardly any extra effort, and they make your program that much more attractive to another user.

2 If you want to use neat graphics or printout, plan the layout carefully, taking into consideration all possibilities. It's not much use having your bridge program display pretty pictures of the cards if one day you discover that when you are dealt ten cards in a suit only nine of them will fit onto one line and your whole display is messed up.

3 Ensure that the user can easily see whose turn it is to play, and what the

last 'move' was. It can be infuriating to leave the computer for a minute or two and then return to find that the program has moved but you do not know what it has done.
4 Make it easy for the user to enter a move and to clear an incorrect move entry.
5 Ensure that the program will reject an illegal, impossible or ambiguous move, or any entry that does not conform to your simple input rules.

One-person games

A one-person game does not involve an opponent. You play against a microcosm of the forces of nature and if you make a mistake it may be possible to recover, and then go on to win. Solving a problem or a puzzle is a good example of a one-person game — when you get near to a solution there is no-one to oppose you by suddenly making the problem more difficult. It may seem at first glance that patience games are one-person games, but in fact many patience games do not permit the player any freedom of choice, so the 'game' has no real interest. Once the cards are cut the player either will or will not finish the game, and all of his decisions are made for him by the rules.

A well-known one-person game, is the 8-puzzle, in which a 3 x 3 array of tiles contains the numbers 1 to 8 and an empty space. (The numbers are sometimes replaced by letters.) The player shuffles the tiles and then tries to reach some target position by successively moving tiles into the empty space. For example:

STARTING CONFIGURATION

3		8
2	5	7
1	4	6

TARGET CONFIGURATION

1	2	3
4		5
6	7	8

Here the task is simple, and one way in which the target can be reached from the starting configuration is by moving the tiles in the following order: 3,2,1,4, 6,7,8,3,2,1,4,6,7,8,5. With other starting and target configurations the task may be more difficult, and for those who find the 8-puzzle too simple there is always the 15-puzzle, in which a 4 x 4 array has fifteen tiles and an empty space; then there's the 24-puzzle, the 35-puzzle and the (n^2 — 1)-puzzle. In fact there is no reason, other than tradition, why the puzzles need to be square.

Heuristics and Algorithms

The 8-puzzle is an excellent example of the type of problem that lends itself to solution by heuristic means. Before describing how we should set about programming games of this type, it would be as well to distinguish between the terms 'heuristic' and 'algorithm', which are often misunderstood.

An *algorithm* is a technique for solving a problem (the problem may be finding the best move in some game) if a solution exists. If there is no solution to the problem the algorithm should determine this fact. Thus, an algorithm always works, otherwise it is not an algorithm.

Most interesting games do not have an algorithmic solution, at least in the practical sense. Of course there is an algorithm for finding the perfect move in a game of chess — simply examine every possible move for both sides until one player is mated or a draw is established — but since the total number of chess games is greater than the number of atoms in the universe, this algorithm would be somewhat slow in practice. In contrast, however, there does exist a useful algorithm for the interesting game of Nim. Nim is played with a number of piles of objects, often matches, and with various numbers of objects in each pile. The players move alternately, and to make a move a player must remove, from one and only one pile, any number of objects he chooses — from one object to the whole pile. The player who removes the last object loses the game. (In another version of the game the player who takes the last object is the winner.)

In order to win at Nim one need only know the following algorithm, and a few exceptional cases: *If the number of objects in each pile is expressed in binary, and each binary column of numbers is added in decimal (without carrying numbers), then if the decimal totals are all even or zero then the person who is next to move is in a losing position.* Here is an example.

			binary
Pile A:	1 1 1 1 1 1 1	= 7 matches =	1 1 1
Pile B:	1 1 1 1 1	= 5 matches =	1 0 1
Pile C:	1 1 1	= 3 matches =	1 1
Pile D:	1	= 1 match =	1
		totals:	2 2 4

All three totals are even so whoever moves next will lose, provided that his opponent plays correctly.

There are some obvious exceptions to the rule. For example if piles A, B, C and D each have one match then the player who moves next will win, and the same is true of a position in which there's only one pile of matches, provided that there are at least two matches in this pile.

The existence of this algorithm does not detract from the interest of the game since its implementation is somewhat difficult for a human being, unless the number of piles and the number of matches in each pile is small. But for a computer program the task is trivial. The program considers each move that it can make, taking one match from pile A, two matches from pile A, and so on, and it evaluates each of the resulting positions until it finds one where the decimal totals of the binary columns are all even or zero, whereupon it makes the move leading to that particular solution. Once a candidate move has been rejected it may be thrown away, so RAM is required only for the current situation, the move or decision currently under consideration, and workspace for the binary/decimal calculations. The program tries each move from the current position, and if a move is found to be unsuccessful it is 'unmade', and the next move tried. In this way it is not even necessary to store both the current position and the candidate position — the program can switch to and fro between them by making and unmaking moves, a technique which is useful for saving RAM in a highly restricted memory environment.

One trick to remember for Nim, or any other game with an algorithmic method of play, is this. Should the program find itself in a theoretically losing position, as might happen at the start of the game, it should make the move that leaves its opponent with the most complex decision. In this way the opponent is more likely to make a mistake. In Nim I would suggest that if your program is in a losing position it should remove one match from the largest pile.

A *heuristic* method of solving a problem relies on commonsense techniques for getting closer and closer to the solution, until the solution is actually within sight. A heuristic is therefore a rule of thumb — it will usually help us to find a solution to the problem, but it is not guaranteed to do so. In situations where a heuristic does work, it will often find the solution much faster than any algorithmic method, though some heuristics, for best results, are often employed in conjunction with an algorithm. A frequently used device which makes use of heuristics is the *tree*, and we shall now examine a method of solving the 8-puzzle by use of a tree and a simple heuristic.

Let us return to the starting configuration on figure 1. We always refer to the starting configuration, or the point from which the program must move, as the *root* of our tree. Before we can decide which move might be best we must know which moves are possible, i.e. in accordance with the rules of the game. A list of these moves is usually supplied by a subroutine called a *legal move generator*, which may be extremely complex, as in chess, or very simple, as in the 8-puzzle. It is not difficult to see that in our starting configuration there are three tiles which may be moved, 3,5 and 8. Our legal move generator would determine these moves by examining the elements of the 3 x 3 array which are horizontally or vertically adjacent to the empty space, and there are many simple methods for doing so. We might, for example, store all the legal moves in a table. If we number the elements of the array table thus:

1 2 3
4 5 6
7 8 9

our table of moves might look like this:

vacant	*moves*
1	2,4
2	1,3,5
3	2,6
4	1,5,7

etcetera

so that by knowing which element in the array was vacant the program could immediately list the legal moves. This type of approach is called *table-driven move generation*. It is often the fastest way to generate the moves but for some games it consumes too much program memory for it to be a feasible proposition.

Having generated the moves 3,5 and 8 from our starting configuration, we can now begin to see the tree grow.

The *branches* of the tree are the moves (m_1 m_2 m_3) that can be made from the root of the tree. We may denote the root position by P_0, the position arising after making the move m_1 is P_1; after making the move m_2 it is P_2, and after m_3 it is P_3. These positions are represented on the tree by *nodes*.

The program now looks to see if it has solved the problem, and if it had done so it will output the move leading

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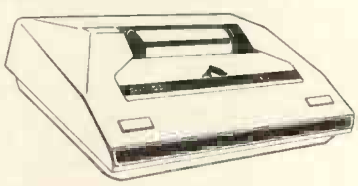

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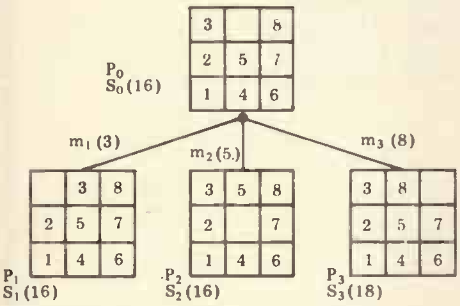
to the solution, followed by a statement to the effect that the game is over and it has found a solution in however many moves, which are then listed. If it has not solved the problem the program might then like to know how close each of its moves has come to providing a solution, in which case it must evaluate each of the resulting positions. This is done with a device known as an *evaluation function* (or scoring function), which supplies a numerical score that represents nearness to or distance from a solution.



A simple evaluation function for the 8-puzzle can be programmed by counting how many vertical and horizontal places each tile is away from its target location, and summing them. This use of the so-called 'Manhattan Distance' is quite common in the computer solution of similar problems. If we examine our starting configuration we can see that:
the 3 is two places away from target
the 8 is two places away from target
the 2 is two places away from target
(1 horizontally, 1 vertically)
the 5 is one place away from target
the 7,1,4 and 6 are all two places away, and the empty space (do not forget it) is one place away.

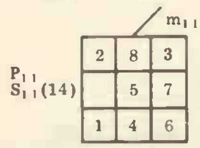
So the total of the Manhattan Distances is $(2 \times 1) + (7 \times 2) = 16$, and this is the score, S_0, which is associated with position P_0.

Counting the Manhattan Distances in P_1, P_2, and P_3 we get:
$S_1 = 16$
$S_2 = 16$
$S_3 = 18$
(Note that when a solution is found, S will be zero.)

So on the basis of our evaluation function it looks as though moves m_1 and m_2 are likely to lead to a faster solution than m_3, since positions P_1 and P_2 seem nearer the target position than does P_3. And this is where the story really begins.

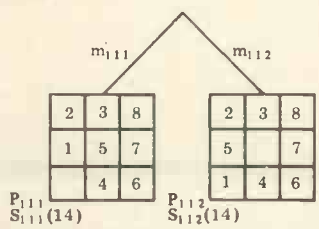
An obvious, though tedious, algorithmic solution to this problem is to look at each of the positions P_1, P_2 and P_3, then generate all the legal moves from each of these positions — look at the newly resulting positions, then generate all the moves from these positions, and so on, until one of the positions is found to be the target (i.e. its score S, the sum of the Manhattan Distances, will be zero). Eventually, this method (which is called *exhaustive search*) will find a solution, that is so long as the program does not run out of RAM. But by using a simple heuristic we can head the program in the right direction, and hopefully a solution will be found sooner than if the exhaustive search algorithm were used.

We have seen that when we expand the node P_0, of the three new positions that appear on the tree, P_1 and P_2 appear to be more promising than P_3. It is clearly logical to expand the more promising nodes before the less promising ones, so at first we should neglect P_3 and concentrate on P_1 or P_2. Since they are of equal apparent merit, the program may choose between them at random. Let us assume that it chooses to expand P_1, from which it will generate the moves of the 2 tile and the 3 tile. Since the 3 tile was moved on the previous turn, and the program is intelligent enough to know that it does not want to go back to where it has just come from, the only move (m_{11}) that the program needs to consider seriously is the move of the 2 tile, which would lead to the following position:



which we denote by P_{11}, and which has a score (S_{11}) of 14.

The best position now on the tree, i.e. the position closest to the target configuration, is P_{11}, since its score of 14 is lower than the scores of all the other nodes. So remembering not to allow the retrograde move of the 2 tile, the program now expands position P_{11}, and the choice is to move the 1 tile or the 5 tile, giving rise to the following position:



Once again we have a tie, two 'best' positions with scores of 14, and so the program again makes an arbitrary choice.

This process continues until a solution is found. It is easy to see that the method can hardly fail to be substantially faster than the exhaustive search process described earlier. The tree is grown intelligently, rather than in a dumb-ox manner, and better use is made of the available memory. With the exhaustive search process the computer's memory will, unless a solution is found, be filled at a stage when a very large proportion of the nodes on the tree are not of any real merit. With the heuristic approach, when memory is exhausted we at least know that most of the memory has not been wasted on unlikely moves, and we can use the best sequence of moves found so far.

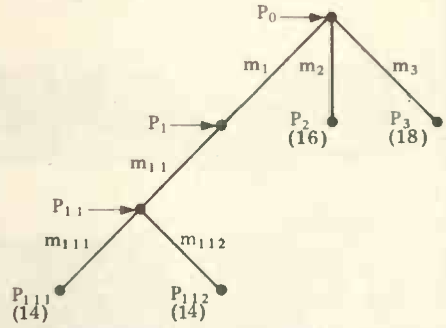
What to do when Memory is Exhausted

Working with a personal computer inevitably poses memory constraints on a different scale from those encountered when writing for a large machine. How can the programmer combat this problem when examining large trees in an attempt to solve a one-person game? I shall describe two approaches to this particular problem:

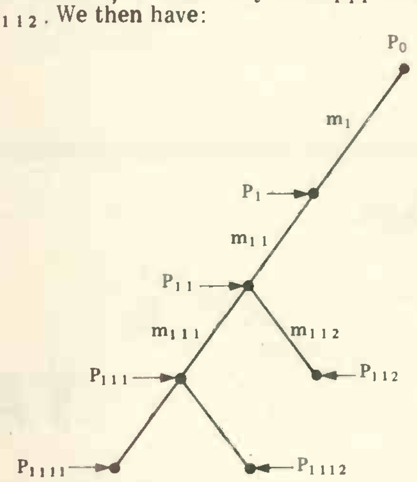
(1) Follow a path through the tree to the best position found so far and output the moves on this path. Then make this 'best position' into the root of a new tree and start again.

(2) More intelligently, when memory becomes full, delete the currently 'worst position found so far' and use the newly scrubbed bytes to store the next position that the programme generates. If this process is continued for long enough, either a solution will be found or the tree will eventually have two paths, each path having no offshoots. When that happens the program must choose the best of the paths, and make the terminal position on this path into the root of the new tree, remembering to output all the moves on the path leading to this position.

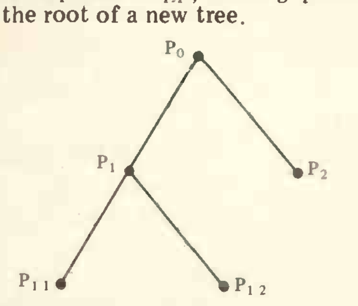
For example, our tree generated for the 8-puzzle now looks like this:



If memory is now full the program would delete m_3 (and P_3), to make room for the successor position produced when it expands P_{111}, or P_{112}. Let us assume that both m_2 (P_2) and m_3 (P_3) are deleted, to make way for P_{111} and P_{112}. We then have:



and the program can now output the moves m_1 and m_{11}, making position P_{11} the root of a new tree.



The new P_0 is the old P_{11}
The new P_1 is the old P_{111}
The new P_2 is the old P_{112}
The new P_{11} is the old P_{1111}
The new P_{12} is the old P_{1112}
And thus the search for a solution continues.

The shortest solution

In most games it is sufficient to win, but there may be reasons why one wishes to win as quickly as possible. For one-person games there exist

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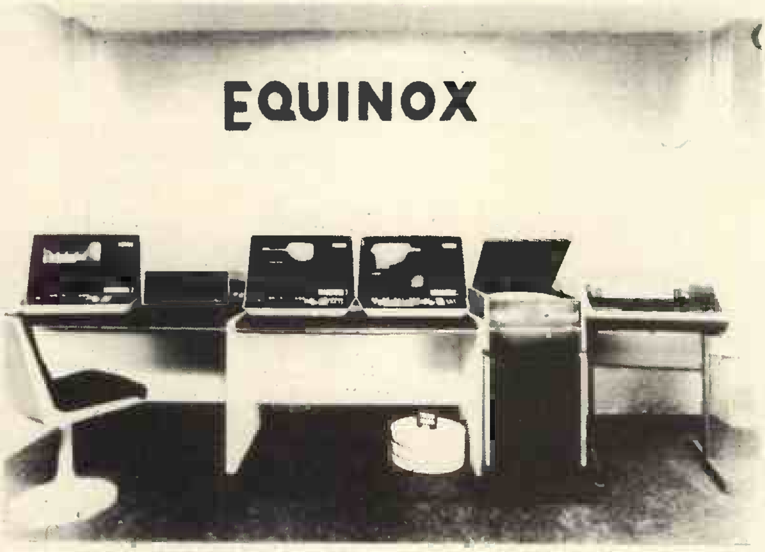

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various refinements on this method of tree searching which are likely to produce such a result.

The underlying philosophy in the search for a speedy solution is the notion that it is not only important how near (or far) you are from victory, it also matters how many moves it took you to get there. With the 8-puzzle, for example, a ten move sequence leading to a position with score 12, may not be so likely to lead to a short solution as a two move sequence leading to a score of 13 — perhaps in the next eight moves it will be possible to improve on the 13 by more than 1, thereby finding a shorter route to the solution.

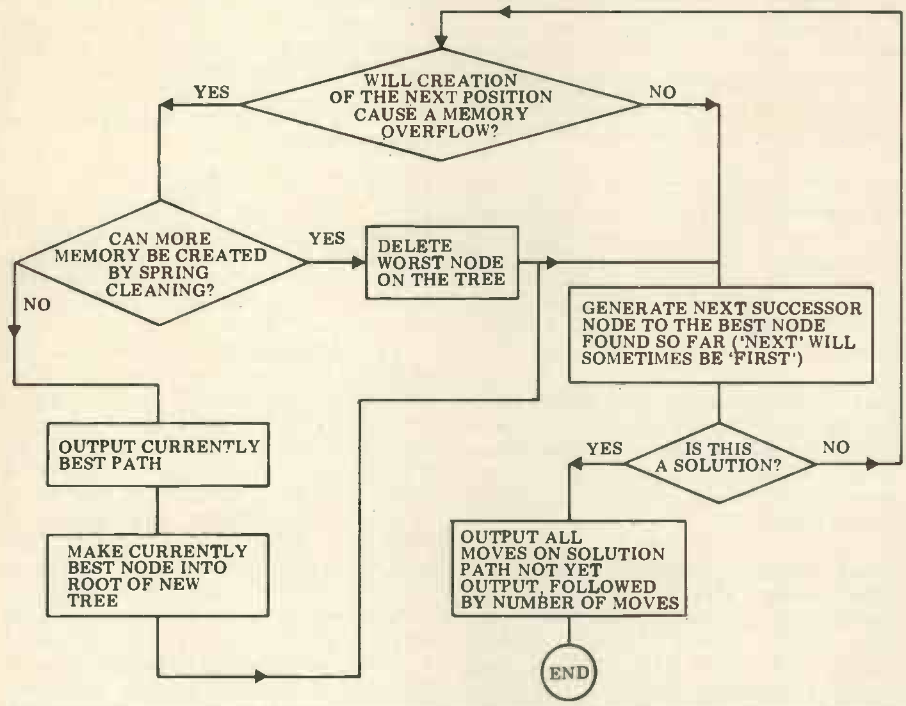
This notion might be expressed numerically in the following evaluation function:

score = sum of Manhattan Distances + M

where M is the number of moves needed to reach this position. Whether or not this expression is the best method of relating the score to effort invested and achievement realised, can only be determined by trial and error. Perhaps M should be replaced by ½M or by 2M, or some other function of M. Playing around with the evaluation function in this way, changing the terms in the function, is one of the delights of game playing programming. When you hit upon a really good evaluation function and you see the program's performance improve dramatically as a result, there is a feeling of exhilaration, rather like watching your child crawl for the first time. In a later article we shall see how evaluation functions can be modified in the light of experience gained with the program, and it will be shown that it is even possible for the program itself to learn from its mistakes and modify its own evaluation routine!

Flow chart

A generalised global flow chart for the search of a one-person game tree is given below. Remember that the most creative part of the work lies in finding a good evaluation function, and the performance of your function can be measured by the number of spurious nodes that are expanded *en route* to a solution. A perfect evaluation function will never expand a spurious node. The very worst function will expand each node at one level in the tree before looking ahead to the next level (this is exhaustive research).



Task of the month

Write a program to solve the 8-puzzle in the shortest number of steps it can. Test the program by setting up various starting and target configurations, and see if your program solves the problems in fewer steps than you do. (Probably neither you, nor your program, will be as fast as Bobby Fischer, who can solve these puzzles with phenomenal rapidity.) When trying the problems yourself remember not to cheat — if you move a tile and then change your mind and move it back, add two to your count.

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Nilsson, N.J: *Searching Problem-Solving and Game-Playing trees for minimal cost solutions*. Proceedings IFIP Conference 1968, vol. 2, pp. 1556-1562.

Schofield, P.D.A: *Complete solution of the 'Eight-Puzzle'*. Machine Intelligence 1 (Ed. Collins, N.L. and Michie, D.), Oliver & Boyd, 1967, pp. 125-133.

Slagle, J., and Bursky, P: *Experiments with a Multipurpose, Theorem-Proving Heuristic Program*. Journal Association Computing Machinery, vol. 15, no. 1, pp. 85-99, January 1968.

SYSTEMS

SALES LEDGER

Compiled and edited by Mike Knight *of Mike Rose Micros.*

The life blood of most businesses is their cash flow. In fact many small businesses go bankrupt because they find it impossible to get their customers — particularly the large ones — to pay their accounts on time. We are therefore concentrating this month's Systems on the control of a major source of business cash — The Sales Ledger.

OBJECTIVES OF SALES LEDGER

The job of the Sales Ledger is to control and record details of monies owing to a company from the sale of their products or services. If you were to ask the accountant what he would expect to find in his Sales Ledger system he would probably reply something like this:-

"I must be able to post dated invoice or credit note amounts to the account of the customer concerned. Similarly I must be able to post any cash I receive from that customer. I want a free choice in the type of accounting system to be used. If I choose a balance forward system I would only expect to see details of transactions in the current period, but I may wish to have dated balances. If I chose an open item system I'd want reference numbers against each invoice and credit note. I might want to produce remittance advices so that my customers can tell me which invoices they are paying and I'd certainly need to be able to allocate cash paid against invoices. I'd also need to be able to deal with cash I can't allocate, which may mean that I need to be able to indicate any invoices which may be in dispute. Whichever accounting system I may choose I would like to be able to change to the other easily; of course I'd accept a compromise in going from balance forward to open item. I might want to have some of my customers on open item and the rest on balance forward. I'd definitely expect customer statements to be produced at the end of each period and I'd probably want an aged debtor analysis to pinpoint my bad paying customers. Of course I'd need an analysis of VAT amounts as well".

Now although Sales Ledger is primarily the province of the accountant there are other interested parties. The customer for instance may like to see payment terms clearly stated, particularly if he can take advantage of any prompt payments discounts. The Sales manager may wish to see some analysis codes in the system so that he can do reports by Rep. or area. The auditor may wish to see Sales and Cash day book listings to assist him in audit

TASKS	G.L.A.S.	Grant Business Systems	TRIDATA
Post invoices	*	*	*
Post credit notes	*	*	*
Post cash	*	*	*
Balance forward system	*	*	*
Aged balances	*		*
Open item system	*	*	*
Allocate cash	*	*	*
Unallocated cash	*		*
Mixed system			
Statements	*	*	*
Aged debtor report	*	*	*
VAT analysis			*
Sales day book			*
Cash day book	*		*
Link to Invoicing	*	*	*
Link to Nominal Ledger	*	*	*
Link to Stock control		*	*
VOLUMES/SIZES			
Max. customers /disc		200	175
/system	200	800	999
Max. transactions /cust			299
/system	1400		1350
Max. balance	varies	varies	£9,999,999
Max. transaction amount	varies	varies	£ 99,999

trails. The salesman may wish to enquire at any time on the indebtedness of his customers and he may need to know how near to their credit limit they are.

Finally Sales Ledger packages are rarely implemented on their own so linkages may be important. Are the input transactions produced automatically by the order processing or invoicing system? Are nominal ledger transactions created automatically by the system? Having to re-input information already known by the system can be a time consuming job.

EVALUATIONS

G.L.A.S. (General Ledger Accounting System)
This system was written by Logma Systems Design of Bolton (0204 389854) and is available from them or B&B (Computers) Ltd. (0204 26644) also of Bolton (previously named B&B Consultants). At present dealerships are being negotiated and it is believed that G.L.A.S. will be available country wide within twelve months. The package is a fully integrated Sales, Purchase and Nominal Ledger system and costs £1,000.

The price will include full personalisation and up to four half day training sessions on site. The minimum hardware requirement is 32K PET, 400K Computhink dual disc drive and a printer — and the minimum cost is £2,500. There are five users at present but the number is expected to increase in the next few months. In addition to the training given on the package, hardware is delivered locally to Bolton and up to one day of operator training is given on site.

Documentation is provided which gives a good overview of the system but would be enhanced by the inclusion of file layouts. Operating documentation is personalised to each customer, being part of the personalisation service included in the package cost. The package is written in BASIC and customisation is done as required at an agreed price. Any systems bugs found would be corrected free of charge.

