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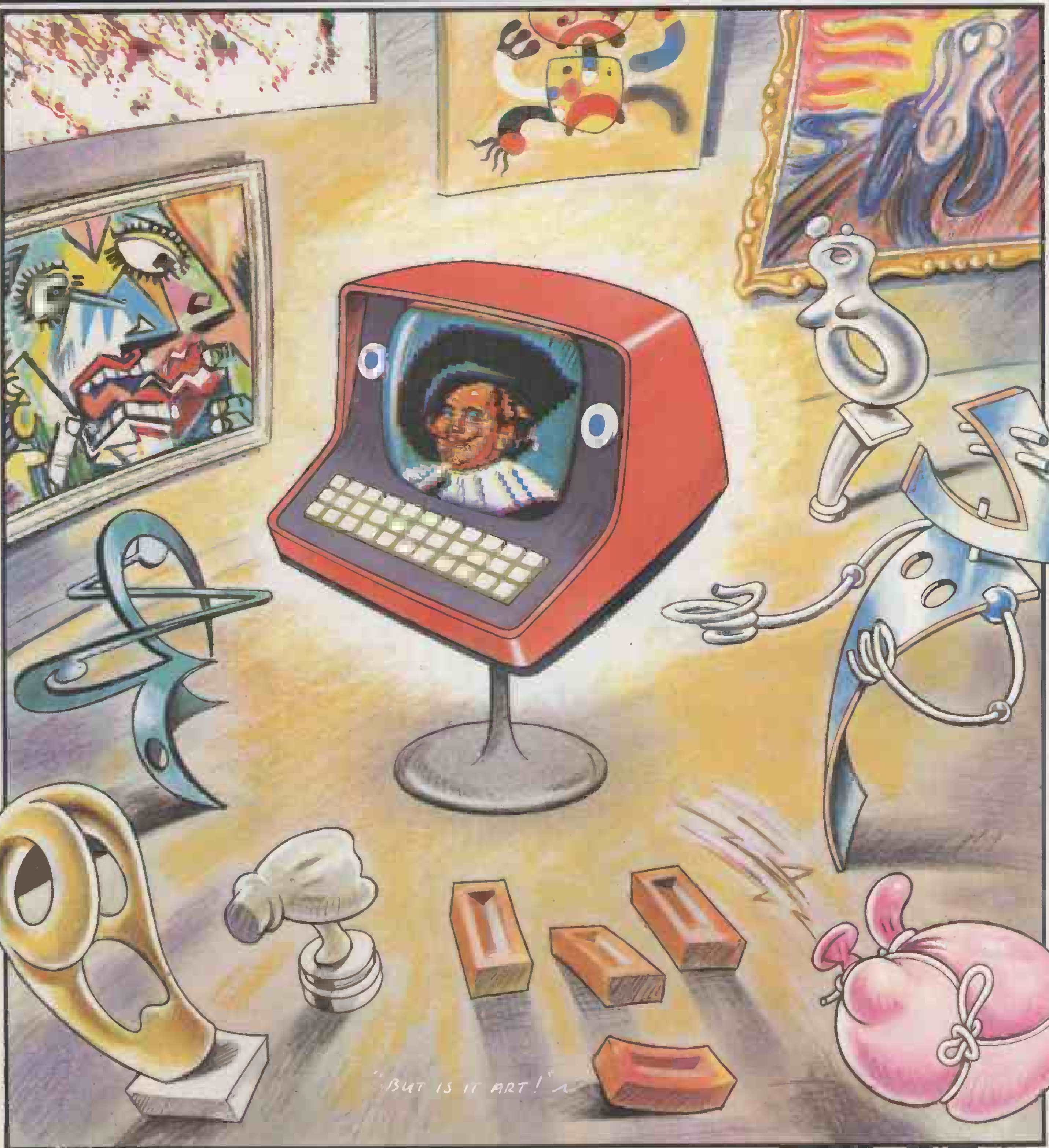
EUROPE'S LEADING MICRO MAGAZINE



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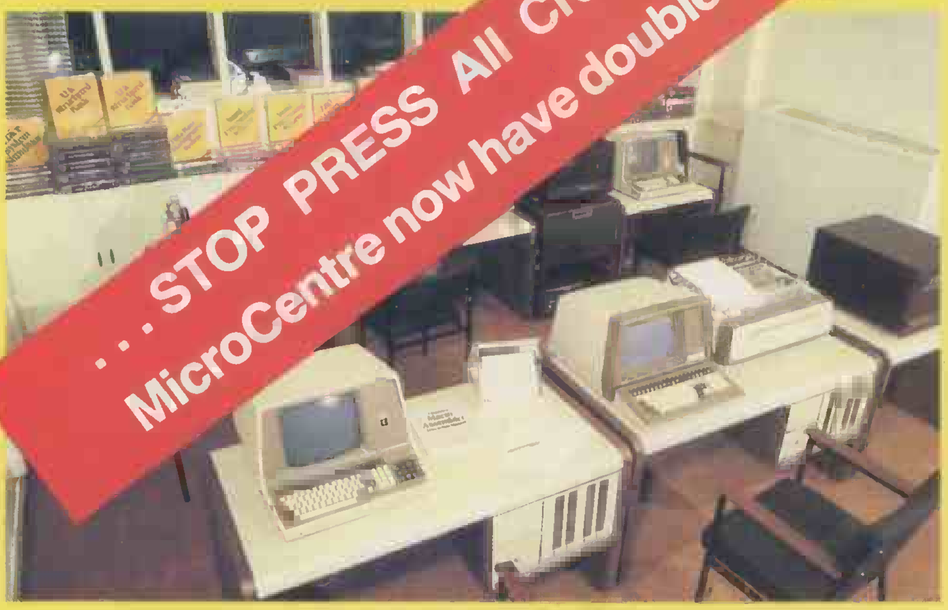

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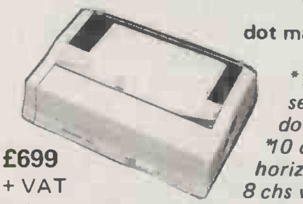

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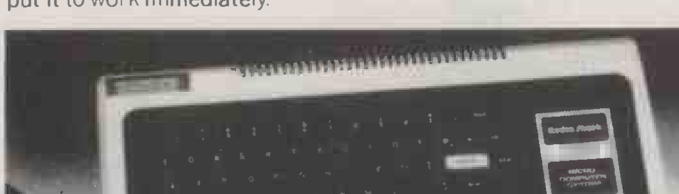

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Originally designed for **scientific** and **technical** applications, the PicChip is also being used in **educational projects, games** and design work of all kinds. The combination of fast plotting and area manipulation makes the PicChip ideal for the continuous display of real-time data in graphical form.

Just see how easy it is to use PicChip commands: the following examples were all photographed directly from a PET screen.

Picture 1 shows two curves, one drawn in fine-density and one in bar form, produced by two program lines:

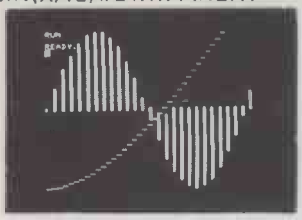
```
10 FOR X=0 TO 39:Y = X↑1.5:!WF:
NEXT
20 Y0=25:FOR X=0TO79 STEP 3:
Y=SIN(X/12)*24:!WY:NEXT
```

Picture 2 adds a third program line to plot a function as adjacent bars:

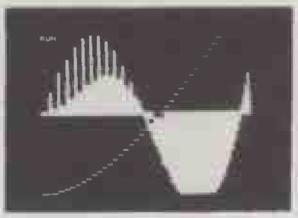
```
30 FOR X = 0 TO 79:Y=SIN(X/12)*
X/2:!WY:NEXT
```

If we just take the second program line and change !WY to !WX, the bars are plotted horizontally:

```
20 FOR X = 0 TO 79:Y=SIN(X/12)*24:
!WX:NEXT
```



(1)



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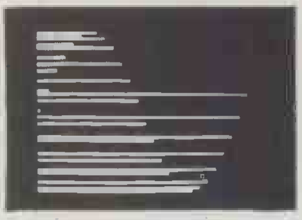
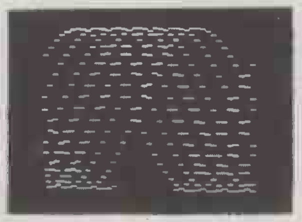


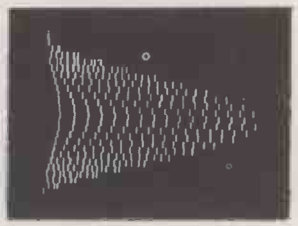
(3)

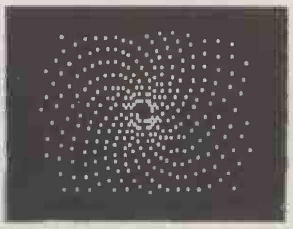
All the other pictures reproduced here were generated by the DEMONSTRATION PROGRAM included in the 20-page Handbook. What we can't show here are the amazing effects produced by shifting or rolling or otherwise manipulating different areas of the screen. There is even a repeat-key function, and commands for reading and setting the cursor position in X,Y coordinates.

PicChip Functions.

Command	Function
SYS 45056	PicChip On
!RE	Restore screen
!CO	PicChip off
!RP	Repeat-Key on
!RO	Repeat-Key off
!CW	Cursor-position Write
!CR	Cursor-position Read
!AF	Area Fill
!AR	Area Reverse
!AN	Area Normal
!AI	Area Invert
!AS	Area in Shift case
!AU	Area in Unshift case
!AC	Area Case invert
!AF	Screen Fill
!SR	Screen Reverse
!SN	Screen Normal
!SI	Screen Invert
!SS	Screen in Shift case
!SU	Screen in Unshift case
!SC	Screen Case invert
!US	Up Shift
!DS	Down Shift
!LS	Left Shift
!RS	Right Shift
!UR	Up Roll
!DR	Down Roll
!LR	Left Roll
!RR	Right Roll
!WP	Write Point
!EP	Erase Point
!WL	Write Line
!EL	Erase Line
!WC	Write Continuous line
!EC	Erase Continuous line
!WX	Write bar in X axis
!EX	Erase bar in X axis
!WY	Write bar in Y axis
!EY	Erase bar in Y axis
!WF	Write fine Y
!EF	Erase fine Y
!FW	Write fine X
!FE	Erase fine X
!CS	Copy Screen
!PC	Poke Character







The standard PicChip plugs into socket UD4 of the PET, but is also available to fit either of the other two sockets. PicChip is therefore **compatible** with **other PET ROM packages.** Installation and use are fully described in the handbook.

The PicChip costs just £50 + VAT. To buy the handbook separately costs £5 but this may be offset against an eventual purchase of the chip. State required socket when ordering. 10% **discount to educational institutions.**

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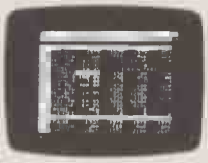

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Apple is providing FORTRAN for use by technical professionals and educators who are both familiar with the FORTRAN language and are using packages written in FORTRAN. Because FORTRAN is a well-established language, large libraries of FORTRAN programs are already in existence, particularly for engineering and scientific applications. Apple FORTRAN provides the sophisticated FORTRAN user with the capability to develop new and modify existing FORTRAN programs on an Apple. Apple does not recommend FORTRAN for the individual new to programming.

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- *provides a comprehensive software design environment including an editor, linker, file handler, assembler, Apple Pascal compiler, and system library, operating in the Apple Language System .*
- *eliminates the need to recompile or reassemble existing code files when incorporating them into FORTRAN programs; compiled P-code and assembled machine code can be combined with a FORTRAN P-code file through the Apple Language System's linker facilities...*
- *allows you to take full advantage of Apple's Hires graphics capabilities by interfacing to graphics routines in the system library...*
- *gives programmers access to large libraries of material, since FORTRAN is a familiar, well-established language...*
- *provides access to special Apple features, such as sound generation and control paddles, through its system library routines...*
- *permits you to combine several source files in a single compilation through compiler directives in the source code.*

First, Some Words About FORTRAN '77

FORTRAN 77 contains significant additions and enhancements to the previous 1966 standard For example mixed-mode arithmetic expressions are allowed Structured programming is supported through expanded IF statement constructs Logical IF, Block IF, ELSE IF ELSE, and END IF statements provide a vastly improved method of clearly and accurately specifying the flow of program control CHARACTER data type replaces Hollerith, alphanumeric data can be represented as strings rather than array elements.

Some Specifics About Apple FORTRAN

Apple FORTRAN is the ANSI Standard Subset FORTRAN 77. It also supports enhancements and facilities from the full FORTRAN 77 language In particular

- Subscript expressions may include array elements and function calls
- DO statement limits may be defined by expressions, rather than just single variables.
- I/O units may be specified by expressions, rather than just constants or simple variables.
- The I/O list of a WRITE statement may include expressions
- All combinations of FORMATTED/UNFORMATTED and SEQUENTIAL/DIRECT files are allowed, with the following restrictions:
  - BACKSPACE is supported only for files connected to the blocked devices, it is not supported for UNFORMATTED SEQUENTIAL files; —
  - DIRECT files must be connected to block devices

Apple FORTRAN contains a number of enhancements beyond the full FORTRAN 77 specifications In particular

- Compiler directives may be included in the source code For instance, the $INCLUDE directive allows you to insert previously-developed code into your program without having to repeat the code This is useful, for example, when you are writing many subroutines which use the same COMMON block You can write the COMMON block just once, and $INCLUDE it in every subroutine
- An additional parameter to the OPEN statement allows you to specify whether the file is blocked or unblocked

There are two minor differences between the ANSI Standard Subset FORTRAN 77 and Apple FORTRAN They are

- Subprogram names cannot be passed as parameters
- INTEGER and REAL data types have different storage requirements—two bytes for INTEGER, four bytes for REAL

Apple FORTRAN is written in Pascal and produces P-code which runs in the Apple Pascal Operating System

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To use Apple FORTRAN, you will need:

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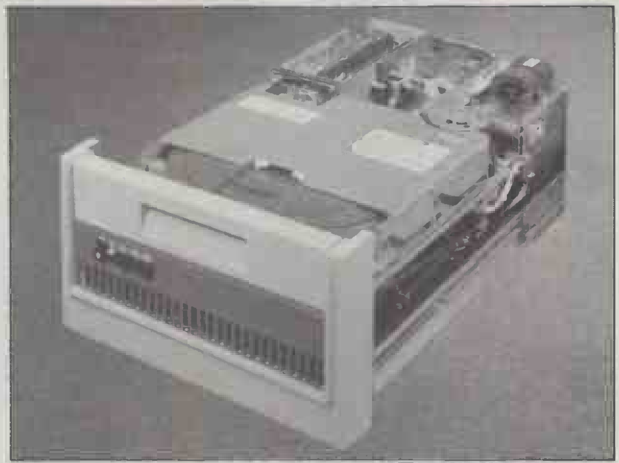

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04=*ENTER PURCHASES

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While immediately supporting our traditional marketplace we intend to expand the company rapidly into the manufacturing of industrial Nascom products. The design of certain products is already under way and the first of these will be a Prestel users receiver which will be available at the start of 1981. This is a separate, stand alone unit having no connection with previous Nascom products. We have several other projects under design or investigation that will give the new industrial division a good start next year.

We have the finance and facilities to exploit new ideas and would be very pleased to hear from any designer who has an idea based around Nascom products. Anyone with hardware or software please write to me at Pall Mall.

Nascom announced many products in the last year few of which arrived. Luckily during receivership many of these designs were completed and we will immediately be purchasing supplies to make these available a.s.a.p.

There are also other Nascom 2 products defined that we will quickly engineer and produce in the next few months.

The future for micros is undeniable and Nascom International intends to retain its rightful place at the head of European microcomputing.

Peter Mathews Chairman

Competition-best caption 2.

To allow the frustrated to vent their ire and the imaginative to vent their flair we invite your captions to the four cartoons that appear this month. A prize for each and the winners published. You can't win if you are too rude as we can't publish. Send to Chesham marked "Cartoon".

New Start With 20,000 users and a good deal of frustration and uncertainty mixed into the enthusiasm we invite everyone to write with their ideas and needs. The new home division will not be able to answer all the letters but policy decisions on direction can best be made on research into user needs.

Dealers We intend to continue the policy of sales through dealers and Nascom International will not be selling products direct to the public. Stocks we know are depleted and we would ask you to allow us time to restock our dealer network.

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The disc unit comes fully assembled complete with one or two 5¼" drives (FD250 double sided, single density) giving 160K per drive, controller card, power supply, interconnects from Nascom 1 or 2 to the FDC card and a second interconnect from the FDC card to two drives, CP/M 1.4 on diskette plus manual, a BIOS EPROM and new N2MD PROM. All in a stylish enclosure.

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Additional FD250 drives .... £205 + Vat

D-DOS SYSTEM
The disc unit is also available without CP/M to enable existing Nas-Sys software to be used. Simple read, write routines are supplied in EPROM. The unit plugs straight into the Nascom PIO.

Single drive system .... £395 + VAT
(please state which Nascom the unit is for)

Certain parts of the CP/M and D-DOS disc systems are available in kit form. Details available on request.

ENCLOSURE FOR N2+5

The Kenilworth case is a professional case designed specifically for the Nascom 2 and up to five additional 8" x 8" cards. It has hardwood side panels and a plastic coated steel base and cover. A fully cut back panel will accept a fan, UHF and video connectors and up to 8 D-type connectors. The basic case accepts the N2 board, PSU and keyboard. Optional support kits are available for 2 and 5 card expansion.

Kenilworth case £49.50 + Vat
2-card support kit £7.50+Vat • 5-card support kit £19.50+Vat

INTERFACE ENHANCING UNIT

The Castle Interface is a built and tested add-on unit which lifts the Nascom 2 into the class of the fully professional computer. It mutes spurious output from cassette recorder switching, adds motor control facilities, automatically switches output between cassette and printer, simplifies 2400 baud cassette operating, and provides true RS232 handshake.

Castle Interface Unit .. **£17.50** + Vat

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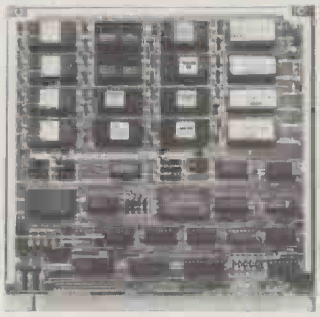

The Nasbus compatible EPROM board accepts up to 32, 2716 or 16, 2708 EPROMs. It has a separate socket for the MK36271 8K BASIC ROM for the benefit of Nascom-1 users. And for Nascom-2 users, a wait state for slower EPROMs. The board also supports the Nascom Page Mode Scheme.

EPROM Board (kit) .... £55 + Vat
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All prices are correct at time of going to press.

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For Nascom ROM BASIC running under Nas-Sys. Supplied in 2x2708 EPROMs. Features include: auto line numbering; intelligent renumbering; program appending; line deletion; hexadecimal conversion; recompression of reserved words; auto repeat; and printer handshake routines. **Price £28+Vat.**

DUAL MONITOR BOARD. A piggy-back board that allows N1 users to switch rapidly between two separate operating systems. **Price (kit): £6.50+Vat.**

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PROM-PROG MKII.
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All the products are available while stocks last from the Nascom dealers below.
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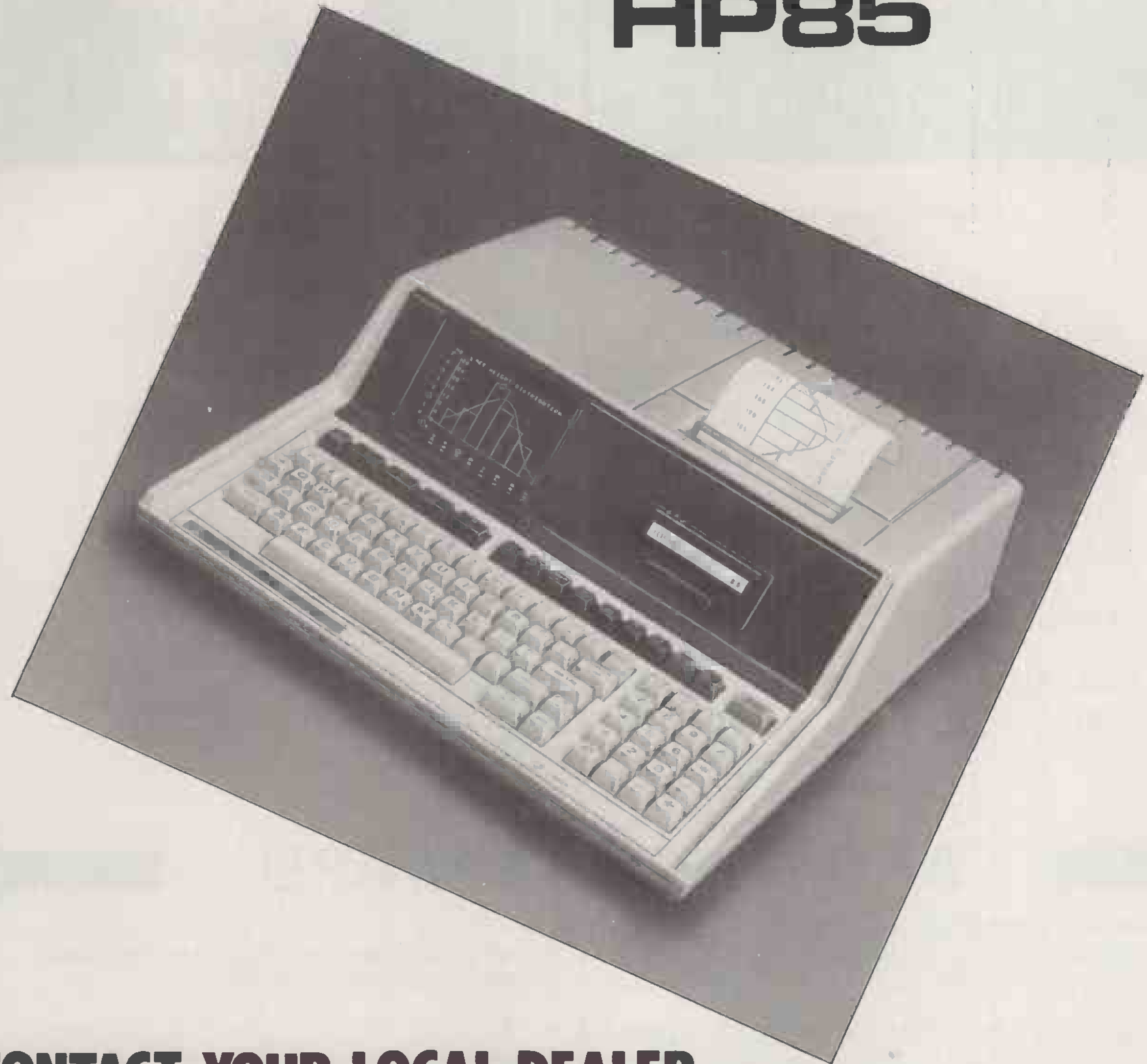