Grant Business Systems Sales Ledger
This system was written by Grant Business Systems and is available from them at the Micro Computer Centre, London, SW14 (01-876 6609) or from dealers throughout England. The package is an integrated Invoicing, Sales Ledger and Stock reporting system and costs £750.

The costs include setting all field lengths to specification, creating all necessary files to specifications, setting up the system generally, all necessary operating manuals, up to five hours editing/programming for customisation and up to five hours staff training. The minimum hardware configuration is 32K PET, 400K Computhink dual disc drive and a printer which costs £2335; the system will allow for expansion up to 1.6M byte disc.

The systems documentation provided is excellent; it covers not only the Sales Ledger system but also Purchase Ledger, Nominal Ledger and Stock Control and gives full details of all files used. Since some customisation is included. The program is written in BASIC with a small amount of machine code incorporated.

Maintenance is comparatively simple because every system is tailored — errors are 'phoned in, an attempt is made to recreate the fault and if a bug is found a corrected version of the program is sent to the customer. If the fault proves to be a corruption of the customers copy a new version is provided at nominal cost. There are approximately 30-40 users and because of customisation and the modular design of the package, all have tailored systems.

TRIDATA Sales Ledger
This system was written by Tridata Micros Ltd. of Birmingham (021-622 1754) and is available direct from them or from most Tandy dealers throughout the country. It has been available since August and there are 33 customers.

The package costs £225 and this includes personalisation and telephone backup during installation. At present no training is provided but a course is starting in January 1980 at a cost to be advised later. The minimum hardware is a 32K TRS 80, 2 mini floppy disc drives and a 132ch tractor feed printer — making a total cost of £3,334. The package is written in BASIC and there are plans over the next few months to convert the package to other hardware ranges. The documentation comprises of a User manual which, though sparse in systems information (a new version is being prepared to overcome this deficiency), is excellent for the 'new' user. Not only are the operating steps shown clearly but many helpful tips are given on general microcomputer usage. Customisation will always be arranged at an agreed charge and linkages are provided to other packages written by Tridata — particularly Stock Control, Invoicing and Nominal Ledger. Any system bugs would be corrected free of charge and a file recovery service is provided in case of master file corruption.

OTHER SALES LEDGER PACKAGES, KNOWN BUT NOT EVALUATED

H B Computers Kettering Northants 0536 83922
Newtons Laboratories London 01-870 4248
Computer Workshop London 01-491 7507
CAP-CPP London 01-404 0911
Computerland Ltd Ilford 01-554 2177
Keen Computers Ltd Nottingham 0602 583254
Raynor Associates Leeds 0532 450667
Compelec London 01-636 1392
ACT Petsoft Birmingham 021-455 8585
Databank Loughborough 0509 217671
Digitus London 01-636 0105
Equinox London 01-739 2387
Euroc London 01-405 3223
Gemsoft Woking 04862 2281
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Sail London 01-359 2818
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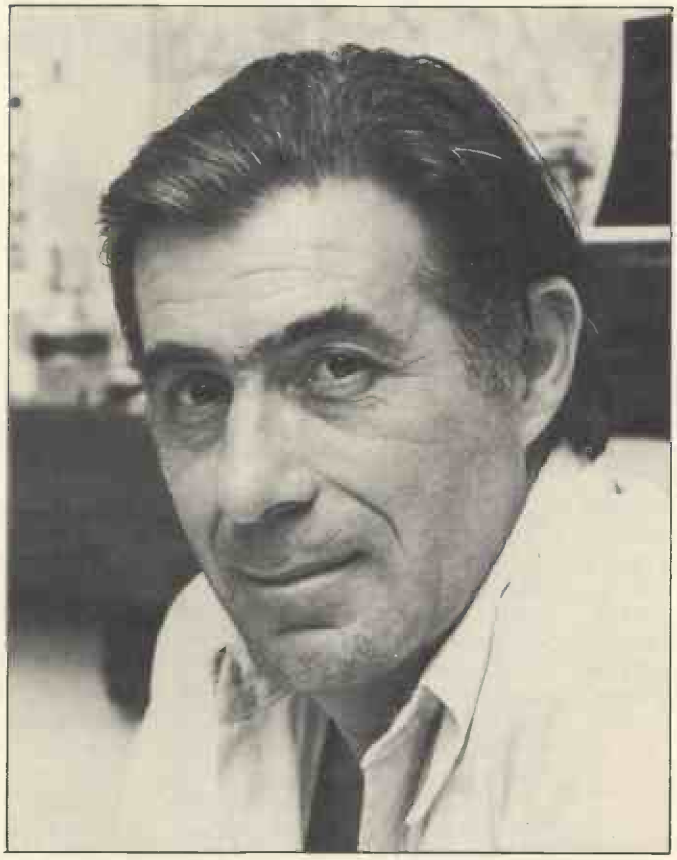
THE MIGHTY MICRO MAN

Dr. Christopher Evans, among many things author of The Mighty Micro, *died in October of this year;* Malcolm Peltu, *a close acquaintance, pays tribute.*



Dr. Christopher Evans was a psychologist, computer scientist and visionary, always one step ahead of his rapidly changing Time. With a degree in psychology from Reading University, he approached the computer world from a unique perspective which he turned into many exciting practical projects during his 15 years at the National Physical Laboratory (NPL) in Teddington, where he was head of the man/machine interaction unit. About five years ago, while British industry slumbered in the bliss of micro ignorance, he began to realise how low cost microelectronics could liberate computer power from the chains of big organisations and place it at the finger-tips of everyone.

When he chaired the first personal computing conference in Britain in May 1977, the Online DIY Computer event, he called the micro a "turning point in computer development". Until then, he said, the computer industry and most computer users were from big business and big organisations but "the micro revolution will move the computer world in significant new directions, becoming available to an enormous range of human beings".

True to his style as an enthusiastic doer, not just an invigorating talker, he and his talented team at NPL produced a number of projects which showed how the micro, by cutting costs and providing portable computer power, could turn bright ideas into working products.

For example, there is Mickie, the patient-interviewing system which can perform some routine medical diagnoses in an interactive discussion with a person suffering from, say, an abdominal pain. Mickie has proved itself in live hospital operation. Then there are Muppet (subsequently renamed Minni) which is a handheld language translator, Malta the aircraft landing simulator and perhaps most importantly of all, Mavis, which was designed to provide a range of new input and output methods to help disabled people use a computer.

Like the micro which he championed, the most appropriate adjective to describe Chris Evans is 'ubiquitous' — you never knew where he would pop up next and what subject he would be discussing. As shown in his book, *The Mighty Micro* (Gollancz), his interests spanned both historic roots of technology and its most futuristic flowers.

At the NPL he organised a lecture series on the Pioneers of Computing; he was thrilled that computer technology had advanced so rapidly, it was possible to interview the founders while they were alive to witness the astounding impact of their invention. For posterity, he recorded the views of many of the pioneers and these tapes are now available from the Science Museum in London.

At the other end of the time continuum, he was fascinated with science fiction and the possibilities of artificial intelligence creating Ultra Intelligent Machines which, in his optimistic technological enthusiasm, he believed would become a beneficial intellectual helpmate to Man. He was also passionately (and everything he did was with committed passion) involved in debunking some of the wilder fringes of science, particularly the Uri Geller-style of spoon bending parapsychology.

He was a regular performer on London's Capital Radio and the BBC World Service 'Discovery' science programme. And his frequent TV appearances included a series of interviews with science fiction writers as well as the Thames TV version of *The Mighty Micro* which, tragically, has to be shown posthumously because of delays caused by the ITV strike. Also being a contributing editor to *Omni* magazine brought together his interests in technology and science fiction.

To keep all these activities going (in addition to writing many books, ranging from *A Dictionary of Psychology* (Harrap) to *Cybernetics* (Butterworth) and *The Mighty Micro* required a huge capacity for hard work. But he seemed to have an in-built energy dynamo which carried him through. To be in his presence was to experience that personal energy field. Yet when giving public presentations he brought a relaxed informality which made him one of the great technology popularisers. In fact, it's true to say that his populist approach and his wide range of activities led to some personal criticism from fellow scientists with a more academic approach to their subject. Such criticism, however, undervalues the importance of opening out the mysteries of science and technology so that academic achievements can be more widely appreciated.

When *Omni* was launched in the UK, a time capsule containing various mementos from Britain in 1978 was sealed by Chris Evans and placed on display in the London Planetarium — to be opened in the year 2000. Those who open it should remember that at the time of general gloomy depression about the future, Chris Evans was concerned enough to send a message to the 21st century and to look forward with enthusiasm to the expanding horizons of the coming micro generations.

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CHAPTER 5 CONTROL STRUCTURES 2

One of the most powerful features of the computer both as an information processor and as a control machine is its ability to detect differing conditions or varying situations and to respond to these, often in a sophisticated and complex way. When analysed, this activity reduces to the capability (of the program) to pose a question, to use the available data to establish the correct answer and then to act on that answer.

This particular feature exists in most programming languages and goes under the name of a *conditional branch* or just a *conditional*. Before looking at what PASCAL provides in the way of such control structures, it is as well to define the constituent elements. The *outcome* of a conditional is always one particular course of action chosen from a set of options laid down in the program. The *function* of the conditional is to select the appropriate course depending on some circumstance. So the format is:

```
              OPTION 1
SELECTOR <    OPTION 2
              etc.
```

Clearly the options are simply sections of code which perform the different actions required. The difficult part is setting up the selection to get the right option in the first place.

Single and double branches

In the simplest kind of branch, the programmer may wish a piece of code to be executed only if some condition holds, and the program to continue once this code is completed. If the condition doesn't hold, the program continues directly anyway. In PASCAL this circumstance is handled by means of the IF — THEN statement which takes the following form:

IF expression THEN statement;

The *expression*, defined in Box 1, takes a *Boolean value* (i.e. TRUE or FALSE) which explains how it behaves as the selector. When the expression is TRUE, the statement following THEN will be executed. Otherwise program control will pass directly to the statement immediately after the ";", which is the next instruction in the program. This type of conditional can be viewed as a "single" branch because there is only one *optional* statement open to the selector.

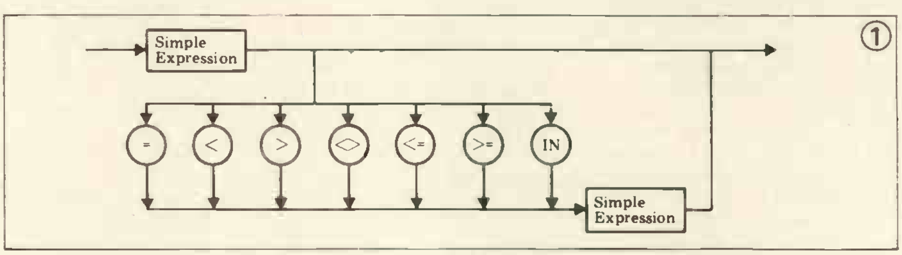
An enhancement of this type of conditional is the "double" branch where the selector directs program control to *alternative* sections of code (depending on whether TRUE or FALSE). At the completion of either alternative, program control passes to the same point in the program — namely the statement immediately following the conditional. In PASCAL this is dealt with by means of the following:

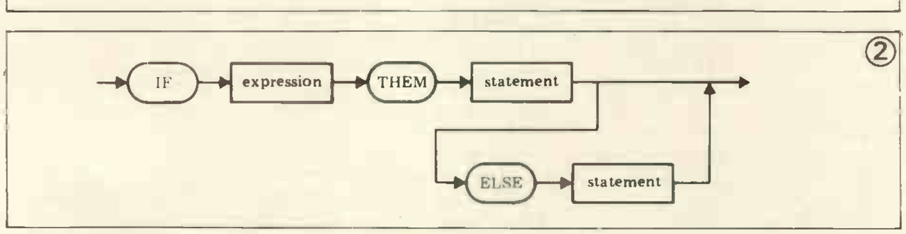
IF expression THEN statement
ELSE statement;

Note that there is no ";" between the statement governed by THEN and the reserved word ELSE. It is a frequent error amongst programmers new to PASCAL to insert a separator here, with erroneous results.

Box 2 gives the syntax diagrams for both of these variations on the IF statement, and Box 3 consists of a sample program which illustrates their use. When writing a program which is likely to be used by other people, particularly if data input is to be handled by inexperienced or unskilled operators, it is advisable to accept all input in ordinary character strings, checking on the validity and sorting out the different data types within the program. If the user makes a mistake, the program will detect it and ask for the input again, instead of crashing the processor. Considering that some such programs may run for hours (or even continuously) and may accept simultaneous input from many terminals (e.g. an airline bookings system), it is unnecessary to give further stress to the advantages of this technique.

Program READINTEGER (Box 3) is an example of the sort of routine one would use for inputting positive integers up to a fixed maximum length. The maximum number of digits allowed in any particular implementation of PASCAL will depend on the hardware being used so the program specifies INTSIZE as a CONST which can be tailored to different machines (line 2). The technique lies in reading the number in





③
```
1  PROGRAM READINTEGER;
2  CONST INTSIZE=5;
3  TYPE SHORTSTRING=ARRAY[0..9]OF CHAR;
4       DIGIT=0..9;
5  VAR TEMPNO,NUMBAS:SHORTSTRING;
6      I,J:DIGIT;
7      NEWNUM:-1..9;
8      NUMBER:INTEGER;
9      WRONG:BOOLEAN;
10 PROCEDURE INITIALISE;
11 VAR ICHR:'0'..'9';
12 BEGIN
13     ICHR:='0';
14     FOR I:=0 TO 9 DO
15     BEGIN
16         NUMBAS[I]:=ICHR;
17         IF ICHR<> '9' THEN ICHR:=SUCC(ICHR);
18     END;
19     NUMBER:=0
20 END; (*INITIALISE*)
21 PROCEDURE GETNUMBA;
22 BEGIN
23     WRITELN('NOW TYPE IN YOUR INTEGER PLEASE:   ');
24     I:=0;
25     WHILE (NOT EOLN) AND (I <= INTSIZE) DO
26     BEGIN
27         READ(TEMPNO[I]);
28         I:=I+1
29     END
30 END; (*GETNUMBA*)
31 PROCEDURE TESTDIGIT;
32 BEGIN
33     FOR J:=0 TO 9 DO
34         IF TEMPNO[I]=NUMBAS[J]
35         THEN NEWNUM:=J
36 END;
37
38 BEGIN (*MAIN PROGRAM*)
39     INITIALISE; (*SET UP NUMBAS WITH RANGE OF POSSIBLE VALUES*)
40     REPEAT
41        WRONG:=FALSE;
42        GETNUMBA; (*READ CHARACTER STRING INTO TEMPNO*)
43        I:=0;
44        WHILE (NOT EOLN) OR (I > INTSIZE) DO
45        BEGIN
46            NEWNUM:=-1; (*CHARACTER INPUT IS A PROPER DIGIT IF THIS
47                              VALUE CHANGES*)
48            TESTDIGIT; (*CHECK FOR DIGIT AND STORE IN NEWNUM*)
49            IF NEWNUM=-1
50            THEN WRONG:=TRUE
51            ELSE NUMBER:=10*NUMBER+NEWNUM;
52            I:=I+1
53        END; (*IN EACH ITERATION NUMBER IS UPDATED WITH NEXT DIGIT*)
54        IF WRONG THEN WRITELN('TRY AGAIN')
55     UNTIL NOT WRONG
56 END.
```

character form (i.e. ASCII) and translating each digit into *numeric* form. In line 16 the array NUMBAS is primed with the character codes of the different digits.

The program reads the integer into a character string in procedure GETNUMBA, lines 22-29. Note the test (line 25) checks for "EOLN" (i.e. carriage return) or for integers which exceed the maximum length. The central ploy of the program can be seen in procedure TESTDIGIT. Each element of the string is compared in turn to a succession of character codes corresponding to the different digits. If the nth comparison is successful then n is the digit sought (c.f. lines 34 and 35). The IF statement allows this to occur without any action being taken for an unsuccessful comparison. In the main body of the program, NEWNUM is used not only to hold each digit as it is "peeled" off the input string but also as the selector (line 49) in the IF statement since a value of -1 means that the last character under scrutiny wasn't a digit at all. The two courses of action (i.e. updating the number or signalling an error) are laid out in lines 50 and 51.

Multiple branching

Frequently, just having two options at some particular point in a program is not enough, since it is necessary for the program to split many ways. Perhaps the most explicit example of this requirement can be seen in the handling of a "menu" of the type found in many "business" packages. Take the example in Box 4 where the relation between the options in MENU and the procedures listed below is obvious. However, in order to get the right item in the menu, the main program has to go through the jumble of IF's from lines 22 to 32.

It is for occasions like these that the PASCAL CASE statement has been defined (most other languages have an equivalent facility). Box 5 shows the syntax diagram for the CASE statement. The format is as follows:

CASE selector OF options END;

Note that the value taken by the selector *must* be one of the items in the list of constants which label the different options. If this is not the case, the outcome is *undefined* — so it is advisable to build a test into the program to ensure that the selector is within the permissible range. Box 6 shows the way in which a CASE statement is used to tidy up SALESLEGDER (yes, SALESLEGDER, we stick by our mistakes!). Lines 20 to 25 lay out the options and SELECTION acts as the selector. However, before SELECTION is "allowed into" the CASE a check is made (lines 17 and 18) to ensure that it will make a successful selection (i.e. that it holds one of the values specified in line 3).

Finally, note the use of the statement separator ";" within the CASE statement (Boxes 5 and 6) since a semi-colon between the last option and the END which finishes the CASE statement will result in a compilation error.

④
```
 1:  PROGRAM SALESLEGDER;
 2:  VAR  SELECTION:INTEGER;
 3:  PROCEDURE MENU;
 4:  BEGIN
 5:    WRITELN('0.  FINISH');
 6:    WRITELN('1.  LIST ALL SALES');
 7:    WRITELN('2.  MONITOR SALES BY STOCK CODE');
 8:    WRITELN('3.  INVOICE SEARCH');
 9:    WRITELN('4.  AMEND LEDGER FILES');
10:    WRITELN('5.  TOTAL ALL SALES');
11:  END; (*MENU*)
12:  PROCEDURE LIST; (*LISTS ALL SALES FROM AND TO GIVEN DATES*)
13:  PROCEDURE STOCKCODE; (*DISPLAYS RECORDS USING STOCK CODE AS KEY*)
14:  PROCEDURE INVOICE; (*DISPLAYS RECORDS USING INVOICE NUMBER AS KEY*)
15:  PROCEDURE AMEND; (*FOR ALTERING FILES*)
16:  PROCEDURE TOTAL; (*TOTALS SALES ON SEVERAL KEYS*)
17:  BEGIN (*MAIN PROGRAM*)
18:    REPEAT
19:      MENU;
20:      WRITE('PLEASE TYPE IN YOUR SELECTION:');
21:      READLN(SELECTION);
22:      IF SELECTION=1
23:      THEN LIST
24:      ELSE IF SELECTION=2
25:           THEN STOCKCODE
26:           ELSE IF SELECTION=3
27:                THEN INVOICE
28:                ELSE IF SELECTION=4
29:                     THEN AMEND
30:                     ELSE IF SELECTION=5
31:                          THEN TOTAL
32:                          ELSE WRITELN('GOODBYE')
33:    UNTIL SELECTION<1 OR SELECTION>5
34:  END. (*** MESSY WASN'T IT? ***)
```

No, this is not a typewriter!

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The new ITT "2020" micro-computer looks like a typewriter.

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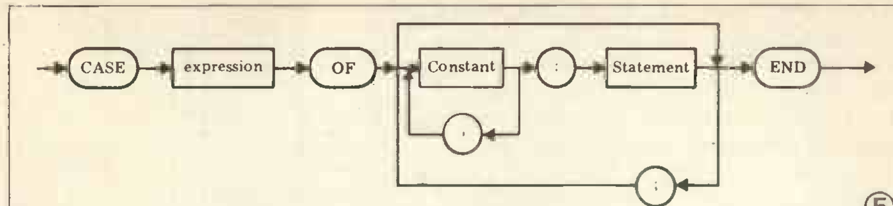
Look up table

PASCAL RESERVED WORDS
IF
THEN
ELSE
CASE
EOLN

JARGON
Conditional Branch
Selector
Case Label

UCSD Exceptions
Undefined selector values "fall through" CASE statements.

EXERCISES
1 Enhance READINTEGER to cater for negative as well as positive integers.
2 Write a program to count the occurrence of each letter of the alphabet and total of all non-alphabetic characters in a piece of text. Use a CASE statement.
3 The situation can arise in OTHELLO where it is impossible for either player to move (i.e. two consecutive PASSES). The current program does not cater for this — adapt it.



5

```
PROGRAM SALESLEGDER;
VAR SELECTION:INTEGER;
    ACCEPTABLE:SET OF 0..5;
PROCEDURE MENU; (*DISPLAYS A LIST OF OPTIONS OFFERED*)
PROCEDURE LIST; (*DISPLAYS A LIST OF ALL SALES*)
PROCEDURE STOCKCODE; (*MONITOR SALES BY STOCK CODE*)
PROCEDURE INVOICE; (*SEARCH ON INVOICE NUMBER*)
PROCEDURE AMEND; (*AMEND RECORDS IN LEDGER FILES*)
PROCEDURE TOTAL; (*TOTAL ALL SALES*)

BEGIN (*MAIN PROGRAM*)
    ACCEPTABLE:=[0,1,2,3,4,5];
    REPEAT
        MENU;
        WRITE('PLEASE TYPE IN YOUR SELECTION');
        READLN (SELECTION);
        IF SELECTION NOT IN ACCEPTABLE
        THEN SELECTION:=0;
        CASE SELECTION OF
            0:WRITELN('GOODBYE');
            1:LIST;
            2:STOCKCODE;
            3:INVOICE;
            4:AMEND;
            5:TOTAL
        END(*CASE*)
    UNTIL SELECTION=0
END.
```

6

Sample program ~Othello

In this section we present a full program to illustrate not only the control structures of this chapter but also some of the data structures introduced in the last. Instead of describing the details of this program in the text, we shall exploit the readability of the PASCAL coding in Box 7. For instance, anyone unfamiliar with the rules of OTHELLO should consult the output text in procedure INSTRUCTIONS (line 17).

When tackling a program in this way, the approach should be to look at the data structures defined in the beginning, in conjunction with the body of the main program to try to deduce the programming strategy. Often the choice of data structures will dictate specific programming tactics within the program. A look at the TYPE statements (lines 2 to 5) will show that a board game is to be played and this is confirmed by the presence of the array BOARD with scalar indices and elements limited to FIRST, SECOND, and EMPTY.