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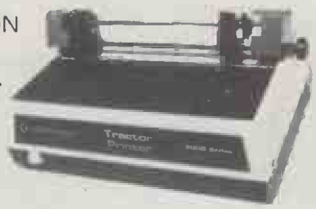

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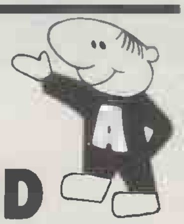

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Sargon Chess Pack:
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All the above for only £35.00

Henelec EPROM Programmer:
This unit allows the NASCOM user to program both 2708 and 2716 EPROMs and complete with operating software costs only £25.95

Interface EPROM Board:
Provides sockets for both 2708 and 2716 EPROMs (up to 16 EPROMs) and also provides a fully decoded socket for the NASCOM 8K BASIC ROM. This board is produced to full NASBUS specification and can be used in "page mode" together with the new NASCOM RAM B. Wait states may be generated on board to allow a NASCOM 1 to run at 4MHz in BASIC.
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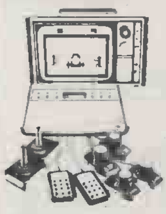

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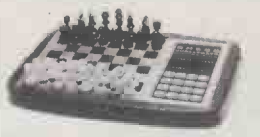

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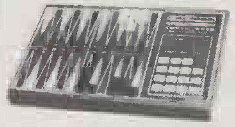

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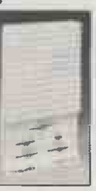

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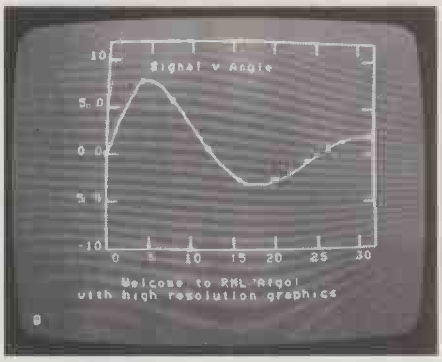

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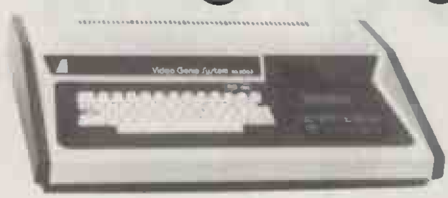

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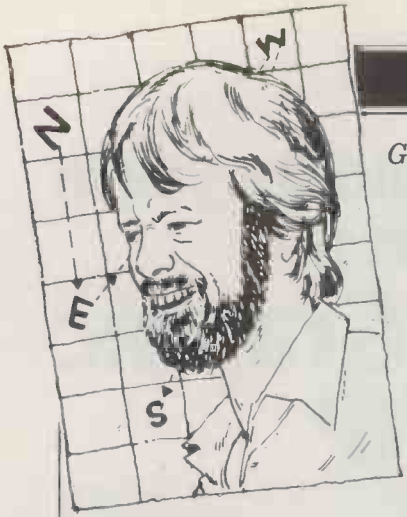


NEWSPRINT

Guy Kewney, Editor of Datalink, *delivers his usual idiosyncratic rendering of all the latest happenings.*

Playing with an Atom

For the last month or so, I have been happily playing with an Acorn Atom, at the earnest request of Acorn's partners, Chris Curry and Hermann Hauser. In a way all this happy playing is designed to settle a bet: is the Atom a nice machine, or not?

Readers whose memories go back to March/April will recall that I got quite excited about the Atom when it was arriving, but that a couple of months later, when it arrived, Mike Dennis did a Benchtest and thought it was nowhere near as nice as its photograph.

Shrewdly spotting which of us was most likely to be responsive to a prolonged test, Acorn accordingly despatched a fully-equipped Atom to me, with the request that I see whether I agreed with Mike.

On two points, I do. The Basic supplied is non-standard. And the video output to a TV *does* require an adjustment of the vertical hold. And one anti-Atom point worth making straight away is that the videc display has a silly fault — a 'flicker' when using graphics software.

Apart from that, I still think it is a worthwhile machine. The Basic is the thing I like most about the Atom. It is definitely a Basic for the programmer, not for the copyist, though the 'improvements' that its designer has put into it are irritating at first because you expect it to do things, and it doesn't.

For instance, in most Basics, a PRINT statement starts its output onto a screen at the beginning of a line, unless the previous PRINT ended in a semicolon. On this, it works the other way: if you want it to print on a new line, you have to end your PRINT by outputting a single quote (') or start the next line with one, of course.

Similarly, the Basic is integer, even when you have the full floating point option, so that a statement PRINT 3/4 will produce 0; you have to say FPRINT 3/4 if you want 0.7500000. This means that all programs written before installing the arithmetic option will continue to work afterwards, an important point.

Now that the Atom has passed its first 1000 sales, we have to start looking forward to the time when it becomes acceptable. Acceptable, as defined in my Rules of Thumb for selecting a system, means having more than 5000 users because that is the sort of figure that attracts software writers to start selling programs. And, right on cue, Bug Byte of Coventry write in with the news that the company is the first to offer Atom programs.

Bug Byte is a partnership of three — Baden, Fitzgerald, and Milner — the last of whom has written to complain that his company, not Econsoft, was the first to offer software for the Sinclair ZX80. For details of their products, Milner says, I should look in the advertisement which he recently sent for inclusion in the December issue of this magazine.

Oh, good; that saves me having to find out what they are and write about them.

Health conf.

You may (if our printers have really pushed themselves getting this issue out) be in time to get over to Loughborough on 11 December, to find out whether video displays are hazardous to health.

A conference is organised by HUSAT (Human Sciences and Advanced Technology) research group at Loughborough University, with medical experts on skin disease, plus ergonomic experts on people shape, and even experts on radioactivity — which should cover all aspects of the problems caused by looking at flickering screens — apart, that is, from the problem of how to debug the flickering program. Details on (0509) 63171.

Coming soon

We are all dying to know what the industry can produce to overtrump Uncle Clive Sinclair's ZX80.

The answer looks like being either the new Nascom Microcomputers machine (see elsewhere) or, more likely, a development of a less-known micro kit, the Tangerine Micro-Tan.

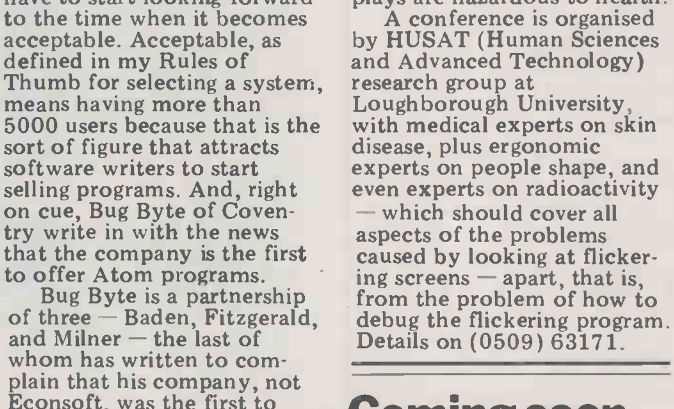
The makers of the new machine deny that it will be a computer. It will, they say, be a Prestel adaptor, for £100 or less. All it will do, they say, is convert your television set into something that can be connected to the telephone lines, and can receive Prestel's database of news and rubbish pages. It will be called Tan Tel and it will be available early next year.

What makes it special, they hint, is the way it can be expanded (unlike the ZX80 which, nice though it is, isn't really worth expanding — you give it to your baby brother instead). It will be compatible with the expanded MicroTan, which is expandable to an enormous extent.

For example, the Tantel can have, for an extra £50 or so, a very good full-typewriter keyboard. For the cost of extra MicroTan memory and disk controller boards, it can have expanded memory and disks. It can have a great deal more memory than standard micros — despite being based on the well-known 6502 chip (in the PET, Apple, Acorn, etc) it can handle over 400 kbytes.

In other words, it can be expanded into a very office-acceptable data processing machine, with the ability to contact remote databases built in. The only real drawback, so far, is that the circuit it uses for talking down a phone line is the modem that the PO specified for Prestel — a modem which cannot talk to another one like itself. So Tantel users can't (initially) talk to each other.

Tangerine hints that this would be quickly cured but won't give details. Impressively, however, it claims that something like 40,000 Tantel units will be made and sold in 1981 — which is enough to attract software writers. Even PET is only up to 35,000-odd in the UK so far.



The only way of deciding whether a music synthesiser is any good is to listen to it. This one is not the Apple synthesiser but is available through all 250 Apple dealers in the UK, being imported by the Apple distributor Microsense. Without having listened to it myself, I can't be sure, but I think the 'special' feature about this one is stereo. "Stereo output is to users' stereo amplifier and speakers, or directly off card with stereo headphones," says the announcement. It sounds (sorry) quite exciting. More on (0442) 48151.

Postponed

Here's how to send a letter to Granny in Canada. You write it at your computer terminal, transmit it to the

The MSC mini-Winnie controller (centre). See 'Disk hook-up'.

IP Sharp timesharing computer locally. That computer instantly transmits it to the computer in Toronto, also owned by IP Sharp. In its turn, the Toronto machine gets on the line, dials Granny's terminal and tells it to print out pronto, Toronto — and Granny is woken from her slumbers by the chattering of the printer. Takes seconds.

It's called electronic mail and the advantages over people running around with bags over their shoulders are obvious. So, naturally, the European postal authorities (mainly the German Bundespost) are anti, and Sharp has been forced to cancel the service.

Of course, the CEPT will provide an alternative service. One day. When they can agree on how it's to be organised.

In the meantime, can we please carry on using the IP Sharp mailbag?

No.

Nice people, the CEPT.

Disk hook-up

Elsewhere on this page you'll find a photo of a computer joined to a little black box joined to a mini-Winnie hard disk. The black box (why are they always black?) is a low-cost ($700) controller, which could give your PET a vast storage capacity.

Two intriguing things are not said in the large amount of information provided by the supplier, Microcomputer Systems Corporation. The first is: why show the controller being driven by the Hewlett-Packard HP-85, and not the PET? And secondly, what is the supplier gcing to do with it?

The magic part of this little black box is the fact that it uses an HP-patented method of connecting a computer to a device — the general purpose interface bus (GP-IB) — which also occurs (with minor variations) in the PET. In fact, the PET had it first — the HP-85 didn't get its own GP-IB until a couple of months ago.

The minor differences between the full GP-IB, as specified under the IEEE and IEC as the 488 standard, and the PET interface, should not affect this device. A disk drive doesn't have subsidiary devices to control, and it is only in the area of subsidiary devices that the PET can need watching. So it's a safe bet that PET will drive the disk (a Shugart ST-506 drive) with this interface. So why didn't Microcomputer Systems say so? Intriguing.

Secondly, the question of why. Microcomputer Systems specialises in hardware interfaces, but is believed to have an interest in promoting products which it knows will be in high demand. Sources in California say that the choice of this drive is linked to Hewlett-Packard's plans to launch a database manager — software for controlling and searching through large volumes of stored data files — soon.

Incidentally, the controller can be used with the PET — and, "with a minimum of cost and design effort," with Apple, Prolog and systems using Intel's Multibus. But on the face of it, stay with PET and HP systems until we know just how 'minimum' this effort is. Details on (0101 408) 733 4200.

Secondhand I/Os

Secondhand input/output devices, remarks the new Computer Junk Shop, "are so necessary to make a relatively cheap microprocessor into a useful system." Too true.

To get cheap peripherals from the Junk Shop, however, you have to live near Widnes in Cheshire. The shop "will offer components, cables, power supplies, computer peripherals (both new and second-hand) together with more usual items such as lamps and batteries."

The company says it is getting its components from "the inevitable obsolescence that the changing technological age of the micro revolution is bringing."

The items on sale will be mainly unused surplus stock, acquired from major electronic manufacturers, and secondhand items, reclaimed from obsolete computer and electronic systems. Now you know what to do with your Science of Cambridge Mk 14 when you've finished jumping on it. Details from Nigel Armitt on 051-420 4590.

Colour display

Real computer users, naturally, use real VDUs, not grotty television sets like imitation computer users have to put up with on their grotty little micros. That, of course, is why real computers have never been able to give their users the benefits of good colour output at less than extortionate prices, while we imitation computer users have had good colour for the price of an ordinary TV.

Ah well, somebody was bound to spot it; Rapid Recall has made the breakthrough, and produced a display system which allows any 'proper' Digital Equipment Corporation micro (the LSI-11 family of single-board minis) to drive a standard colour TV set.

The system is the VTV 30 J, and it is sold with the idea of allowing engineers to generate colour pictures mimicking the process in the process control system that the computer is controlling. The system takes up two printed circuit boards, and generates pictures by itself, once the computer has transmitted them — just like a real microcomputer. Clever, isn't it? Details on (0494) 26271.

Help from MUSE

Teachers needing national information and advice on micros, can now ask MUSE.

MUSE is Mini and microcomputer Users in Secondary Education, and it has set up a centre in Birmingham with a full-time teacher in charge — Bob Trigger — who has been seconded from Birmingham's Marsh Hill Comprehensive School, and starts work on the first day of the New Year. Muse claims that Trigger has many years' experience of teaching computer studies, so can presumably advise relative beginners when they get stuck.

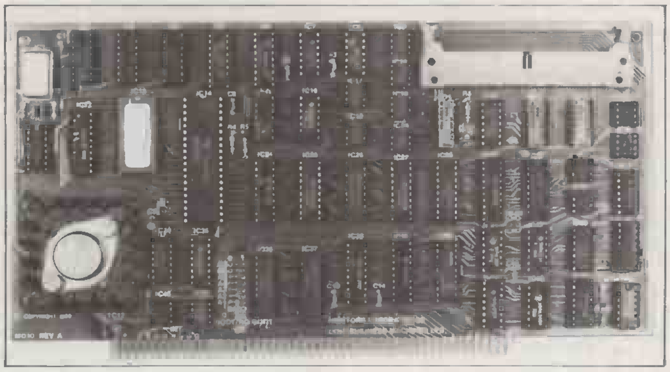
Funding for the centre has been provided as part of the government's £9 million microelectronics development programme for schools and colleges.

Anyone who feels that the Centre should know of their work in computers or in education or both, should contact the centre. Bob Trigger's phone number is 0527 76074.

New software

People who use operating systems tend not to like working with the nitty-gritty detail of getting binary codes in and out of disk storage — they like having it done for them. This provides a neat trap for some software publishers who wish to 'protect' their programs. They include disk storage in their programs and let the program fetch its data in a non-standard way. So, when you try to copy the data, you find that sector three under CP/M isn't sector three on this disk.

Annoying. Therefore let the computer tackle it. Get a program like PROZAP from A J Harding (Molimerx). This enables disk users to get into their disk and carry out examinations and modifications, Harding points out. Alternatively, try DISKAID — another 'zap' program designed to get round the

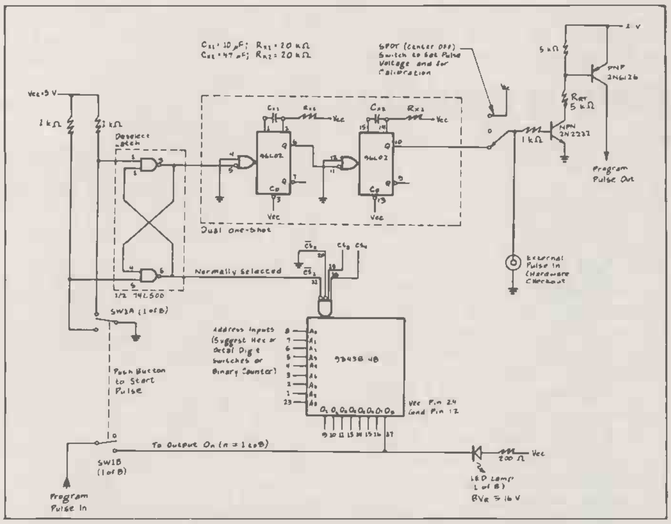


The newest "mini winchester" big-capacity storage systems are not yet available in removable cartridges — which means that micro users wanting removable big-storage devices either have to keep tape copies of their disks, or they have to use the older (and rather costly) cartridge disk drives.

An interface to connect S100-based computers to one of these cartridge drives is available from Newtons Laboratories. As shown, it includes operating software to run under the CP/M operating system (version 2.2) with a "rewritten BIOS which will allow the user to boot from either his floppies, or from the cartridge disk drive."

If the hard disk is used in this way to start the system, then the floppy disk storage units can be used as peripheral storage — and vice versa, says Newtons.

Details from Theo Van Dort or Mike Osler on 01-874 6511.



Politely, the giant chip-making company Fairchild has refrained from saying, in so many words, that people sell devices for loading programs into permanent memory at overhigh prices. Instead, the company has published this circuit, which it suggests can be built quickly, with a minimum number of parts, at low cost.

It is designed for the permanent programmable memories, not the ultraviolet eraseable and reprogrammable EPROMs.

It blows the fuses on the memory chip, producing LOW outputs from the required memory cells (when made, they are all HIGH; must be nice being a cell. . .).

Details from Fairchild on (0707) 51111.

same nasty problem.

"It is fair to say that Prozap contains more commands and features than Diskaid," comments Harding, in the latest addition to its catalogue. "On the other hand, Diskaid costs a little less than Prozap."

The machine catered for is primarily the Tandy TRS-80 in its many guises.

There is a new NEWDOS called Newdos80 — better than NEWDOS+, says Harding, and much better documented; "it is not an upgrade but an entirely new piece of software. Unfortunately, therefore, we are not permitted to upgrade existing NEWDOS+ customers."

There is a touch-typing course, a board game called Dark Void (locating atoms in the void by shooting rays into it), Farmer Brown (strictly for the children), Hannibal and lots more. Details on (0424) 220391, or write to 28 Collington Avenue, Bexhill-on-Sea, E Sussex.

School scheme

"As a ZX80 owner," writes a teacher from St Ives, Cambridgeshire, "I have been extremely impressed with the cheapness and versatility of the machine, and have used it extensively in my profession as a primary school teacher. As there appeared to be a complete lack of educational programs on the market, I had to write my own to fit the particular needs of the junior school age range."

The correspondent earns this free printing of his letter here because of the low price for his software: he is asking a mere £3.50 per cassette. So let him continue, unadulterated: "I feel that there is a definite need for good, reliable and above all tried and tested educational programs, so have decided to market my products. "Junior ZX80 Education Enterprises' aim is to produce reliable programs dealing with specific needs, as cheaply as possible. The information sheet will be sent to anyone interested."

It includes programs which could be used as games, but which are meant to be used in lessons. There is also a list of future projects, including a spelling game comprising the 300 words that comprise some 55 per cent of all written material and an offer to market any software supplied by others.

"We would like to point out, however, that every cassette has to be checked and tried with children, so the emphasis is on quality, rather than quantity."

Send stamped envelopes to Mr Squibgle, Junior ZX80 Education Enterprises, 38 Bedford Cres, St Ives, Cambs PE17 6DE.

It's all a moustake

There was no end of bitterness over the mouse competition.

The mouse competition? (you ask)?

Yes, the mouse competition. It was the idea of John Billingsley, of Euromicro exhibition fame, to create a maze that could be solved by clever robot mice.

A micromouse with an RCA 1802 micro in it, devised by Geoff Pikes and Nick Smith, was the first into the centre of the maze on the day. Loud cheers, because they built it with less than £200 and no sponsorship and beat a great many sophisticated beasts from heavily sponsored entrants.

Well, having done the loud cheers, it remains to be admitted that the event wasn't an unqualified success. First, the maze itself was made of rather flimsy material, and many of the mice pushed it over. Second, most of the entered mice never actually found their way into the centre. In fact the winner, Sterling Mouse, was the only one that made it. And there were strong feelings that this was luck rather than judgement, because in the course of trying to map out the maze, preparatory to running, Sterling got lost and crashed.

In other words, Sterling couldn't build up a picture of the twists and turnings and gaps, but he (she?) still got to the centre — hmmm.

Prizes were awarded, however. Sterling got $1000 in nice new notes, a Finnish entry, Midnight Sun, tied with the UK version, Fred Mouse, and each got the Computabits £100, which was nice of Nick Hampshire: and Brainy Bricks got a clock barometer plus £20 from the Computer Bookshop for the best performance in plotting the map (with which it still couldn't find its way to the centre, but never mind).

The remaining entries, Meryl, Pascal Mouse Engine, Amcomical and Yamohick 4 (!) were awarded consolation prizes. Nothing will persuade me to reveal what these were, or you will think me an utter sadist. I have my own ideas of what the word 'consolation' means, and these prizes could not qualify.

Commodore, however, decided that the terms under which it had originally agreed to provided a trip to its US plant, had not been complied with. The entrants all grumbled about this, but I must confess that for once, my sympathies are with Commodore. Other prize sponsors decided to be magnanimouse (sorry), and so much the better. But Commodore said that nobody actually qualified for the prize — and you really can't argue with that.

Copmstof

Compsoft is too busy using its computer to write useful PET software to let it be distracted by mundane tasks such as running word processing programs.

I know, because the company has just announced a data management system, DMS, which is used to keep track of such things as stock records, agency personnel records, financial and scientific analysis, patient or student records, sales analysis, maintenance contracts, and so on. The program is not restricted to PET users. It runs on all 32 kbyte PETs, plus Computhink machines, plus CP/M machines.

How on earth, you ask, can anyone tell from all that, that Compsoft doesn't use its computer for word processing? Because, I answer, the announcement includes such interesting words as sutdent instead of student, thanm instead of than, CP/m instead of CP/M and cannon instead of cannot.

I only hope the telephone number (0483 39665/39665) is not similarly mistoped.