In the main program the outer REPEAT — UNTIL loop (lines 277 to 300) allows players as many games as they like. It contains procedures to get each game started and to give the score when finished together with an inner WHILE-DO loop, (lines 279 to 297) which controls a single game.

```
1  PROGRAM OTHELLO;
2  TYPE ROWNUM = '1'..'8';
3       COLCHAR = 'A'..'H';
4       DIR = (N,NE,E,SE,S,SW,W,NW);
5       MOVE = (FIRST,SECOND,EMPTY);
6  VAR NOUGHT,CROSS:ARRAY[1..10] OF CHAR;
7      BOARD:ARRAY[ROWNUM,COLCHAR] OF MOVE;
8      MOVER,TARGET:MOVE;
9      COUNTER:0..60;
10     ROWNOW:ROWNUM;
11     COLNOW:COLCHAR;
12     ANSWER:CHAR;
13     LEGAL,GAMEOVER,NOMORE,
14     PASS,FINISHED:BOOLEAN;
15     DIRECTION:DIR;
16     FLIPCOUNTER:ARRAY[DIR] OF 0..60;
17  PROCEDURE INSTRUCTIONS;(*PRINTS OUT RULES OF OTHELLO*)

18  BEGIN
19      WRITELN('OTHELLO IS A BOARD GAME PLAYED BETWEEN TWO PLAYERS. EACH ');
20      WRITELN('PLAYER HAS A DIFFERENT COLOURED COUNTER. THE PLAYERS START');
21      WRITELN('WITH TWO COUNTERS.EACH IN THE CENTRAL FOUR SQUARES OF THE BOARD.');
22      WRITELN('THE FIRST PLAYER MUST PLACE A COUNTER IN AN EMPTY SQUARE');
23      WRITELN('ADJACENT TO AN OCCUPIED SQUARE IN SUCH A WAY THAT AT LEAST ONE');
24      WRITELN('OF THE OPPONENT''S COUNTERS LIES BETWEEN THE CURRENT COUNTER');
25      WRITELN('AND ANOTHER OF HIS OWN COUNTERS IN A STRAIGHT LINE DRAWN');
26      WRITELN('HORIZONTALLY, VERTICALLY, OR DIAGONALLY ACROSS');
27      WRITELN('THE BOARD. ALL OF THE OPPONENTS COUNTERS SO ''SANDWICHED''');
28      WRITELN('BECOME CAPTURED. THAT IS THEY CHANGE COLOUR.');
29      WRITELN('AS THE NUMBER OF COUNTERS BUILDS UP MORE AND MORE HAVE TO BE');
30      WRITELN('SWAPPED IN EACH MOVE SO THAT OTHELLO IS CLEARLY A TEDIOUS');

31      WRITELN('GAME TO PLAY BY HAND. THIS IMPLEMENTATION USES ''O'' AND ');
32      WRITELN('''X'' TO REPRESENT THE DIFFERENT COLOURS AND EMPLOYS A');
33      WRITELN('STANDARD A-H, 1-8 CHESSBOARD CONVENTION  THE PLAYER WITH');
34      WRITELN('THE GREATER NUMBER OF COUNTERS AT THE END OF THE GAME');
35      WRITELN('WINS. A PLAYER MAY BE FORCED TO PASS IF NO EMPTY SQUARE');
36      WRITELN('EXISTS WHICH IS ADJACENT TO AN OPPONENT''S SQUARE');
37      WRITELN('IN A LINE CONTAINING ONE OF HIS OWN.');
38      WRITELN;
39      WRITE('PLEASE PRESS RETURN WHEN YOU ARE READY TO PLAY.');
40      READLN
41  END; (*INSTRUCTIONS*)
42  PROCEDURE IDENTIFY; (*ASKS FOR THE PLAYERS NAMES*)
43  VAR I:INTEGER;
44  BEGIN
45      WRITE(      'WHO''S GOING TO HAVE FIRST MOVE? ');
46      I:=1;
47      WHILE (NOT EOLN) AND (I<11) DO
48      BEGIN READ(      CROSS[I]); I:=I+1 END;
49      WRITELN(      'RIGHT ',CROSS,' YOUR SYMBOL IS ''X''');
50      WRITE(     'WHO''S NEXT? ');
51      I:=1;
52      WHILE (NOT EOLN) AND (I<11) DO
53      BEGIN READ (     NOUGHT[I]); I:=I+1 END;
54      WRITELN(      'THANKS',NOUGHT,' MAY THE BEST PLAYER WIN!')
55  END; (*IDENTIFY*)
56  PROCEDURE STARTGAME; (*INITIALIZES GAME BOARD*)
57  VAR ROW:ROWNUM;
58      COL:COLCHAR;
59  BEGIN
60      FOR ROW:='1' TO '8' DO
61        FOR COL:='A' TO 'H' DO
62          BOARD[ROW,COL]:=EMPTY;
```

Note the use of BOOLEANS (GAMEOVER, NOMORE, LEGAL and PASS) to make the control structures (both loops and conditionals) obvious and easy to read. During the game, MOVER keeps tabs on whose move it is (lines 293 to 295) and COUNTER monitors the number of successful moves made (lines 290 and 295). After a move has been input (procedure GETMOVE), accepted (CHECKMOVE) and made (FLIPS), COUNTER and MOVER are altered to reflect the state of the game.

The core of the program lies in the "move" mechanism described by these three procedures. GETMOVE gets the player's move from the keyboard and determines whether the characters input refer to (any) square on the board. This constitutes a check for *validity*. Note the use of the set VALID (line 133) to guarantee that the CASE selector in DETAILEDCHECK (lines 111 to 121) will find one of the options. Note also that the move can be typed in, in either order — i.e. "4A" will work as well as "A4".

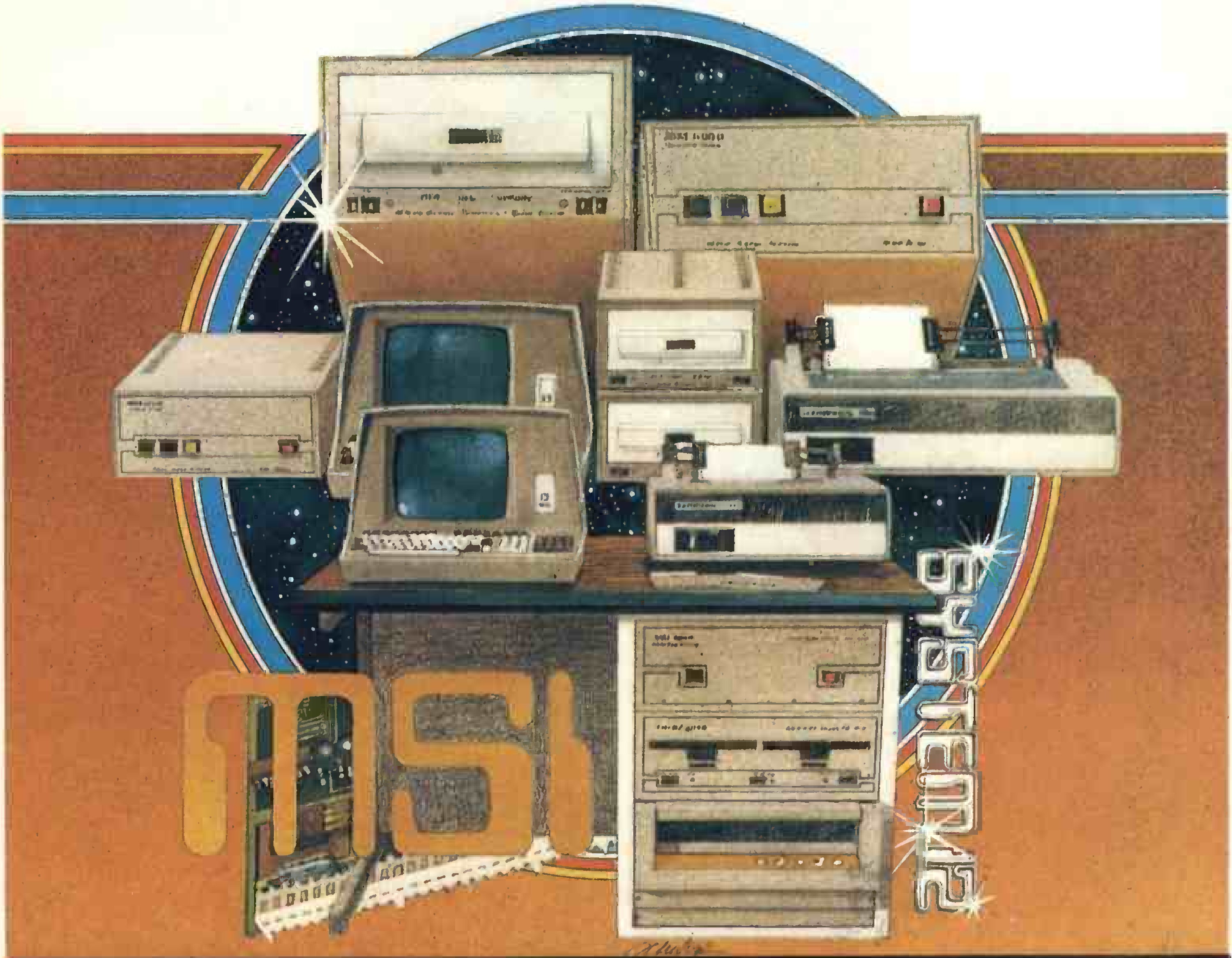
CHECKMOVE checks on the legality of the move, ensuring that the indicated square is unoccupied (line 205) and then "looking" in every direction (lines 210 to 220) to see if a winning sequence of "target" squares exists (i.e. a sequence of the opponent's counters followed by one of the player's own counters). Procedure CHOOSESQUARE handles the different sequences (CASE statement, lines 152 to 182) and checks for the edge of the board, while CHECKIT has the job of tallying up a FLIPCOUNTER for each direction (line 190). Note that CHECKMOVE looks in all directions, even when the move is known to be legal. This ensures that FLIPCOUNTER is set for each direction so that the business of making the actual move (FLIPS, line 223 to 241) is fairly straightforward.

Our thanks to Jim Wood of Ithaca Intersystems for letting us use a DPS-1 for this project. We were able to use the latest implementation of PASCAL/Z which now supports real numbers.

```
63      BOARD['4','D']:=FIRST;
64      BOARD['4','E']:=SECOND;
65      BOARD['5','D']:=SECOND;
66      BOARD['5','E']:=FIRST;
67      COUNTER:=0;
68      GAMEOVER:=FALSE;
69      MOVER:=FIRST;
70  END; (*STARTGAME*)
71  PROCEDURE PRINTBOARD; (*DISPLAYS CURRENT GAME BOARD.*)
72  CONST TAB='          '; (*10X*)
73        SPACE='  ';  (* 2X*)
74  VAR ROW:ROWNUM;
75      COL:COLCHAR;
76      I:INTEGER;
77  BEGIN
78      FOR I:=1 TO 24 DO
79          WRITELN(TTY);
80      WRITE(TTY,TAB,SPACE);
81      FOR COL:='A' TO 'H' DO WRITE(TTY,SPACE,COL); (*COL. TITLES*)
82      FOR ROW:='1' TO '8' DO
83      BEGIN
84          WRITELN      ;
85          WRITE(     TAB,ROW,' '); (*ROW TITLES*)
86          FOR COL:='A' TO 'H' DO
87          BEGIN
88              CASE BOARD[ROW,COL] OF
89                  EMPTY:WRITE(     SPACE,'-');
90                  FIRST:WRITE(     SPACE,'X');
91                  SECOND:WRITE(     SPACE,'0')
92              END (*CASE*)
93          END
94      END
95  END;(*PRINTBOARD*)
96  PROCEDURE GETMOVE; (*REQUESTS AND VALIDATES MOVE*)
97  PROCEDURE ASKFORMOVE; (*REQUESTS APPROPRIATE MOVE*)
98  BEGIN
99      IF MOVER=FIRST
100     THEN WRITE(     CROSS,'''S MOVE: ')
101     ELSE WRITE(     NOUGHT '''S MOVE: ')
102 END; (*ASKFORMOVE*)
103 PROCEDURE GETINPUT;
104 VAR CORRECT,COLIN,ROWIN,:BOOLEAN;
105     VALID:SET OF CHAR;
106     RESPONSE:ARRAY[1..2] OF CHAR;
107     I:1..2;
108 PROCEDURE DETAILEDCHECK; (*TESTS FOR AND ACCEPTS LEGAL MOVE*);
109 BEGIN
110     FOR I:=1 TO 2 DO
111         CASE RESPONSE[I] OF
112             '1','2','3','4','5','6','7','8':BEGIN
113                                                 ROWNOW:=RESPONSE[I];
114                                                 ROWIN:=TRUE
115                                             END;
116              'A','B','C','D','E','F','G','H':BEGIN
117                                                  COLNOW:=RFSPONSE[I];
118                                                  COLIN:=TRUE
119                                             END;
120              'P':PASS:=TRUE
121         END;(*CASE*)
122         IF (COLIN AND ROWIN) OR PASS
123         THEN CORRECT:=TRUE
124         ELSE
125         BEGIN
126             WRITELN(     'BAD MOVE - TRY AGAIN');
127             CORRECT:=FALSE
128          END
129 END; (*DETAILEDCHECK*)
130 BEGIN (*GETINPUT*)
131     COLIN:=FALSE;
132     ROWIN:=FALSE;
133     VALID:=['1','2','3','4','5','6','7','8',
134                 'A','B','C','D','E','F','G','H','P'];
135     READ(TTY,RESPONSE[1]);READLN(TTY,RESPONSE[2]);
136     IF (RESPONSE[1] IN VALID) AND (RESPONSE[2] IN VALID)
137     THEN DETAILEDCHECK
138     ELSE
139     BEGIN
140         CORRECT:=FALSE;
141         WRITELN(     'IMPOSSIBLE MOVE - TRY AGAIN')
142     END;
143 END; (*GETINPUT*)
144 BEGIN (*GETMOVE*)
145     ASKFORMOVE;
146     REPEAT
147       GETINPUT
148     UNTIL CORRECT
149 END; (*GETMOVE*)
150 PROCEDURE CHOOSESQUARE; (*CHOOSE NEXT SQUARE FOR EXAMINATION*)
151 BEGIN
152     CASE DIRECTION OF
153        N: IF ROW='1' THEN FINISHED:=TRUE ELSE ROW:=PRED(ROW);
154        NE:IF (ROW='1') OR (COL='H') THEN FINISHED:=TRUE
155                                    ELSE
156                                    BEGIN
157                                        ROW:=PRED(ROW);
158                                        COL:=SUCC(COL)
159                                    END;
160         E :IF COL='H' THEN FINISHED:=TRUE
161                       ELSE COL:=SUCC(COL);
162         SE:IF (ROW='8') OR (COL='H') THEN FINISHED:=TRUE
163                                     ELSE
164                                     BEGIN
165                                         ROW:=SUCC(ROW);
166                                         COL:=SUCC(COL)
167                                      END;
168         S :IF ROW='8' THEN FINISHED:=TRUE ELSE ROW:=SUCC(ROW);
169         SW:IF (ROW='8') OR (COL='A') THEN FINISHED:=TRUE
170                                     ELSE
171                                     BEGIN
172                                         ROW:=SUCC(ROW);
173                                         COL:=PRED(COL)
174                                     END;
175         W :IF COL='A' THEN FINISHED:=TRUE ELSE COL:=PRED(COL);
176        NW:IF (ROW='1') OR (COL='A') THEN FINISHFD:=TRUF
177                                     ELSE
178                                     BEGIN
179                                         ROW:=PRED(ROW);
180                                         COL:=PRED(COL)
181                                     END
182     END (*CASE*)
183 END; (*CHOOSESQUARE*)
184 PROCEDURE CHECKMOVE;
185 VAR COL:COLCHAR;
186     ROW:ROWNUM;
187 PROCEDURE CHECKIT; (*EXAMINE SQUARE*)
```

Continued in 'Programs'

All Systems Are Not Created Equal



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SHOW CHESS

SARGON STOMPS THROUGH

David Levy reports

One of the most exciting events at this year's PCW Show was the second microprocessor chess tournament. Competition was much fiercer than last year and the standard of play was very noticeably higher, a sure sign than an increasing number of personal computing enthusiasts are getting to grips with the complex task of writing a chess program. At the first tournament we had only six contestants, this year there were nine and a further fifteen people intimated that they had programs which were not quite ready to participate. It would not surprise me if next year, when it is hoped to hold the first World Microprocessor Championships, we have as many as thirty entries.

A new feature this year was the size of the first prize, £1,500, which was awarded to the highest placed home brew entry. The destiny of the cheque was virtually decided in the very first round when last year's winner, Mike Johnson, introduced a completely new program which he had put together in only a few days. MIKE II was two pawns ahead when it allowed a mate in two by VEGA, and this allowed David Broughton's program to snatch a vital point. In fact VEGA missed the mate when it was first available, but on the following move, when MIKE II had still not noticed the threat, VEGA was not so generous.

VEGA's luck held out in round two, when it reached a position in which its opponent, MYCHESS, was a queen and three pawns ahead. Due to an error in MYCHESS' timing mechanism it loses track of how long it has taken under certain circumstances, and MYCHESS lost on time despite its overwhelming material advantage. This left VEGA with 2 out of 2 and in the next round it met the Chafitz/Sargon program. Sargon was running on a specially designed chess board which senses the moves made by its opponent's pieces and illuminates small LEDs to indicate its own moves. This impressive piece of equipment, which, will be on sale next year at around £800 ($850 in the USA) was undoubtedly the strongest program in the tournament. It crushed all the opposition in its path, including the hitherto fortunate VEGA, and by the end of round four it was already assured of first place. VEGA played sensibly in the two final rounds, drawing an up and down game with the Voice Challenger and then beating DELTA in round 5. It is a solid, well debugged program, and despite the fact that it was very lucky I still consider it to be the strongest of the home brew entries and well deserving of the prize, which incidentally was some £300 more than first prize in this year's British Championship (for humans)!

The games that follow are amongst the most interesting. Readers who would like xerox copies of all the games should send a large stamped addressed envelope and 50p to: PCW (Chess Games), 14 Rathbone Place, London W1. I should like to thank PCW for sponsoring this important tournament and giving computer chess enthusiasts the opportunity to test their wares. Watch these pages for news of next year's PCW tournament, the first World Championship for micros!

White: Voice Challenger
Black: Sargon

1 d2-d4 g7-g6
2 d1-d2

It is a little surprising that a program which purports to have such a large openings book can make a move like this so early in the game.

2 ... g8-f6
3 b1-c3 d7-d5
4 g1-f3 f8-g7
5 d2-d3 0-0
6 e2-e4 d5xe4
7 c3xe4 c8-f5

An awkward pin on the knight, which ties White down to defence.

8 e4xf6+ g7xf6
9 d3-c4 f5-e6
10 c4-b4 b8-c6
11 b4-b5 c6xd4
12 f3xd4 d8xd4
13 b5xb7 d4-e5+
14 e1-d1??

White had to play f1-e2. Now his king will never be safe.

14 ... f8-d8+
15 f1-d3 e6-d5
16 b7-b4 d5xg2
17 h1-e1 g2-f3+
18 d1-d2 f6-g5+
19 e1-e3 d8-d4
20 b4-c3?

Of course White is quite lost, but this move makes matters easier for Black by blocking the possible escape square c3.

20 ... g5xe3+
21 f2xe3 e5xh2+
22 d2-e1 h2-g1+
0-1

Voice Challenger is a sporting opponent who resigns when it sees an inevitable mate.

PROGRAM	R1	R2	R3	R4	R5	Tot
1 Chafitz/Sargon (USA) Dan & Kathe Spracklen (Assembly)	W7	W4	W2	W3	W6	5
2 Vega (UK) David Broughton (Assembly)	W5	W3	L1	D6	W8	3½
3 Mychess (USA) David Kittinger & John Urwin (Assembly)	W8	L2	W4	L1	W7	3
4 Tiny Chess 86 (Belgium) Jan Kuipers (Assembly)	W6	L1	L3	bye	W9	3
5 Mike II (UK) Mike Johnson (Fortran/Assembly)	L2	W9	L6	W8	bye	3
6 Voice Challenger (USA) Programmer not named (Assembly)	L4	W7	W5	D2	L1	2½
7 Max (UK) Guy Burkill (Basic/Assembly)	L1	L6	bye	W9	L3	2
8 Delta (UK) David Wilson (Assembly)	L3	bye	W9	L5	L2	2
9 Wizard (UK) Jeffrey & Clare Cooper (Assembly)	bye	L5	L8	L7	L4	1

White: Tiny Chess 86
Black: Mychess

1 a2–a3. This is Tiny's favourite opening move.

1	. . .	g8-f6
2	b2-b4	b8-c6
3	g1-h3	d7-d5
4	h3-g5	h7-h6
5	g5-h3	c8-h3
6	g2xh3	e7-e6
7	f1-g2	g7-g6

Up to now the game has been rather unexciting, but no sooner has White castled than MYCHESS launches an all-out attack on its opponent's king.

8	. . .	g6-g5!
9	c1-b2	f8-d6
10	d1-c1	a7-a6
11	f1-e1	h8-g8
12	e1-f1	g5-g4

Here it comes!

13	h3-h4	f6-h5
14	f1-d1	d8xh4
15	g1-f1	h5-f4
16	b2-c3	h4-h2

While White has been doing nothing on the Q-side, Black has brought most of his pieces to bear on the enemy K-side.

17 g2xd5

The only way to defer mate.

17 . . . e6xd5

0-1

TINY CHESS is also polite!

On The Line Continued from Page 55

established *are* imposed on personal computer systems, this would certainly seem to inhibit a potentially large source of off-peak revenue for the Post Office.

4 Your requirement for users of acoustic couplers to obtain written approval from their local Telephone Area (Sales) Office is understandable and I cannot see any problem with this.

. . . I hope you will accept that I believe a more liberal attitude to the connection of personal computers to be in the best interests of the Post Office and the UK microcomputer industry. I would neither expect, nor wish for, the relatively uncontrolled situation that exists in the United States. However, I do consider special provision should be made for this new, exciting and (potentially) revenue-earning marketplace."

Will David (Hebditch) slay Goliath (PO)? Read the conclusion to this gripping tale — next month.

CALCULATOR CORNER

Judging by the amount of mail I am now receiving, Calculator Corner is striking a chord with some of you out there who either cannot or don't want to own a micro. The general feeling seems to be that you'd like to see more software and advanced programming info. than I've been providing, so for the next few months that's what you're going to get!

Dick Pountain

TI 58/59 pseudo op-codes

We'll start off with some notes from reader, Rolf Howarth, of Wimborne, Dorset concerning various TI 58/59 operations which are not to be found in the manual.

"When a program is entered it is stored as a sequence of two-digit numbers, each of which corresponds to one or more key strokes. However, not all of the 100 possible codes (00-99) are used, and a 'pseudo' op-code can be placed in program memory by entering RCL nn and then deleting the RCL, leaving the code nn as required.

Keycode 82

This is the most useful pseudo code, and is normally referred to as HIR (this is the mnenomic printed when listing on the PC-100). With it one can access the eight internal registers used as the pending operations stack, and print register when the PC-100 is connected. The format of the instruction is 82 ab, where a is the operation and b the number of the register (1-8) on which the operation is performed. There are six different operations, which are used in the same manner as ordinary register arithmetic: 0 — STO store display contents in internal register; 1 — RCL recall contents of internal register to display; 3 — SUM add display to internal register; 4 — PRD multiply internal register by display contents; 5 — INVSUM subtract display contents from register; 6 — INVPRD divide register by display contents. 2 will perform no operation and 7, 8 and 9 all do the same as 6. Note: When performing register arithmetic with the pending operations registers, place the calculator in scientific display mode, as any number smaller than one will otherwise have its exponent made positive (eg. 0.02 turns into 200. after HIR 38).

These registers may be HIRed when the programmer has no spare data registers, though one has to take into account the fact that they are actually used by the calculator (!).

Keycode 31

This op-code corresponds to the LRN key, which can of course not be placed directly in program memory, as the calculator leaves learn mode when it is pressed. When the code is encountered during program execution, the calculator stops in learn mode at the following location.

Keycode 21

This code, which corresponds to the 'shift' key, 2nd, has several interesting uses. 1) Crashing the calculator. After the sequence 21 sin, cos or tan, the TI58/9 crashes, requiring it to be switched off to reset it. 2) 21 in front of a R/S or 31 instruction causes the next key pressed to have its second function taken. 3) Testing the display. It is possible to branch to one of two user-defined key labels as the result of testing whether the number in the display has been entered (ie. a function or operation key has been pressed since the number was keyed in). The sequence is 21 and then a user-defined key A-E'. The calculator jumps to one of two labels; if the number has been entered the first label will be called, otherwise the label search mechanism starts from step 001. So in the following example, when B is pressed one or other of the Lbl A's is called. The first Lbl A' must be at step 000 for this to work. Lbl A'. . INVSBR Lbl A'. . . INVSBR Lbl B 21 . A' . .

If the number has been entered the . will clear it and the first Lbl A' is called. The test may be reversed if CE is used in place of the point. The first label will be called if the number is unentered, and vice versa. Any error condition and/or unentered number will be cleared by the CE as normal.

DSZ

The decrement and skip on zero function may be used with any data register, not just registers 0-9 as stated by the manual. The number of the register has to be placed in the right place using the same method as when entering a pseudo code. Note that register 40 may not be used, as Dsz 40 is recognised as Dsz Ind.

Finally I would like to give the owners of a TI58/9 a puzzle to solve. It is possible to look at the 380 steps which contain the routines that do the polar to rectangular and sexagesimal to decimal conversions and statistics. I have found out how to do this, and wonder whether anyone else can."

Your ten and up ten!

I would like to make a confession; sacreligious though it may be to computer persons, I have always preferred card games to chess. More specifically I am addicted to Poker; seven card stud when played well has a degree of psychological sublety and complexity for which it is seldom given adequate credit.

Given this leaning (or perversion, in the eyes of some) it is most gratifying to note that the Artificial Intelligence community have recently turned to Poker as a suitable subject for computer simulation.

Rather rashly I decided to try to produce a calculator program for the Casio Fx-502 which could make 'intelligent' betting decisions in a simulated card game. Poker is too complex by virtue of the five card combinations, and so I settled upon 3-card Brag. Any game of the Brag family (which includes Poker) is in one sense trivial with only two players since either always has the option to "see" the other; but my object was merely to have the calculator make realistic bets based on the perceived strength of its hand and its opponent's betting.

The 'deck' is of necessity grossly simplified, being merely the numbers 1 to 13 with no suits. This means flushes are not possible; pairs, runs and prials (3 of a kind) are the only hands above Ace high. (In an earlier card game I represented suits by 1, 2, 3, or 4 following a decimal point eg. 1.2, 9.3, but this adds impossibly to the complexity here). The 'hands' are dealt using the DMS format of the 502, so 2°2°9 is a pair of twos.

The program deals two hands and assesses its own hand before displaying yours. By a series of tests it identifies pairs and prials and then runs, and according to the outcome assigns a 'value' to the hand which is in the range 6-18 for a pair, 18-31 for a run and 56-68 for a prial. This value is weighted within its range by the magnitude of the face values of the cards.

The program then compares your last raise with the value of its hand and raises, sees or folds according to one of two algorithms (which depends on the value). When betting first the calculator 'suckers' you, ie. conceals the strength of its hand by basing the first bet on the *square root* of its value. And to avoid predictability it bluffs wildly on a random basis on an average of one in ten hands.

Given the limitations of a pocket calculator I was surprised that the program turned out to be quite a strong player; normally cautious but never underplaying a good hand. It can usually be made to fold by a really outrageous raise, but then so can most humans! Just pretend its real money and don't go mad.

When a hand is finished the human player has to see the calculator's hand and decide the winner. The program could perform this function using the 'assessing' subroutine again but it slows the game down too much.

The calculator keeps a running bank balance for each player, debits each bet as it is made and puts the bets into a jackpot which is credited to the winner manually by the human player.

Those familiar with the fx-502 will be surprised that I have opted to use its Mickey Mouse random number generator in the dealing subroutine. This is not because I am unaware of its inadequacies; nor because I don't know any good pseudo-random number routines, which I do (later column?). Frankly it's because the poor distribution gives you better hands!

A word of warning. In the listing I have followed my own preferred format which is to omit all INVs (for 2nd functions) and the commas between steps in the interest of space and readability.

User instructions

1 Clear memories with MAC.
2 Enter playing funds e.g. 1000 into memories 15 and 16.
3 Press PO. This deals the first hand and displays yours e.g. 6°6°8.
4 Enter a bet e.g. 2.
5 Press PI. This accepts your bet and replies with calculator's bet e.g. 5.
6 Repeat 4 and 5 until:-
a) You wish to see. Do this by equalling the calculators bet i.e. by not raising. The calculators hand will be displayed automatically.
b) You wish to fold. Enter a bet of 0. Your hand will be displayed automatically.
c) The calculator sees you by equalling your last bet. Press P7 to see calculator's hand and P2 to recall your own. (These may be done at any time but no cheating!)
d) The calculator folds by a bet of 0.
7 When a game has terminated by a) b) c) or d) determine the winner.
8 If you are the winner press P3. Your bank balance is displayed. (This may be done at anytime). Press EXE and the jackpot is displayed and simultaneously added to your balance.
9 If calculator has won P4 and EXE perform similar functions.
10 Repeat from 3. Note that PO does not clear all memories (this would lose bank balances) so be careful to collect all winnings. Otherwise the jackpot carries over to the next game.
11 To allow the calculator to bet first (first betting should alternate) press P6. Then enter your reply and press P1; continue as normal with steps 4 and 5.

Memory contents

0 SQUARE ROOT VALUE
1, 2, 3 CALCULATORS CARDS
4, 5, 6 YOUR CARDS
7 YOUR BET
8 CALCULATORS BET
9 YOUR RAISE
10 VALUE OF HAND
11, 12, 13 PAIRWISE DIFFERENCES
14 BLUFF VALUE
15 YOUR BANK
16 CALCULATORS BANK
17 —
18 JACKPOT
19 —

Program listing

```
PO    6 Min0
LBL8  GSB P9 IND Min0 DSZ GOTO 8                  DEALS SIX CARDS
      MR3 Min13 − MR1 Min11 = Min12               TAKES PAIRWISE DIFFERENCES
      MR2 M-11 M-13
      MR11 x=0 ·1 MinF MR12 x=0                   TESTS FOR ZERO DIFFERENCES
      ·2 M+F MR13 x=0 ·3 M+F                      DIFFERENCES
      MRF ABS FRAC MinF x=0 GOTO 1
      ·2 x≥F GOTO2                                IDENTIFIES PAIRS AND PRIALS
      ·3 x≥F GOTO3
      50 +
LBL2  MR1 − MR2 +                                 VALUES PAIRS AND PRIALS
LBL3  MR2 + 5 = Min10 GOTO 9
LBL1  MR11 × MR12 × MR13 = ABS − 2 = x=0 GOTO 5   IDENTIFIES RUNS
      GSB P9 MinF + 10 = Min14                    INTRODUCES RANDOM BLUFF
      MR1 + MR2 + MR3 = ÷ 7 = INT
      x≥F MR14 Min10 GOTO 9
LBL5  18 + MR1 = Min10                            VALUES RUNS
LBL9  SAC MR10 MinF √ INT Min0 GSB P2


P1    Min7 M+18 M-15                              DEBITS YOUR BET
      x=0 GSB P2                                  HAVE YOU FOLDED?
      MR15 x≥0 GOTO 2                             ARE YOU SOLVENT?
      EE HLT                                      INDICATES INSOLVENCY
LBL2  MR7 − MR8 = Min9 x=0 GSB P7                 ARE YOU SEEING?
      25 x≥F GOTO 3                               CALCULATORS STRATAGEM
      MR7 + 1 = M+8 GOTO 8                        FOR VERY STRONG HAND
LBL3  ÷ MR10 − 3* = x≥0 GOTO 1                    SHALL CALCULATOR FOLD?
      +2*= x≥0 GOTO 9                             SHALL CALCULATOR SEE?
      MR10 M+8 DSZ GOTO 8                         CALCULATOR BETS
LBL9  MR7 Min8 GOTO 8
LBL1  0 Min8
LBL8  MR8 M+18 M-16 MR16 x≥0 GOTO 5               DEBITS CALCULATORS BET. IS IT SOLVENT?
      EE +/− HLT                                  INDICATES CALCULATORS INSOLVENCY
LBL5  MR8                                         CALCULATORS BET DISPLAYED
```

* These constants control the 'caution' of calculators play. Increasing them makes it less cautious and vice versa.

```
P2    AC MR4 + MR5 ÷ 6 0 + MR6 ÷ 3 6 0 0 = °’” HLT    DISPLAYS YOUR HAND

P3    MR15 HLT MR18 M+15 M-18                         YOU RECEIVE JACKPOT

P4    MR16 HLT MR18 M+16 M-18                         CALCULATOR RECEIVES JACKPOT

P7    AC MR1 + MR2 ÷ 6 0 + MR3 ÷ 3 6 0 0 = °’” HLT    DISPLAYS CALCULATORS HAND

P9    RAN# RAN# × 13 + 1 = INT                        DEALS A CARD
```

IN STORE

As more and more microcomputers come on to the British market, so our unique machine lising, *In Store*, continues to expand at great pace. However, it's important that in terms of editorial 'page consumption', Direct Access strikes a reasonable balance with the remainder of the magazine. Therefore, for the time being at least, we are making the following changes:

User Group Index A complete list of user groups, clubs, societies and associations will be published *quarterly*. Otherwise, each month the section will include only those groups of which we have been newly notified.

Diary Data PCW's diary will project approximately two months ahead of publication day. In addition, though, we will continue to give details of particularly interesting events occuring ahead of that date.

Machine (Price from)	Main Distributor/s (No. of dealers)	Hardware	Software	Documentation	Miscellaneous
ABC 80 (£790)	CCS Microsales: 01-444 7739 (TBA)	16-40K RAM: Z80A: C: 12", 16x40 b&w VDU: 4680 bus: IEEE 488: RS232 port: option — dual 5¼" F/D (160K, own DOS), £895	DOS: BASIC: games: *W/P: Database: Engineering & construction prog*	S	Graphics loudspeaker with 128 effects: Viewdata compatible.
ALPHA MICRO (£5,700)	Alpha Micro Systems UK Ltd: 01-930 1991 (TBA)	64K-16M RAM: W/L 16 bits: Dual 8" F/D (1.2MB): 6 S/P: modular	multi-user O/S: BASIC: M/A: PASCAL: T/E: U: *B/P*	E	Expands to 1200 MB, 32 terminal system: average 10MB H/D system — £1,100
APPLE II (£810)	Microsense: 0442 63561 (80+)	16-48K RAM: 6502: 8 I/O slots: 15"x18"x5": options — single 5¼" F/D (116K), £425; C, £33; RS232 int, £110; 16K RAM, £110	O/S: BASIC: *PASCAL: games*	S	280x192 high resolution graphics: integer BASIC in 6K ROM
ATTACHE (£7,000)	R. H. Thorpe Ltd: 0276 29492. R. J. Spiers Ltd: 0603 416573 (TBA)	48K RAM: 8080: dual 8" F/D (616K): 9", 16x64 b&w VDU: 180 cps printer	ExBASIC: B/P: *FORTRAN*	S	W/P package available soon
BILLINGS BC-12FD (£4,295)	Mitech: 04862 23131 (TBA)	64K RAM: Z80A: dual 5" F/D (640K): 12",24x80 b&w VDU: options — 80 col 160 cps printer, £375: 132 col 55cps DM printer, £975	DOS: BASIC: *FORTRAN: COBOL: A.*	S	Also avail, BC-DF2M with dual 8" F/D (2MB) instead of 5", £6,000; extra dial 8" F/D, £2,750; with 50MB H/D from £11,000; Graphics.
CBS Mk I (£4,900)	Compelec: 01-636 1392 (n/a)	64K RAM: Z80: dual 8" F/D (1MB): 12", 24x80 VDU: 132 col, 30 cps printer: 2 S/P: 1 P/P: options — 150cps bi-directional printer, £2,000: 55cps W/P printer, £2,000	CP/M: BASIC: *W/P: U: B/P*	S&H	Mk II available with 2MB F/D, £5,900. Can upgrade to Mk III. Desk mounted.
CBS Mk III (£8,150)	As above	64K RAM: Z80: dual 8" F/D (1MB): 12", 24x80 VDU: 132 col, 30cps printer: 11MB H/D: 6 S/P: 1 P/P: options — 150cps bi-directional printer, £2,000: 55cps W/P pointer, £2,000 12", 24x80 VDU, £655.	CP/M: BASIC: *W/P: U: B/P*	S&H	Up to 44MB H/D possible, £4,500 extra. Multi-user system with 280K RAM, £10,150.
CHALLENGER — 1P (£238)	Mutek: 0225 743289 Byte Shop: 01-518 1414. CTS: 0706 79332 U-Microcomputers: 0606 853390 Microcomputer Business Machines: 01-980 3993	4-32K RAM: 6502: C int: RS232 port: 15"x16"x4": option — dual 5¼" F/D (160K), £550	O/S: BASIC: A: games: *ExBASIC: Data Man: B/P (limited).*	S	D/A conv: colour capability: 8K microsoft BASIC in ROM
CHALLENGER C2 (£404)	As above	4-48K RAM: 6502: C int: RS232 port: 15"x16"x4": options — dual 5¼" F/D (160K), £550; dual 8" F/D (1.15MB); 20MB H/D.	O/S: BASIC: A: games: *ExBASIC: Data Man: B/P (limited)*	S	Can run OSI business software if 8" F/D inc.

List of Abbreviations

A Assembler
B BASIC
B/P Business package
C Cassette
C/P Commercial package
E Extensive
F/D Floppy disc
G/C Graphics card
H Hardware
H/D Hard disc
I Introductory
int Interface
I/S Indexed sequential
K/B Keyboard
M/A Macro assembler
N/P Numeric pad
O/S Operating system
P/P Parallel port
S Software
S/P Serial port
TBA To be announced
T/E Text editor
T/P Text processor
U Utility
W/L Word length
W/P Word processor

Please note: Software items listed in *italic* are not included in the basic price of the equipment. All prices are *exclusive* of VAT

IN STORE

DIRECT ACCESS

Machine (Price from)	Main Distributor/s (No. of dealers)	Hardware	Software	Documentation	Miscellaneous
CHALLENGER C3 (£2334)	As above	32-56K RAM: 6502, 6800, Z80: dual 8" F/D (1.15MB): 2-16 S/P: 17"x22"x12"	OS65U: BASIC: *CP/M FORTRAN COBOL: B/P: W/P: Data Management*	S&H	Also C3B & C3P H/D modules: 74MB for about £10,000
COMMA VO3 (£4,200)	Comma: 0277 811131 (n/a)	32K RAM: LSI 11: dual 8" F/D (512K): 4 serial DLU11S ports: modular	*RT11 0/S (£750): BASIC: COBOL: FORTRAN: B/P (limited)*	H	Many configs possible: max 20 MB, H/D — about £27,000
COMPELEC SERIES (£2,400)	Compelec: 01-636 1392 (n/a)	64K RAM: Z80: dual 8" F/D (512K): 2 RS232 ports, 1 P/P	CP/M: A: CBASIC: COBOL: FORTRAN: PASCAL: *W/P: B/P*	S	Also with double density F/D, 1MB, £2,900; 1K EPROM
COMPUCORP 625 (£6,000)	Compucorp: 01-952 7860 (15)	60K RAM: Z80: dual 5¼" F/D (700K): 9", 16x80 b&w VDU: 40cps printer 1 RS232 port: 20"x28"x10"	A: BASIC: U: *W/P: B/P*	B	Also available, 655 model with 315K F/D capability & 12", 20x80 VDU — £3,750
COMP WORKSHOP SYSTEM 1 (£1,600)	Comp Workshop: 01-491 7507 (n/a)	32K RAM: dual 5¼" F/D (170K): 9", 16x64 b&w VDU: modular	A: BASIC: FORTRAN: FLEX: PASCAL: PILOT: *B/P*	E	These systems are example configs from a fully compatible modular range
COMP WORKSHOP SYSTEM 2 (£11,000)	As above	128K RAM: 6809: dual 8" F/D (1.2MB): 3 intelligent 20x80 terminals; 80 col, 125cps printer: daisy wheel Sprint 3 printer	A: BASIC: FORTRAN: FLEX: PASCAL; PILOT: *B/P*	E	As above
COMP WORKSHOP SYSTEM 3 (£36,000)	As above	768K RAM: 6809: dual 8" F/D (1.2MB): 64MB H/D: 10 intelligent 20x80 terminals: 2 132 col, 120cps printers: 2 80 col, 125cps printers: 2 daisy wheel Sprint 3 printers: max 16 ports.	A: BASIC: FORTRAN: FLEX: PASCAL: PILOT: *B/P*	E	As above
COMPUCOLOUR II (£1,058)	Abacus: 01-580 8841 (6)	8-32K RAM: 8089: 13" 32x64 8-colour VDU: single 5¼" F/D (51K): RS232 port: 18"x15"x13"	ExBASIC (ROM): *A: personal data base: games*	I	16K module, £1,134; 34K, £1,137; maintenance & programming manual available.
CROMEMCO SYSTEM 2 (£1,995)	Comart: 0480-215005. Datron: 0742-585490. Microcentre: 031-225 2022 (20)	64K RAM: Z80: dual 5¼" F/D (180K): options — dual 8" F/D (512K), £1370; 11MB H/D, £3495; 22MB H/D, £5999	CDOS: *BASIC: COBOL: FORTRAN (£55): multi-user BASIC*	E	Expandable to multi-user system (2-7 users), £3,455-£6,400
CROMEMCO SYSTEM 3 (£2,995) (64K, £3,293	As above	32-64K RAM: Z80: dual 8" F/D (512K): options as above: extra dual F/D, £1,200	CDOS: *BASIC: COBOL: FORTRAN; multi-user BASIC*	E	As above
DIGITAL MICROSYSTEM DSC-2 (£5,395)	Modata: 0892 39591 (TBA)	64K RAM: Z80: dual 8" F/D (2.28MB): 4 RS232 ports: EIA port: 17"x21"x7"	CP/M: BASIC-E: *CBASIC: COBOL: FORTRAN: PASCAL: CAP B/P*	H	Up to 6 additional F/D units possible
DURANGO (£7,750)	Comp Ancillaries: 07843 6455 (12)	48K RAM: 8085x3: dual 5¼" F/D (1MB): 9", 16x64 green VDU: 132 col 165cps printer: N/P: options — add F/D £1,753; aux VDU £875	O/S: *DBASIC: B/P*	S	Takes up to 4 workstations: fully integrated system 15"x30"x24"
DYNABYTE DB8/1 (£1,500)	Dynabyte UK/Europe Ltd: 0723 65559 (6)	32-64K RAM: Z80: S100 bus; 2 RS232 ports: 1 P/P: 20"x18"x7": option — dual 8" F/D (1MB), £2,000	CP/M: *BASIC: COBOL: FORTRAN: PASCAL: W/P: B/P*	H	Expands to multi-user system: also DB8/2 with dual 5¼" F/D (400K), £3,000
EG 3003 (£378)	Lowe Electronics:0629 2817 (TBA)	16K RAM: Z80: 500 bps C: 32x64 TV int: extra C int: 1 P/P: K/B	BASIC: *M/A: FORTRAN: B/P*	I	BASIC in 12K ROM; Graphics available; F/D system under development.
EQUINOX 200 (£9,995)	Equinox: 01-739 2387 (n/a)	64-256K RAM: Z80: 10MB H/D: 15", 24x80 b&w VDU: 15cps printer	CP/M: BASIC: COBOL: FORTRAN: MVT/ FAMOS	S&H	
EQUINOX 300 (£11,750)	As above	64-256K RAM: W/L 16 bits: 10MB H/D: 15", 24x80 b&w VDU: 150cps printer: 6 S/P	O/S: BASIC: COBOL: M/A: PASCAL: *LISP: SNOBOL: T/P multi-user:*	S	Up to 1200MB of storage possible (4x300MB, Calcomp Tridents)

IN STORE

Machine (Price from)	Main Distributor/s (No. of dealers)	Hardware	Software	Documentation	Miscellaneous
EUROC (£7,995)	Eurocalc Ltd: 01-405 3113 (TBA)	64K RAM: 8080A: dual 8" F/D (1MB): 15", 25x80 b&w VDU: 132 col, 140cps printer	CP/M: CBASIC: A: account system: U: *B/P*	S	A year's maintenance and stationary supply inc.
EXIDY SORCERER (£650) (16K, £760; 32K £859)	Liverpool Data Products Ltd: 073 670 6320 (27)	8-32K RAM: Z80: RS232: 1 P/P: S100 connector: 30x64 VDU I/O: options — dual 5¼" F/D (630K), £1,200; 12", 30x64 green VDU, £240; S100 chassis, £210	O/S: ExBASIC (ROM): *W/P: Editor: A: games*	I	High resolution graphics capability.
H11 Kit (£1,844)	Heath: 0452 29451 (n/a)	LSI 11: 16-32K RAM: 24x80 VDU int: up to 16 S/P or P/P: options — dual 8" F/D (512K), £1,325: 12", 24x80 VDU, £558	*O/S: BASIC: FORTRAN: A: games: T/E: U.*	S&H	CPU and VDU int boards sold as separate items.
HEATH WH89 (£1,380)	As above	16-48K RAM: Z80: single 5¼" F/D (102K): 12", 25x80 b&g VDU: RS232: 13"x17"x20": options — 16K RAM, £158	*BASIC: A: W/P: B/P*	I	Cassette available instead of F/D, £882; in kit form WH89 is £1,200
IMS 5000 (£1,935)	Equinox: 01-739 2387 (20)	32-64K RAM: Z80: dual 5¼" F/D (320K)	CP/M: BASIC: COBOL: FORTRAN: *PASCAL: W/P*	S&H	3 drives option
IMS 8000 (£3,515)	As above	64-256K RAM: Z80: dual 8" F/D (1MB)	CP/M: BASIC: COBOL: FORTRAN: *PASCAL: W/P: CAP: Micro COBOL: MVT/FAMOS: multi-user*	S&H	4 drives optional
IMSAI VDP 42 (£3,900)	Computermart: 0603 615089. Corner Comp: 03727 41101 (2)	32-64K RAM: 8085: dual 5¼" F/D (400K): 9", 24x80 b&w VDU: 1 S/P: 1 P/P: 18"x27"x12"	IMDOS (CP/M comp): A: ExBASIC: U: *CBASIC: COBOL: FORTRAN*	H	Can support 8 additional F/D drives; also available, VDP 44 with F/D (780K), £4,400
IMSAI VDP 80 (£6,200)	As above	32-64K RAM: 8085: dual 8" F/D (1.2MB): 12", 24x80 b&w VDU: 1 S/P: 1 P/P: 25"x15"x25"	IMDOS: A: ExBASIC: U: *CBASIC: COBOL: FORTRAN: CAP B/P*	H	
ITT 2020 (£867) (32K, £931 48K, £995)	ITT: 0268 3040 (15)	16-48K RAM: 2020: 15"x 18"x4": options — single 5¼" F/D (116K), £425, C, £33; 60cps printer, £825; 16K RAM, £110; RS232 port, £96	Monitor: A: ExBASIC: Dis-A: *games*	B	360x192 high resolution graphics: ExBASIC in 6K ROM.
LX-500 (£3,500)	Logabax Ltd: 01-965 0061 (13)	32K RAM: Z80: dual 5¼" F/D (180K): 12", 25x80 b&w VDU: 100bps printer: option — 80 col 60cps printer, £500	DOS: BASIC: A	S	Other printers available.
MEGAMICRO (£6,080)	Bytronics: 0252 726814 (5)	256K: 8080A: dual 8" F/D (1MB): 12", 20x80 b&w VDU: 120cps printer: 2 S/P: 2 P/P: option — printer stand, £100	CP/M: U: *B/P*	H&B	
MICRO-ENGINE (£2,080)	Pronto: 01-599 3041 (TBA)	64K RAM: MCP 1600: 2 RS232 ports: 2 P/P: 16"x13"x5": options — dual 5¼" F/D (1MB), £1,500; dual 8" F/D (2MB), £1,200	BASIC: PASCAL: File Manager: U	H&S	CPU has user written word set: PASCAL uses integral P code: available as board, £1,400

List of Abbreviations

- A Assembler
- B BASIC
- B/P Business package
- C Cassette
- C/P Commercial package
- E Extensive
- F/D Floppy disc
- G/C Graphics card
- H Hardware
- H/D Hard disc
- I Introductory
- int Interface
- I/S Indexed sequential
- K/B Keyboard
- M/A Macro assembler
- N/P Numeric pad
- O/S Operating system
- P/P Parallel port
- S Software
- S/P Serial port
- TBA To be announced
- T/E Text editor
- T/P Text processor
- U Utility
- W/L Word length
- W/P Word processor