The important feature of this photograph is not the train set. Nor, surprisingly, is it the Sol computer (I think it's a Sol, but it's not clear in the photo) on the little table. No, it's the pneumatic drive — the bank of air cylinders — in the background.

It is an electronic switching box connected to the bank of air cylinders which Teddy Wright (left) developed, and was here using to drive the trains.

No, I don't understand it either, but ask Thomas Wright (Bradford) Ltd yourself on (0274) 663471 if you want details. Let me know what you have in mind — there must be things that really call for pneumatic control but I can't think what they are.

Apples get together with Nestar

Painstakingly, you type out a screen of letters, four inches high, on the display of your Apple. The letter G is made up of forty Gs, the big U is made up of equally strategically placed Us, and the Y is a masterpiece of collated Ys.

Then you transmit the screen through a network to your mate Gonzo who is sitting at the console of a Tandy. Instantly the last letters of Y are transferred onto the next line, screwing up the whole display with unwanted line feeds.

This is the reason Zynar has brought Nestar to Britain, but has dropped the idea of putting anything other than Apple computers into the network.

Nestar was first demonstrated publicly at the West Coast Faire this year in San Francisco, where it took quite a long time to find your message (if there was one) but then lost it forever.

It now works quite a lot better and Harry Saal, the head of Nestar, came to Britain with it, to give UK rights to the new firm, Zynar.

The product is almost enough to make you take it seriously by itself. What makes it even more impressive is the man at the head of Zynar: Colin Crook.

Crook it was who forced Motorola to design the 6800, the biggest 16-bit microprocessor in the world (until IBM releases details of its System/370 chip). Crook was virtually head of Motorola's world-wide micro operations, when he suddenly got out of America to bring his children back to where they could learn to speak properly — and for all the other things that make this country a nice place in which to grow up.

Now he has got the microsystem bug and is scathing in his scorn for those who don't see the future as a networking one. "There are people trying to design multi-user software systems, and they're absolutely mad," Crook confided at the Zynar launch in September. "The way to give extra power is to give extra computers, not to slice up cheap ones into things driving terminal teleprinters. Who for (.....)'s sake wants a terminal on the end of a 300 baud line?" Who indeed.

Mind you, you can have fun with the Nestar net. Type in a buffer full of Control G characters, then transmit, and listen as everybody else's computers seize up, bleeping. No, don't do that; it would be irresponsible.

Details from Zynar, on Uxbridge (0895) 59831. They may even let you have some Apples to run the cluster network on.

This briefcase has a computer in it. Not for you to use but to keep the case shut until you type in the right combination code. Only one small point: if the battery runs down, the lock won't open. Nasty. Details on 01-882 2992.

Cheap printer

As long as the printer on a system isn't going to pretend it is an electric typewriter, it can cost £200 and still offer full width (80 characters per line) and 30 characters per second speed. The device that gives print at this price is the 'unihammer' dot matrix printer made by Seiko and marketed in the UK by Mitrecrest of Basingstoke.

Normal matrix printers can, theoretically, be stopped as soon as they have printed one character, because they print lines of dots, seven or nine lines at a time. This one only produces one line of dots. Rather like a TV screen scan, it runs down the paper dot-line by dot-line until it has built up the characters. That makes it a bit slow, but cheap. Details from Ian Jones on (0256) 56468.

It wasn't fair to print a picture of this printer in its version that has no keyboard. Now that Weyfringe has produced one with keys, I happily display it here; this time as a terminal, not just as a printer. Details on Middlesbrough 210587. See the August PCW *for the original mischief.* (Hee! Hee! — Ed.)

Biggies grow up

The first sign of the future, the first indication that 16-bit 'big micros' are coming must be the announcement of a version of CP/M for the Intel 8086 micro.

At the moment there aren't a whole lot of 8086 systems around. The very first was the British Elite system from Modular Business Systems in Leeds. Since then, there have been a few others, mainly from people like Burroughs, and IBM. (Yes, IBM. Its latest word processor, the Displaywriter, turns out to be an Intel 8086 with floppy disks. Only one snag: IBM won't let your nasty little fingers in to program the machine. And it does have a loverly spelling program, which shows you which words have been spelled wrongly.)

Digital Research produced CP/M before the 8080 and Z80 micros had become as popular with micro users as they are now. In fact a major cause of that popularity was CP/M. If Digital Research can do it again then we can expect good things of the 8086 and any other micros that run the same programs. At the moment, that is none; put your money on imitations for the future, however.

Digital Research is represented in Europe by the Belgian firm Vector International, tel 32 (016) 202496.

From the man who gave us Nascom...

The man who started Nascom by saying "What can we offer for £200?" has been asking himself "What can we build for under £1000?" And he has come up with Gemini.

Gemini, from John Marshall, will have a full 64 kbytes of memory, a small disk, a keyboard and some software (Basic, maybe APL) in a case oddly reminiscent of the Apple III (whatever happened to the Apple III?).

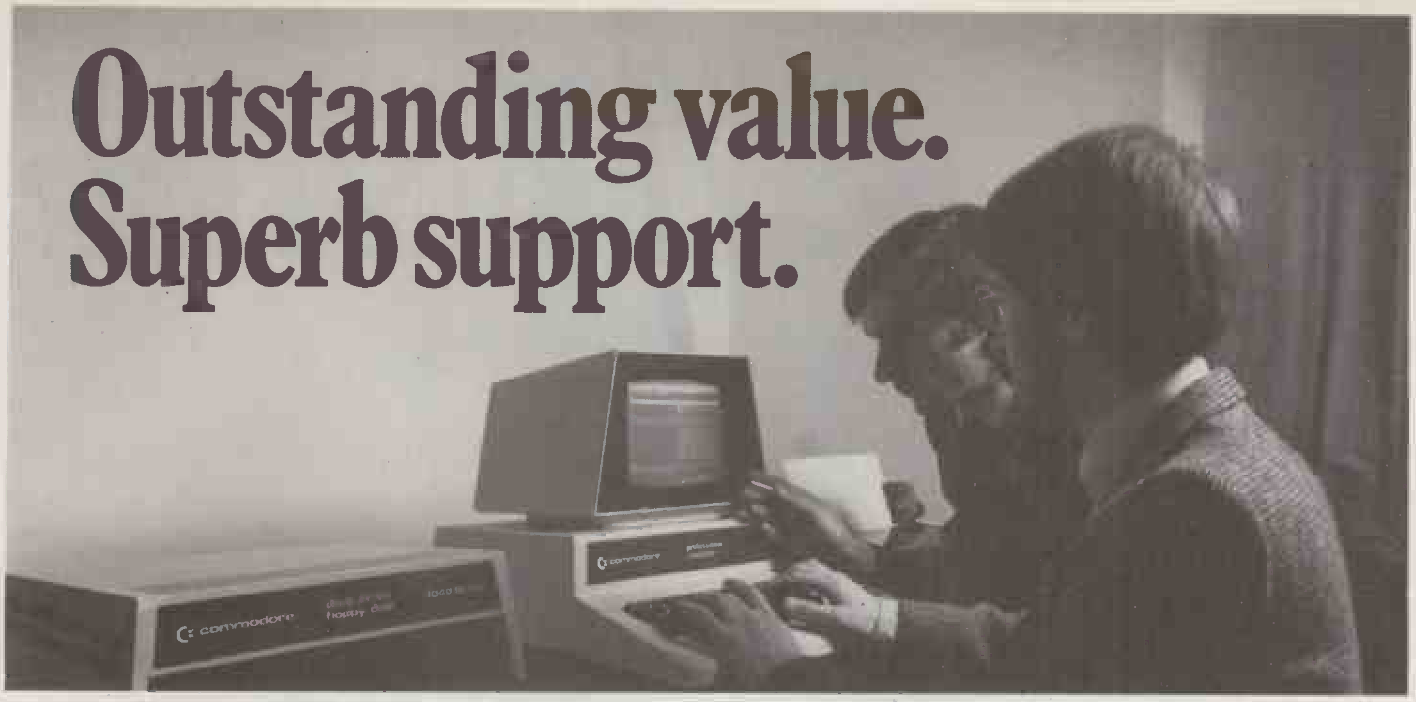
The disk drives will be available as add-ons for Nascom systems, by the way, but the future for Gemini and Marshall lies in the new machine.

It will run CP/M and eventually it will allow expansion on the S100 bus, Marshall says. The micro is, once again, the Z80. More details soon, says Marshall.

Moved

Last time your favourite electronics magazine published a sneaky little circuit to make your computer turn itself on, or to wipe your feet, or to imitate your boyfriend's voice when your parents phone, you probably had trouble finding the compo-

Outstanding value. Superb support.



Commodore produce Britain's number one microcomputer. But we don't stop there. We also insist on providing comprehensive support throughout our national dealer network.

Our dealers can examine your needs and demonstrate which hardware and software will suit you best. Their trained engineers are always at hand and a 24-hour field maintenance service is available. Your local dealer can tell you more about the following Commodore Services.

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The Commodore PET computer range covers everything from the self-contained unit at under £500 to complete business systems at under £2,500.

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Compatible products of other manufacturers with Commodore's mark of approval are also available.

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Commodore offer a range of residential training courses and one day seminars. An excellent start. And when you have installed your system the PET User's Club Newsletter can keep you informed of new ideas and latest developments.

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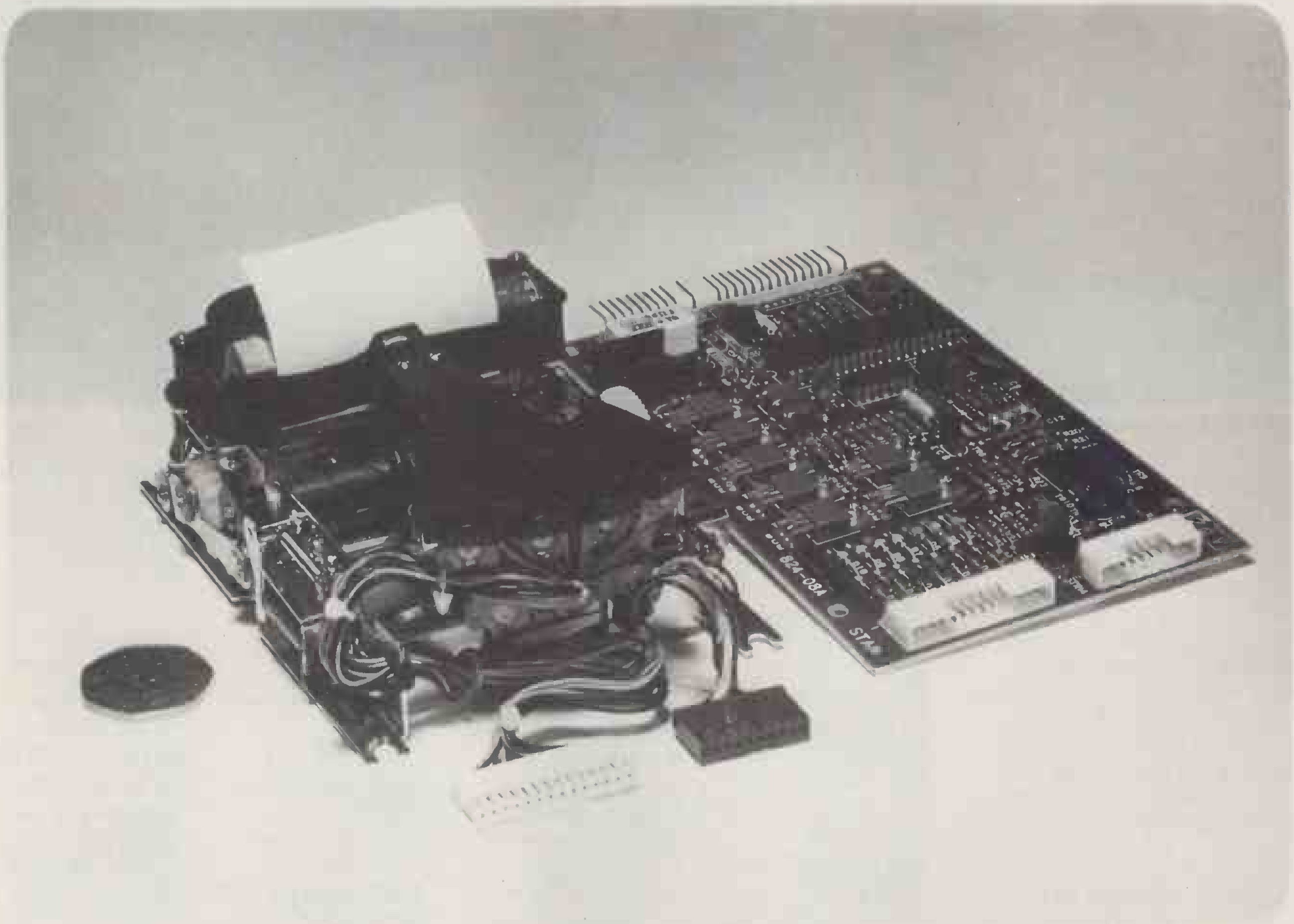

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Look carefully: it isn't an Apple III, it's a Transam Tuscan. And its price has been cut.

The very cheapest version is £235. You need a terminal to do anything at all with that, so you will be more interested in the £370 you have to spend to get a 16 kbytes system going with a video driver and keyboard, and Basic. A full 48 kbyte system, with twin disk drives, is £1481. That's assembled and tested, that last price. The other two are kit prices and the kit turns out to be quite nice to build and quite good at running when built. I've been watching a colleague at Datalink build it — his first ever venture with solder and clippers — and it worked first time, which is about as thorough a recommendation as anyone could give a single board system, especially one that offers a place to plug in five S100 cards.

Details (and details of a planned colour card, to interface to Prestel) on 01-405 5240.

nents to build it. You may have found that Ace Mailtronix in Batley, Yorks, were the people who eventually helped you out.

You will now be wondering where the heck Ace Mailtronix has gone. They've moved. The address is 3A Commercial Street, Batley WF17 5HJ, and the number is (0924) 441129.

CP/M for MZ-80K

The nice thing about the Japanese Sharp computer was the fact that it was like a PET in size, price and appearance but used the well-known Z80 micro.

Unfortunately, the reason the Z80 is 'the nice thing' about the Sharp is the fact that you can load the CP/M operating software and then get into that huge heap of very cheap software in the CP/M user library. And the Sharp MZ80K didn't have CP/M.

Until now, that is. The benefactor is Crystal Electronics, well known as the company which did both Nascom and Tandy a lot of favours by helping users. It has now added a CP/M for the machine to the 9 kbyte Basic it already supplies (leaving more internal memory free). The software to run CP/M costs £200, and the price includes a "small, easily fitted circuit board."

Crystal reports that the 9k Basic is even being sold in Japan, and that Sharp dealers have accepted the CP/M addition. If you want info from the horse's mouth contact Crystal at 40 Magdalene Road, Torquay, Devon, tel 0803 22699.

Clever guys

After their first successful year marketing teach-yourself-computing courses to run on computers, Little Genius says it is improving the courses. As before, it is starting with the Apple II computer on which it launched the first Little Genius program. Versions of the improved course, covering the ITT/2020, the PET and the Research Machines RML 380Z, will be available "in the near future".

For past users, the main improvements appear to be in the analysis of answers and in the skill assessment abilities of the training program. The improved versions cost £40 each, or £90 for the three courses in the series. Talk to Jon Baldachin on 01-580 6361 for details, or write to Suite 504, Albany House, Regent St, London W1.

Graftless graphics

It is very easy to draw pictures with the graphics command of microcomputers.

That's one of those statements that needs elaboration. It is easy, in the same way that it's easy to program a computer in hex code. It's a lot easier than doing the job that the computer is meant to do, by hand, but it still isn't actually *easy*.

A program to help with graphics on the Research Machines RML 380Z was developed during the course of a project at New College, Durham. The project, (the Durham Microcomputer Project) became quite famous at the time for showing a great many things that could and could not be done with computers in education. This bit of software is one of the good results that can be used by those of us not in education. Details of the product, called BASPIC, are given in a Users' Guide, published by Duncan Sledge.

It isn't as easy as it might be, because Sledge and Research Machines have failed to agree on a way of licensing Durham College to sell the Basic that BASPIC needs to run. BASPIC itself costs £75, but you have to configure it to your own RML 380Z — which might cost you some effort. Details on Durham 47325.

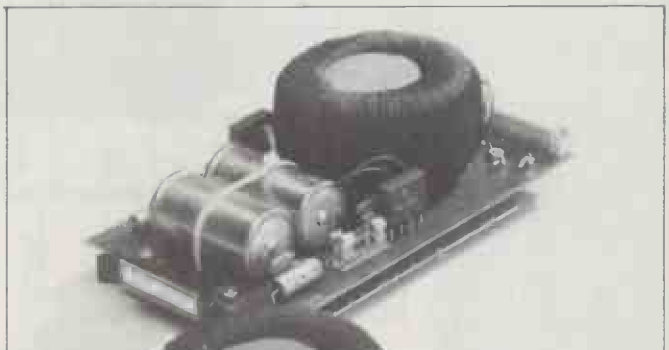
Bandwagon time

You thought it was bad enough having two users groups for the Sinclair ZX80, didn't you? How about a third — based on Morris Plains?

Yup, that's in New Jersey, USA. They're even putting together a magazine, called Sync, and (here's the cheeky bit) are hoping to sell it to UK users. So we now have David Blagden's Users' Club, Tim Hartnell's National User Club, and Sync, from. . . oh thank God, it's available from Nuneaton, England. It may not be a British mag, but at least you don't have to write out dollar cheques.

Details (including games with a hurkle in them) from Sync at 27 Andrew Close, Stoke Golding CV13 6EL. Send £10 for a year's subscription (six issues).

Incidentally, don't hold your breath waiting for Uncle Clive's latest addition, a big new Basic. He's had to cancel it. He says this is so that when he releases his cheap printer, he won't have to release *another* new memory chip but I'm afraid I suspect a bug. I'd be quite happy to have my full Basic now and buy a printer driving Basic when I get my printer.



A big power punch on a little circuit card — 5 V at 5 amps, from Vero. What makes it special is the provision of an F-type connector which, says Vero, will give higher current-carrying capacity and will prevent the power supply being inadvertently plugged into the wrong position.

Details on (04215) 66330.

COMPETITION

Modern microcomputer technology has many applications, but one where it has so far had little impact is in reducing the problems of disability.

To mark the designation by the United Nations of 1981 as "The International Year of Disabled People", *PCW*, in conjunction with the IYDP Technology Working Group, is holding a competition for the best article on the subject:

"The application of micro-computer technology to the problems of disability".

There must be many possible applications for microtechnology in the fields of physical and sensory disabilities — remember, these include handicaps such as deafness, blindness, diabetes and epilepsy, as well as the more obvious physical impediments .

£100

We are offering a prize of £100 for the best article of around 2,500 words, which can be either theoretical or a description of an actual application (with photographs, if possible), and which we will print in *PCW* later in the year.

Entries will be judged by *PCW's* Editor, David Tebbutt, and Adrian V Stokes, Chairman of the IYDP Technology Working Group. A third judge will be announced soon.

Please send your entry to IYDP Competition, 14 Rathbone Place, London W1P 1DE; to arrive not later than 30 April 1981, enclosing a suitable SAE if you would like it returned.

Personal Computer World

19 81

International Year of Disabled People

YANKEE DOODLES

While Britain wallows in a depression, business is booming in Silicon Gulch, as Tom Williams reports.

The boom rolls on. Apple Computer has gotten big enough to cause something of a furore on that citadel of American capitalism, Wall Street. After Apple announced that it was about to launch its first public sale of stock, it rapidly became one of the hottest offerings ever. The company has been forced to ration shares to various brokers who, in turn, are giving only their best accounts first crack at buying Apple stock.

Apple is truly a business success story and is predicted to double its earnings over last year's to a whopping $300 million — up from the paltry $150 million of a year ago. What all this appears to mean for the personal computer market is that we will be seeing even more Apples and Apple-related products than the veritable flood to which we have become accustomed. The sale of stock will, for one thing, provide good revenue for continued expansion and the attention Apple has gained in the business world may well put it in a position to challenge Tandy for the title of top dog. There has even been a series of radio commercials by Dick Cavett *(not the Dick Cavett, surely? — Ed)* promoting Apple computers.

All, however, is not well in Apple Land. The long-awaited Apple III, which was debuted last May at NCC, has still not shown up on dealers' shelves. There were rumours about soldering problems in the power supply that forced the company to delay volume production for a while.

"All... is not well in Apple Land."

On the forefront of new technology we once more find Zilog. After having overcome what appears to be the last hurdles for the Z-8001 (the Z-8000 version with segmented addressing that accesses eight megabytes), Zilog is reported to be working on a Z-9000. The Z-9000 will not have a new 32-bit architecture but will combine the Z-8000 16-bit architecture with virtual memory support on a single chip.

Virtual memory is a technique whereby the CPU creates 'virtual addresses' for all data, which it treats as if they were all a part of one continuous memory. It then sends these virtual addresses to a memory management unit (MMU) which converts them into physical addresses, which may exist in RAM or on disk. National Semiconductor had earlier presented its 16000 family of 16-bit CPUs, one member of which combined with an MMU chip to support virtual memory. If Zilog does come out with the Z-9000, it will be the first to combine CPU and MMU on a single chip.

The reason for all this activity in the area of greater and greater memory is the demand of the market for multiuser systems and distributed computing. Manufacturers are pursuing all approaches, but three watchwords are: modularity, expandability, and compatibility. These are sometimes, but not always, satisfied by massive amounts of RAM under a single CPU. At the low end (one to four users) which is admirably served by such manufacturers as Altos, a moderate amount of RAM supports the users and the systems offer expandability in the direction of disk storage.

A new entry has just joined this area in the shape of Morrow Designs' Decision 1 System. Morrow has combined a long experience in S100 systems with a range of Winchester disk technology to produce a line of computers that are almost continuously expandable from single-user floppy based configurations with between 200k and 2 Mbytes of disk storage up to a multi-user system with 256k of RAM and 28Mb of hard disk, priced at just over $14,000.

The Z80-based Morrow system offers memory management hardware (not to be confused with virtual memory above) that has a memory map to support up to 16 tasks with complete memory protection and automatic memory allocation. In addition, a UNIX-like operating system, uNIX, and CP/M are offered such that the new uNIX can communicate with CP/M.