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IN STORE

DIRECT ACCESS

Machine (Price from)	Main Distributor/s (No. of dealers)	Hardware	Software	Documentation	Miscellaneous
MICRO-NOVA (£12,000)	Digitus: 01-636 0101 (3)	64-1128K RAM: N601: 10MB H/D (5 fix, 5 rem): 12", 24x80 VDU: 132 col 60cps printer: 4 S/P: 1 P/P	DOS: M/A: U: T/E: I/S: debug: FORTRAN IV: *BASIC: PASCAL: W/P: B/P*	E	Larger configs usual: bus system for multi-user; smaller system possible with F/D
MICRO-STAR 45 PLUS (£4,950)	Data Efficiency: 0442 57137 (TBA)	64K RAM: 8085: dual 8" F/D (1.2MB): 3 S/P: RS232 port: 17"x26"x8"	STARDOS: CP/M: BASIC: COBOL: FORTRAN: UPDATE (database): *B/P*	E	
MSI 6800 (£1,203)	Strumech: 05433 4321 (5)	16K RAM: 6800: C: (9", 16x64 b&w VDU: 1 S/P: option — PROM prog	BASIC: mini A T/E: U	H&S	Up to 8 serial or parallel interfaces possible.
MSI 6800 SYSTEM 1 (£2,175)	As above	32K RAM: 6800: dual 5¼" F/D (160K): 9", 16x24 b&w VDU: 1 RS232 port: option — dual 8" F/D (624K), £1,640	DOS, BASIC: U: *A: FORTRAN: T/E*	H&S	As above
MSI 6800 SYSTEM 2 (£7,500)	As above	56K RAM: 6800: Single 8" F/D (312K): 10MB H/D: 1 RS232 port: 9", 16x64 b&w VDU: options — dual 8" FYD (624K), £1,640 10MB H/D £4,250	DOS: BASIC: multi-user BASIC: A: *B/P*	H&S	Rack mounted
NORTH STAR HORIZON (£4,650 for 48K)	Comart: 0480 215005. Comma: 0277 811131. Equinox: 01-739 2387 (20)	24-56K RAM: Z80A: dual 5¼" F/D (360K): 15", 24x80 b&w VDU: 150cps printer: 2 S/P: 1 P/P	DOS: BASIC: *CP/M: COBOL: FORTRAN: PASCAL: B/P*	E	
PET 2001-8 (£550)	Commodore: 01-388 5702 (150)	8K RAM: 6502: C: 9", 25x40 VDU: IEEE488 (non standard) port: options — dual 5¼" F/D (353K), £795; 80 col 93cps printer, £645; expand to 32K RAM, £249	O/S: BASIC: A: *FORTH: PILOT: games*	I	Graphics facility: BASIC in 8K ROM: also available, dual 5¼" F/D (800K), £995 + £30 for operating ROM
PET 2001 - 16/32 (£675) (32K, £795)	As above	16-32K RAM: 6502: C: 9", 25x40 green VDU: IEEE488 (non standard) port: options — dual 5¼" F/D (353K), £795; 80 col 93cps printer, £645	O/S: BASIC: A: *FORTH: PILOT: games*	I	As above but disc operating ROM included.
POWER-HOUSE 2 (£1,200)	Powerhouse Micros: 0442 48422 (TBA)	32K RAM: Z80A: 5", 27x96 b&w VDU: 1 S/P: 1 P/P: 17"x11"x7": options — IEEE488 int, £110; C, £170; G/C, £190	FDOS: BOS: BASIC: *games: C/P: ExBASIC (14K EPROM), £260*	I	
RAIR BLACK BOX (£2,300)	Rair: 01-836 4663 (n/a)	32-64K RAM: 8085: dual 5¼" F/D (160K): 2 RS232 port: 20"x16"x 5": option — dual 5¼" F/D (520K), £1,000	CP/M: BASIC: COBOL: FORTRAN: M/A: T/E: *B/P*	H	16K RAM expansion, £250.
RESEARCH MACHINES 380 - Z (£1,048) (56K, £1,654)	Research Machines: 0865 49791 (n/a)	16-56K RAM: Z80A: C: RS232 port: 19"x16"x6": options — dual 5¼" F/D (168K), £895; dual 8" F/D (1MB), £1,695 (fitted in machine)	Tiny BASIC: games: graphics: *A: ExBASIC: CBASIC: COBOL: FORTRAN: ALGOL: CP/M: U*	S	Designed for education: high resolution graphics being developed
SDS 100 (£4,290)	Airamco: 0294 57755 (11)	64K RAM: Z80: dual 8" F/D (1MB): 12", 24x80 VDU: S100 bus: RS232 port: N/P: 1 P/P	CP/M: A: ExBASIC: *COBOL: FORTRAN: CAP B/P*	E	Facility for 8K PROM
SEMEL 1 (£2,900)	Strutt Electrical: 0822 5439 (n/a)	16-64K RAM: Z80: single 8" F/D (250K): 12", 24x80 b&w VDU: RS232 port: options — single 8" F/D (250K), £500; light pen	BASIC: *COBOL: FORTRAN: B/P*	I	Supports up to 8 drives
SHARP MZ-80K (£520-£740)	Sharp UK: 01-571 2157 (TBA)	6-34K RAM; Z80: C: 10", 24x40 b&w VDU	BASIC: A: *games*	B	Graphics: loudspeaker: BASIC in 14K RAM

IN STORE

Machine (Price from)	Main Distributor/s (No. of dealers)	Hardware	Software	Documentation	Miscellaneous
SIMPELEC Mk I (£6,900)	Compelec: 01-636 1392 (n/a)	64K RAM: Z80: dual 8" F/D (1MB): 12", 24x80 VDU: 55cps daisywheel printer: 2 S/P: 1 P/P: options — 150cps bi-directional printer, £2,000; 55cps W/P printer, £2,000	CP/M: BASIC: W/P	S&H	Also available, Mk II with 2MB F/D, £7,900. Can upgrade to MkIII. Portable
SIMPELEC Mk III (£10,150)	As above	64K RAM: Z80: dual 8" F/D (1MB): 11MB H/D: 12", 24x80 VDU: 55cps daisywheel printer: 6 S/P: 1 P/P: options — 150cps bi-directional printer, £2,000; 55cps W/P printer, £2,000; W/P VDU, £900	CP/M: BASIC: W/P	S&H	Up to 44MB H/D possible, £4,500 extra. Multi-user system with 208K RAM, £12,150.
SIROCCO (£3,900)	Elvingate Computers: 069 24 5189 (TBA)	64K RAM: Z80: dual 5¼" F/D (740K): 12", 24x80 VDU: RS232 port: 19"x 14"x13": options — up to 3 ports; 10MB H/D, £4,000	CP/M: CBASIC: *COBOL: MBASIC: FORTRAN: PASCAL: LISP*	S	Direct memory addressing. Memory mapped VDU. Free standing keyboard.
SMOKE SIGNAL CHIEFTAIN 1 (£3,050)	Windrush Micro Designs: 069-24 5189 (TBA)	32-64K RAM: 6800: dual 5¼" F/D (160K): 12", 24x80 VDU: 112cps printer: RS232C port: option — 16K RAM expansion, £500	DOS: BASIC: *DBASIC: RBASIC: A: FORTRAN: U: T/E: B/P*	E	Also available, Chieftain 3 with dual 8" F/D (1MB), £3,950.
SOLITAIRE/ WP (£6,750)	Solitaire/KPG: 04252 71448 (TBA)	64K RAM: 8085: dual 5¼" F/D (700K): 14" VDU (with own CPU): 45cps printer: CPU	DOS: W/P: *BASIC*	S	All Solitaire systems are compatible: graphics on 11x13 dot matrix
SOLITAIRE/ BS200 (£7,950)	As above	64K RAM: 8085: dual 8" F/D (960K): 14" VDU (with own CPU): 45cps printer: CPU port	DOS: BASIC: W/P: *specialised B/P*	S	As above
SOLITAIRE/ HBS100 (£9,500)	As above	64K RAM: 8085: 10MB Fix H/D: 14" VDU (with own CPU): 200cps printer: CPU port: option — up to 40MB H/D	DOS: BASIC: W/P: *specialised B/P*	S	Up to 8 interface terminals can be used: also available, HBS200 with 20-80MB H/D.
SORD M100 ACE (£2,650)	Dectrade: 0602 861774 (TBA)	48K RAM: Z80: single 5¼" F/D (143K): 12", 24x64 colour VDU: RS232 port: option — single 5¼" F/D, £300	O/S: BASIC	I	With colour graphics: 8K ROM
SORD M223 (£3,500)	As above	64K RAM: Z80: single 5¼" F/D (350K): 12", 24x80 b&w VDU: S100 bus: RS232 port: option — extra F/D, £450	O/S: BASIC: *CAP B/P*	I	Other configs possible.
SUPER-BRAIN (£1,995)	Icarus: 0632 29593 (TBA)	64K RAM: 2xZ80: dual 5¼" F/D (320K): 12", 25x80 b&w VDU: S100 bus: RS232: TRS80 port: 21"x23" x14": options — dual 5¼" F/D (320K); dual 8" F/D (2.4MB); 8-120MB H/D	CP/M: A: *BASIC: COBOL: FORTRAN: APL: B/P*	H&S	Limited graphics: mainframe interface available
TANDBERG EC10 (£5,000)	Tandberg: 0532 35111 (n/a)	50K RAM: 8080A: single 8" F/D (250K): 12", 25x 80 b&w VDU: RS232 port	ExBASIC (24K): multi-user BASIC: A: U: *COBOL*	H&S	Pascal available next year
TANDY TRS 80 LEVEL 1 (£380)	Tandy: 021 556 6101 (200)	4-16K RAM: Z80: C: 12", 16x64 b&w VDU	BASIC: games: A	I	BASIC in 4K ROM: upgradable to level 2
TANDY TRS 80 LEVEL 2 (£515-£1,005)	As above	4-48K RAM: Z80: C: 12", 16x64 b&w VDU: RS232 int: 1 P/P: option — single 5¼" F/D (78K), £478 (max of 4)	BASIC: games: *M/A: FORTRAN: B/P*	I	16K machines include N/P: 4-16K upgrade, £120; without pad, £85

List of Abbreviations

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C/P Commercial package
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F/D Floppy disc
G/C Graphics card
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H/D Hard disc
I Introductory
int Interface
I/S Indexed sequential
K/B Keyboard
M/A Macro assembler
N/P Numeric pad
O/S Operating system
P/P Parallel port
S Software
S/P Serial port
TBA To be announced
T/E Text editor
T/P Text processor
U Utility
W/L Word length
W/P Word processor

Please note: Software items listed in *italic* are not included in the basic price of the equipment. All prices are *exclusive* of VAT

Machine (Price from)	Main Distributor/s (No. of dealers)	Hardware	Software	Documentation	Miscellaneous
TECS (£1,600)	Technalogics: 051 724 2695 (TBA)	16-56K RAM: 6800: 8K PROM: RS232 port: C int: option — dual 5¼" F/D (320K), £800	BASIC	H	256 char graphics: Prestel compatible: plugs into standard TV
TEI 208 (£4,400)	Abacus: 01-580 8841 (5)	32-60K RAM: 8080/8085: dual 5¼" F/D 320K: 9", 24x80 green VDU: 3 S/P: 3 P/P: 17"x18"10": option — 150cps printer, £1,250	CP/M: *BASIC: COBOL: FORTRAN: PASCAL: ALGOL: B/P*	H&S	
TEI 212 (£5,067)	As above	32-60K RAM: 8080/8085: dual 8" F/D (1MB): 15", 24x80 green VDU: 3 S/P: 3 P/P: 17"x20"x17": option — 150cps printer, £1,250	CP/M: *BASIC: COBOL: FORTRAN: PASCAL: ALGOL: B/P*	H&S	
TERODEC DPS 64/1-4 (£3,014)	Terodec (Microsystems) Ltd: 0344 51160 (TBA)	64K RAM: Z80: dual 8" F/D (1MB): 12", 24x80 b&w VDU: 2S/P 3P/P: options — dual 8" F/D (1MB), £1,150; dual 8" F/D (2MB), £1,455	CP/M: *BASIC: CBASIC: COBOL: FORTRAN: ALGOL: PASCAL: W/P: B/P: DATABASE*	H&S	TMZ 80 enhanced model in integral workstation £5,495, (with 4MB F/D); DPS 64 with 2MB F/D is £3,319
VECTOR GRAPHICS MZ (£2,300)	Almarc: 0602 248565 Sintrom Microshop 0734 84322 (5)	48K RAM: Z80: dual 5¼" F/D (630K): 1 S/P: 2 P/P: 20"x17"x8"	DOS: BASIC: A: *CP/M: CBASIC: COBOL: FORTRAN: PASCAL:*	E	4K PROM
VECTOR GRAPHICS SYSTEM B (£2,850)	As above	48K RAM: Z80: dual 5¼" F/D (630K): 12", 24x80 b&w VDU: 1 S/P: 2 P/P: 20"x17"x8"	DOS: BASIC A: *CP/M: CBASIC: COBOL: FORTRAN: PASCAL*	E	With graphics and N/P
ZENTEC (£5,700)	Zigal Dynamics: 0753 71049 (1)	32-64K RAM: 2x8080: dual 5¼" F/D (280K); 15", 25x80 b&w VDU: RS232 port: options — dual 5¼" F/D (280K, £600; dual 8" F/D (1MB), £2,100 RS422 port, £105	O/S: A: U: *BASIC: micro COBOL: W/P*	S	User programmable character set
ZILOG MCZ1/05 (£4,200 - portable)	Micropower: 0256 54121. Memec: 084421 5471 (n/a)	64K RAM: Z80: dual 8" F/D (600K): RS232 port	Rio O/S: M/A: U: T/E: *BASIC: COBOL: FORTRAN: PASCAL: B/P*	H&S	Debug in 3K PROM: also available as desk top unit or R/M model, both £4,800.
ZILOG MCZ1/35 (£1,200)	As above	64K RAM: Z80: 10MB H/D (5 fix, 5 rem): RS232 port	Rio O/S: M/A: U: T/E: *BASIC: COBOL: FORTRAN: PASCAL: B/P*	H&S	Internal disc control with own Z80
Z-PLUS (£4,000)	Rostronics: 01-874 3665 (TBA)	32-64K RAM: Z80: dual 8" F/D (1MB): 2 S/P: 2 P/P: 10"x29"x11"	CP/M: A: U: *BASIC: COBOL: FORTRAN: PASCAL: Database: B/P*	H&S	

SINGLE BOARDS

Machine (Price from)	Main Distributor/s (No. of dealers)	Hardware	Software	Documentation	Miscellaneous
ACORN (£65)	Acorn: 0223 312772 Microdigital: 051227 2535. Newbear: 0635 30505 (n/a)	1.1/8K RAM: 6502: EPROM socket: Hex K/B: C int: 8 digit LED display: up to 16 ports: options — Eurocard 64 way connector: VDU card: Full K/B card.	½K monitor: *Basic*	S&H	Kit: programmable address linking; on board 5V regulator: available assembled, £79.
AIM 65C (£265)	Pelco: 0273 722155 (4)	1-4K RAM: 6502: 12K ROM: full K/B: 20 char LED display: 20 char thermal printer: Cx2: RS232 port.	A: Dis A: T/E: 8K monitor in ROM	E	Available as S100 system with A or BASIC in ROM (£480) from Portable Micros (0280 702017): they also have briefcase version (£750)
CROMEMCO SC (£260)	Comart: 0480 30505 (17)	1K RAM: Z80A: 8K EPROM sockets: RS232 port: 3 P/P: option — S100 bus.	*Monitor and control BASIC in EPROM*	E	5 program interval timers: can put own BASIC programs in EPROM.

Machine (Price from)	Main Distributor/s (No. of dealers)	Hardware	Software/ Firmware	Documentation	Miscellaneous
ELF II (£114)	Newtronics: 01-739 1582 (15)	1/4K RAM: RCA 1802: Hex K/B: 2 digit LED: TV int: C int: RS232 port: options — 4K RAM, £69; full K/B; VDU card	1K monitor: A: Dis A: T/E: *BASIC: games*	H	TTY, n-line decoders: low resolution graphics (high resolution available), kit.
EXPLORER (£295)	Newtronics: 01-739 1582 (15)	4K RAM: 8085: Hex K/B: RS232 port: S100 bus: C int: options — 6 slot S100, £32; 8K EPROM sockets, £50	2K monitor: *CP/M: BASIC*	S&H	Programmable 14 bit counter: kit
H8 (£262)	Heath: 0452 29451 (TBA)	4K RAM: 8080A: Octal K/B: 6 digit LED: speaker: options — single 5¼" F/D (102K), £399; 16K RAM, £314; C int, £72	1K monitor: *BASIC in RAM: FORTRAN: T/E: A: U: games.*	S&H	Kit
HEWART 6800S (£299)	Hewart: 0625 22030 (n/a)	16K RAM: 6800: full K/B: VDU int: 2xC int: 1 S/P: 2 P/P: option — 16K RAM, £90.	1K monitor: A: T/E	H	Can be upgraded with 6809.
HEWART 6800 Mk III (£152)	As above	1K RAM: 6800: VDU board: options — single 5¼" F/D (75K), £350; PROM programmer, £32: calculator board, £32	1K monitor	H	
Mk 14 (£39.95)	Science of Cambridge: 0223 311488 (n/a)	8060: 1/4-2K RAM: Hex K/B: 7 char LED: options — VDU int (32x16 with graphics), £29; C int, £6; PROM prog, £10, 2K memory expansion, £15	Machine code	H	Designed for control applications rather than high level computing expansion.
NASCOM 1 (£165)	Nascom: 02405 75155 (20)	4K RAM: Z80: full K/B: TV int: 2 P/P: 1 S/P	2K monitor: *BBASIC: tiny BASIC: A: T/E: U*	S&H	Now available as Nascom 2 with 8K RAM and 8K microsoft BASIC in ROM, £295
SBC 100 (£135)	Airamco: 0294 57755 (11)	1K RAM: Z80: 8K ROM: S100 bus: 1 S/P: 1 P/P: option — voltage regulator.	*1K monitor: DOS in ROM*	E	Kit: available assembled, £196
SUPER-BOARD (£188)	NBM: 01-981 3993 (n/a)	4-8K RAM: 6502: 10K ROM: full K/B: VDU int: C int: options — RS232; single 5¼" F/D (100K), £316; 8K RAM, £188	BASIC in 8K ROM: *games: B/P: Database*	S&H	Available with 32K RAM and single 5¼" F/D, £867
SYM-1 (£160)	Newbear: 0635 30505 (n/a)	1-4K RAM: 6502: Hex K/B: 244 bps C int: VDU int: 2x6522 ports: option — TV int.	4K monitor: *BASIC: A*	S&H	Can be expanded to 64K RAM
TRITON 4.1 (£286)	Transam: 01-402 8137 (n/a)	2K RAM: 8080: 3K ROM: full K/B: 16x64 VDU or TV int: C int: 1 S/P: option — 2K RAM, £30	1K monitor: 2K BASIC: U	S&H	64 character graphics: 8 levels interrupt: kit
TRITON 5.1 (£294)	As above	2K RAM: 8080: 4K ROM: full K/B: 16x64 VDU or TV int: C int: 1 S/P: C: options — 8K RAM, £97; 8K EPROM, £97	1K monitor: 2K ExBASIC: U	S&H	Kit:assembled version, £393
TRITON 6.1 (£399)	As above	2K RAM: 8080: 4K ROM: full K/B: 16x64 VDU or TV int: C int: 1 S/P: C: options — 8K RAM, £97; 8K EPROM, £97	2K monitor: 7K scientific BASIC in 8K EPROM or A: Dis A: U	S&H	Either firmware package available for extra £110: CP/M compatible disc interface available soon.
UK 101 (£219)	Computer Shop: 01-440 7033	4K RAM: 6502: full K/B: 16x48 VDU or TV int: C int: RS232 port: option — 4K RAM, £49	1K monitor: 8K BASIC: *Dis A: U*	S&H	Graphics: will run Superboard software.

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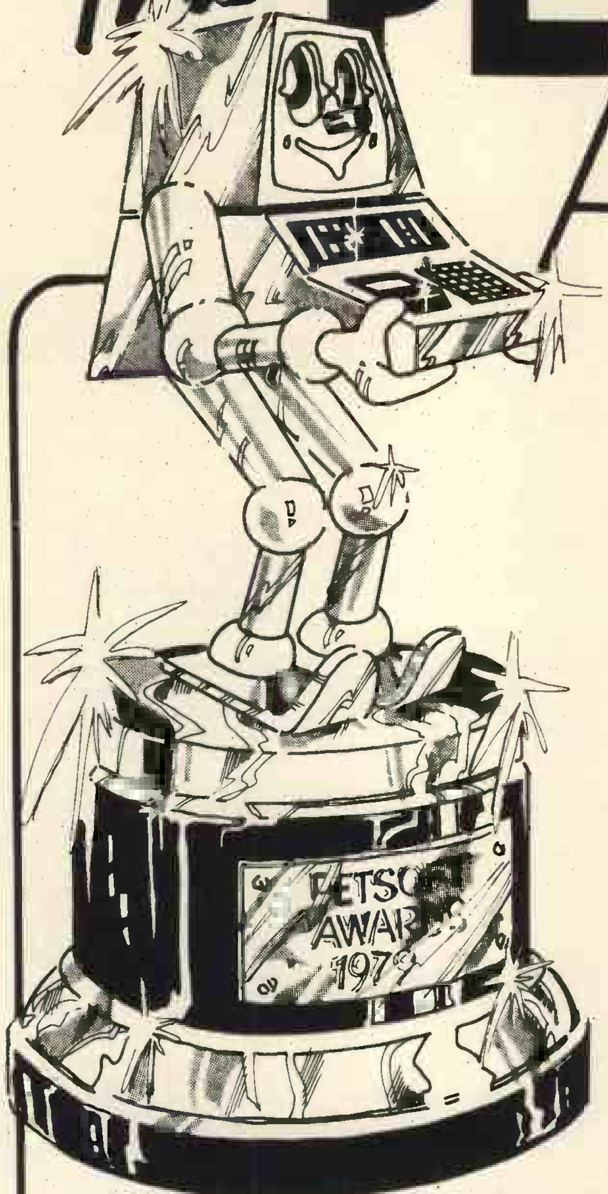
int Interface
I/S Indexed sequential
K/B Keyboard
M/A Macro assembler
N/P Numeric pad
O/S Operating system
P/P Parallel port
S Software
S/P Serial port
TBA To be announced
T/E Text editor
T/P Text processor
U Utility
W/L Word length
W/P Word processor

Please note: Software items listed in *italic* are not included in the basic price of the equipment. All prices are *exclusive* of VAT

the PETSOFT AWARDS



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4. PET BASIC TUTORIAL **£15** Let PET teach you how to program in BASIC.
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I have a new/old ROM PET I have NO PET

DIRECT ACCESS

USER GROUPS INDEX

PCW will next be publishing a full list of clubs and user groups in its April edition. Month by month, however, we shall continue to notify readers of updates and additions.

NATIONAL

Amateur Computer Club — 2650 Library. No meetings, no newsletters, the library serves to act as a help point for disseminating 2650 related data on demand. Contact Roger A. Munt, 51 Beechwood Drive, Feniscowles, Blackburn, Lancs BB2 5AT (0254 22341).

Minicomputer Users in Secondary Education (MUSE). MUSE is the national organisation for coordinating activity in schools, teacher training institutions, colleges of technology and so on. Meetings are held on both a regional and national basis. For full details on MUSE's range of activities, contact the Treasurer, R. Trigger, 48 Chadcote Way, Catshill, Bromsgrove, Worcestershire.

COUNTY DURHAM

Northeast PETS. Contact: Jim Cocallis, 20 Worcester Road, Newton Hall Estate, Durham. They meet the 2nd Monday of each month for software tuition and the 3rd Monday for hardware tuition (both in addition to normal activities). They start at 7.00pm and meet in the PET Lab, Newcastle Polytechnic, Ellison Building, Newcastle upon Tyne.

YORKSHIRE

Shipley College Computer Group (Sorcerer/6800). They meet Tuesdays (software) and Wednesdays (hardware/advanced) between 7.00 & 9.00 pm. Contact Paul Channell on Shipley 595731.

West Yorkshire Microcomputer Group. Formed following an inaugural meeting on October 23rd, a varied diary of events has been drawn up. For details contact the Chairman, Phillip Clark, Care Computer Services, 15 Wellington Street, Leeds LS1 4DL (0532 450667) OR the Secretary, Keith Knaggs, Price Waterhouse & Co., Leeds (0532 448741).

DIARY DATA

Birmingham, England	TV MEX. Montbuild Ltd., 11 Manchester Sq., London W1M 5AB. Tel: 01-486 1951	Jan 15 - Jan 17
Wembley, England	Microsystems '80 Exhibition & Conference. Iliffe Promotions Ltd., Dorset House, Stamford St., London SE1 9LU. Tel: 01-261 8000.	Jan 30 - Feb 1
Leeds, England	BEX — Business Equipment Exhibition. Douglas Temple Studios Ltd., 104b Old Christchurch Rd., Bournemouth, Dorset. Tel: 0202 20533	Feb 6 - Feb 7
Solihull, England	Mini Computers, Word Processors & Copying Machines Exhibition. Groundrule Exhibition Company, 7 Market Street, Altrincham, Cheshire WA14 2QW. Tel: 061 928 2227	Feb 12 - Feb 13
London, England	Business Computing, Word Processing & Information Mgt., Exhibition & Conference. BED Exhibitions Ltd., Bridge House, Restmor Way, Wallington, Surrey. SM6 7BZ. Tel: 01-647 1001	Feb 12 - Feb 15
Wembley, England	IMEC — European Information Management Exhibition & Conference. Clapp & Poliak Europe Ltd., 232 Acton Lane, London W4 5DL. Tel: 01-995 4806	Feb 18 - Feb 21
Bournemouth, England	BEX — Business Equipment Exhibition. Douglas Temple Studios Ltd., 104b Old Christchurch Rd., Bournemouth, Dorset, Tel: 0202 20533	Feb 20 - Feb 21
Swansea, Wales	OFFEX — Office Equipment Exhibition. Phoenix Exhibitions Ltd., 1st Floor, Burrows Crambers, East Burrows Rd., Swansea. Tel: 0792 460364	Feb 20 - Feb 22
Birmingham, England	IEA — International Instruments, Electronics & Automation Exhibition. Industrial & Trade Fairs Ltd., Radcliffe House, Blenheim Court, Solihull, West Midlands, B91 2BD. Tel: 021 705 6707	Feb 25 - Feb 29
Birmingham, England	Computermarket '80, Couchmead Ltd, 42 Great Windmill Street, London W1V 7PA. Tel: 01-437 4187	Mar 4 - Mar 6
Liverpool, England	Mersey Micro Show. Online Conferences Ltd., Cleveland Road, Uxbridge UB8 2DD. Tel: 0895 39262	April 30 - May 2
London, England	Microcomputer Show. Online Conferences Ltd., Cleveland Road, Uxbridge UB8 2DD. Tel: 0895 39262	July 22 - July 24
Birmingham, England	Computer Graphics '81 Exhibition. Online Conferences Ltd., Cleveland Road, Uxbridge UB8 2DD. Tel: 0895 39262	Aug 11 - Aug 13

TRANSACTION FILE

For sale

MK.14. . . extra RAM, single step, cassette interface, 2 PSUs, data sheets, manual, Greenwood Programming the SC/MP, Sybex Introduction to Microcomputers, needs replacement for keyboard, also early articles on Mk.14 — will deliver within reasonable distance of Preston, Lancs. Phone Preston 55591 evenings & weekends.

Teletype KSR33. . . 20mA current loop, auto stop/start with full manuals, extra paper ribbons & spares — £120.

Triton Computer. . . full on-board 8K inc V5 basic, less keyboard — only £150. Magnay — Tel. Abingdon 834402 (Oxon).

15 Dynamic RAM Chips. . . MK 4027N-4, £25 the lot. Also expansion for SWTP 6800 systems parallel interface board MP-LA and calculator interface board (number cruncher) MP-N: both built and tested but unused, £30 each. Phone Wakefield (0924) 62848 after 6pm or weekends.

Nascom 1. . . expansion bus, buffer board, 8K memory board, CC Soft level B BASIC, B-Bug, Nascrunch arithmetic processor board — £250. Phone 061-436 4727

Apple ITT 2020. . . 32K RAM, 6 months old and 3 easy to follow manuals, Applesoft BASIC, Reference full of games. Plus automatic cassette recorder, tapes with 30 various programs, box and packing — £825 o.n.o. Phone Warrington (0925) 811191.

PET 2001-8K. . . as new, only used at home, plus some games and manuals — £485 o.n.o. Phone 01-992 6424, evenings and weekends.

Character Generators. . . 2513 — CM2140 (U.C.) and 2513-CM3021 (L.C.) — £8 per pair or singles @ £4.50. 30 sets available, Chris Rees, 289 Quilter Road, Basingstoke, Hants. Phone 0256 23668.

Mk.14. . . extra RAM, fully socketed, revised monitor, cassette interface, single step, new keyboard and expensive SC/MP documentation. All bus lines brought out to a second plug-in board for easy expansion. PSU required (extra) — £65. Robin Lowis — phone Bristol 293701.

AIM 65. . . complete with 4K RAM, assembler ROM, edge connectors, original packing and full documentation. Fully operational, offers around £300. Phone Nelson (0282) 693029 after 6pm.

Verbatim Soft Sector Discs. . . 5¼", unopened box of ten for £20. Ten used very briefly, sold singly at £1.90 each. Phone Pershore 4352.

Kim 1. . . ASCII keyboard plus 1K of add-on memory — will split — £120 o.n.o. Contact Radio Society QMCSU. Phone 01-980 1240/5303.

Nascom 1. . . with 8K expansion, buffer board, PSU and B-Bug monitor. Full working order and all neatly finished in Verocase with programs on cassette, documentation, £275 o.n.o. Phone Tenbury Wells (Worcs) 810015 evenings.

PDP 8i. . . with 8K core store, in rack with PSU. Offers to Mr J. Haigh, Commonwealth Hall, Cartwright Gardens, London WC1H 9EB. Must sell, all reasonable offers replied to.

Motorola M6800 D2 Development Kit . . . extra RAM on board, excellent working order, full documenation and extra 8K RAM board thrown in — all for £100. Phone Jim on Garston (Herts) 79973, evenings.

Casio FX-502P. . . as new, plus Casio FA-1 adapter for taping programs, program library, manuals, keyboard overlays, tape, etc. All boxed and as illustrated in PCW October issue (page 50), I'm buying a larger computer — £70 the lot o.n.o. Phone 01-539 1243.

Triton Computer. . . including programs, cassette, extended Tiny BASIC. Ready built and tested for only £185 (run at 18 MHz). Phone 01-859 0323.

Nascom 1. . . built and tested by Nascom and fitted with the latest NAS-SYS 1 2K monitor. Full documentation and PSU — £175 o.n.o. Phone Colchester 74791, evenings.

Centronics 700 Printer. . . with RS232 board, line length programmable to 132 chars., standard and double width characters — £450 o.n.o. Phone Dave on 01-460 2580, evenings.

Pye 'Ceefax/Oracle' news/information unit. . . with keyboard, for any colour TV — only £240.

Sinclair 2" micro TV. . . unused, with accessories — £60.

PET 200-8K. . . with programs, excel-

TRANSACTION FILE

DIRECT ACCESS

lent condition — £435.

IEEE/RS232 Serial Interface B. . . input/output for PET, cost £205, sell £140.

Teletype 'ASR33'. . . terminal/printer RS232 interface, as new, not clapped out — £450 (stand available). Phone Medway (0634) 53127, evenings.

Triton. . . 8080 based machine, built & working with revised L5.1 monitor & upgraded clock, 4K RAM and Tiny BASIC in ROM. All documentation included — £250. Contact John Wheatley at 12 Shakespeare Road, Harpenden, Herts — phone Harpenden 63593.

Mk.14. . . with RAM I/O, extra RAM, tape interface, PROM programmer, PSU, 21 keyboard, full documentation, professionally cased into desk-top unit, size 11"x8½"x3¾" (sloped front), with room for 2K expansion and VDU Interface — £63. Phone 08444 4537.

Teleprinter '54'. . .Baudot coded, full instruction KB: and printer T 50 baud interface v.g.c. — £55 o.n.o. Mark Wyllie on Hertford 59081.

Sinclair Cambridge Programmable. . . with full instructions, Duracell battery, Sinclair & Personal Program Library — £9 o.n.o. plus £1.00 postage. Martin Fisher, 10 Cusworth Lane, Doncaster, S. Yorks DN5 8YL.

SWTP PR40 Printer. . . adapted for Sorcerer, but suitable for any 8-bit parallel interface — £120.

KSR 33 Westrex Teletype. . . with 20mA loop — £100.

Sorcerer 32K. . . with all leads, manuals and software library. Has additional facility for 110 baud RS232 transmission; 6 months old, excellent condition — £635. Phone Omagh (0662) 2109.

Complete Chip Set. . . for 8085 system, includes 8085, (2) 8212, (2) 8224, (8) 21L02 (350ns), 16 minature toggle switches (with hardware), sockets for all chips — first £40 takes it. Also a few LM3914 bar graph display drivers — £2.50 each. All chips prime quality; D.Wolf Ph.D., 15 Princess Road, London NW1.

Powertran Comp-80. . . full on-board RAM (5K), BASIC, graphics with graph plotting functions, complete with TV monitor and cassette recorder. Fully built and working, offers around £295. Phone Tim Brown on Stafford 850244.

Triton. . .professionally built, complete with case and manual, perfect order — £210. Phone Basingstoke (0256) 29623.

Triton. . . full documentation, cased, RS232 interface, full on-board RAM, V5.1 monitor and L5.1 BASIC with editing facilities — £350 o.n.o. Also expansion motherboard, built and including extra 74LS 245's — £50. Phone Steve on Andover (Hants) 66681.

LSI 11. . . micro for sale to highest offer; complete with 20K RAM, power supply and programming manual. Also optional desk available! Alternatively will exchange for goods — anything considered, not necessarily computer equipment. Phone Mike Stanley on Wrexham (0978) 261121.

Sinclair Cambridge Programmable Calculator. . . and full, four volume program library for sale; mint condition — £12 only. Contact Terry Cymbalisty, 45 St Lesmo Road, Edgeley, Stockport, SK3 0TX — Phone 061 0527, evenings.

Texas TI-59. . . plus PC100-C print cradle. Programmable calculator Includes 960 prog. steps, 100 memories and magnetic card reader. Also latest printer capable of alphanumerics. Both items less than 9 months old — owner is upgrading. Price £199 for the pair, but separate sale considered. Phone 01-368 2762, evenings.

ROM Chips. . . two MM5204Q with ETIBUG 1 and 2 (or blank), £4 each; 2513 uc, £3; DM8 678 CAB/N, £7. Contact S. Ross, 44 Premier Avenue, Grays, Essex.

SWTPC 6800. . . 4K static RAM board (S50 bus) — £40. Phone 01-550 8965.

Compucorp 265E Accountant. . . learn mode programmer for 256 steps; ten data storage registers; prints up to 14 digits. Complete with card reader for programming (or it can be programmed from keyboard). Phone Telford 3490.

Digital Equipment Corp. RT01 Data Terminals. . . less display boards and displays (2 available), 110 baud, RS232 and teletype interface, £40 each or £70 the two. Also consolidated computers terminal (inc. VDU), £100 — all with circuits. Details, phone Ru on 01-837 8855, extn 222, weekdays.

Super Nascom 1. . . extended with 18K RAM, 2400 baud cassette interface, 8K BASIC on tape. Housed in Veroframe with keyboard in professional case. All this and lots of software for £320. Phone Dave Link on 01-340 9882.

ELF 11. . .system with giant board, 8K RAM, VID, ASCII board, heavy duty PSU, in ELF cabinets. Fully socketed and professionally checked in good woking order. also Tiny BASIC, 16 games on tapes, Full documentation, cost over £500, best offer buys. Phone 01-560 0793.

PET 2001-8K. . .as new, green screen, BASIC BASIC tape, manuals of instruction and various taped games — £475. 6 weeks old, perfect condition. Phone 01-668 6155.

Texas 9900. . . 16-bit micro board, double Eurocard — £100 o.n.o. (see March '79 PCW). Contact Mark Wirt, 12 Alleyn Crescent, London SE21; phone 01-670 4819.

TI-58. . . programmable calculator, 480 steps, 60 memories — £60 o.n.o. including mains adaptor, master and statistics libraries. Contact Brian Holley on Hoddesdon 66573, evenings or weekends.

Wanted

Triton Users. . . help! — L6 BASIC PROM listing required (18MHz version). Contact Stevenage 62680 anytime.

Home Computer. . . TRS-80 Level 2 4K/16K keyboard or Tandy preferred. Other ROM BASIC Systems, built kits etc. considered. Upper limit, £450. Phone G. Born on Worcester 421631.

FAX

DIRECT ACCESS

The 6800 Mnemonics arranged by op code

LSB / MSB	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
0	*	NOP (INH)	*	*	*	*	TAP (INH)	TPA (INH)	INX (INH)	DEX (INH)	CLV (INH)	SEV (INH)	CLC (INH)	SEC (INH)	CLI (INH)	SEI (INH)	0
1	SBA	CBA	*	*	*	*	TAB (INH)	TBA (INH)	*	DAA (INH)	*	ABA (INH)	*	*	*	*	1
2	BRA (REL)	*	BHI (REL)	BLS (REL)	BCC (REL)	BCS (REL)	BNE (REL)	BEQ (REL)	BVC (REL)	BVS (REL)	BPL (REL)	BMI (REL)	BGE (REL)	BLT (REL)	BGT (REL)	BLE (REL)	2
3	TSX (INH)	INS (INH)	PUL (A)	PUL (B)	DES (INH)	TXS (INH)	PSH (A)	PSH (B)	*	RTS (INH)	*	RTI (INH)	*	*	WAI (INH)	SWI (INH)	3
4	NEG (A)	*	*	COM (A)	LSR (A)	*	ROR (A)	ASR (A)	ASL (A)	ROL (A)	DEC (A)	*	INC (A)	TST (A)	*	CLR (A)	4
5	NEG (B)	*	*	COM (B)	LSR (B)	*	ROR (B)	ASR (B)	ASL (B)	ROL (B)	DEC (B)	*	INC (B)	TST (B)	*	CLR (B)	5
6	NEG (IND)	*	*	COM (IND)	LSR (IND)	*	ROR (IND)	ASR (IND)	ASL (IND)	ROL (IND)	DEC (IND)	*	INC (IND)	TST (IND)	JMP (IND)	CLR (IND)	6
7	NEG (EXT)	*	*	COM (EXT)	LSR (EXT)	*	ROR (EXT)	ASR (EXT)	ASL (EXT)	ROL (EXT)	DEC (EXT)	*	INC (EXT)	TST (EXT)	JMP (EXT)	CLR (EXT)	7
8	SUB (A) (IMM)	CMP (A) (IMM)	SBC (A) (IMM)	*	AND (A) (IMM)	BIT (A) (IMM)	LDA (A) (IMM)	*	EOR (A) (IMM)	ADC (A) (IMM)	ORA (A) (IMM)	ADD (A) (IMM)	CPX (A) (IMM)	BSR (REL)	LDS (IMM)	*	8
9	SUB (A) (DIR)	CMP (A) (DIR)	SBC (A) (DIR)	*	AND (A) (DIR)	BIT (A) (DIR)	LDA (A) (DIR)	STA (A) (DIR)	EOR (A) (DIR)	ADC (A) (DIR)	ORA (A) (DIR)	ADD (A) (DIR)	CPX (A) (DIR)	*	LDS (DIR)	STS (DIR)	9
A	SUB (A) (IND)	CMP (A) (IND)	SBC (A) (IND)	*	AND (A) (IND)	BIT (A) (IND)	LDA (A) (IND)	STA (A) (IND)	EOR (A) (IND)	ADC (A) (IND)	ORA (A) (IND)	ADD (A) (IND)	CPX (A) (IND)	JSR (IND)	LDS (IND)	STS (IND)	A
B	SUB (A) (EXT)	CMP (A) (EXT)	SBC (A) (EXT)	*	AND (A) (EXT)	BIT (A) (EXT)	LDA (A) (EXT)	STA (A) (EXT)	EOR (A) (EXT)	ADC (A) (EXT)	ORA (A) (EXT)	ADD (A) (EXT)	CPX (A) (EXT)	JSR (EXT)	LDS (EXT)	STS (EXT)	B
C	SUB (B) (IMM)	CMP (B) (IMM)	SBC (B) (IMM)	*	AND (B) (IMM)	BIT (B) (IMM)	LDS (B) (IMM)	*	EOR (B) (IMM)	ADC (B) (IMM)	ORA (B) (IMM)	ADD (B) (IMM)	*	*	LDX (IMM)	*	C
D	SUB (B) (DIR)	CMP (B) (DIR)	SBC (B) (DIR)	*	AND (B) (DIR)	BIT (B) (DIR)	LDA (B) (DIR)	STA (B) (DIR)	EOR (B) (DIR)	ADC (B) (DIR)	ORA (B) (DIR)	ADD (B) (DIR)	*	*	LDX (B) (DIR)	STX (B) (DIR)	D
E	SUB (B) (IND)	CMP (B) (IND)	SBC (B) (IND)	*	AND (B) (IND)	BIT (B) (IND)	LDA (B) (IND)	STA (B) (IND)	EOR (B) (IND)	ADC (B) (IND)	ORA (B) (IND)	ADD (B) (IND)	*	*	LDX (IND)	STX (IND)	E
F	SUB (B) (EXT)	CMP (B) (EXT)	SBC (B) (EXT)	*	AND (B) (EXT)	BIT (B) (EXT)	LDA (B) (EXT)	STA (B) (EXT)	EOR (B) (EXT)	ADC (B) (EXT)	ORA (B) (EXT)	ADD (B) (EXT)	*	*	LDX (EXT)	STX (EXT)	F
	0	1	2	3	4	5	6	7	8	9	A	B	C		E	F	

DIR = Direct Addressing Mode, EXT = Extended Addressing Mode, IMM = Immediate Addressing Mode, IND = Index addressing Mode, INH = Inherent Addressing Mode, REL = Relative Addressing Mode, A = Accumulator A, B= Accumulator B.

STAR WARS

```
10      !!!! 'STAR WARS' BY SIMON AINSWORTH , MANCHESTER GRAMMAR SCHOOL !!!!
20      &CHR$(24%):&:&
30      &"                              DEATHSTAR ATTACK"
40      &"                              ******************":&:&
50      &"                        A 'STAR WARS' COMPUTER GAME":&:&
60      ON ERROR GOTO 990
70      Y$=SYS(CHR$(6%)+CHR$(-7%)):INPUT"   DO YOU REQUIRE INFORMATION";A1$
80      IF ASCII(A1$)<>89% AND ASCII(A1$)<>121% GOTO 130
90      &CHR$(24%):J%=1%:K%=16%:GOSUB 930        !PAGE 1 OF HELP TEXT
100     &"   WHEN YOU HAVE READ THAT PRESS 'RETURN'":OPEN "KB:" AS FILE 2%
110     INPUT £2% A1$:CLOSE 2%
120     &CHR$(24%):J%=17%:K%=27%:GOSUB 930       !PAGE 2 OF HELP TEXT
130     &:INPUT"   ARE YOU AN EXPERIENCED PILOT";A1$
140     IF ASCII(A1$)<>89% AND ASCII(A1$)<>121% GOTO 170
150     &CHR$(24%):J%=28%:K%=31%:GOSUB 930       !TIE FIGHTERS WARNING
160     K1%=1%:SLEEP 8%
170     RANDOM:X=1500%+INT(1000%*RND):RANDOM:Y=-15500%+INT(1000%*RND)
180     Z=2000%:K2,K3=1%:V1=100%:N1%=1%:B1=-45%
190     &CHR$(24%):&:&:&CHR$(14%),"                PROGRESS REPORT NO."N1%
200     &:B3=B1:GOSUB 470
210     B2$=B4$:B3=ATN(X/Y)*180%/PI:GOSUB 470
220     B3$=B4$:&"X POSITION        :"X"M.":&"Y POSITION       :"Y"M."
230     &"ALTITUDE          :"Z"M.":R=INT(SQR(X*X+Y*Y+Z*Z))
240     &"HEADING           :"+B2$:&"PITCH                 :"P1"DEG."
250     &"VELOCITY          :"V1"M/S":&"THROTTLE           :"A1+1%
260     &"TARGET RANGE      :"R"M.":&"TARGET BEARING :"+B3$
270     &:&"COURSE & THROTTLE CHANGES"
280     INPUT"HEADING CHANGE, STARBOARD +VE";B2
290     INPUT"PITCH CHANGE, CLIMB +VE";P2
300     INPUT"THROTTLE CHANGE";A2:IF K1%=1% THEN GOSUB 550
310     IF ABS(B2)>30%*K2 THEN B2=SGN(B2)*30%*K2
320     IF ABS(P2)>30%*K2 THEN P2=SGN(P2)*30%*K2
330     IF ABS(A2)>5%*K3 THEN A2=SGN(A2)*5%*K3
340     B1=B1+B2:P1=P1+P2:A1=A1+A2:IF A1>5% GOTO 890 ELSE IF A1<-1% THEN A1=-1%
350     S=V1*10%+A1*1000%:V2=V1+A1*100%:B4=B1*PI/180%:P4=P1*PI/180%
360     IF S>0% GOTO 380
370     &"  THE DEATHSTAR DEFENCE SCREENS ARE PULLING YOU DOWN...":GOTO 870
380     X1=X+S*COS(P4)*SIN(B4):Y1=Y+S*COS(P4)*COS(B4)
390     Z1=Z+S*SIN(P4):IF Z1<=-100% GOTO 870
400     IF Z1<=0% AND ABS(X1)>=20% GOTO 870 ELSE IF Z1=Z GOTO 430
410     K9=Z1/(Z1-Z):IF K9>1% OR K9<0% GOTO 430
420     IF ABS(X1+K9*(X-X1))>20% GOTO 870
430     IF Y1>=0% GOTO 660
440     X=X1:Y=Y1:Z=Z1:V1=V2:A3=A3+A1+1%:N1%=N1%+1%
450     IF A3>20% GOTO 910 ELSE GOTO 190
460     !ANGLE SUBROUTINE
470     IF B3<0% THEN B3=B3+360%:GOTO 470
480     IF B3>360% THEN B3=B3-360%:GOTO 480
490     B3=FIX(B3*10%)/10%
500     IF B3=0% THEN K8%=2% ELSE IF B3<1% THEN K8%=3%
510     B4$="":IF B3>=1% THEN K8%=2%-INT(LOG10(B3))
520     B4$=B4$+"0" FOR I%=1% TO K8%:IF B3>=0% THEN B4$=" "+B4$
530     B4$=B4$+RIGHT(NUM$(B3),2%):RETURN
540     !TIE FIGHTER SUBROUTINE
550     RANDOM:IF RND<.85 THEN RETURN
560     N2%=N2%+1%:IF N2%=5% GOTO 630
570     K2=N2%*-.05+1%:K3=N2%*-.08+1%
580     RANDOM:IF RND<.25 GOTO 610
590     J%=39%:K%=39%:GOSUB 930                   !LASER HIT WARNING
600     RETURN
610     J%=40%:K%=41%:GOSUB 930                   !LUCKY HIT
620     GOTO 970
630     J%=42%:K%=43%:GOSUB 930                   !5TH HIT
640     GOTO 970
650     !OVER TARGET ROUTINE
660     K4=Y1/(Y1-Y):X2=X+K4*(X1-X)
670     IF ABS(X2)>10% GOTO 850
680     IF ABS(B1)>5% OR ABS(P1)>5% GOTO 800
690     Z2=Z+K4*(Z1-Z):IF Z2>=0% GOTO 850 ELSE IF Z2>=-50% GOTO 830
700     J%=44%:K%=46%:GOSUB 930                   !OVER TARGET ON COURSE
710     &"1600M. TO TORPEDO RELEASE POINT...":SLEEP 2%:&
720     IF K1%=1% THEN GOSUB 550
730     &"1200M. TO TORPEDO RELEASE POINT...":SLEEP 2%:&
740     &"800M....":SLEEP 2%:&:&"400M....":SLEEP 1%:&
750     IF K1%=1% THEN GOSUB 550
760     &"200M....":SLEEP 1%:&:IF K1%=1% THEN GOSUB 550
770     &"                     KERPOW!!!"+CHR$(7%)+CHR$(7%)+CHR$(7%)
780     J%=47%:K%=51%:GOSUB 930                   !END OF DEATHSTAR
790     GOTO 970
800     J%=52%:K%=55%:GOSUB 930                   !OVER TARGET,WRONG TRAJECTORY
810     IF A3<=15% THEN J%=56%:K%=57%:GOSUB 930 !SUCCESSFUL REPEAT APPROACH
820     IF A3>15% GOTO 910 ELSE GOTO 710
830     J%=58%:K%=60%:GOSUB 930                   !TOO HIGH
840     GOTO 810
850     J%=61%:K%=63%:GOSUB 930                   !TOTALLY UNSUITABLE TRAJECTORY
860     GOTO 970
870     J%=37%:K%=38%:GOSUB 930                   !CRASH
880     GOTO 970
890     J%=35%:K%=36%:GOSUB 930                   !ENGINES
900     GOTO 970
910     J%=32%:K%=34%:GOSUB 930                   !NO FUEL
920     SLEEP 1%:GOTO 870
930     OPEN"SWARS.TXT"AS FILE 1%:INPUT LINE £1% A$ FOR I%=1% TO J%-1%
940     &:FOR I%=J% TO K%:INPUT LINE £1% A$
950     &LEFT(A$,LEN(A$)-2%):NEXT I%
960     CLOSE 1%:&:RETURN
970     INPUT"   DO YOU WANT TO PLAY AGAIN";A1$
980     IF ASCII(A1$)=89% OR ASCII(A1$)=121% THEN CHAIN"SWARS"
990     Z$=SYS(CHR$(0%)):CLOSE 1%:&"PROGRAMME TERMINATED...":END
```

YOU ARE THE PILOT OF A REBEL X-WING FIGHTER, CARRYING A PROTON TORPEDO WITH WHICH TO ATTACK THE GIANT ARTIFICIAL PLANET, THE DEATHSTAR, WHICH THE TYRANT, GRAND MOFF TARKIN, IS USING TO TERRORISE THE GALAXY. YOUR OBJECTIVE IS TO FLY YOUR FIGHTER TO A TRENCH IN THE STAR'S SURFACE, FLY ALONG IT AND LAUNCH THE TORPEDO INTO A VENT SHAFT LEADING TO THE DEATHSTAR'S NUCLEAR REACTORS.