Another new entry which showed up at the recent Wescon show held in Anaheim, California in September is a rather novel machine by Piiceon Corp. of San Jose. The Sword computer (not to be confused with the long defunct Japanese Sord) is one of the first stand-alone systems to use the Intel 8086. The most striking thing about the Sword-100 is its CRT display, which is a 15-inch tube mounted 'on its side'. With this arrangement, the machine can display up to 66 lines of 80 characters each, a particularly nice feature for word processing. Memory consists of up to 8 kbytes of ROM and 64 kbytes of RAM. Disk storage consists of two Qume double-sided, double-density drives giving a total of 2 Mbytes.

But — and here is a point once again indicative of the trend in the industry — it is designed to be an intelligent terminal workstation which can also fit into a distributed processing local network.

These local networks — individual processors sharing more expensive resources such as disks and printers — are starting to show up everywhere. The Bank of America has recently purchased a Nestar Cluster/One with *56* Apples for use as a preprocessor for entering cheques. The results are of course then fed into the bank's IBM behemoth for further digestion. According to Nestar's president, Harry Saal, the long touted 'office of the future' is not just around the corner — it's already here with a vengeance, and almost without anyone noticing.

"...who's using those 64k RAM chips..."

Everyone is asking "who's using those 64k RAM chips in a real product?" The answer is Hewlett-Packard. To be sure, the HP-1000 L Series is not exactly your garden variety personal computer but it should not take long for the technology to spread to personal computers, especially when the results of some of HP's tests become better known, and prices come down with volume sales.

HP recently introduced a 312k RAM board using the new 64 kbit chips. During reliability tests, technicians found the 64k chips to be more reliable than conventional 16 kbit memory chips. This obviated the need to incorporate costly error-correcting circuitry into the new memory system. Until recently, one of the most important problems with memories of this density was soft errors introduced when random alpha particles strike memory cells. Newer techniques in IC fabrication and technology are reducing these errors by a factor of ten over their previous rate. As a result memories should continue to become denser, and faster with a per-bit cost rollback of 20% to 30% per year. *(I think he means they'll get cheaper — Ed.)*

The boom rolls on!

"And she threw everything at me — including the computer aimed at the home user!"

COMMUNICATIONS

PCW welcomes correspondence from its readers but we must warn that it tends to be one way! Please be as brief as possible and add "not for publication" if your letter is to be kept private. Please note that we are unable to give advice about the purchase of computers or other hardware/software — these questions must be addressed to Sheridan Williams (see 'Computer Answers' page). Address letters to: **'Communications', Personal Computer World, 14 Rathbone Place, London W1P 1DE.**

Superboard query

I read your magazine every month, and have actually sacrificed ********* ********* for it! I am at present using a Superboard and I would appreciate your help. When I bought it, I used it on an ancient Baird television which merrily displayed 23 x 23 characters. So that I could have the TV nearer, and as the Baird was on its way to the scrap heap, I rushed out with £69.95 and purchased a little 12in portable, made by NEC. Great picture on normal TV but when I plugged the Superboard in I couldn't see the first two characters on each line, except by adjusting the horizontal hold which causes the top five rows to 'bend up'. Can you help?

By the way, I thought the *PCW* show was really excellent. I came to London specially for it, and it was well worth the trip.
G Monro, Woodbridge, Suffolk

We can think of a couple of ways of tackling your display problem. One would be to contact Steve Hanlan at Beaver Systems on 084421 5020. He apparently sells a device which should help. The other would be to join the OSI user's group and ask for issue four of their newsletter. This contains details of a DIY hardware solution. Apart from the cost of components, this approach will cost you £10 pa for membership of this excellent club. Contact George Chkiantz at 12 Bennerly Road, London SW11 6DS, or phone 01-228 4839 — Ed.

ZX80 memory

I noticed in one of your recent issues a letter asking how to find the amount of memory left in a ZX80. The answer you suggested was in fact wrong, measuring the amount of working space being used by the computer.

The unused memory is the part marked 'spare' on p106 of the ZX80 manual. The address of the bottom of this area is held in RAM locations 16400 and 16401 which can be PEEKed. The address of the top is held in the SP register of the Z80 CPU chip and cannot be PEEKed (although you could use a USR routine to read it); in practice, however, it will be close to the physical top of RAM — 17408 for the basic 1k RAM, or with 1024 added for each extra 1k in an extension. Thus for 1k of RAM, PRINT 17408 — PEEK(16400)—256*PEEK (16401) will give you about half a dozen more than the number of bytes of memory left.
S J Vickers, Waterbeach, Cambs

Acorn Atom

A number of readers have contacted PCW regarding long delivery times for the Acorn Atom, certainly much longer than the 28 days promised in the advertisements. To clear the air, we wrote an open letter to Acorn Computer, the text of which is reproduced below, together with Acorn's reply:

We are currently receiving several enquiries per week about the delivery delays on the Atom.

We would be grateful if you would let our readers know what the backlog situation is and when orders placed now will be delivered. Please also let us know if the situation varies depending on whether the machine ordered is in kit form or assembled.

We received the following reply:

Thank you for your letter regarding delivery times for the Atom. Our original production plan was delayed by nearly six weeks because of last minute problems with the case moulding and this caused a backlog of orders which is taking some time to overcome. However we are now despatching in sufficient quantities to allow an order placed at the beginning of October to be delivered within six weeks, halfway through October within four weeks and halfway through November delivery should be ex-stock. We must point out that orders that include any of the later optional extras or that require special configuration may be subject to different delivery times.

If at any time a customer wishes to cancel we always give a refund and the option to re-order in the future on a high priority allocation.
C J Curry, Director, Acorn Computers Ltd, Cambridge

Superbrain waver

I have just been reading your review of the Superbrain in August 1980 issue.

In one paragraph you erroneously explain that the reason there is no screen waver on the Superbrain is because the 240 V transformer is fitted behind the disk drives. I would like to point out that, with the chassis constructed from aluminium, the transformer is still much too close to the tube for it to have no effect on the screen. Screen waver on American computers is due to beating (or heterodynes) between the 60 Hz screen scan rate and 50 Hz stray field from the transformer(s). The cooling fan situated under the drives is another substantial source of 50 Hz field.

The real reason why you experienced no screen waver is that the screen scan rate is programmable, with the appropriate parameter combined in the DOS. Your machine must have been reprogrammed for 50 Hz before you got it. In our Superbrains the program CONFIGUR asks you which frequency you have and re-records the DOS.
David N Sands, Intelligent Artefacts Limited, Royston

DDE for me

I would like to add some comments about the DDE SPC/1 computer to those of your reviewer, Sue Eisenbach (*PCW*, July).

Firstly, my reasons for buying the SPC/1 early this year were that it has Comal and Pascal, supports large disk systems and has a modern multi-user facility with memory bank-switching. I did my homework properly by contacting Danish users on the questions of general quality, reliability and support. I also compared it with multi-user systems like Cromemco and LSI-11-based machines.

There are a few quirks and the documentation needs to be improved (I am producing my own teaching booklet and other materials) but my system has performed reliably and is a joy to use. This is because Comal and Pascal are a new world to someone brought up on outdated languages like Basic, Fortran and Algol, but also because the system is inherently well-designed and constructed to high technical standards.

I think the final sentence of Sue Eisenbach's review: "I certainly prefer it (Comal) as both a teaching and as a programming language to Basic" is the crucial one. As a teacher deeply involved with schools and teacher education I deplore the failure of Basic to encourage good programming and problem analysis skills. Comal solves the problem beautifully by combining the simplicity and easy operating environment of Basic with the educationally sound and highly practical control structures of Pascal. For these reasons I regard the SPC/1 and the RC702 'Piccolo' (shortly to be released here) as valuable contributions to the UK market.
Roy Atherton, Bulmershe College, Earley, Reading

Flowcharting standards

Derrick Daines, in his article 'Gateways to Logic' uses incorrect flowchart symbols. In fact the symbols he lists as 'Additions and Alternatives' are more correct than those he lists as 'Basic Flowchart Symbols'.

As Chairman of the British Standards Committee DPS/15, which is responsible (among other things) for the Standard on flowcharting symbols, I have a vested interest in seeing that the correct symbols are used. The current British Standard is: BS4058:1973 "Specification for Data Processing flow chart symbols, rules and conventions". Copies of this can be obtained from BSI at 101 Pentonville Road, London N1 9ND. For the benefit of non-UK readers the International Standards ISO 1028 and ISO 2636 cover the same ground as BS4058. These symbols have international agreement and most nations have their national equivalents of the ISO standards, eg Germany has issued standards under the references DIN 66 001 and 66 220 which cover much the same ground as the ISO standards but, like the BS standard, give more practical examples of the use of the flowchart symbols.

Finally, a new International Standard is being prepared by a committee, of which I am a Convenor, which will eventually replace ISO 1028 and 2636 and on

which many national standards will be based. This revised standard will cover flowchart symbols for program and data flowcharts, system flowcharts, program network charts and configuration charts. This revised standard is not, however, likely to appear in under two years, but as it does not introduce any drastic changes, it will be possible to continue to use the existing standards without fear of the symbols becoming obsolete.
V J Day, Malvern Wells

Survey wanted

In the name of sanity, can someone — and I suggest Guy Kewney as he seems the most sensible, and is definitely the most readable of all the computer magazine columnists — help me and no doubt a few thousand other poor souls, by doing a comparison of micros for gaming and hobby purposes. Without being too big-headed, I consider that I am above average intelligence with a minimum knowledge of micros but the microworld is slowly driving me nuts. Every manufacturer advertises his product as being excellent for business/games/education/hobbies/ data processing/ scientific applications et cetera. . . ad nauseum. Now this is categorically impossible! I am your ordinary average amateur computerist who wants to play with a micro at home.

I have a 4k ZX80 and it's an excellent little toy. But it is no more than that and Clive Sinclair's new upgraded language and 16k RAM will only make it an excellent little supertoy. Until he brings out Disk and Printing systems it will remain little else. Even if/and/or (delete as applicable) when he does this, should he approach the change with the same built in obsolescence, by the time we arrive at a 32k MPU + Disk + Printer we might well be spending more (overall) than by buying a PET, TRS-80 or any other presently available system.

Now, I have just sent off my money to Science of Cambridge to upgrade my ZX80, but thus far and no further. I shall let my two boys have it when I purchase a more suitable system. The system I require will be used primarily for monitoring the play of a fantasy role playing game of the Dungeons & Dragons genus; specifically Chivalry & Sorcery. It will be required to present at any given time the rules and regulations and perform any of the calculations required in the playing of the game. Also I shall require it to act as a Real Time Monitor.

Can someone, somewhere do a comparison of micros for such a purpose?
Brian R Timmins, Portsmouth

Fast Apple copy

Have you got an APPLE II computer running DOS 3.2? Do you need to copy disks from slot-to-slot? Are you annoyed at the inordinately slow speed of the standard Apple Copy Program?

If your answer to any of the above questions is yes, the following will be of interest to you.

The standard Applesoft Copy Program, supplied on the DOS 3.2 Master Diskette, may be converted to a fast slot-to-slot Copy Program by entering:

```
] LOAD COPY
] 140 LM = 2
] SAVE FASTCOPY (or
  another filename of your
  choice)
] RUN
```

The program will ask you for the destination Slot and Drive, instead of automatically defaulting.

If you use the modified Copy Program to copy from slot to slot, you will find that it takes about 30 seconds to format and copy a disk, against two-and-a-half minutes when using a single disk controller card.
Paul Smith, Vlasak Computer Systems

Cobollers

I have just read the latest (Sept) issue of your excellent magazine. For the last two years I've taken *PCW* and the other (unmentionable) magazine. Due to 'recession' one must go and I have no hesitation in keeping my order for *PCW*. The reason? — it's produced with the 'hobbyist' in mind and caters very well for us.

But do I detect a hint of 'snootiness' in Malcolm's 'Bookfare' column? Especially in his recent article on the Basic language?

I have a relation who is a professional programmer. From information received and the gift of an obsolete System 4 ANSI Cobol manua (weight 3.5 lb!) and having just built a Nascom II (an excellent instrument) and received their Basic manual (15 double pages), I am now in the happy position of being able to do simple programming and to understand the majority of programs printed in *PCW*. What would the situation be if Basic didn't exist? We would be committed to Cobol or Fortran or some other language and I would still be struggling with chapter two of the manual, having suffered a hernia due to carting it about!

Do professional programmers really have to take so many man/woman hours to get questionable results or is it one big con trick? Before Malcolm and others start cocking a snoot at the amateur, let them remember that it's the amateur that gives computing its lifeblood, as it is in electronics and other sports and sciences. Is the professional worried that the amateur and Basic can do more for computing in quicker time (and therefore cheaper) than the professional?

I suggest that "Malcolm" gets down off his high horse and writes for the good of both sectors of the industry and *PCW*, or moves on to one of the professional papers (*Steady on — Ed*) and makes way for an enthusiast.
D McFarlane, Histon, Cambs

Off beam

As you may be aware, we advertised in the August issue of *PCW*, offering software and books under the name Beam Software.

Our advertisement attracted not only useful business but an objection from Beam Office Equipment who have established extensive trademarks and other rights in the Beam name.

As you know, we have discontinued use of the name Beam Software, and apologised to Beam Office Equipment for the inadvertent infringement of their right.

We will be continuing our business in software and books under our registered name, Melbourne House Publishers.
Alfred Milgrom, Leighton Buzzard

Answers back

With respect to S Withers' response to my 'Computer Answer' regarding 'GETting' a character from the keyboard of a North Star Horizon using DOS v5, I am afraid he is mistaken. I hadn't forgotten INCHAR$ at all. My routine does something that the INCHAR$ is incapable of — that is, return if no key is depressed, an essential element in interactive games.
Sheridan Williams, St Albans

Gun fun

I had great fun with the UK101 'Gunfight' program published in the October *PCW*. The right hand player would appear to have a couple of slight advantages: for example, he can kill the left hand player without hitting him! Also, once the branches are removed from the cactii then the bullets lodge in the cactus but the left hand man is killed anyway. Perhaps the impact of the bullet on the cactus generates some sort of death ray. The cure to these problems is to modify lines 15 and 23 of the program making PR = 53880 (instead of 53878) and POKE 53256 (instead of 53257) respectively.
John Bass, Grays, Essex

"Sure I believe it's the third malfunction today. Just try telling those 2,000 warheads that set off after the second malfunction."

RAANND SP1

PASCAL MICROENGINE

At last Sue Eisenbach has got her hands on a British-built system based around the Pascal Microengine!

UCSD Pascal is an operating system with a language compiler written at the Institute for Information Systems at the University of California at San Diego. It was devised to run on as large a range of microprocessors as possible and was therefore written for an imaginary machine whose machine code is called pseudo-code (or p-code). To implement Pascal on a new machine, all that is needed is a written interpreter to translate p-code to the new machine's target code. Of course, p-code executes more slowly than native code since every statement has to be interpreted. It was only a matter of time before the p-code stopped being just an imaginary code and someone designed a real p-code processor.

At Western Digital a processor — the Pascal Microengine (or WD/9000) — was designed to execute p-code directly. WD then built a single board computer (the WD/900), based on the new processor, and a boxed computer (the WD/90), based on the single board. Raannd, a Scottish company, has built an all-in-one computer, the Raannd SP1, by enclosing the Western Digital board in a case that also contains a VDU and disk drives. The review machine was a prototype version of the Raannd SP1.

Hardware

The Raannd SP1 comes in an IBM blue and cream steel case. With dimensions of 600 mm by 600 mm by 350 mm and a weight of 30kg (66lb), it is semi-portable. (That is, *I* can't lift it but for someone who can, it can be moved in one trip.) A couple of screws hold the top of the box; when it is removed, the CRT, disk drives, fan and PSU are revealed.

The single board computer requires further dismantling as it is contained in the bottom section of the case. The WD 900, the single board computer, contains the processor, 54k of RAM, two serial ports, two parallel ports, a DMA controller and a floppy disk controller.

The heart of the SP1 is a 16-bit stack oriented processor, the WD/9000. Western Digital second source LSI 11s for Digital Equipment and the WD/9000 seems to be based on the LSI 11 design, with different microcode. The processor comprises five LSI/MOS circuits each contained in a 40-pin package. These consist of a data chip containing the ALU, registers and microinstruction decoder, the control chip, containing the macroinstruction decoder, portions of the control circuitry, the microinstruction counter and the I/O control logic and three 22 by 512-bit MICROM chips, containing processor microinstructions. The processor requires four power supplies (+5 V, +12 V, -5 V and -12 V).

The memory consists of 32k 16-bit words (that is 64 kbytes) provided in 32 16k dynamic RAM ICs where each chip is organised as 16k words by one bit. The processor communicates with the memory, peripheral ports and controllers via a 16-bit data bus, a 16-bit address bus and several control lines.

The WD/900 board contains two RS232 asynchronous serial ports. One is used by the SP1 VDU (9600 baud), leaving the other for a serial printer. Both ports have switch selectable baud rates (which are not that easy to reach as they are on the board rather than on the back of the case). All devices (printer, console, disks) are accessed via a name and the software is configured so that the second serial port can be accessed by reading from or writing to REMOTE (assuming all the necessary wires have been connected and the baud rate switch properly set). This port is bi-directional and so can be used for either a serial printer or a teletype device. The review machine had an LA34 connected to it for a while, which appeared to work satisfactorily.

I felt that the SP1 VDU showed room for improvement. Dr Gordon Rankin of Raannd said that changes will be made in the production models. The CRT display characters were rather small and were not perfectly steady on the screen. The screen was behind a polarising filter which left it rather dark in my flat. Perhaps in an office environment with bright light it would be better although I prefer a glare-free screen which is usable under variable lighting conditions. The keyboard lacked cursor keys and so cursor movement (needed in the editor) requires two keystrokes. Dr Rankin said that machines delivered in 1981 would probably have a cursor and numeric pad; I hope so.

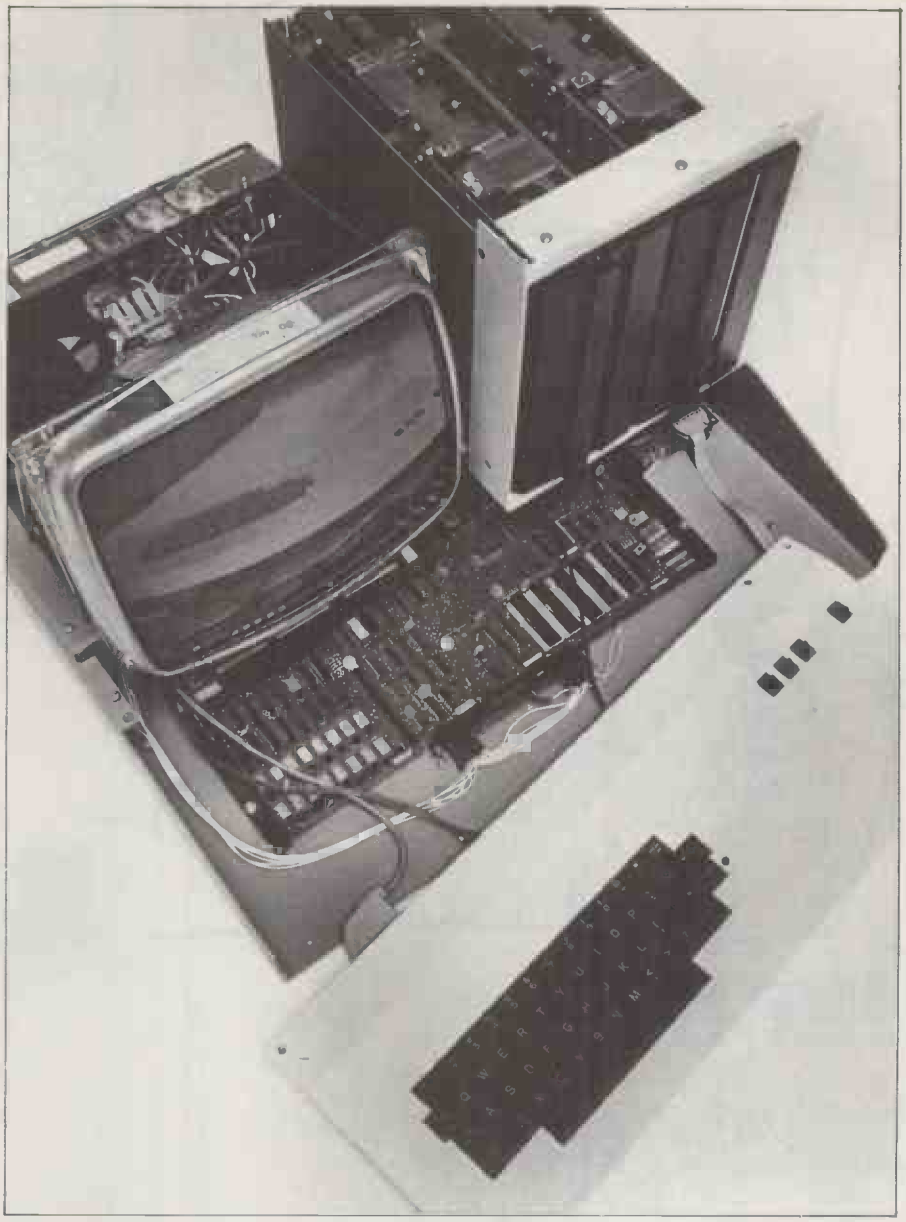
The serial ports are implemented with two UC1931A/B ICs, which are programmable (synchronous or asynchronous). The operating system automatically programs these on loading, but according to the manual they can be reprogrammed.

An 8255A programmable peripheral interface with 24 programmable pins provides the parallel I/O. When the operating system is loaded, it programs the 8255A to provide an 8-bit input port (port A), an 8-bit output port (port B), suitable for a parallel printer, and an 8-bit control port (port C). The control port can generate and receive handshaking signals. Assuming the appropriate wires are connected, port B should be accessible by transferring files to the named device PRINTER. This was not tested on the review machine.

There are four switches on the keyboard under the disks. Only one switch, the reset button, was connected. It had to be held down for several seconds to boot the system up. Dr Rankin said that the other switches would be used in the production model to provide write protection for each of the drives and to allow the user choice over which drive to boot from.

The FD1791/2 floppy disk controller provided is switch selectable for single or double density five inch or eight inch disks and can handle up to four drives of the same type. It operates under the control of the DM1883A/B DMA controller which allows data transfers between the floppy disks and memory without intervention by the processor.

The drives in the review machine were MFE 700 double sided, double density drives. Each disk holds 1600 kbytes unformatted or 1976 blocks (½ kbyte each) formatted, which is accessed as two logical volumes. I found the disks noisy but reliable. The production model will probably have MFE 750 drives instead, which are said to be lighter, quieter, more reliable and use half the power of the 700s.

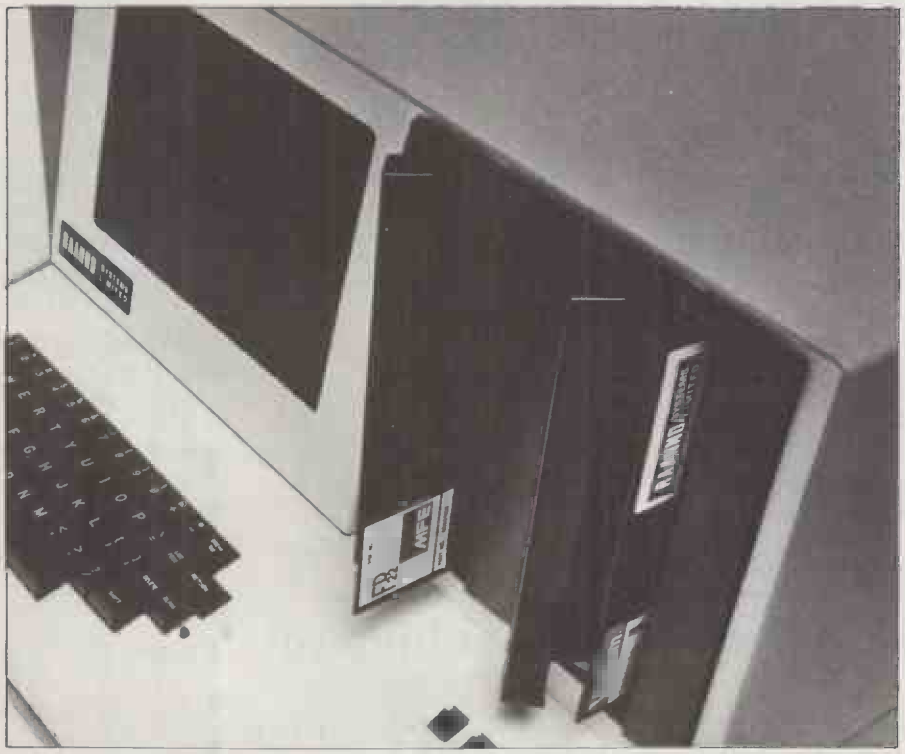


Software

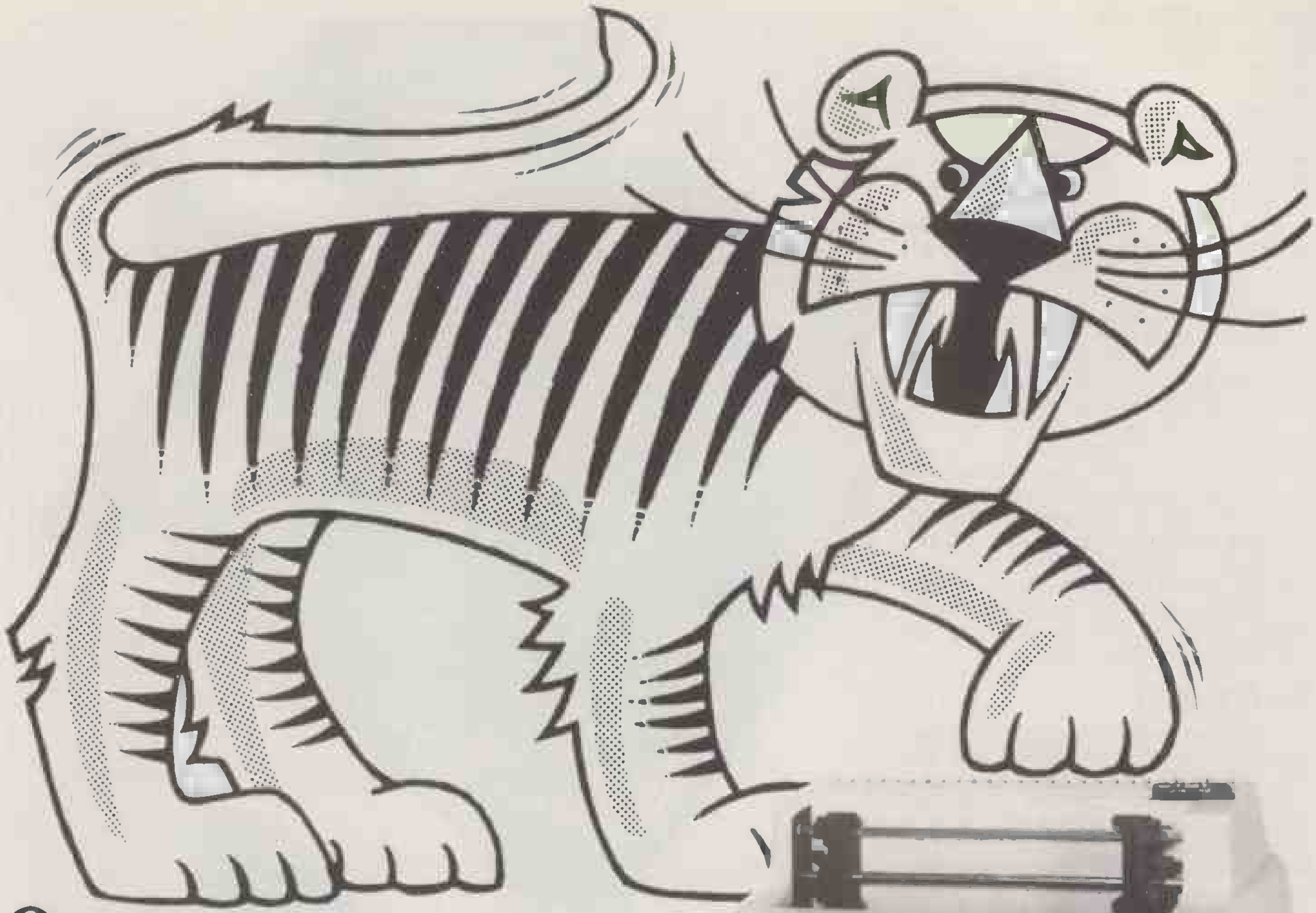
In common with all microcomputers based on the Western Digital chip set, the Raannd SP1 runs under the UCSD operating system. UCSD is a two-level operating system. At the first level it gives the user the option to E(dit, F(ile, R(un, C(omp, L(ink, X(ecute, D(ebug, U(ser restart, I(nitialise, or H(alt.

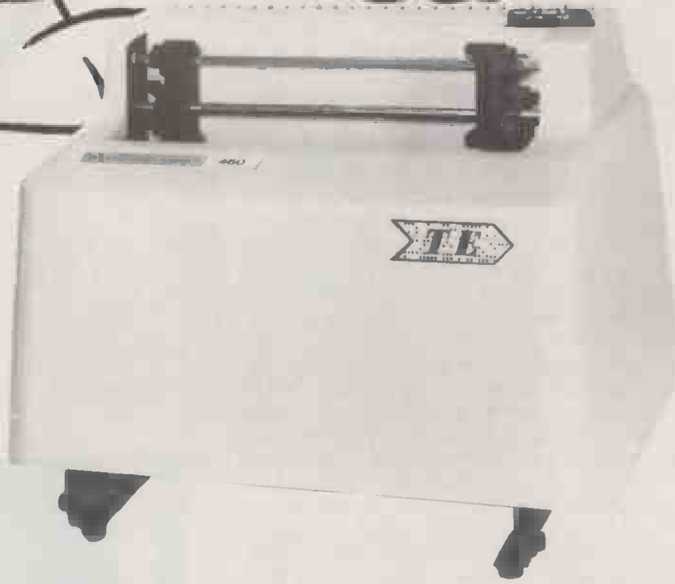
At this level the user must type a letter to reach one of the second-level system programs (except H which crashes the system and requires the user to switch the machine off then on to set it to work again). Anything other than one of the prompt characters is ignored.

Fundamental to the philosophy of the operating system is the concept of a default workfile, which is created by typing a program into the editor. After it has been saved, unless the user takes specific steps to avoid it, all operations take place on this workfile. The editor reads it in automatically and, upon completion of the edit, writes it to SYSTEM. WRK. TEXT. The compiler places object code in SYSTEM. WRK. CODE which can be executed by typing R. If it doesn't exist, the compiler is automatically initiated to compile SYSTEM. WRK. TEXT into SYSTEM. WRK. CODE. This is linked to any library routines needed and then executed. If SYSTEM. WRK. TEXT doesn't exist when the compiler is called then the user is asked for a file to compile. The resulting machine code is put into SYSTEM. WRK. CODE. As soon as a SYSTEM. WRK. TEXT is altered in the editor, the operating system removes the old SYSTEM. WRK. CODE. The linker allows the user to combine several CODE files into SYSTEM. WRK. CODE. Typing X enables the user to execute any code file. D invokes the compiler, as the Debugger was never released.



The concept of a workfile is convenient if one is developing a single program, but quite irritating when switching regularly between files (eg entering and compiling the benchmarks). I personally don't like it. To change the workfile the user has to enter the File Handler (with F) giving the user the op-





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tion to call the following functions: — G(et, S(ave, W(hat, N(ew, L(dir, R(em, C(hng, T(rans, D(ate, Q(uit;
Filer: G(et, S(ave, W(hat, N(ew, L(dir, R(em, C(hng, T(rans, D(ate, Q(uit; Typing? gets the user;
Filer: B(ad blks, E(xt-dir, K(runch, M(ake, P(refix, V(ols, X(amine; Z(ero.

The File Handler or Filer provides a comprehensive set of routines to manipulate files and disks. The filing system uses two wild cards '=' and '?'. The question mark requests verification for each file whereas the equals sign doesn't. In general the user is requested to confirm that an action should be undertaken before any action takes place. The Filer's routines are described in the table below.

The filer is comprehensive and easy to use for the first time user. The prompts mean there is no need to memorise commands. The major disadvantage of the Filer is that many of these commands are not in the outer level of the operating system. When one wants a directory listing, it is irritating to have to load the Filer (several seconds), type L, then answer the question 'Dir listing of what vol?' (volumes have both user given and number names and can be accessed by either) before the directory is read from the disk and written to the screen.

The user bears more responsibility for disk maintenance than he would under CP/M. Whenever a file is written to disk it is written to the largest free space available. If the file doesn't fit then the writing is unsucessful. (No linking up of free spaces as in CP/M.) If the filename already exists, then the file is still written to the first free space and upon successful writing the original file is removed. This process has the tendency to fragment the free space on a disk and hence to require frequent file compression using Krunch (which takes several seconds). Fortunately krunching does not move BAD files forward.

Three editors (YALOE, SCREEN and L2) come with the system. Whichever is renamed SYSTEM.EDITOR is invoked when a user types E in response to the outer lever prompt. The review machine came with SCREEN.EDITOR as the system editor. It is a screen orientated editor designed for convenient entry of both programs and text. The cursor can be moved to anywhere in the file for insertion or deletion of characters. The editor is set up for entering programs; It has an auto indent feature which causes the cursor to start the next line with an indentation equal to that of the last. The editor can be altered for ordinary text — the auto indent can be turned off and filling turned on. Filling allows the user to type between user set margins without pressing return. (Not quite as nice as WORDSTAR as there isn't automatic right justification, but still quite nice.) SCREEN has a few bugs in it — sometimes it doesn't clear the screen before it overwrites its next screen full and occasionally it shows you the cursor one line above or below its actual position (so insertion or deletion takes place on the wrong line), but these can be avoided. As a whole, SCREEN is powerful, easy to learn and a pleasure to use.

YALOE (Yet Another Line Oriented Editor) appears identical to DEC's TECO type line editor. It is designed for use on a slow console device or one that doesn't have cursor addressing and it seems bug free. Both SCREEN and YALOE only allow the user to edit a file that can fit into memory. (SCREEN can hold a 26k file whereas YALOE can hold 42k.) This limitation is overcome in the third editor Ls. Ls is supposed to be just like SCREEN except that it uses a memory buffer so that files of any size can be edited. Unfortunately it's filled with bugs. It crashes the whole system (the system didn't crash when I was using other software so it is unlikely that hardware was at fault). After a crash SYSTEM.WRK. TEXT occupies all the free space on the disk (eg 300k). Fortunately L2 makes a backup so this file can have its name changed to SYSTEM.WRK.TEXT and editing can continue.

The operating system comes with a variety of utilities in code form (so they can be Xecuted). These include a disassembler (which produces a listing with P-code mnemonics, hex, and any input or output calls), a librarian (for altering the SYSTEM.LIBRARY), a simple calculator, a library map and a bootstrap copier.

UCSD is quite a powerful operating system, although being written by students at University of California at San Diego it has a somewhat amaturish feel. The system lacks consistency in its user interface. In particular some of the programs in the operating system require a suffix, some require no suffix and some don't care whether the suffix is included or not. This can be quite frustrating to a new user but an experienced UCSD user probably doesn't think twice about it.

Languages

The UCSD operating system supports four language translators: compilers for Pascal, Basic and Fortran 77 and an adaptable assembler for the machine that UCSD is running on. The review machine came with just the Pascal compiler. There is no P-code macro assembler available but the Basic and Fortran 77 compilers (both written in Pascal) should be available if desired. The Pascal compiler was the first written for microcomputers and has become an industry standard. Other Pascal compilers written for microcomputers tend to show the influence of the UCSD version.

UCSD Pascal is quite close to that described in Jensen and Wirth. The major alterations were implemented to take advantage of the interactive nature of the system. In particular input and output default to the terminal rather than a file, and a file type of 'interactive' exists so that interactive input doesn't hang the system (as it would in standard Pascal). It has an additional data type 'STRING' and an appropriate set of intrinsic functions and procedures. In order to take advantage of the random access capabilities of disks, UCSD Pascal provides random access files as well as standard sequential access files.

Other additions to the language include the ability to segment a program into up to seven overlays, long integers (up to 36 digits) and CASE statements that don't crash if there isn't a label to match the CASE selector (control just drops through to the first statement after the CASE statement).

Potential

The SP1 is aimed at software houses who have, or are planning to develop, business software on a UCSD system (probably an Apple) and want a larger system for customers who want an upgrade. Programs should transfer directly from an Apple onto the SP1, with its substantially faster processor (I haven't benchmarked Apple Pascal but after it has been compiled into p-code it still must be interpreted for the 6502) and much larger disks (2 Mb). Its case has been designed to look at home in a business environment.

The other market at which the SP1 is aimed is the academic one. Lack of interpreted Basic and graphics rules it out as a machine for schools but it is quite a nice machine for teaching Pascal. Regrettably, UCSD turtle graphics are not supported by the Raannd hardware.

Documentation

Documentation tends to be the last item any manufacturer gets around to producing. Since the review system was a

File command table

Get-Get a new file for the workfile.
Save-Save the workfile under another name.
What-Find out what the workfile is.
New-Clear the workfile.
Ldir-List a directory.
Rem-Remove a file from the directory.
Chng-Change the name of a file.
Trans-Transfer a file (or disk) to another place. A transfer can occur to another disk, the printer or the screen.
Data-Allows the date to be changed. All directory listings include dates.
Quit-Returns the user to the outer level of the operating system.
Bad blks-Checks a disk for bad blocks.
Ext-dir-Lists a directory with information about file types and space usage of disk.
Krunch-Compresses all the files on a disk.
Make-Makes a disk file with the specified name.
Prefix-Allows the user to change the default disk. The default disk can be different from the system disk in which case the operating system will look on one disk for the system (and SYSTEM.WRK.=) and another for all other files.
Vols-Allows the user to see which volumes are on line. On the review machine these included four disks (each side of a disk is a different volume), the console and a remote port.
Xamine-Allows the user to examine possible bad blocks and to create files with suffix .BAD to contain them.
Zero-Reformats a disk.

prototype, it did not contain the final version of the documentation. Instead, I was provided with the Western Digital WD/90 Pascal Microengine Reference Manual and a one page advertising blurb for the Raand SP1. The manual is really two books with a manila paper separator between them. The first is called the User's Manual while the second is called the Pascal Operations Manual. Actually the first is a hardware manual and the second an amended version of the standard UCSD Pascal operating system manual.

Raannd says that the SP1 will be supplied with the following: a hardware manual based on the Western Digital User Manual altered to describe the SP1; a software manual based on the Western Digital Pascal Operations Manual; the *Pascal User's Manual and Report* by Jensen and Wirth; and *Microcomputer Problem Solving Using Pascal* by Ken Bowles.

I hope that the Raannd manuals are slightly more accurate than their advertising blurb, which is filled with comparisons between this and other UCSD Pascal systems (both speed and memory usage) that don't check out.

The Bowles book is a very good textbook for learning UCSD Pascal. It places a strong emphasis on Turtle graphics, which unfortunately aren't supported on the SP1. Although Bowles produced a very readable introductory text it doesn't cover the full language (among the omissions are files and pointer types) and makes a rather poor reference work (it's too chatty and not indexed). The Jensen and Wirth book on the other hand is quite easy to use as a reference but probably too concise to be used as a text. Of course it is a reference for standard Pascal rather than UCSD Pascal and so it doesn't accurately describe the language implemented on the SP1. The Pascal Operations Manual contains a list of differences between UCSD Pascal and standard Pascal and so it needs to be used in conjunction with the *User Manual and Report*.

I thought that the Western Digital hardware manual was quite reasonable. Although it doesn't contain an index, the table of contents is quite comprehensive, including an overview, installation, operating and troubleshooting procedures, plus the theory of operations. The manual contains a large number of illustrations and tables.

The Pascal Operations Manual isn't quite so good. Firstly, it seems to describe a later release of software than I had. (Who knows — maybe the production model's software will fit the manual.) Secondly and more importantly, it is confusing — emphasis isn't placed on the important points. For example, in the file handling section a command M(ake is described for creating a file entry in the directory and reserving space on the disk for it. Unfortunately it doesn't say how to get anything onto that disk space or when the command might be used. It is an improvement, though, when compared to the UCSD standard manual. There are no pages out of order and explanations are somewhat lengthier, especially concerning P-code.

I doubt that the Raannd manuals will be markedly better, as alteration to the Western Digital manual had not been started at the time of the review.

At a glance

FIRST IMPRESSIONS	
Looks	****
Setting Up	****
Ease of Use	**
HIGH LEVEL LANGUAGES	
Basic	n/a
Cobol	n/a
Fortran	n/a
Pascal	****
System Software	***
PACKAGES	n/a
PERFORMANCE	
Processor	*****
Cassette	n/a
Disks	****
Bus	n/a
EXPANDABILITY	
Memory	n/a
Cassettes	n/a
Disks	n/a
COMPATIBILITY	
Hardware	**
Software	****
DOCUMENTATION	**
VALUE FOR MONEY	***

***** excellent, **** V. good, *** good, ** fair, * poor.

Benchmark Timings (in seconds)

Program Name	Timing
Magnifier	0.85
Forloop	9.52
Whileloop	9.29
Repeatloop	9.09
Literalassign	11.02
Memoryaccess	11.45
Vector	26.40
Equalif	15.96
Unequalif	15.78
Real algebra	6.79
Real arithmetic	8.75
Noparameter	4.55
Value	4.96
Reference	4.98
Maths	7.00

Expansion

The Raannd SP1 will be sold as a fully expanded system only. There is no current plan for adding any optional extras to the system.

Prices

Raannd is not planning to sell its computer on a one-off basis. Their pricing structure reflects this policy and is as follows:

1 off	£5500
2–4	£5000
5–9	£4500
10–19	£4000
20+	£3500

It will be up to any dealer to fix a price. At the time of this review, Dicoll and Pronto have decided to carry the machine.

Conclusion

The Western Digital Microengine is a computer whose hardware was designed to execute UCSD Pascal efficiently. If one wants to work in this software environment there can be no faster implementation than this. The Raannd single-unit computer is based on the Microengine. I found the review machine robust, reliable and attractive and, assuming its preproduction teething problems are solved (in particular a more stable display, a cursor pad and documentation), it should be quite a nice machine. Since this particular system contains quite a large amount of disk space and doesn't contain the hardware necessary to run UCSD graphics software, its primary potential market must be commercial software houses.

Technical Data

CPU:	WD/9000 Pascal MICROENGINE chip set (16-bit micro)
Memory:	64 kbytes dynamic RAM
Keyboard:	54 keys
Screen:	White P4 phosphor with polarised filter
Cassette:	N/A
Disks:	8in, double density, double sided
Ports:	1 serial, 2 parallel
System Software:	UCSD Pascal Operating System
Languages:	Pascal

PASCAL BENCHMARKING

A suite of standard Benchmark programs have long been a feature of PCW's Benchtests but as they're written in Basic they were obviously unsuitable for this month's Benchtest of the Pascal Microengine-based Raannd SP1. Chris Sadler and Sue Eisenbach — authors of our Pascal series - have therefore devised a set of Pascal Benchmarks, which will be used in all future PCW Benchtests of machines which run Pascal.

When comparing the performance of different microcomputer systems, it is helpful to try to identify the different elements which contribute to that performance. Firstly, however, it is important to categorize those properties which characterize 'high' performance and, for the purpose of this discussion, the following definition will be adopted: a system will be considered to have demonstrated high performance if its operation (relative to competing systems) is fast, efficient and reliable; and if it can produce correct results with convenience of operation. These terms take on varying degrees of relevance when considered in relation to the different components of a system. It is therefore necessary to separate out those factors which may contribute to, or detract from, these qualities in different contexts.

Starting with the hardware, it is clear that the speed of execution will depend on the particular processor used and on the design of the outlying system — eg width of the bus, I/O cycles, etc. Likewise, reliability in this context, together with the correctness of results, will depend on decisions made by the designers of the entire configuration — have they cut corners on the quality of various system components for instance? The next major element to consider is the operating system and here reliability can be interpreted as consistent behaviour (eg does it always give the same error message when the same condition arises under different circumstances? Do default values apply globally or only for specific commands?). Convenience of use implies that interaction with the user is unambiguous, flexible and 'friendly'. Finally, the speed of operation at system level depends crucially on the efficiency of the system routines and utilities, particularly those that deal with disk access and other I/O activity.