TO LAUNCH THE TORPEDO AT PRECISELY THE RIGHT INSTANT YOUR FIGHTER'S NAVIGATIONAL SYSTEMS MUST BE CALIBRATED 2000M. FROM THE VENT BY FLYING OVER A CALIBRATION TARGET WHOSE POSITION RELATIVE TO THE VENT IS KNOWN. THIS TARGET IS 20M. WIDE AND 50M. LONG AND IS CENTRED ON CO-ORDINATES (0,0). IF, WHEN YOU FLY OVER THE TARGET, YOUR PITCH AND HEADING ARE WITHIN 5 DEGREES OF ZERO, AND YOU ARE WITHIN 50M. OF THE FLOOR OF THE TRENCH, WHICH IS 40M. WIDE AND 100M.

PCW is always on the lookout for original programs

```
DEEP, YOUR INBOARD COMPUTER WILL TAKE OVER AND COMPLETE THE MANOEUVRE. NOTE:
THE TRENCH IS REALLY 48M. WIDE, BUT SINCE YOUR FIGHTER HAS A WINGSPAN OF 8M, IT
CAN BE ASSUMED THAT YOU ARE A POINT MASS WITHIN A TRENCH 40M. WIDE.
   INITIALLY YOU ARE HEADING ON A BEARING OF 315 WITH ZERO PITCH AT 100M/S,
AN ALTITUDE OF 2000M. AND AT APPROXIMATELY (2000,-16000), IE. 2000M. STARBOARD
OF THE Y-AXIS (THE TRENCH) AND 16000M. ALONG IT FROM THE CALIBRATION TARGET.
   TO ASSIST YOU YOUR POSITION ON THE X-Y GRID, ALTITUDE, HEADING, PITCH,
VELOCITY, THROTTLE SETTING, TARGET RANGE AND TARGET BEARING ARE GIVEN AT
INTERVALS OF 10 SECS. YOU CONTROL YOUR HEADING, PITCH AND THTOTTLE SETTING.
THE UNITS OF THROTTLE SETTING APPROXIMATE TO EARTH 'G'S. A SETTING OF 1 OR
MORE WILL ACCELERATE YOUR SHIP, LESS THAN 1 AND THE DEATHSTAR'S DEFENCE
SCREENS WILL SLOW YOU DOWN.
   WARNING! THE DEATHSTAR WILL LAUNCH TIE FIGHTERS AGAINST EXPERIENCED PILOTS.
YOUR HIT INDICATOR WILL INFORM YOU OF LASER STRIKES AGAINST YOUR SHIP.
   THE TIE FIGHTER PILOTS HAVE BEEN NOTIFIED THAT YOU ARE AN EXPERIENCED PILOT.
THEY WILL HUNT YOU OUT AND LAUNCH UNEXPECTED ATTACKS AGAINST YOU. YOUR SHIP
CAN SURVIVE ONLY 4 SUCCESSFUL HITS TO ITS HULL OR ENGINES. EVERY HIT WILL REDUCE
MANOEUVRABILITY AND ACCELERATION.
   YOUR FIGHTER IS LOW ON FUEL. INBOARD COMPUTER CALCULATES THAT YOU HAVE
INSUFFICIENT FUEL TO COMPLETE THE MANOEUVRE AND HAS BROKEN OFF ATTACK TO RETURN
TO BASE. BETTER LUCK NEXT TIME.
   CONGRATULATIONS! YOU JUST BLEW YOUR ENGINES TO PIECES AND ARE DIVING OUT OF
CONTROL INTO THE DEATHSTAR!
   YOU JUST PILED INTO THE DEATHSTAR. KAMIKAZE TACTICS WENT OUT WITH PISTON
ENGINED FIGHTERS! TRY NOT TO BE SO ENTHUSIASTIC NEXT TIME!
   TIE FIGHTER ATTACK! LASER STRIKE ON SHIP.
   A LUCKY HIT! TIE FIGHTER HAS GOT UNDER YOUR SHIELDS AND WRECKED YOUR SHIP
WITH A SINGLE BURST.
   THAT WAS THE FIFTH STRIKE ON YOUR SHIP. YOUR SHIELDS HAVE BEEN PENETRATED
AND YOUR SHIP WRECKED.
   OVER TARGET!!
   INBOARD COMPUTER REPORTS FIGHTER ON COURSE FOR VENT SHAFT. COMPUTER HAS
TAKEN OVER CONTROLS AND WILL RELEASE TORPEDO. MAY THE FORCE BE WITH YOU.
   CONGRATULATIONS! YOU HAVE SUCCESSFULLY ANNIHILATED THE DEATHSTAR AND SAVED
THE GALAXY FROM THE EVIL CLUTCHES OF DARTH VADER AND HIS MINIONS.
   YOU WIN A WOOKIE, TWO WOMP RATS(?) AND THE HAND OF PRINCESS LEIA ORGANA
IN MARRIAGE.
   WHO SAYS SCIENCE FICTION ISN'T FUN ANY MORE?!?
   OVER TARGET!!
   INBOARD COMPUTER REPORTS TRAJECTORY OF FIGHTER UNSUITABLE FOR ATTACK.
HOWEVER NAVIGATIONAL SYSTEMS HAVE BEEN CALIBRATED SO THE COMPUTER WILL ATTEMPT
TO REPEAT ATTACK AND RELEASE TORPEDO AUTOMATICALLY.
   COMPUTER HAS SUCCESSFULLY REPEATED APPROACH AND HAS RECALIBRATED NAVIGATIONAL
SYSTEMS.
   TOO HIGH!!
   YOU HAVE OVER-FLOWN THE CALIBRATING TARGET. COMPUTER WILL ATTEMPT TO REPEAT
ATTACK AND RELEASE TORPEDO AUTOMATICALLY.
   YOU HAVE MISSED THE CALIBRATION TARGET. COMPUTER REPORTS PRESENT TRAJECTORY
MAKES REPEAT ATTACK IMPRACTICAL AND IS RETURNING TO REBEL BASE. BETTER LUCK
NEXT TIME.
```

ALIEN ATTACK

by Peter Wright

This program, written for PET will work with or without a sound box. Full instructions (with one spelling mistake) are included in the program.

```
2 GOSUB3300
5 J=50
6 R=INT((36)*RND(1))+1
10 PRINT"[graphics]"
20 X=32769:M=1:T=60
30 IFX<32769THENM=1
40 IFX>32806THENM=-1
41 IFA$="@"ORA$="="THEN43
42 GOTO50
43 IFM=1THENM=-1:GOTO50
44 M=1
50 X=X+M:POKEX,83:POKEX-1,32:POKEX+1,32
52 IFPEEK(X+320)=160ORPEEK(X+320)=214THENGOTO1000
53 IFPEEK(X+640)=214THENK=X+600:GOTO1010
54 IFFF=0THEN60
55 IFFF=1THENGOSUB304
56 IFFF=1THEN30
60 TT=(J-H):T=T+1:IFT<TTTHEN100
65 N=INT((3)*RND(1)):IFN=1THEN73
66 POKE0,20:POKE1,20:SYS(826)
70 PRINTTAB(R)"[graphics]":GOTO80
73 FORN1=0TO10:POKE0,20 :POKE1,20 :SYS(826):NEXT
75 PRINTTAB(R)"[graphics]"
80 T=0:R=INT((36)*RND(1))
100 GETA$
110 IFA$=" "ORB$="F"THENFF=1:F=X+40:POKE0,20 :POKE0,10 :SYS(826):GOSUB304
120 GOTO30
304 IFRI=1ORLE=1THEN3000
305 F=F+40
306 GETA$:IFA$="@"ORA$="="THEN307
307 GOTO310
308 IFM=1THENM=-1:GOTO310
309 M=1
310 IFPEEK(F)=160ORPEEK(F)=214THENH=H+1:GOTO500
311 IFPEEK(F)<>233THEN320
312 POKEF-40,93:POKEF-41,77:POKEF-1,68
313 FORQ=0TO80:NEXT:POKEF-40,32:POKEF-41,32:POKEF-1,32
314 POKE0,20:POKE1,20:SYS(826):D=1:RI=1:F=F-1:GOTO327
320 IFPEEK(F)<>223THEN327
321 POKEF-40,93:POKEF-39,78:POKEF+1,68
322 FORQ=0TO80:NEXT:POKEF-40,32:POKEF-39,32:POKEF+1,32
325 POKE0,20:POKE0,20:SYS(826):D=1:LE=1:F=F+1
327 IFF>33728THENFF=0:D=0:RI=0:LE=0:POKEF-40,32:RETURN
328 IFD=1THENRETURN
330 POKEF,46:POKEF-40,32
340 RETURN
500 POKEF-40,32:POKE0,225:POKE1,50 :SYS(826)
501 POKEF-40,32:POKEF,32:POKEF-1,32:POKEF+1,32:POKEF+39,32:POKEF+41,32
510 FORQ=0TO1
520 POKEF,127:POKEF+39,127:POKEF+40,127
525 POKEF,224:POKEF+39,224:POKEF+40,224
526 POKEF-1,42:POKEF+1,42
530 POKEF+41,127
540 POKEF,225:POKEF+39,255:POKEF+40,255
545 POKEF,102:POKEF+39,102:POKEF+40,102
546 POKEF-1,171:POKEF+1,171
547 POKEF-1,32:POKEF+1,32
550 POKEF+41,255
```

PCW is always on the lookout for original programs.

FUN & GAMES

```
552 POKEF,32:POKEF+39,32:POKEF+40,32
553 POKEF+41,32
560 NEXT:FF=0
570 IFF=K-40THENPOKE0,255:POKE1,255:SYS(826):GOTO1500
580 D=0:RI=0:LE=0:RETURN
1000 K=X+280
1010 IFPEEK(K)=83THEN1110
1020 POKEK,224
1025 POKE0,100:POKE1,10 :SYS(826)
1030 K=K-40:GOTO1010
1100 POKE0,100:POKE1,10:SYS(826)
1110 POKEK,211:POKEK-80,32:POKEK-40,224
1115 POKEK+39,78:POKEK+41,77
1116 POKEK+39,32:POKEK+41,32
1120 K=K+40:IFPEEK(K)=90THENF=K-40:GOSUB501
1130 GOTO1100
1500 FORX=0TO24
1550 FORZ=0TO20:NEXT
1600 PRINT POKE0,50:POKE1,50:SYS(826)
1700 NEXT
2000 GA=GA+1
2001 IFB$="P"THENPRINT"▒▒▒▒▒▒▒▒▒▮▮▮▮▮I GOT "H"BUT I'M ONLY YOUR PET":GOTO2005
2002 PRINT"▒▒▒▒▒▒▒▒▒▮▮▮▮▮YOU DESTROYED"H"OF THE ALIENS"
2005 IFH2<HTHENH2=H:PRINT PRINT"▒▮▮▮▮▮IT IS THE BEST SCORE SO FAR":GOTO2010
2006 PRINT:PRINT"▮▮▮▮▮THE BEST SCORE IS"H2
2010 FORA=0TO10
2020 GETA$:NEXT
2024 PRINT:PRINT"▮▮▮▮▮TO PLAY AGAIN PUSH ANY KEY"
2025 PRINT:PRINT"▮▮▮AFTER 30 SECONDS I WILL PLAY ALONE"
2026 TI$="000000"
2027 IFTI$="000030"THENB$="P":H=0:J=5:D=0:GOTO6
2030 GETA$:IFA$=""THEN2027
2035 IFGA=22THENRUN5
2040 J=50:B$="":H=0:D=0:RI=0:LE=0:GOTO6
3000 IFLE=1THENK=41:GOTO3020
3010 K=39
3020 F=F+K:IFF>33723THENPOKEF-K,32:FF=0:D=0:RI=0:LE=0:RETURN
3025 IFPEEK(F)<>32THENPOKEF-K,32:H=H+1:GOTO3040
3030 POKEF,46:POKEF-K,32:RETURN
3040 IFPEEK(F+1)=160ORPEEK(F+1)=214THENF=F+1:GOTO500
3045 IFPEEK(F)=160ORPEEK(F)=214THEN500
3050 IFPEEK(F-1)=160ORPEEK(F-1)=214THENF=F-1:GOTO500
3060 IFPEEK(F-41)=160ORPEEK(F-41)=214THENF=F-41:GOTO500
3070 IFPEEK(F-39)=160ORPEEK(F-39)=214THENF=F-39:GOTO500
3080 IFPEEK(F+41)=160ORPEEK(F+41)=214THENF=F+41:GOTO500
3300 POKE59459,255
3310 FORHB=826TO870
3320 READB:POKEHB,B:NEXTHB
3330 DATA165,1,162,215,142,64,232,170,202,208,253,240,0,240,0,240,0,240,0,240
3340 DATA0,162,233,142,64,234,170,202;208,253,198,00,208,5,234,234,234,234
3350 DATA96,240,00,240,00,208,213
3500 PRINT"▒▒▒▒▒▒▒▒▒▒▒▮▮▮▮▮▮▮▮▮▮▮▮▮ALIEN ATTACK"
3520 PRINT"▮▮▮▮▮▮▮▮▮▮▮▮▮▮BY PETER WRIGHT"
3540 FORX=0TO2000:NEXT
4000 PRINT"▒▒▒▒▒▒▒▒▒▒▮▮▮▮▮▮▮▮▮DO YOU NEED INSTRUCTIONS ?"
4010 GETA$:IFA$=""THEN4010
4020 IFA$="N"THENRETURN
4030 PRINT"▒YOU ARE THE '♦' AT THE TOP OF THE SCREEN"
4040 PRINT"THE OBJECT OF THE GAME IS,
4045 PRINT"▒TO DSETROY THE ALIENS SHOWN BELOW."
4050 PRINT"▒1.HAS SHORT RANGE WEAPONS AND 2.LONG"
4060 PRINT"▒▒NO1. ◤ ◥        NO2. ◤x◥
4070 PRINT"      ♦♦♦             ◤♦◥
4080 PRINT"THEY WILL APPEAR AT THE BOTTOM."
4090 PRINT"▒IF THEY ARE NOT DESTROYED THEY WILL."
4100 PRINT"▒MOVE UP AND DESTROY YOU."
4110 PRINT"▒TO FIRE AT THEM PRESS THE 'SPACE' KEY."
4120 PRINT"▒YOUR SHOT MUST HIT DEAD CENTRE,"
4130 PRINT"▒IF IT DOES NOT IT WILL BOUNCE OFF."
4140 PRINT"▒▒          PUSH ANY KEY TO CONTINUE          "
4150 GETA$:IFA$=""THEN4150
4160 PRINT"▒YOU MAY REVERSE THE DIRECTION,"
4170 PRINT"▒YOU ARE MOVING AT ANY TIME,"
4180 PRINT"▒WITH THE '=' KEY OR THE '@' KEY."
4190 PRINT"▒THE NUMBER YOU DESTROY IS SHOWN AT,"
4200 PRINT"▒THE END OF EACH GAME."
4201 PRINT"▒THE ALIENS ARE SLOW TO ADVANCE AT FIRST,"
4202 PRINT"BUT THE MORE YOU DESTROY THE FASTER,"
4203 PRINT"▒THEY WILL MOVE."
4204 PRINT"▒DON'T LET THEM GET TO CLOSE BECAUSE,"
4205 PRINT"▒WHEN THEY FIRE THEY NEVER MISS."
4207 PRINT"▒PLUG IN A SOUND BOX IF YOU HAVE ONE!"
4210 PRINT"▒▒          PUSH ANY KEY TO PLAY          "
4220 GETA$:IFA$=""THEN4220
4230 RETURN
```

For those interested in a BASIC Lissajous figure plotting program, see Sheridan's Computer Answers on page 57 of this issue. Great fun — we promise.

PROGRAMS

```
BEGIN
    IF BOARD[ROW,COL]=TARGET
    THEN FLIPCOUNTER[DIRECTION]:=FLIPCOUNTER[DIRECTION]+1
    ELSE
    BEGIN
        FINISHED:=TRUE;
        IF BOARD[ROW,COL]=MOVER
        THEN IF FLIPCOUNTER[DIRECTION]:>0
             THEN LEGAL:=TRUE
             ELSE FLIPCOUNTER[DIRECTION]:=0 (*EMPTY*)
     END
END; (*CHECKIT*)
BEGIN (*CHECKMOVE*)
    LEGAL:=FALSE;
    IF MOVER=FIRST
    THEN TARGET:=SECOND
    ELSE TARGET:=FIRST;
    IF BOARD[ROWNOW,COLNOW]=EMPTY
    THEN
    BEGIN
        ROW:=ROWNOW;
```

```
            COL:=COLNOW;
            FOR DIRECTION:=N TO NW DO
            BEGIN
                   FINISHED:=FALSE;
                   FLIPCOUNTER[DIRECTION]:=0;
                   REPEAT
                       CHOOSESQUARE;
                       IF FINISHED (**EDGE REACHED**)
                       THEN FLIPCOUNTER[DIRECTION]:=0
                       ELSE CHECKIT
                   UNTIL FINISHED
            END
        END
END; (*CHECKMOVE*)
PROCEDURE FLIPS;
VAR ROW:ROWNUM;
     COL:COLCHAR;
     I:INTEGER;
BEGIN
     ROW:=ROWNOW;
     COL:=COLNOW;
     BOARD[ROW,COL]:=MOVER;
     FOR DIRECTION:=N TO NW DO
     BEGIN
          ROW:=ROWNOW;
          COL:=COLNOW;
          FOR I:= 1 TO FLIPCOUNTER[DIRECTION] DO
          BEGIN
               CHOOSESQUARE;
               BOARD[ROW,COL]:=MOVER
          END
     END
END; (*FLIPS*)
PROCEDURE GIVESCORE;
VAR COL:COLCHAR;
     ROW:ROWNUM;
     FIRSTCOUNT,SECONDCOUNT:0..60;
BEGIN
     PRINTBOARD;
     FIRSTCOUNT:=0;
     SECONDCOUNT:=0;
     FOR ROW:='1' TO '8' DO
          FOR COL:='A' TO 'H' DO
               IF BOARD[ROW,COL]=FIRST
               THEN FIRSTCOUNT:=FIRSTCOUNT+1
               ELSE SECONDCOUNT:=SECONDCOUNT+1;
     WRITELN(     CROSS,'              ',FIRSTCOUNT);
     WRITELN(     NOUGHT,'              ',SECONDCOUNT);
     IF FIRSTCOUNT=SECONDCOUNT
     THEN WRITELN(     'IT''S A TIE')
     ELSE IF FIRSTCOUNT>SECONDCOUNT
          THEN WRITELN(     CROSS,' WINS')
          ELSE WRITELN(     NOUGHT,' WINS')
END; (*GIVESCORE*)
PROCEDURE ANOTHERGO;
VAR CONTINUE:CHAR;
BEGIN
       WRITE(     'WOULD YOU LIKE ANOTHER GAME? TYPE Y OR N. ');
       READLN(     CONTINUE);
       IF CONTINUE='Y'
       THEN NOMORE:=FALSE
       ELSE NOMORE:=TRUE
END; (*ANOTHERGO*)
BEGIN (*MAIN PROGRAM*)
     WRITE(     'DO YOU WANT TO READ THE INSTRUCTIONS? TYPE Y OR N.');
     READLN(     ANSWER);
     IF ANSWER='Y' THEN INSTRUCTIONS;
     IDENTIFY;
     REPEAT
     STARTGAME;
          WHILE NOT GAMEOVER DO
          BEGIN
               REPEAT
                    PRINTBOARD;
                    PASS:=FALSE;
                    GETMOVE;
                    IF PASS THEN LEGAL:=TRUE ELSE CHECKMOVE
               UNTIL LEGAL;
               IF NOT PASS
               THEN
               BEGIN
                    FLIPS;
                    COUNTER:=COUNTER+1
               END;
               IF MOVER=FIRST
               THEN MOVER:=SECOND
               ELSE MOVER:=FIRST;
               IF COUNTER=60
               THEN GAMEOVER:=TRUE
        END;
        GIVESCORE;
        ANOTHERGO
     UNTIL NOMORE
END.
```

Parkinson's Revas

(This concludes the listing for David Parkinson's reverse assembler)

```
FDB9                    0916 ; LD A,R  LD A,I  LD R,A  LD I,A
FDB9                    0917 ;
FDB9  CD 06 F9          0918 IR:      CALL   WRLD      ;WRITE "LD"
FDBC  E6 03             0919          AND    3         ;ISOLATE ID
FDBE  47                0920          LD     B,A       ;DO *3 FOR TABLE OFFSET
FDBF  07                0921          RLCA
FDC0  80                0922          ADD    B
FDC1  21 CA FD          0923          LD     HL,IRTAB  ;LOAD BASE ADDRESS
FDC4  CD 2A F9          0924          CALL   FTADR     ;FORM ADDRESS
FDC7  C3 23 F9          0925          JP     COPY3     ;COPY OVER
FDCA  49 2C 41 52       0926 IRTAB:   DB     'I,AR,AA,IA,R'
      2C 41 41 2C
      49 41 2C 52
FDD6                    0927 ;
FDD6                    0928 ; INVALID CODE. WRITE 'DB' AND COPY CODE OVER.
```


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```
FDD6                  0929 ;
FDD6  E1              0930 NTVL:    POP   HL         ;THROW AWAY TWO RETURNS
FDD7  E1              0931          POP   HL
FDD8  EB              0932 NOTVAL:  EX    DE,HL      ;WRITE 'DB'
FDD9  36 44           0933          LD    (HL),'D'
FDDB  23              0934          INC   HL
FDDC  36 42           0935          LD    (HL),'B'
FDDE  11 32 10        0936          LD    DE,BUFFER+32;SET FOR OPERAND
FDE1  21 18 10        0937          LD    HL,BUFFER+6;SET FOR OPCODES
FDE4  3E 20           0938          LD    A,' '
FDE6  CD 17 F9        0939 NVLP:    CALL  DOLLAR     ;WRITE '$'
FDE9  CD 25 F9        0940          CALL  COPY2      ;COPY OVER OP
FDEC  23              0941          INC   HL         ;PAST SPACE
FDED  BE              0942          CP    (HL)       ;IS ANOTHER THERE?
FDEE  C8              0943          RET   Z          ;NO,DONE
FDEF  CD 11 F9        0944          CALL  COMMA      ;WRITE ','
FDF2  18 F2           0945          JR    NVLP       ;COPY IT OVER
FDF4                  0946 ;
                      0947          END

CROSS REFERENCE

ADCSBC   FCF9    0842
ADDHL    F96D    0131 0795
ADDR     1003    0047 0072 0185 0187 0541
ARITH8   FA1C    0096 0126 0142
ARTAB    FA34    0288 0403 0789 0794
AUTO     FCC9    0805
BRCM     FD3A    0823 0836
BRSTAB   FCAB    0722
BSPBM    FB81    0575
BUFFER   1012    0060 0066 0086 0214 0530 0562 0639 0714 0717 0821 0936
                 0937
BYOUT    F904    0202
BYTE     F8DB    0058 0276 0278 0361 0382 0536 0718 0799
CALETC   FA63    0140
CB       FC4F    0619
CBETC    FBBB    0136
CCODES   FAAB    0317 0458 0534
CCTAB    FAB8    0472
CJR      FA7A    0114 0118 0122 0130 0134 0138 0433 0569 0633
CJRTAB   FA9F    0448 0637 0873
COMMA    F911    0275 0294 0335 0462 0535 0608 0626 0667 0681 0696 0703
                 0742 0944
COPY2    F925    0310 0356 0474 0625 0627 0638 0776 0783 0820 0940
COPY3    F923    0256 0289 0405 0493 0506 0596 0603 0646 0730 0759 0833
                 0863 0874 0913 0925
COPY4    F921    0389 0421 0450 0485 0512 0595 0824 0837
COPY5    F91F    0576
COPY6    F91D    0553
DEC      F934    0123 0135 0139
DECM     F94A    0255
DECODE   F85A    0059
DI       FB86    0572
DJNZ     FB12    0521
DJNZM    FB1B    0511
DOLLAR   F917    0283 0373 0383 0498 0939
EADDR    1007    0049 0051
EI       FB8A    0621
EXAETC   FB49    0129
EXAFM    FB57    0552
EXTND    FD08    0431
EXX      FBFF    0634
FTADR    F92A    0103 0347 0355 0404 0449 0473 0484 0729 0758 0775 0782
                 0924
HALT     FA12    0328
HALTM    FA18    0388
HEX1     F8C1    0157
HEX2     F8B8    0174 0176 0195 0374 0384 0499
HEX4     F8D0    0074 0284
HXYFLG   100B    0071 0315 0354 0357 0438 0710
HXYTAB   F9A7    0353
IMO      FD95    0888
IMM      FA09    0338 0597 0607
IN       FB92    0618
INC      F92F    0119 0121 0137
INCM     F947    0253
INITB    F827    0056
INM      FB9E    0594 0819
IR       FDB9    0904
IRTAB    FDCA    0923
JPETC    FB67    0120
JR       FB26    0549
L8B      F9BF    0408
LABELA   100E    0282
LABELP   1010    0070 0281
LD1      FC2B    0640 0655 0695 0705
LD16     F94D    0115
LD16A    F957    0463 0690
LD16B    F960    0543
LD16I    FC45    0679 0850
LDIND    FC1B    0133
LDSP     FBEE    0636
LINEA    100C    0073
LOAD8    F9AD    0094 0125 0141
```

PROGRAMS