The third element is the language translator which, for the purposes of this article, is a Pascal compiler. Once again, it is the competence of the designer which is being judged. An efficient compiler will produce code which executes rapidly, while reliability and correctness here refer to the legality of the source code which the compiler will accept. (For Pascal, a suite of programs exists which fully tests these aspects of a compiler — details can be had from Dr Brian Wichman of the National Physical Laboratory.) Convenience of operation might imply, for instance, that effectual error messages and supporting diagnostics are provided.

The above discussion (summarised in Table 1) should place into perspective the role of the Benchmarks to be analysed in the next section. These don't cover everything one needs to know about a system — instead, they concentrate specifically on the skill with which the compiler writer has implemented certain features of the language, with particular reference to the execution speed of the ensuing object code and, additionally (inevitably), on the performance of the processor in handling that code. They are perhaps analogous to the petrol consumption tests given in car advertisements — a necessary (and objective) set of statistics, but by no means enough information with which to judge the whole car.

The Benchmarks

The idea behind these Benchmarks has been to try to isolate specific features of the language (ie instructions) so that the performance of any particular compiler in dealing with these features can be measured. Every attempt has been made to eliminate extraneous system-specific factors (like disk transfers) so that it is only the effect of the processor executing the compiled code that will be detected. In each case execution begins with the letter S (for start) and finishes with E (for end). These characters indicate when the stopwatch button should be pressed and are inevitable overheads in the process — a system with slow I/O will fare relatively worse than a speedier system, regardless of the quality of the compiler.

In addition, in order to give meaningful intervals for timing, each process is embedded in a loop (1...10000 in most cases as opposed to the smaller loop in *PCW*'s Basic Benchmarks). The first test is called MAGNIFIER and consists solely of the S and E signals and the loop. By subtracting its time from those of the ensuing Benchmarks, the timing for 10,000 instances of the single instruction or feature under consideration can be calculated. The specific features can be grouped under broader 'construct' headings as in Table 2. The individual Benchmark names are intended to be self-explanatory.

Figure 3 contains a listing of the Benchmark which can be input as individual programs and 'run by hand'.

Compiler design

Now that the goals of the Benchmarks have been fully declared, it would be as well to review some of the features of compiler design which may affect the results produced. It is worth noting that no account has been taken of the speed with which the compiler performs, al-

	Hardware	Operating System	Compiler
Speed	processor and bus	efficient utilities	—
Efficiency	processor and bus	efficient utilities	Benchmarks
Reliability	good design, high quality components	consistent structure	good design
Correctness of Results	good design, high quality components	consistent structure	legality of syntax
Convenience of Operation	packaging and finish	friendly and flexible	effective diagnostics

Table 1

Category	Benchmark name	Function
Overheads	MAGNIFIER	Measure of overhead involved in timing other benchmarks.
Loops	FORLOOP	10 iterations of FOR—DO loop.
	WHILELOOP	10 iterations of WHILE—DO loop.
	REPEATLOOP	10 iterations of REPEAT—UNTIL loop.
Assignments	LITERALASSIGN	10 assignments of constant value.
	MEMORYACCESS	10 assignments of a stored value.
	REALARITHMETIC	Single assignment of expression in which all arithmetic operations occur on constant values.
	REALALGEBRA	Single assignment of expression in which all operations occur on symbolic values.
	VECTOR	10 assignments involving array element access.
Branches	EQUALIF	10 operations of IF—THEN—ELSE in which each branch is executed with equal frequency.
	UNEQUALIF	10 operations of IF—THEN—ELSE in which the THEN branch is executed only once.
Procedures	NOPARAMETERS	5 nested procedure calls with no parameters.
	VALUE	5 nested procedure calls with call-by-value parameters.
	REFERENCE	5 nested procedure calls with call-by reference parameters.
Library calls	MATHS	2 calls to library functions.

Notes:
1 All timings can be offset by the MAGNIFIER measurement which takes account of the common overheads.
2 In MATHS, the MAGNIFIER loop has been reduced to 1000 to give a more reasonable figure.
3 The assignment and branch Benchmarks are all embedded in FORLOOP so an additional adjustment is necessary.
4 IF—THEN—ELSE has been given two tests because it is often faster to place the more frequently accessed segment in one branch or the other.
5 The procedure calls have been nested in order to investigate the build-up of the stack (and its effect on processing).
6 In VECTOR, matrix elements are employed on both sides of the assignment to investigate index addressing — compare with MEMORYACCESS. The initial assignment occurs only once so should be too short to affect the measurement.

Table 2

though this is a significant factor, especially to someone doing a large amount of development work. Instead, the Benchmarks investigate the performance of the target (object) code, but it is not only speed that needs to be reckoned with. Some compilers are written to produce p-code — the machine code of a (hypothetical) pseudo-machine. To run these objects on a real machine, a p-code interpreter is required which dynamically translates the p-code instructions into the native code of the host machine at run-time. Clearly, these compilers can be expected to produce slower times (all else being equal) than their alternatives which translate directly into native code, cutting out the overhead of the p-machine. As a variation of the latter approach, some compilers generate assembler language macros which are subsequently submitted to a macro-assembler which, in turn, produces the object code. This extra step lengthens the time taken to prepare a program for each execution but offers great flexibility during overall development, particularly for optimisation and 'system' work. Finally, the Pascal Microengine (reviewed elsewhere in this issue) is a real implementation of the pseudo-machine, so its native code is p-code.

The second point has more to do with those language features whose implementation is open to a much freer interpretation on the part of the designer. In particular, the idea of sets and set manipulation, packing and unpacking, dynamic allocation of space (the heap) and garbage collection have not been incorporated into Benchmarks because it was felt that the variations in implementation were likely to be so wide as to defy comparison. Additionally, these are among the features most frequently left out of certain compilers which would not, in consequence, be comparable at all. The arithmetic operators are looked at in REALARITHMETIC and REALALGEBRA and some typical library functions are referred to in MATHS. Considerably more could be made of the mathematical facilities available, but only at the expense of a substantial increase in the total number of Benchmarks could such features as the precision and speed of different modes of data representation, the accuracy of the function results and the performance of any floating point hardware be investigated.

Thirdly, certain features have not been considered suitable for Benchmarks because they tend to be intrinsically non-standard. In particular, the issue of disk-file access has been passed over because there are too many contributory variables to allow any meaningful measurements. This is not to say that non-standard features (like random access facilities) are necessarily a bad thing. In fact, they are usually more of a help than a hindrance — provided the user sticks to a single system. The compiler designer would not go to the trouble of implementing them if this were not the case. However, it is not possible to design 'objective' tests to compare such variable features.

Finally, compilers may differ widely in terms of the types and sizes of the source programs which they will accept, and these are not investigated in much detail in the Benchmarks. Legality can be checked for with Dr Wichman's suite, but this will give no indication of what size program will bring the compiler to a standstill. The compiler writer will have had to have made a number of decisions about how to apportion the compiler's work-space into stack space, variable lists and tables, etc, and these parameters, although crucial to a consideration of the development environment which a system offers (how deep can procedure nesting go? How big can an array be? . . . etc), are not easily accessible to tests of this nature. Perhaps a future set of tests could be devised which investigates the space-utilisation of compilers as opposed to their time-efficiency as measured here.

Conclusion

In the meantime, the Benchmarks are offered as a means of testing some aspects of a compiler's performance against those of other compilers. Below are the measurements for our Heathkit H-11A (LSI 11/2) under UCSD and with the EIS chip in. Any figures for other systems would be welcome. Send them to Pascal Benchtests, *PCW*, 14 Rathbone Place, London W1P 1DE.

H-11A Benchmarks

MAGNIFIER	3.88
FORLOOP	42.76
WHILELOOP	40.11
REPEATLOOP	35.00
LITERALASSIGN	49.95
MEMORYACCESS	52.04
REALARITHMETIC	61.74
REALALGEBRA	40.61
VECTOR	102.89
EQUALIF	66.79
UNEQUALIF	65.79
NOPARAMETERS	26.40
VALUE	29.31
REFERENCE	29.69
MATHS	25.30

(All times in seconds)

Pascal Benchmarks

```
program magnifier ;
var k : integer ;
begin
   writeln ('s') ;
   for k : = 1 to 1ØØØØ do ;
   writeln ('e')
end .
```

```
program forloop ;
var j, k : integer ;
begin
   writeln ('s') ;
   for k : = 1 to 1ØØØØ do
      for j : = 1 to 1Ø do ;
   writeln ('e')
end.
```

```
program whileloop ;
var j, k : integer ;
begin
   writeln ('s') ;
   for k : = 1 to 1ØØØØ do
   begin
      j : = 1 ;
      while j < = 1Ø do j : = j + 1
   end ;
   writeln ('e')
end .
```

```
program repeatloop ;
var j, k : integer ;
begin
   writeln ('s') ;
   for k : = 1 to 1ØØØØ do
   begin
      j : = 1 ;
      repeat
         j : = j + 1
      until j > 1Ø ;
   end ;
   writeln ('e')
end .
```

```
program literalassign ;
var j, k, l : integer ;
begin
   writeln ('s') ;
   for k : = 1 to 1ØØØØ do
      for j : = 1 to 1Ø do l : = Ø ;
   writeln ('e')
end .
```

```
program memoryaccess ;
var j, k, l : integer ;
begin
   writeln ('s') ;
   for k : = 1 to 1ØØØØ do
      for j : = 1 to 1Ø do l : = j ;
   writeln ('e')
end .
```

```
program realarithmetic ;
var k : integer ;
   x : real ;
begin
   for k : = 1 to 1ØØØØ do
      x : = k/2*3 + 4 — 5 ;
   writeln ('e')
end .
```

```
program realalgebra ;
var k : integer ;
   x : real ;
begin
   writeln ('s') ;
   for k : = 1 to 1ØØØØ do
      x : = k/k*k + k — k ;
   writeln ('e')
end .
```

```
program vector ;
var k, j : integer ;
   matrix : array [Ø. . 1Ø] of integer ;
begin
   writeln ('s') ;
   matrix[Ø] : = 1 ;
   for k : = 1 to 1ØØØØ do
      for j : = to 1Ø do
         matrix[j] : = matrix[j—1] ;
   writeln ('e')
end .
```

```
program equalif ;
var j, k, l : integer ;
begin
   writeln ('s') ;
   for k : = 1 to 1ØØØØ do
      for j : = 1 to 1Ø do
         if j < 6 then l : = 1
                  else l : = Ø ;
   writeln ('e')
end .
```

```
program unequalif ;
var j, k, l : integer ;
begin
   writeln ('s') ;
   for k : = 1 to 1ØØØØ do
      for j : = 1 to 1Ø do
         if j < 2 then l : = 1
                  else l : = Ø
   writeln ('e')
end .
```

```
program noparameters ;
var j, k : integer ;
procedure none5
begin
   j : = 1
end ;
procedure none4 ;
begin
   none5
end ;
procedure none3 ;
begin
   none4
end ;
procedure none2 ;
begin
   none3
end ;
procedure none1 ;
begin
   none2
end ;
begin
   writeln ('s') ;
   j : = Ø ;
   for k : = 1 to 1ØØØØ do
      none1 ;
   writeln ('e')
end .
```

```
program value ;
var j, k : integer ;
procedure value5 (i : integer) ;
begin
   i = 1
end ;
procedure value4 (i : integer) ;
begin
   value5 (i)
end ;
procedure value3 (i : integer) ;
begin
   value4 (i)
end ;
procedure value2 (i : integer) ;
begin
   value3 (i)
end ;
procedure value1 (i : integer) ;
begin
   value2 (i)
end ;
begin
   writeln ('s') ;
   j : = Ø ;
   for k : = 1 to 1ØØØØ do
      value1 (j) ;
   writeln ('e')
end .
```

```
program reference ;
var j, k : integer ;
procedure refer5 (var i : integer) ;
begin
   i : = 1
end ;
procedure refer4 (var i : integer) ;
begin
   refer5 (i)
end ;
procedure refer3 (var i : integer) ;
begin
   refer4 (i)
end ;
procedure refer2 (var i : integer) ;
begin
   refer3 (i)
end ;
procedure refer1 (var i : integer) ;
begin
   refer2 (i)
end ;
begin
   writeln ('s') ;
   j : = Ø ;
   for k : = 1 to 1ØØØØ do
      refer1 (j) ;
   writeln ('e')
end .
```

```
program maths ;
var k : integer ;
   x, y : real ;
begin
   writeln ('s') ;
   for k : = 1 to 1ØØØØ do
   begin
      x : = exp(k) ;
      y : = sin(k)
   end ;
   writeln ('e')
end .
```

YES, BUT IS IT ART?

Malcolm Banthorpe is already well known to PCW readers for his articles on colour and three dimensional plotting. This month he ponders the true nature of computer art, illustrating his theme with a bumper selection of pictures from his scrapbook.

Mention 'art' and 'computer' in the same breath and someone is bound to question whether the two words -- generally considered to be mutually exclusive — can have any sort of valid connection. Yet almost since their inception, attempts have been made to use computers for aesthetic purposes, to generate music and poetry as well as graphic art — the subject of this article.

Computer art is still far from gaining critical acceptance, placing it in a similar position to that suffered by photography for many years. A wider acceptance of computer art may occur when, as is starting to happen, computers are held in less awe and silicon chips cease being the subjects of sensational media reports.

Critics find computer art hard to accept because it requires no animal skills like those of painting or sculpting. Although it possesses many of the attributes of conventional art, it cannot be judged by the same criteria. What it *does* require of its practitioners is some appreciation of computer science and programming, and it therefore appeals to both artists and technologists, some of whom have welcomed it as a unique fusion of the disciplines.

A common stumbling block to public acceptance is the belief that "if it's produced by a machine, then it can't be art," an attitude that is widespread, but which misses the point that the computer is merely being used as a tool and, as such, is similar in principle to the painter's brush. The computer is commonly regarded as a sort of autonomous being, responsible for its own output: few realise that the computer can do nothing at all without programming. Politicians and bureaucrats are fond of this image because it allows them to attribute mistakes to 'computer error' when it would be more honest to blame the programmer or the person who supplied the faulty data.

The use of the term 'artificial intelligence', though not always apposite in the context of computer art, may partially be responsible for the misconception that the computer has somehow created the work. Another factor is the considerable random element of much computer art, which removes some of the detail of the work from the direct control of the programmer. It is nevertheless the set of instructions (ie the program) that the programmer feeds into the computer — including which parameters will be randomly determined and within what limits — which is entirely responsible for the computer's output.

As for the examples accompanying this article, I'll just say that they're designs and patterns produced for their own sake, on a computer. Some of them involve the plotting of mathematical functions (though nothing more complex than a few sines and cosines), but their purpose is not to illustrate those functions, merely to produce an aesthetically pleasing visual effect. As it's quite possible that someone will now object to my use of the expression 'aesthetically pleasing' to describe computer output, I'll stop trying to justify the title before my arguments become completely circular.

The sort of computer art that I'm writing about here covers a wide variety of graphics programs. Sometimes the results are similar in appearance to work which could have been produced by more conventional means. Other examples suggest the means of their generation. In all cases, however, the aim is to produce a design which exploits those characteristics unique to the computer. There is little point in using a computer to emulate a design which could have been more easily produced manually: one of the useful characteristics of the computer is its ability to repeatedly perform complex instructions, without error or fatigue; hence its effectiveness in generating patterns which would otherwise require an unreasonable amount of time and effort.

Computer graphic designs differ from their manually produced counterparts in the way in which they are initially conceived. Generally, if one were producing a design manually, one would start with a mental picture of the design and then set about achieving it in practice. In computer art, a more usual starting point is an idea for a programming technique which is then tried, with only a vague idea of what the outcome will be. Often two or more techniques, of known effect, will be combined to "see what happens". This is, of course, a broad generalisation and it is not possible to categorise all computer and conventional art so simply. There are times when, with a knowledge of techniques and their effects on a particular machine, it is possible to visualise a result and then set about achieving it.

An important aspect of computer art is the balance between explicit rules and random decisions. A program which is totally explicit will produce the same output each time it is run. Provision may be made to vary some of the parameters via user inputs such as the keyboard but the results will still be repeatable for any given input and will be totally in the control of the programmer. Alternatively, some or all of the program parameters may be determined by a random number generator.

One of the joys of computer art is the production of results which cannot be entirely predicted (and are occasionally unpredictably awful), by virtue of this random element. The range of random values which may be generated for a given parameter needs to be carefully controlled, otherwise the design can easily degenerate into visual 'noise' or chaos. A suitable range for each parameter can only be determined empirically. There is also the question of which parameters should have a random element and which should be fully predetermined. Again only trial and error can suggest the correct balance for a particular program. When initially experimenting with a program, it is a good idea to manually vary just one parameter at a time, so that the effect can be observed and a useful range of values found. The best results are often obtained by making a parameter partially predetermined and partially random. For instance, a horizontal coordinate may be calculated as a function of the vertical coordinate plus a random number, eg:

H = V * 1.5 + RND(1) * 4

Interactive computer art offers some interesting possibilities in the way that the progress of a program may be controlled. As well as the more obvious human interfaces such as the keyboard and joystick controls, it is possible to communicate with the computer by means of sound and light. Richard Lawrence has shown (*PCW* March 1980) how, by means of a simple machine code routine and a microphone connected via an amplifier to the cassette port of an ITT or Apple computer, it was possible to control the program with sound. A method of changing the colour of the display by whistling notes of different pitches was shown. A trivial example, perhaps, but it gives a good idea of what can be achieved with a

YES, BUT IS IT ART?

little imagination. A further level of sophistication would be to use a voice recognition program. It would also be easy to interface a photosensitive element so that a program is initiated or changed by, for instance, the shadow of someone standing in front of the computer.

In all the examples shown on page 65, the graphics were designed to be displayed directly on a cathode ray tube — a video monitor or TV. Other programs may be designed to produce an output to a printer or plotter. The advantages of a CRT output are that it is generally cheaper and faster than hard copy, it can display dynamic as well as static images, and is clearly superior where a colour display is involved. A printer or plotter can provide an instant permanent record of the computer output and a plotter has an added advantage when greater detail is required. Where a permanent record of a CRT display is required, it is a fairly simple matter to photograph the screen. Where moving images are involved, film can be used, although because of the problems of synchronising the camera shutter with the television frame rate, it is easier to photograph one frame at a time. This frame-by-frame technique has the advantage that it can allow designs whose plotting time is slow to be animated. Video tape would provide a more convenient medium for the direct storage of moving images, but hasn't, to my knowledge, been used to any extent in this context. Some computers provide a video signal which is sufficiently standard to be recorded on a domestic video cassette recorder, but those which generate a 525 line, 30 frame per second American standard signal are unlikely to be successful in this respect unless you have a dual standard VCR.

The computer I used was an ITT 2020 and the photographs taken directly from the screen of a 13" portable colour TV set. The ITT 2020 can generate genuine high resolution graphics in four colours, plus black and white. The colour system used, like that on the Apple, has some limitations, but these can be largely overcome (see last month's *PCW*). In fact, I've exploited some of the quirks of the system to produce specific effects. The fact that each screen point can only appear in one colour permits some interesting textures. Although only four colours are directly available, programming allows additional colours to be effectively displayed through a form of mixing.

Genuine high resolution graphics (ie with each point on the screen individually addressable, as opposed to the pixel graphics which some manufacturers still persist in describing as high resolution) is the most versatile system for computer art and most other graphics applications. It is, however, essential, and the lower resolution pixel graphics (typically 40 x 25 or 48 x 16) can be used to experiment with various design concepts, though they allow less freedom as one is restricted to using the predefined graphics characters as building blocks. A machine such as the Sorcerer, which permits a number of user-defined pixels, offers a step in the direction of the versatility of bit-mapped high resolution graphics.

The ability of the cathode ray tube to display moving images can be exploited by some graphics programs such as those which use line-drawing commands. For example, Palsoft Basic on the ITT 2020 permits a line to be drawn between any two points on the screen almost as speedily as plotting a single point. This means that fairly complex images can be drawn and modified quickly enough to give the illusion of movement. Programs which involve curves generally require the coordinates of each point to be evaluated separately and the execution of these programs is consequently slower, taking perhaps several minutes to complete a single image. This was the case with the program used to generate Figures 5, 6 and 7.

On the other hand, Figure 9 was photographed from a program which generates a continually changing pattern. It makes use of an 'exclusive-OR' line-drawing technique to generate a design which at any stage is dependent on all that has previously been plotted. Palsoft Basic has a command called XDRAW which is used in conjunction with its shape table facility. The shape table allows a number of shapes to be predefined in line form and subsequently drawn anywhere on the screen with variable scale and rotation. Using the XDRAW command, as opposed to the more straightforward DRAW command, allows the lines of the shape plotted to be exclusive-ORed with whatever is already on the screen. Its most common use is as a convenient way of erasing a shape without clearing the whole screen. Experiment showed that the command could be used to give some interesting colour effects. Normally, it would be used with the plotting colour set to white: a white line crossing a second white line would result in black being displayed where the two lines overlapped. More interestingly, a coloured line crossing a white line was found to generate the complementary colour at the point of intersection. For example, a blue line crossing a white line would result in yellow at the intersection. Other combinations of line colours produced similarly useful effects.

To make use of the phenomenon, the simple shape of a square was used. By re-drawing the square several times at the same coordinates, with the scale incremented each time, a solid square can be formed rather than just a bare outline. The pattern program uses four such incremented squares which overlap to bring the exclusive-OR effect into action. The increment and the plotting colour are determined randomly for each group of four squares. The degree of randomness in the increment was fairly critical: too great a degree caused the pattern to become over complex and chaotic — too little caused it to repeat and become predictable. The final program used is very simple (just 13 lines of Basic) and produces a constantly changing pattern of almost infinite variety, which, incidentally, shows little evidence of the square shapes from which it is built.

Figures 1, 2 and 4 were photographed from programs which generate moire patterns. A moire pattern could be described as a perceptual effect resulting from the superimposition of two sets of parallel or near-parallel lines, with a slight angular displacement or variation in line spacing between the two sets. This is the sort of repetitive task to which a computer is well suited. Here, the two sets of lines are of different colours.

Figures 5, 6 and 7 are drawn using a three-dimensional plotting technique as described in *PCW* last month. The final program draws a rectangular plane in perspective with raised contours and employs a hidden-line removal algorithm to erase those parts of the image which would theoretically be hidden by the foreground.

The design of Figures 3, 8 and 10 are based on the well-known Lissajous patterns which will be familiar to most readers. They are usually plotted as a series of points, whose coordinates are calculated as:

X = K * SIN(P * A)
Y = K * COS(Q * A)

where A is an angle in radians and K, P and Q are constants. In this case, I've calculated two sets of coordinates using different constants and then joined pairs of points with straight lines. Additional interest is generated by making the centre section of each line a different colour from the rest.

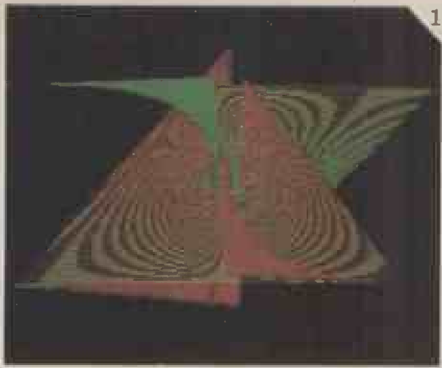
Each of the techniques used is, in itself, very simple, though some have undergone considerable development to achieve just the right effect. I hope that I've been able to show how design-generating programs can be developed from a few simple ideas.

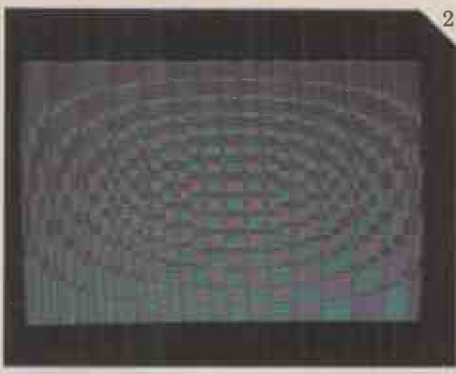
As a postscript, it would perhaps be helpful to give a few guidelines on taking photographs directly from a video monitor or television set, as the results can otherwise be disappointing.

The first and most important requirement is to use a suitable camera shutter speed. The normal television frame rate is 25 pictures per second. This means that if the camera shutter speed is less than 1/25 of a second, then part of the screen image will not appear on the film, as only part of the screen will have been scanned while the shutter is open. A speed of 1/15 of a second or more is preferable, to eliminate any possible shading of the picture. A tripod or some other means of supporting the camera will be required if camera shake is to be avoided.

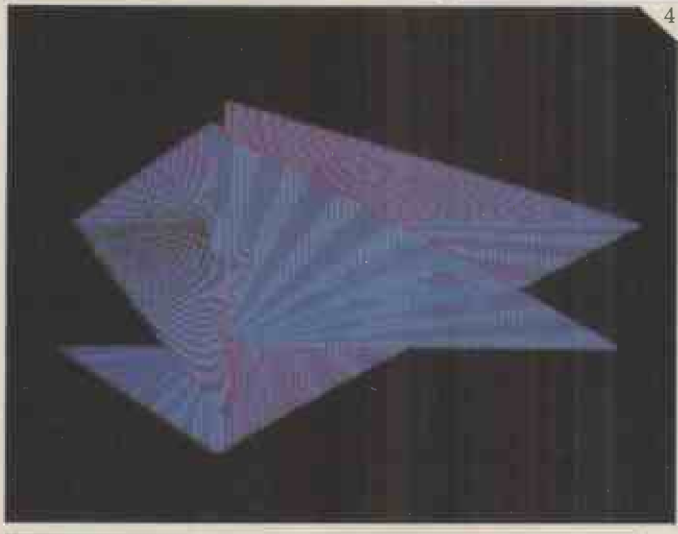
The camera must be aimed squarely at the screen face to avoid distortion of the image and to minimise the effects of the curvature of the screen. If you're using a camera with a non-reflex viewfinder, beware of parallax errors caused by the close focussing distance.

Reflections on the tube face are a common source of problems but are easily overlooked. Perhaps because we're accustomed to viewing television sets in lit rooms, it seems that the human brain contains a neat subroutine to filter screen reflections out. Even when looking at the screen through a camera viewfinder, it's easy not to


1

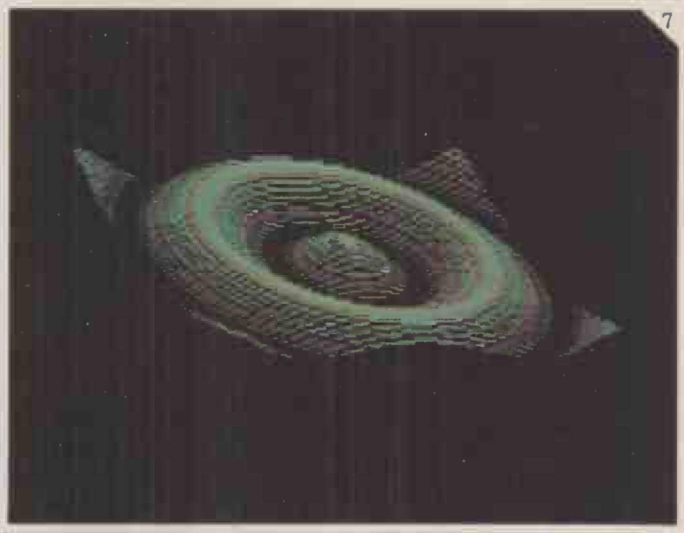

2


3


4


5


6


7


8


9


10

notice them. Unfortunately they still register on the film and the only real solution is to keep the room as dark as possible.

For black and white photographs the exposure is not too critical and an automatic camera will generally give acceptable results. If the shutter speed is set automatically by the camera, make sure it's slow enough. For colour film the exposure is more critical and the approach that I've taken for both colour and black and white is as follows: first, devise a simple program to fill the screen with white dots or lines, evenly distributed, such that the screen area is effectively divided into half white and half black. The screen will now be emitting half its theoretical maximum amount of light. Set the exposure on this and maintain it regardless of the meter readings given by the images to be photographed. This only needs to be done once, as the same exposure setting can be used on future occasions, as long as the brightness and contrast controls of the set are in the same positions. Adjustment will still be needed, of course, to allow for different film speeds.

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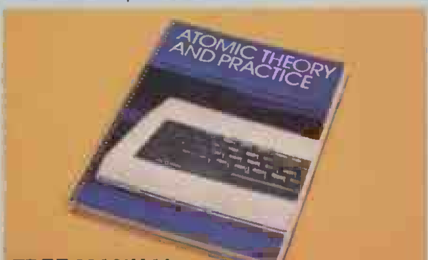

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COMPUTERTOWN UK!

NEWS

ComputerTown UK! – a nationwide computer literacy project – is under way with centres already opened in Nottingham and Hillingdon and lots of interest being shown in other parts of the country. To contact CTUK! write c/o PCW, *14 Rathbone Place, London, W1P 1DE, enclosing an SAE if you want a reply. Please don't try to ring the* PCW *office as this project is carried out in our spare time.*

The ComputerTown issue of *PCW* hit the news stands just as we were putting this one to bed so it is still too early to gauge reaction to the announcement. In the meantime we can tell you that, following a very low-key launch at the *PCW* show, quite a few people have shown interest and several have already set the wheels in motion in their own communities. A number of businesses have pledged software and machines to the project and, if these initial reactions are anything to go by, then CTUK! promises to be a huge success.

One interesting — but not very surprising — reaction has been the almost universal dislike of the name ComputerTown UK! Some say it's too American, some say it's meaningless, while others just can't put their fingers on the reason. We all know that the name is utterly irrelevant; it's what we're doing that's important. But if someone out there would like to donate a name which reflects the theme of 'taking computers out into your local community in order to promote computer awareness and remove fear,' then we'd love to hear from you. Write to us at the above address.

Now let's look at what's happened so far. First of all, Sutton-in-Ashfield and Eastcote will have CTUK!s running by the time you read this article. In each case, the local library is being used with a great deal of enthusiasm and commitment from the library staffs themselves.

Sutton-in-Ashfield is starting off in a big way with several machines, including at least one Atom, Sharp, PET, ZX80, Apple, Microtan and maybe a TRS-80 as well. They have managed this by making CTUK! an adjunct to their already thriving Sutton-in-Ashfield Computer Club (other clubs please note!). Graham Handley and Roy Griffin of Leasalink Viewdata have kindly provided them with an Atom on 'permanent loan'.

Sutton-in-Ashfield is getting its software either by developing it in-house or by scrounging. Anyone wanting to get involved should contact Deric Ellerby on Mansfield (0623) 753576. You may be interested to learn that Deric is aided and abetted in this venture by our very own Derrick Daines.

Eastcote CTUK! is starting rather less spectacularly in the (very small) local library. In fact there's only room for two machines. Contingency plans have been made for the time when interest (and the number of volunteers) grows. Three other local libraries have been offered as potential CTUK! sites: Ruislip, South Ruislip and Ruislip Manor. Mr P Colahan, the Hillingdon borough librarian, is very sympathetic to CTUK! so, if anyone else in the borough wants to start up, you'll find him a most approachable man.

As with Sutton-in-Ashfield, software is being developed or scrounged. In fact, Eastcote-based software house, Supersoft has kindly given the project a number of programs from its catalogue. Thank you Supersoft. The people responsible for CTUK! Eastcote are Martin Baldwin and *PCW*'s editor, David Tebbutt. David can be contacted (but not by phone) at the main CTUK! address.

Hammersmith looks like being a lively area when it comes to CTUK! We've already heard from three people who'd like to set up there. We've put them in touch with each other but if anyone else would like to join in ring either Jo Gedrych on 01-602 1269 or our very own Malcolm Peltu on 01-995 1548. We can't yet give the third person's name because we're still waiting for permission. Jo and Malcolm see their project as CTUK! West London, although this doesn't mean that West London can now be considered covered! Good luck lads — we hope to hear some more news soon.

We had a nice letter from another West London man. His name is Mike Baker and he lives in Hanwell, W7. He'd like to hear from other people in his locality who'd be interested in starting a CTUK! there. Mike can be contacted on 01-840 0030.

Exciting news comes from Ingersoll, UK distributors of the Atari computer systems. Marketing manager, Steve Bernard, strongly believes in CTUK! to the extent that he has pledged a number of machines to the project. We welcome his support and look forward to installing his computers in permanent CTUK! locations.

We also had a letter from David Payne, who works for Tandy. Although he's not in a position to scrounge free machines, he'd love to help in any way possible. He lives in South West London but any letter should be sent to the main CTUK! address for the moment and we'll forward them.

Edward Teague, until recently Sharp's PR man, popped in the other day and went away to propose a CTUK! in his home town of Romiley in Cheshire. For the moment contact Edward through the main CTUK! address.

While typing this report I had a phone call from Lyn Antill, author of our Systems series. Guess what? — she'd like to get a CTUK! going in the City of London. Anyone interested in joining in should write to her at 1 Defoe House, Barbican, London EC2Y 8DN.

Well that's it for this month. Our thanks to all those people mentioned; we really appreciate what you're doing. Next month we hope to bring you news of several more developments. Remember CTUK! should eventually cover the entire country, so it still needs plenty more volunteers. Anyone needing further information about CTUK! write to the main address enclosing an SAE. Once again, *please don't phone the* PCW *offices*, because CTUK! is a spare time activity.

We look forward to hearing from you, especially if you have news of your own local CTUK! progress. All news received by the middle of the month will appear in *PCW* a month later (or thereabouts).

ComputerTown UK! in brief

ComputerTown UK! *is* a voluntary, nationwide, community-based activity which aims to promote computer literacy by making microcomputers freely accessible to anyone interested. In particular it recognises the need for our future leaders, especially today's children, to feel completely at ease with the new technology. In ComputerTown the keywords are *fun* and *enjoyment* with the emphasis on learning through discovery at the keyboard.

ComputerTown UK! *isn't* just a passing craze any more than are microcomputers themselves. It's not a plot to turn Britain into a nation of programmers nor is it a sneaky way to sell computers — in fact ComputerTown represents no commercial interests at all and is not a profit-making activity.

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SHARP COMPUTER APPLICATIONS

Malcolm Peltu reviews two new books on the impact of micros in communications and and in industry in general and takes a look at some recent fiction.

The massage medium – or, on the eighth day

Something funny happened to me on the way to reviewing *Goodbye Gutenberg*, Anthony Smith's tome on the 'newspaper revolution' which formed the basis of a recent *Horizon* programme. I couldn't get hold of a copy of the book.

Following exposure on *Horizon*, the publishers had run out of review copies. So I set off on a search which in itself is relevant to the meat of this review. I started out at my local WH Smith, then successively through a chain of bigger WH Smith's. But it seems that the limited space given over to hardback books is filled with autobiograhies of TV frontmen and sports personalities and hundreds of Books Of Lists Of Books of Lists. I even found it difficult to find out whether or not *Gutenberg* was in stock in the shops.

Eventually I went to Foyles, the 'world's biggest bookshop'. I tried the technology section without finding *Gutenberg*. I asked a polite assistant who stared at me blankly and asked what it was about. I tried to explain that it was about the application of information technology to the newspaper industry. He stared blankly and took me to a more senior person. Instantly he knew where to find it — in the Commerce department.

This scenario seems to be some kind of physical enactment of Marshall McLuhan's principle that the "Medium is the Message". One of Smith's arguments is that electronic information technology will turn the librarian into a "sentinel at the gateway of information and knowledge and society may come to find itself demanding to see his (sic) credentials." In other words, access to, and organisation of the database becomes crucial.

By walking between bookstores I found what I wanted. In order to do so, I had to guess at the way the book was classified and in the end was dependent on dialogue with an intelligent human being to explain my meaning.

Having found it, however, I was disappointed. A few years ago, I read an article by Smith which seemed to me to get to the heart of the way information technology is radically changing the nature of the news and entertainment media.

In that article, he pointed out that one of the virtues of current newspaper formats is that they contain more than the specialist interests of any one reader. Even if the prime reason for buying a paper is the boobs on page 3, or the crossword, or Clive James' TV review, or the business section, the purchaser gets the whole paper. The *Sun* reader might therefore learn something about political developments after looking at page 3 and something on the arts page might capture the eye of the businessman. With the help of computerised technology in the US, however, papers are already getting more and more sectionalised. They become a collection of supplements, so that you can throw away the ones you don't want.

With electronic information media like Prestel, he commented, the process was taken further so that the 'reader' selects just the information needed and no more. In order to do this, a certain degree of skill will be needed to interact with the system, to scan and search the database. Smith warned that this could harm democracy because it would make the informed better informed but would remove even the incidental educational and informative effect gained from the words on pages 1 and 2 when looking for the girl on page 3.

In over 300 pages, *Goodbye Gutenburg* provides no fresh insights or even a real development of this important theme. Instead of providing what I thought would be a critical analysis of new technology, it is a technology-obsessed promotion of the wonders of technology.

Actually that is unfair. The bulk of the book is a very good, detailed study of the American newspaper industry and the impact on it of computer technology. It also has good background on the nature of electronic news media like viewdata and the history of printing and libraries. But this well-researched core is wrapped around with flimsy and pretentious philosophising which I found hard work to digest and not worth the effort once I had. He seems so in love with the electronic medium that he fails to really question the nature of the message. By the end, information technology becomes an electronic message medium, smoothing down poetry and loveletters, timetables and invoices, births, marriages and wars into a passionless bit-stream.

Here is a typical chunk of his philosophising, full of sinewy, hard to swallow sentences and clever-sounding phrases: "Words have lost their hard edges in the age of the audio-visual. A world of facts is dissolving into a factless world overloaded with information, dominated by images. The provision of information has become the privilege of great feudalities, vast corporations that collect and disseminate material through a multiplicity of media; but at the same time the very abundance has made the receiver, the consumer, more powerful in the process of communication. The greater the profusion and the wiser the choice, the more dangerous is the fact that very few control it; but the danger is set against the greater freedom of the reader and the viewer." Phew, What a Scorcher!

His assertions are dubious. Words have *not* lost their edge. If they had, why would Smith spend so much time sculpting them? Words have weight and colour; poetry and literature are not dead — Shakespeare did not need a VDU; an abundance of information gives no power to the recipient. These are my beliefs, my assertions and I find it dangerous when people like Smith diminish the values of wisdom, creativity, wordcraft, etc, in the flush of electro-love.

The words of Hazel O'Connor's song *On The Eighth Day* should be imprinted like a government health warning on every book about the wonders of technology. Her refrain: "Nobody laughed, nobody cried" in the world of machines could become the epitaph of the 'micro revolution'.

Although Smith makes an important point about the power of the database organiser and computer librarian, he again takes an enthusiastic step towards the Eighth Day: "Within the creative process it is becoming clear that the talent lies in the refining of past knowledge, in reformulation, in recirculation, in reordering the vast human storage of information that springs from the collective intellectual activity of the species, an unencompasable totality of versions and facts. The creative task lies in being able to manipulate this ever-expanding totality."

To support this, he quotes T S Eliot, who said that the most individual parts of a poet's work may be those in which "the dead poets, his ancestors, assert their immortality most vigorously." Smith's interpretation seems a travesty. The *human* process of *creation* does build on conscious and subconscious stimuli from the past and present and on the individual's own intelligence, emotions and creativity. This is a million bytes away from organising databases and sifting through them.

Smith also states that 'we' have passed a turning point in information development, equivalent to the creation of a diverse range of food and consumer goods, once basic physical needs have been catered for. He claims that "we" have changed "from the basic diet of mass entertainment for the work-weary to the profusion of choice required by societies where individual interests can be indulged." Perhaps too much American TV has dulled his senses.

Anyone seeing the 'profusion of choice' on American TV and most American newspapers will realise there is little choice at all — just a homogeneous wodge of blandness. More information does not mean better. More technical virtuosity does not mean more creativity.

Smith was on the original team of the original *Tonight* programme on BBC. Made in black and white, without the advantages of modern electronic technology, using jour-

Illustrated by Ross Collins

nalists with an edge to their words, this was one of the best current affairs programmes ever produced.

Perhaps he should take time out at his current job, as director of the British Film Institute, to look back at some old silent movies. In just a single reel of a Buster Keaton film, say, he will find more creativity, beauty, humour and humanity than any modern billion-dollar multi-media super-technology film.

But, despite my criticism of the book's philosophical trappings, I would recommend it strongly for anyone interested in newspaper technology, ancient and modern. Just skip the beginning and end.

Need for skills

For too long, the analysis of the employment effects of information technology was regarded as a numbers game — how many would be made employed/unemployed. Now it is being realised that there are other important issues to consider, more practical and concrete than guesstimating numbers.

One of the most important problems is ensuring that there are sufficient skilled people available to apply the technology, otherwise money will be wasted in investments in technology that prove inefficient and ineffective, or just be idle. There is no easy, flip answer to the problem. Clearly, money should be spent on training. But training who and in what skills? What order of priorities should be set? Which skills are becoming redundant and which new skills are likely to be needed?

An outline of how these training needs could be met is provided in an important new book, *Microelectronics and the Engineering Industry*, edited by Nuala Swords-Isherwood and Peter Senker of the Science Policy Research Unit (SPRU) at Sussex University.

It is based on detailed research work carried out by SPRU for the Engineering Industry Training Board and provides a detailed analysis of the skills needs in a variety of engineering processes and industries. There are chapters on assembly skills and welding, vehicle and mechanical industries, the electronics industry and offices.

Strong messages come through the book which pinpoint some of the basic reasons why British industry is melting away. In comparing attitudes in West Germany and the UK, based on a study of a number of companies, Senker comments: "It was in the area of attitudes to graduate engineers, their recruitment and deployment that the greatest difference was found between West Germany and the UK." In West Germany, graduate engineers and technologists were recruited as a matter of routine because companies recognise the need for people with skills and innovative ideas. In the UK, however, Senker found that graduates were regarded as a 'luxury'. British management, he says, has relied on traditional apprenticeship schemes and part-time training to produce engineers. Although he believes this method has developed many good engineers in the past, it is totally inadequate when introducing new technology for which there is no existing base of experience in the company or where a broad systems approach needs to be taken.

On manpower planning, the editers conclude: "Manpower planning in even its simplest form is less practised by indigenous British companies than in foreign multinationals based in Britain." One British computer manufacturer, they say, even kept the little manpower information it had by manual methods rather than on a computer!

Inadequate manpower information can lead, for example, to a company having an ageing group of essential workers with insufficient time to recruit and train replacements. The failure to give attention to manpower planning also indicates that issues such as career development and training are regarded as peripheral to the main objectives to the enterprise.

"This contrasts most markedly with the approach of Japanese companies in particular, which integrate all aspects of the planning exercise," they say. The editors aptly summarise a crucial challenge facing British industry: "The prime requirement for competitive success and for coping with microelectronics is to have a highly educated, trained and skilled workforce at all levels. Those countries and firms which recognise this and implement appropriate policies will be successful in the microelectronics age." Their book indicates the way forward.

Unmarvellous fiction

"Time for a little light fictional relief," I thought, settling down with the latest book of *Creative Computing* stories, *Tales Of The Marvelous Machine*. But I found it heavy-going and would have given up at an early stage if I was reading it for pleasure rather than to review it.

Most of the stories could have been written by a computer, as their style generally lacks individuality or character, although there are over 30 authors. Typically, they seem to be based on 'terminal musings', the kind of thing that a programmer might imagine while sitting at a computer terminal or personal computer. Like, "What if the computer was programmed with a human personality. . ."; "What if aliens from space used the computer to communicate . . ."; etc. Boringly etc.

The best story is the longest one, *Entelechy*, by David Sosnowski. It creates a genuine sense of mystery, of driving the reader to want to know what is happening and will happen. It has elements of mysticism, is full of poetic images and is a vivid and interesting reworking of what is basically a well-worn sci-fi idea.

Most of the others, however, would provide as much interest (or lack of it) if they were reduced to two-paragraph summaries. The first paragraph would explain the idea behind the story, such as: "Will people care about intelligent robots as if they were friends? What will happen when such a robot is being traded in at a second-hand robot store?" The second paragraph will give the punch line. (I won't in this example, which is *The Used Computer Dealer* by Stephen Kimmel, in case you want to find out for yourself.)

Even the well-known sci-fi writer Frederik Pohl falls into the dull mode of the rest of the book. Besides Sosnowski, only two authors display a strong literary style — and these are parodies of other authors'. Dick Hoover's *Legend of Jimmy The Green* is an uninteresting story made enjoyable by being written in the style of Damon Runyon. And Ian Malcolm Earlson produces a numerical puzzle which would have been interesting as such but is boring in the guise of a wearisome mimicry of Conan Doyle in Sherlock Holmes and Charles Babbage (would you believe?).