```
MADDR   1005   0048 0052 0188 0191
MEM     F9D4   0345
MORE    F819   0440
NEGM    FD71   0862
NEXTL   F80B   0062
NOP     FB09   0522
NOPETC  FB1F   0113
NOPM    FB0F   0505
NOTIM   FDA0   0883
NOTIN   FD3F   0815
NOTIXY  FA04   0359 0364 0691
NOTLD   FD65   0843
NOTNEG  FD74   0856
NOTOUT  FD52   0828
NOTRET  FD88   0867
NOTSP   F993   0307
NOTVAL  FDD8   0770 0801 0803 0807 0861 0872 0890 0892 0911
NOTXY   FC61   0713
NTVL    FDD6   0753
NUMB    F8CC   0163
NVLP    FDE6   0945
OPCADR  1009   0078 0192 0197
OPTAB   FCE9   0774 0778
OUT     FBA5   0570
OUTM    FBB8   0602 0832
OUTPUT  1000   0061
PLUS    F9F9   0365
POP     FA4C   0116
POPM    FA5F   0415
PUSH    FA51   0124
PUSH1   FA54
PUSHM   FA5B   0420
REGPR   F97E   0261 0274 0293 0423 0578 0648 0689 0697 0702
RETETC  FBD6   0132
REVAS   F800
RMTAB   FAD5   0483
ROTATE  FC90   0721
ROTMIS  FAC8   0127 0143
ROTTAB  FCB4   0757
RPRTAB  F9A1   0306 0346 0624
RRDM    FDB3   0908 0912
RST     FAF5   0128 0144
RSTM    FB06   0492
SPM     FBFC   0645
SREG    F9C4   0265 0334 0716 0747 0822 0838
ST1     FC16   0680
ST16I   FC3C   0664 0853
STIND   FC06   0117
TABLE   F878   0102
TESTXY  FC89   0762
UCD     FB3B   0514 0532
UNCND   FA9C   0456
WREX    FB5D   0551 0574 0623 0653
WRLD    F906   0272 0330 0644 0660 0675 0847 0918
WRrD    FDB0   0909
```

BELLS & WHISTLES

PLANET NAME GENERATOR

by Derrick Daines

Recently I was working on a very long and complex program that involved elements of Startrek, Lunar Lander and Battleships. As the player was visiting several planets in outer space, it was necessary to generate outlandish but pronouncable names for these planets. I estimate that the following routine will generate around 300 million different names. If you are tempted to change any of the syllables then I recommend that you try them out in private — the results can be acutely embarrasing! My favourite name is AX-TEPAXTEP, don't ask me why. Incidentally, if you use a PET you need to put an integer in the brackets following RND. eg RND(1). . .

```
0100 GOSUB 1000
0110 PRINT "YOU ARE ON THE PLANET ";N$
0120 ETC.....
1000 REM - NAMING SUB
1010 REM - FIX NUMBER OF SYLLABLES
1020  N=INT(RND(0)*3+2)
1030  N$=""
1040 FOR X=1 TO N
1050 REM - FIND SYLLABLE
1060 FOR Y=1 TO INT(RND(0)*50+1)
1070 READ C$
1080 NEXT Y
1090 RESTORE
```


PCW is always on the lookout for original programs

BELLS & WHISTLES

```
1100 REM - HYPHENATED?
1110 IF X=1 THEN 1140
1120 IF X=N THEN 1140
1130 IF RND(0)>.75 THEN N$=N$+"-"
1140  N$=N$+C$
1150 NEXT X
1160 RETURN
9000 DATA AR,RA,CO,OC,ET,TE,LO,OL,ES
9010 DATA ED,XA,AX,TO,OT,OM,OB,OV,VO
9020 DATA OZ,ZO,IX,XAL,WAR,REW,RU,UR
9030 DATA OR,OB,UG,CAS,SAC,MI,ETH,YU
9040 DATA COM,TEP,REK,BOK,KI,IK,SKO
9050 DATA UM,VAY,ZAS,BIR,KOL,CER,FAM
9060 DATA EM,BAS
```

LEISURE LINES

With J. J. Clessa

A very good response to our 'Palindromic' Leisure Lines (over 60 entries) despite the fact that some kind of computerised aid was necessary for the solution — or, alternatively, one hell of a lot of spare time!

In fact, all the answers received were correct ones and the answers are as follows:

1 Alan & Bert's mileometers are palindromic after 321123 miles.
2 Alan & Colin's mileometers after 111111 miles.
3 Bert & Colin's mileometers after 0110 miles.
4 All three mileometers mutually palindromic after 655666 miles.

Thanks to Dave Tebbutt's ability to generate random numbers with extreme rapidity on a borrowed PET (and with Sue Eisenbach on hand to ensure fair play and no program bugs) we were quickly able to select a winning entry — from:
S.T.M. Ratcliffe, 105 Fordwater Road, Chertsey, Surrey, KT16 8HH.

Congratulations, Mr. Ratcliffe, £10 worth of stamps are on their way — courtesy of the PO.

QUICKIE

Short and snappy for this month, and as usual, no solutions and no prizes.

Which number, when added to 1¼ gives the same result as when it is multiplied by 1¼?

PRIZE PUZZLE

Again, fairly brief for this month. This time I'd like you to find the smallest palindromic number that is also a perfect square, and which contains an even number of digits. Thus 121 is a perfect square — and also a palindromic number — but unfortunately it contains an odd number of digits.

THIS MONTH'S PRIZE

For the lucky winner, a Paper Mate Pen & Pencil set — finished in olive green and gold.

BLUDNERS

November: FAX (sorry!) contained the following non-facts: The second half of columns 5 and 6 should refer to registers E and L, not D and H. C2 should read JNZ not JZ.

December: Page 34 shows a picture of the 68000, not the 6800 as stated.

Continued from page 52

robot as 'Your Plastic Pal Who's Fun To Be With'."

The Hitch Hiker's Guide, however, defines the marketing division of the Sirius Cybernetics Corporation as "a bunch of mindless jerks who'll be the first against the wall when the revolution comes". It also has a footnote saying it is looking for someone interested in becoming its robot correspondent.

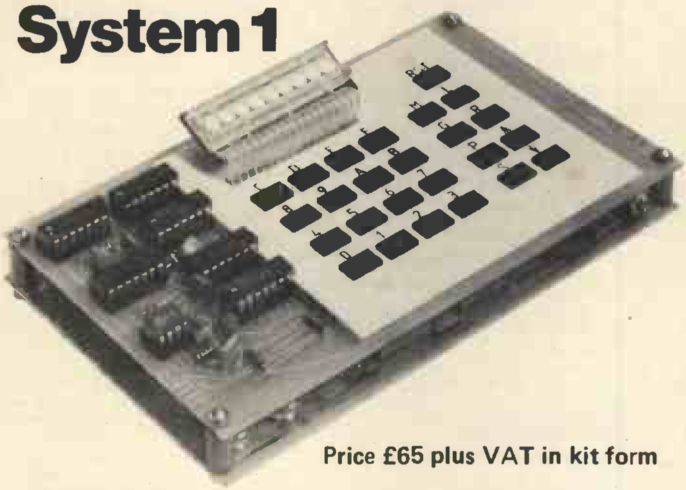
Douglas Adams also tells us that, thanks to an Encyclopedia which conveniently fell through a time warp from a thousand years in the future, the publication had to eventually record that "the marketing division of the Sirius Cybernetics Corporation was a bunch of mindless jerks who were the first against the wall when the revolution came."

For those like me who got a taste of the Hitch Hiker's Guide on radio (it was first broadcast in March 1978 and has been repeated a few times since) the book is an enjoyable read filling out the airwaves flesh with many rich asides and jokes. I am sure some radio addicts may savour the book with less relish, but for anyone who approaches the book afresh, there is a treat in store.

Books discussed in this month's Bookfare have been:
The Conquest of Will by *Abbe Mowshowitz (Addison-Wesley, £8.20)*
Inside Information by *Abbe Mowshowitz (Addison-Wesley, £7.35)* — contains bibliography to other stories mentioned in the review.
Omni magazine, published monthly and available at most bookshops.
Take My Computer. . . PLEASE? by *Steven Ciarcia (Scelbi Computer Consulting, £3.25 — available from LP Enterprises)*
The Hitch Hiker's Guide to the Galaxy by *Douglas Adams (Pan 80p)*

The Perfect Lead...

Acorn Microcomputer System 1



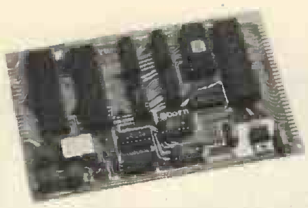
Price £65 plus VAT in kit form

This compact stand-alone microcomputer is based on standard Eurocard modules, and employs the highly popular 6502 MPU (as used in APPLE, PET, KIM, etc). Throughout, the design philosophy has been to provide full expandability, versatility and economy.

Specification
The Acorn consists of two single Eurocards.
1. MPU card
6502 microprocessor
512 x 8 ACORN monitor
1 K x 8 RAM
16-way I/O with 128 bytes of RAM
1 MHz crystal
5 V regulator, sockets for 2K EPROM and second RAM I/O chip.
2. Keyboard card
25 click-keys (16 hex, 9 control)
8 digit, 7 segment display
CUTS standard crystal controlled tape interface circuitry.
Keyboard instructions:
Memory Inspect/Change (remembers last address used)
Stepping up through memory
Stepping down through memory
Set or clear break point
Restore from break
Load from tape
Store on tape
Go (recalls last address used)
Reset
Monitor features
System program
Set of sub-routines for use in programming
Powerful de-bugging facility displays all internal registers
Tape load and store routines

Applications
As a self teaching tool for beginners to computing.
As a low cost 6502 development system for industry.
As a basis for a powerful microcomputer in its expanded form.
As a control system for electronics engineers.
As a data acquisition system for laboratories.

START WITH SYSTEM 1 AND CONTINUE AS AND WHEN YOU LIKE

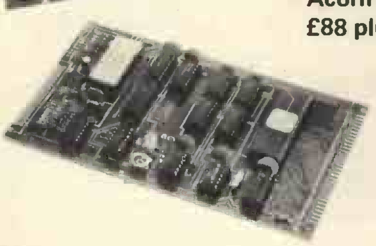


Acorn Controller
£35 plus VAT (min config.)

the CPU card of System 1, it allows for up to 4½ k EPROM, 1¼ k RAM and 32 I/O lines. It has on board 5 V regulator and optional crystal control. Custom programs may be developed on System 1 and the card makes an ideal dedicated hardware module.

Acorn Memory 8 k
£95 plus VAT (kit form)

A fully buffered memory card allowing up to 8 k RAM plus 8 k EPROM on one eurocard, in an Acorn system both BASIC and DOS may be contained in this module. Static RAM (2114) is used and the card may be wired into other systems.



Acorn VDU
£88 plus VAT (kit form)

A memory mapped seven colour VDU interface with adjustable screen format. Full upper and lower ascii and teletext graphics are features of this module which along with programmable cursor, light pen, hardware scroll etc., make this the most advanced interface in its class.

Acorn Software in ROM

Acorn BASIC – a very fast integer BASIC in 4 k
Acorn COS – a sophisticated cassette operating system with load and save and keyboard and VDU routines in 2 k
Acorn DOS – a comprehensive disc operating system in 4 k

Acorn Computers Ltd.
4A Market Hill, Cambridge, Cambs.
Cambridge (0223) 312772.

Order Form

PCW 1

Please send me the following:

☐ (qty) Acorn Microcomputer kit @ £65 plus £9.75 VAT.
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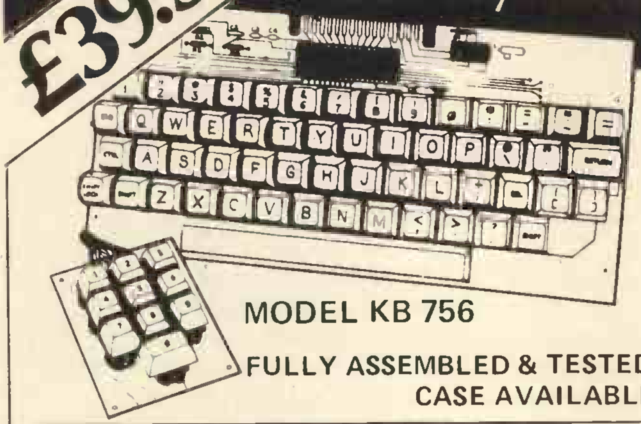

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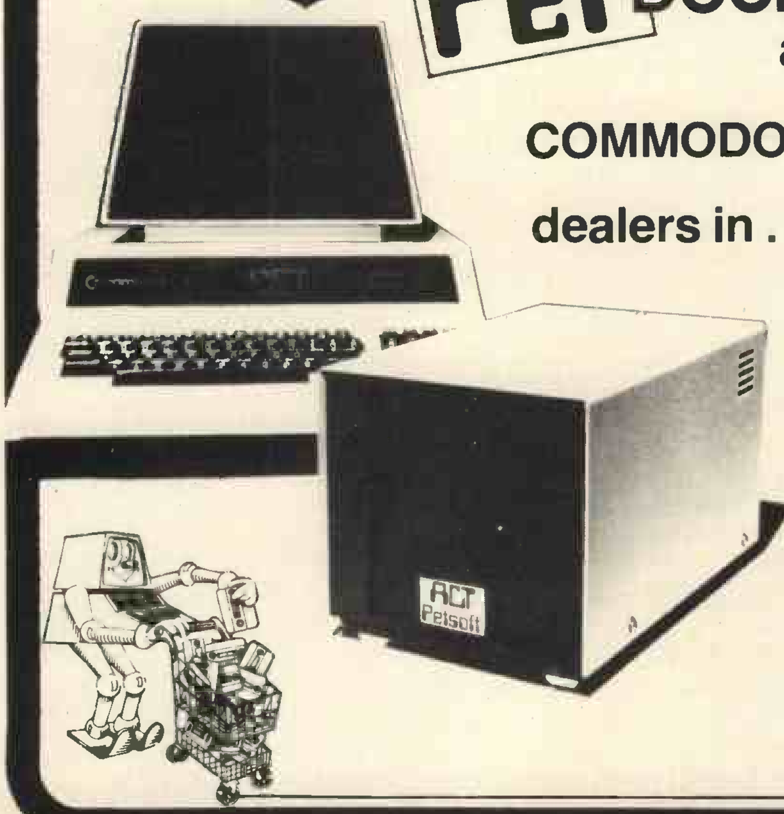

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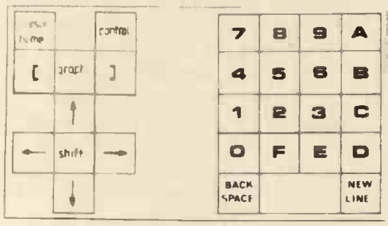

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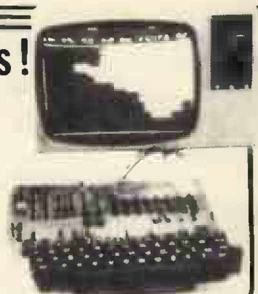

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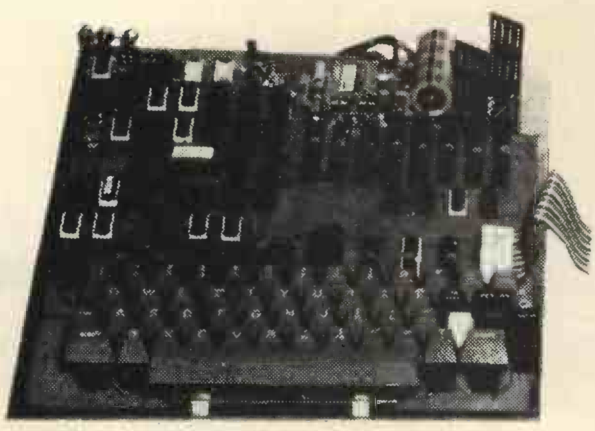

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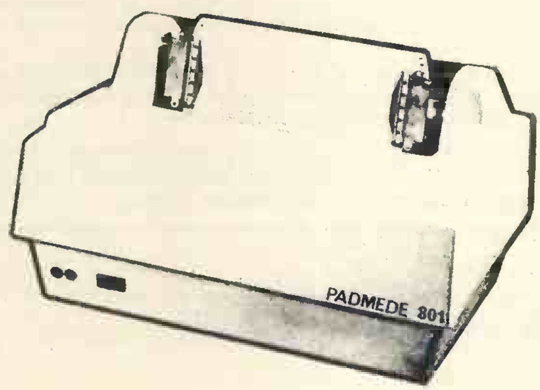

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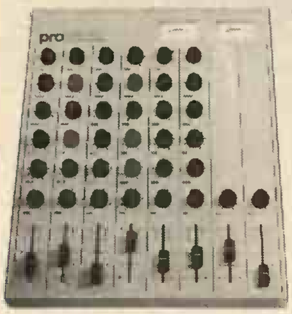

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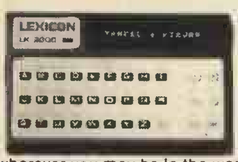

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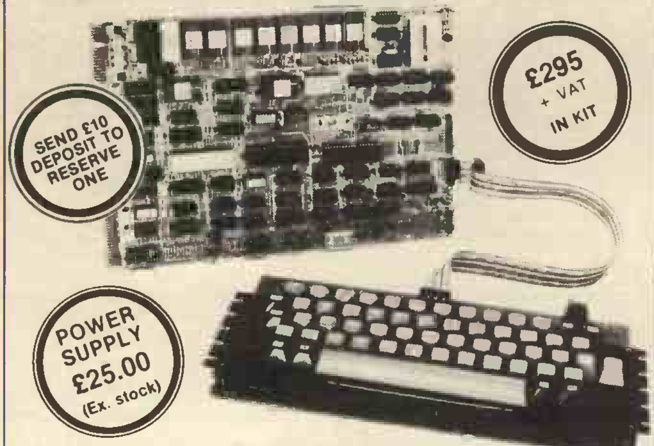

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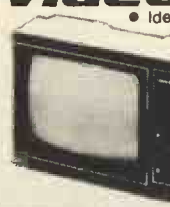

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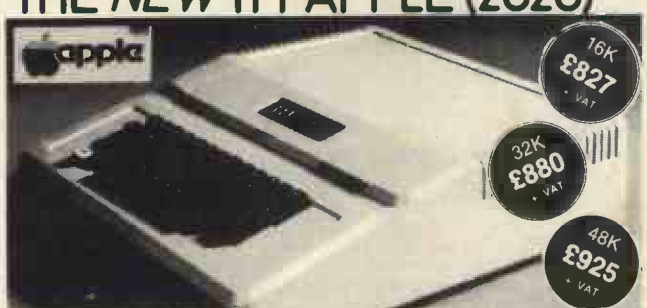

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THE TRS80 (Special Scoop) Low Priced, Ready to Go!

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FULL RANGE OF TRS80 SOFTWARE NOW AVAILABLE

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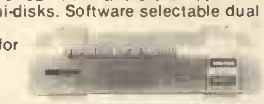

ANADEX DP8000

ONLY £540 + VAT

PET Connector — £49

The DP 8000 prints the 96-character ASCII set in single or double width at 84 lines per minute. ● The unit operates bi-directionally to print a 9 x 7 matrix on multiple copy, pin-feed plain paper. ● This model accepts RS-232C or current loop serial data at baud rates switchable from 110 to 9600 and Parallel Bit data input at over 1000 characters per second. ● Standard storage capacity of 256 characters ● Other features include Out of Paper Detector, Top of Form Programming and Skip Over Perforation Control.

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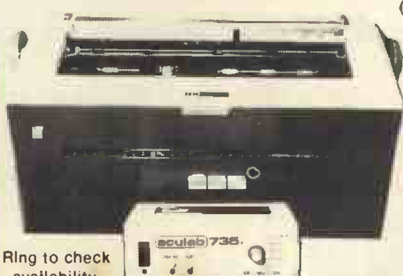
Comes complete with interface to Centronics parallel standard. Switchable golfball heads makes this the most versatile golfball printer around. Fits the Sorcerer, TRS80 Expn. Interface, Apple & ITT2020 (with parallel card extra), Pet (with special connector extra) and any machine that has Centronics compatable parallel output. Control buttons to enable you to suspend printing while changing paper. Recognises control codes to switch printer on or off.



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- ★ High quality thru plated P.C.B. with all I.C.'s mounted on sockets.
- ★ Professional 52 Key keyboard in 3 colours — software polled meaning that all debouncing and key decoding done in software.

COMMANDS

CONT LIST NEW NULL RUN

STATEMENTS

CLEAR	DATA	DEF	DIM	END	FOR
GOTO	GOSUB	IF..GOTO	IF..THEN	INPUT	LET
NEXT	ON..GOTO	ON..GOSUB	POKE	PRINT	REAC
REM	RESTORE	RETURN	STOP		

EXPRESSIONS

OPERATORS

+, -, /, ↑ NOT.AND.OR. >.<.<>.>=.<= RANGE 10^{-32} to 10^{+32}

VARIABLES

A.B.C. ....Z and two letter variables
The above can all be subscripted when used in an array. String variables use above names plus $.e.g.A$.

*8K Microsoft Basic means conversion to and from Pet, Apple and Sorcerer easy. Many compatible programs already in print.

SPECIAL CHARACTERS

@ Erases line being typed, then provides carriage return, line feed.

← Erases last character typed.

CR Carriage Return — must be at the end of each line.

: Separates statements on a line.

CONTROL/C Execution or printing of a list is interrupted at the end of a line.

"BREAK IN LINE XXXX" is printed, indicating line number of next statement to be executed or printed.

CONTROL/O No outputs occur until return made to command mode. If an Input statement is encountered, either another CONTROL/O is typed, or an error occurs.

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FUNCTIONS

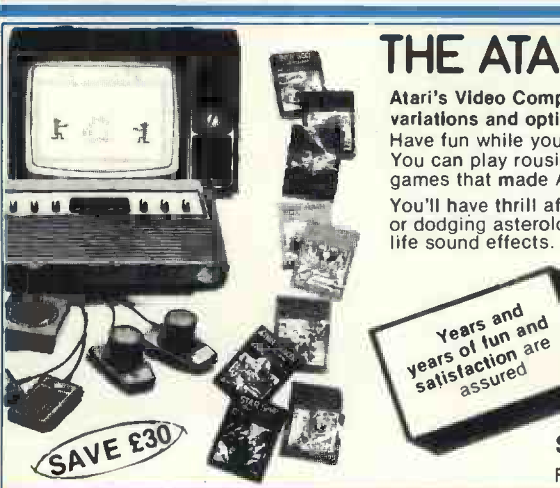
ABS(X)	ATN(X)	COS(X)	EXP(X)
LOG(X)	PEEK(I)	POS(I)	RND(X)
SPC(I)	SQR(X)	TAB(I)	TAN(X)
FRE(X)	INT(X)		
SGN(X)	SIN(X)		
USR(I)			

STRING FUNCTIONS

ASC(X$)	CHR$S(I)	FRE(X$)	LEFT$(X$.I)
RIGHT$(X$.I)		STR$(X)	
LEN(X$)	MID$(X$.I.J)		
VAL(X$)			

COLOUR ADD-ON CARD AVAILABLE SOON

Enables you to choose your foreground the background colour anywhere on the screen. Flash any character on the screen at will. Full documentation and parts in kit form.



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