But I would like to claim a place in the *Guiness Book Of Records* as the first book critic to find a numerical fault in a literary work. To prove that *Creative Computing* knows how to sort lists, the book has 14 different indices, such as alphabetical lists of titles, physical locations, those stories which are about 'improving the human lot' and those about 'computers as they are now'. One list is by length of words — and I am sure that the story *Pulling the Plug* is nowhere near its claimed 3740 words.

If the *Creative Computing* book is largely based on the fantasies of frustrated programmers, *Programme for a Puppet* reads like the fantasy of an Australian journalist who has dabbled with writing about computers, has lived in Earls Court and dreamed of living in Strand-on-the-Green (in-joke for those who know London) and has realised that topical adventure yarns which interweave politics, spying and screwing have a good chance of selling well.

The author, Roland Perry, wrote about computers, economics and politics on the *Melbourne Age* for five years and lived in London and New York. The hero of the book is an Australian journalist in Europe.

Its plot combines big business corruption, spying, killer thugs, computer smuggling to Russia, thrusting buttocks and undulating curves. The hero fights a battle against Lasercomp, a giant computer manufacturer — clearly with a satirical hint of IBM — which develops a programme to install a puppet president in the US to carry out its will.

If this sounds like your can of Fosters, you will probably enjoy it. But once again, I read this one for business reasons, not pleasure.

Sounds goods

Here is a book which sounds interesting, has lots of interesting and witty drawings, chapter titles and section headings but is still searching for the appropriate text to fit the packaging.

Computer Consciousness — Surving in the Automated 80s sounds intriguing, doesn't it? And how about chapter titles like *Fauna of the Solid-State Age?*

In fact, this book is nothing more than yet another introduction to basic computing concepts. As such it is a rather mundane and workmanlike description, ranging from hardware to the human factor in applications. The illustrations are the best part but the overblown title and packaging make it all seem a bit silly.

Reviewed in this month's Bookfare were:
Goodbye Gutenberg by Anthony Smith (Oxford University Press, £8.50).
Microelectronics and the Engineering Industry edited by Nuala Swords-Isherwood and Peter Senker (Frances Pinter, £10.00).
Tales of the Marvelous Machine edited by Robert Taylor and Burchenal Green (Creative Computing Press).
Programme for a Puppet by Roland Perry (Hamlyn Paperbacks, £1.25).
Computer Consciousness by H Dominic Covvey and Neil Harding McAlister (Addison-Wesley, £3.85).

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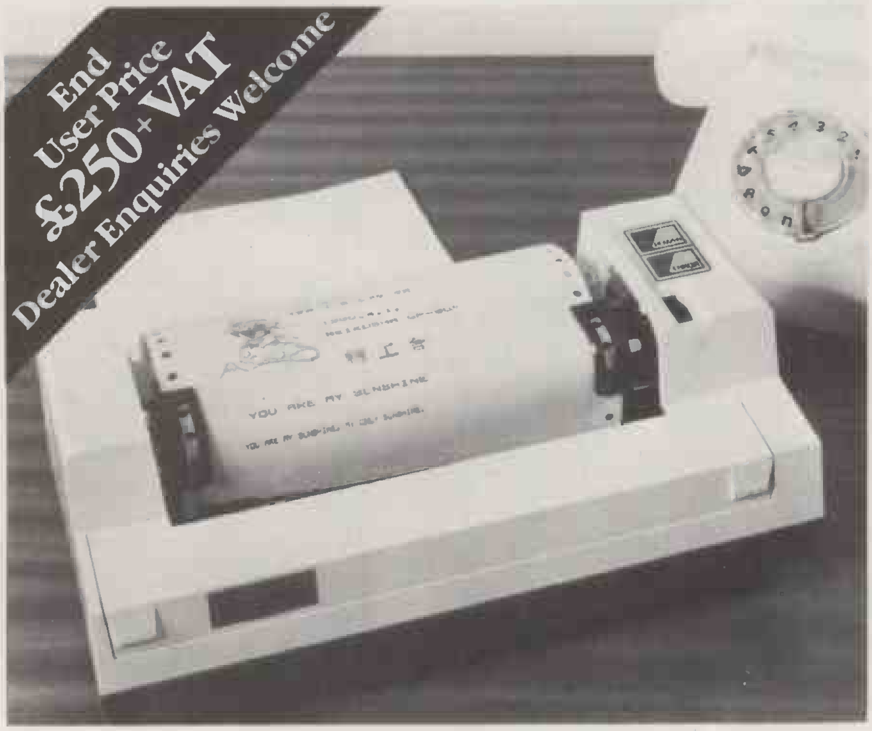

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FEATURE INDEX

Index to current volume, up to, and including, last month. (Previous volumes were indexed in March and April 1980 issues)

Hardware Projects

Benchtest

Series

Fact Sheets

Personal Opinion

Evaluations (Checkout)

Calculator Corner

Indexes

Special Features

Package evaluations

Programs

MICROWRITER

The Microwriter attracted much publicity when it appeared a couple of years ago, along with some scepticism as to its practicality. Can you learn to type with just one hand? Peter Rodwell reports.

About six years ago, writer and word-games addict Cy Endfield, an expatriate American living in London, bought one of the early pocket calculators. It struck him that a calculator-sized device with an alphanumeric keyboard and display would make the ideal basis for a word-game he'd invented — but he didn't like the idea of a full keyboard with one key for each letter of the alphabet. It would be too fiddly, he thought.

Thus was born the idea for the Microwriter, a device which would allow you to type alphanumerics using just one key for each finger and pressing them in various combinations to produce the required characters.

There was a problem, though. To do this you'd have to memorise the key combinations, and that seemed an almost impossible task to ask of anyone. Also, decoding the key combinations and producing characters from them seemed rather complicated.

Two innovations changed this. Firstly, the development of microelectronics — and, in particular, the availability of low-cost CMOS chips — made the decoding task easy. And Cy himself solved the key combinations problem by hitting on the idea of using the shapes of the letters themselves as mnemonics.

These two innovations made the Microwriter not only a possibility but a practicable reality and Cy quickly developed the idea beyond the stage of a word-game to that of a fully-fledged text inputting and storage device, which is the stage the Microwriter is at now.

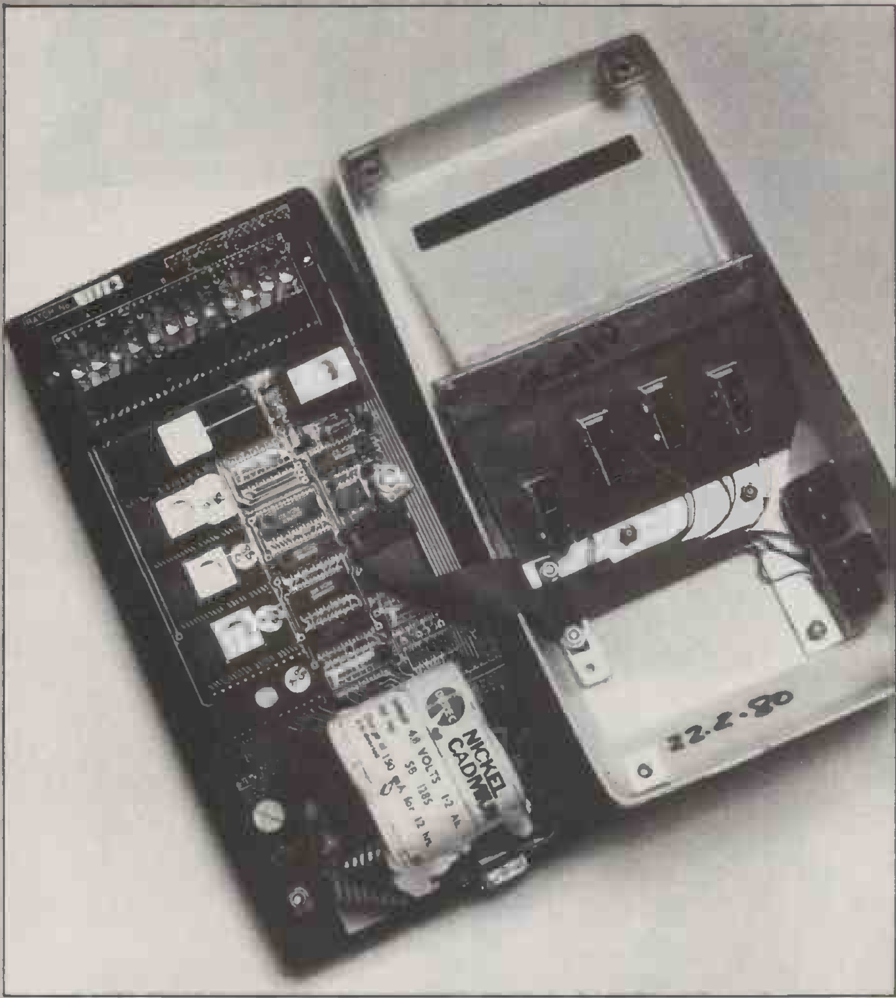
Getting the Microwriter into production wasn't easy, and Cy Endfield has quite a horror story to tell about his experiences when trying to get backing. His big break came when his invention was shown on *Tomorrow's World* and caught the eye of a director of Hambros Life Assurance Ltd. The result was Microwriter Ltd, owned jointly by Cy Endfield and Hambros, which has been producing Microwriters for the last two years or so and has already sold some 500 of them.

Above — the Microwriter with some of its interfaces: at the back is the TV interface with a sample display; centre left is the printer interface and to its right, the cassette interface and recorder.

Hardware

The Microwriter comes in a rugged, well-made plastic casing and has a 12-character alphanumeric display formed with 16-segment LEDs. The device is operated by six keys, one for each finger and two for the thumb; on the front edge are the on/off switch, battery charger socket and a nine-pin socket for the tape, TV and printer interfaces. The unit comes with a neat zip-up carry case and a battery charger; at about 11 cm wide, 22 cm long and 6.5 cm high, it's not pocket-sized but will fit into a large briefcase.

Inside, an RCA 1802 CPU does all the hard work, aided by assorted CMOS chippery with 2k of EPROMs to hold the firmware and 8k of RAM in which the text is stored; throughout, the standard of construction is neat and professional. Under the frontal 'hump' on which you rest the palm of your hand is a set of rechargeable batteries which permanently powers the RAM so that its contents are preserved



Inside the Microwriter. The RAM lives on a second PCB under the board you see here.

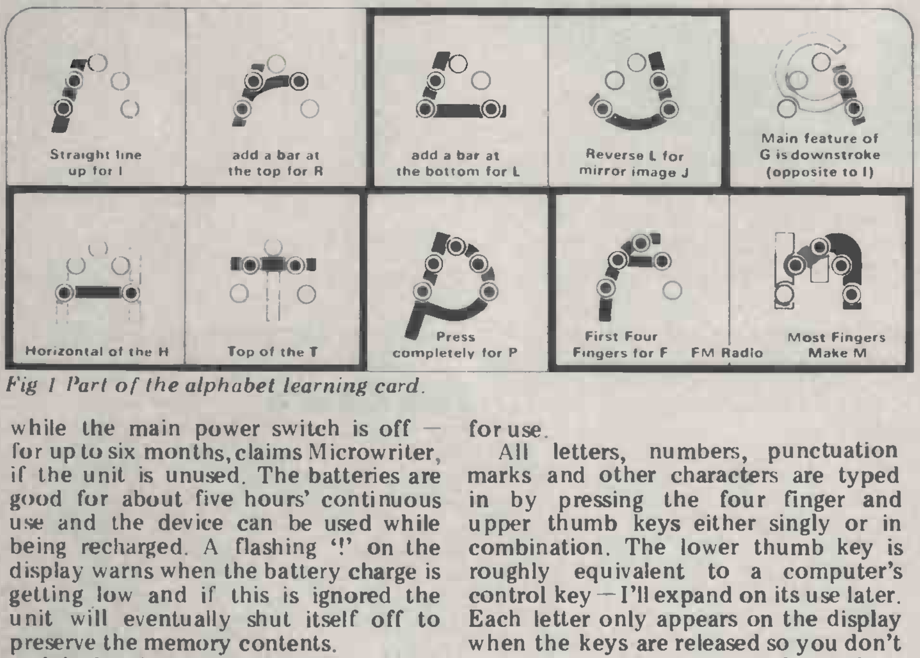


Fig 1 Part of the alphabet learning card.

while the main power switch is off — for up to six months, claims Microwriter, if the unit is unused. The batteries are good for about five hours' continuous use and the device can be used while being recharged. A flashing '!' on the display warns when the battery charge is getting low and if this is ignored the unit will eventually shut itself off to preserve the memory contents.

I had only two dislikes on the hardware side. I would prefer an LCD display — perhaps with more than 12 characters — to the LEDs and I found the keys too sensitive; Microwriter claims this is deliberate to allow faster use but I still think they're a mite too easily triggered accidentally.

In use

On power-up, the Microwriter displays its name; pressing the upper thumb key (actually the 'space' character), replaces this with 'START' on the left side of the display and the unit is then ready for use.

All letters, numbers, punctuation marks and other characters are typed in by pressing the four finger and upper thumb keys either singly or in combination. The lower thumb key is roughly equivalent to a computer's control key — I'll expand on its use later. Each letter only appears on the display when the keys are released so you don't have to try to press or release them absolutely simultaneously.

On the version I used, I counted 59 key combinations which displayed characters, with a further 26 control combinations, some of which involved entering two characters. An enhanced version of the software will shortly be available with further characters and commands.

Earlier, I mentioned Cy Endfield's system for memorising the key combinations, without which the Microwriter would be virtually unusable. It involves visualising the shape of each letter or symbol and pressing those keys which form the outline or salient points of that shape. Figure 1, taken from one of the handy learning cards supplied with the machine, gives a far better idea of how this works than I could explain in words. Note the little mnemonic phrases that go with each letter: although one or two of these are a little contrived, they really do help with the learning process.

The Microwriter has two 'registers' (as the manual calls them): 'alpha' and 'punctuation'. At power-on the machine is automatically in the alpha register, in which all letters of the alphabet plus the most commonly-used punctuation marks — full stop, comma, hyphen and apostrophe — are available. Pressing the control key by itself latches the device into the punctuation register (denoted by a Union Jack-like symbol on the display) where numerics and other punctuation marks are available together with symbols such as '@' and '%'; in fact all the symbols you normally find on a typewriter are available on the Microwriter except for fractions. In this mode, the control key has a toggle action — pressing it again puts you back into the alpha register.

There are separate learning cards for punctuation and numerics and, again, a lot of thought has gone into making the learning process easy. The '£' sign requires the same key combination in the numeric register as that which, in the alpha register, produces 'L', for example (although the resulting display character looks a little odd); similarly, '?' uses the same key combination as 'Y' (mnemonic 'why?'); and numeric '0' is the same key as letter 'O'.

The control key also functions in combination with other keys to allow a range of commands to be executed. This is mostly achieved using letters whose key combinations normally include the thumb key, except that the control key is used instead. Again care has been taken to make them easy to remember: you press CTRL—J to Jump back through text, CTRL—I to Insert text, for example. Many commands can be extended by first typing CTRL—Y; so while CTRL—F moves the display Forwards by one character, the sequence CTRL—Y, CTRL—F gives continuous forward scrolling — which you can Halt by hitting CTRL—H.

Text can be divided into separate blocks by inserting special block start and end symbols. This is necessary for printing or recording on cassette, as I'll explain later. It's also useful for deleting sections of text — you simply insert markers around the unwanted section, position the display anywhere within that section and type CTRL—W twice to Wipe it out.

The LED display shows all characters in upper case but the Microwriter stores them — and sends them to the printer — as lower case. Upper case characters can be defined single by typing CTRL—Y before you type the character, and the equivalent of a shift lock is available by pressing CTRL—P (for Permanent capitals). Upper case characters are denoted on the display simply by their flashing quickly, which I found slightly irritating.

As I said earlier, the Microwriter has an 8 kbyte text buffer, enough for about 1500 average-length words. When the buffer is full, the words 'MEMORY FULL' appear on the display; unfortunately this crashes the machine and you have to switch off then on again before you can do anything more, such as save what you've just written onto cassette. The next software release will contain a 'Memory full' early warning to eliminate this.

Learning

Learning the key combinations is, of course, the whole key to using the Microwriter and it's remarkably easy. It took me about half an hour to learn the alphabet and about the same period to learn the numerics, punctuation marks and assorted symbols.

Once the key combinations have been learnt, the rest is a matter of practice to build up speed. At first I found it quite frustrating — although I *knew* the combinations I still had to think before pressing the right keys.

Inevitably, I'd [illegible] learnt the combina[illegible] and I seemed to be [illegible] control key accident[illegible] machine into the punc[illegible] so that numbers and symbols [illegible] when I was expecting letters.

After a fortnight, however, [illegible] thing had changed. I'd built up a [illegible]able speed by practising for an aver[illegible] of two hours a day and mistakes were getting fewer and fewer. There were still occasions when I'd mentally 'seize up', unable to think of a combination, but by the end of the third week this, too, had been overcome, although I still needed to refer to the learning cards occasionally for some of the lesser-used symbols such as '*' or '&'.

From what Microwriter tells me, this seems a reasonably typical learning curve; unfortunately I didn't have time to contact Microwriter users and compare notes — I'd be interested to hear from any Microwriting *PCW* readers.

Microwriter claims that speeds in the region of around 45 words a minute are possible. This is far faster than handwriting but slower than the faster typists. Although I've yet to reach this level of proficiency, I've certainly passed handwriting speed — it's now actually quicker and easier to use the Microwriter than to write in longhand. Despite several attempts to learn touch-typing, my typing still follows the Biblical method ('Seek and ye shall find. . .') so the Microwriter wins hands (or, rather, hand) down in this respect for me. (It occurs to me that you might be able to reach dictation speed using Speedwriting-style abbreviations on the Microwriter — then, if you were really clever, you could play it back into a word processor equipped with suitable translation software! If anyone does this, I want a royalty.)

So I found learning to use the Microwriter quite easy — far easier than learning to type. This review was written entirely by Microwriter, in fact.

An interesting aside: I'm left-handed and the Microwriter is designed for use with the right hand yet, apart from an initial clumsiness which soon vanished, I had no difficulties. Microwriter is contemplating a left-handed version, aimed primarily at disabled users, but which some non-disabled sinistrals might prefer; I'm not sure how the key combinations would work, though.

A user's handbook comes with the Microwriter and explains every detail of its operation as well as reproducing the charts of key combinations. It is clearly written and logically laid out, although I spotted a couple of spelling mistakes. It was, of course, written using a Microwriter.

Interfaces

The Microwriter can be interfaced to a cassette recorder, a monitor or TV set and a printer. So you can save text, retrieve it, edit it, format it for printing on a screen, and print it.

The cassette interface is a calculator-sized black box which plugs into the Microwriter and a recorder, and it takes its power from the Microwriter. Having found the text block you want to save, and positioned the display anywhere between the start and end markers, you just type CTRL—Y, CTRL—W. The words 'TAPE WRITE' appear on the display until the block has been saved. At 1200 baud it takes about a minute to save an entire memory-full of text and each cassette holds up to ten loads per side. However, the user's manual sensibly warns against putting too many blocks onto one tape without recording verbal leaders to identify each one. Foolishly I ignored this advice and managed to overwrite a hefty portion of this review — the fault was entirely mine, not the machine's.

Microwriter supplies a Lanier micro cassette recorder with the interface, which is set up to operate specifically with this recorder. I tried three other recorders without success, despite much fiddling with volume controls. However, if you already have a recorder, Microwriter will sell you the interface by itself and set it up to work with your machine.

Retrieving text from tape is similarly straightforward — plug in, switch to play, and type CTRL—Y, CTRL—R. 'TAPE READ' pops up on the display until the block has been read in. Using markers to define text blocks, you can add text to whatever's already in memory and concatenate them afterwards by removing the markers. Using the Lanier, I found the whole process reliable and trouble free, but if the Microwriter encounters garbage during the read process, it aborts the read and flashes a symbol to warn you.

The TV interface is housed in a largish Verobox, is mains-powered and has both monitor and UHF outputs. Using simple commands, you can display up to 16 lines of text on screen; the characters appear in black on a grey background with upper case characters in white. I tried a monitor and both black and white and colour TVs, which gave respectively excellent, good and slightly fuzzy displays, although all three were rock steady.

If you're working on a long text block, the video interface is almost essential. A 12-character 'window' into the Microwriter's memory just isn't enough for editing, particularly as the scrolling speed is rather slow — again, Microwriter intends to remedy this in the next software release, which will have two scrolling speeds.

Using the screen, you can format text for printing, as the text appears exactly as it would when printed. Formatting is a little rudimentary — you can set the left hand margin and insert tab characters; both work in five-character units. On both screen and printer, a line of 55 characters is output and a carriage return performed at the next space character in the text stream. You can, however, insert a special character to force a CR whenever you want one. Right-hand justification isn't available.

On-screen editing or writing isn't possible. . . yet. On the machine I used you could only dump to the screen; if you didn't like what you saw you could edit the text in the Microwriter but you then had to re-dump it to check that you'd got it right. Again, this is to be remedied soon, with on-screen writing and editing facilities.

The printer interface is identical in appearance to the cassette interface and is also Microwriter-powered. There are two print commands, one giving single line spacing and the other giving double spacing. Printing can be stopped at any time with CTRL—H. Microwriter sells two printers, a typewriter-quality Ricoh daisywheel and a cheaper, dot matrix Centronics unit.

Although the interfaces were easy to use they didn't seem to have been given the same degree of thought which has gone into the Microwriter itself. You can only plug in one at a time to the Microwriter, so if you're involved in a long taping, editing and printing session, you're continually swapping plugs around. You also end up with quite a tangle of wires when using the three interfaces together; I'd have preferred a cradle-type arrangement to house both printer and cassette interfaces, into or onto which the Microwriter could fit, with three output sockets to eliminate all that plug-swapping.

Users

So who's going to use a Microwriter? Well, just about anyone who needs to put words onto paper. Cy Endfield sees it as much, much more than a replacement for the typewriter keyboard — he considers it as a pencil and paper replacement.

Personally, I can see a big sales potential for executives in the much-heralded office of the future. Few executives are likely to have either the time or inclination to learn touch-typing but most could Microwrite with ease. Interestingly, Government departments are keen Microwriter users; apparently there's a Home Office section which uses them to produce neatly-typed documents on subjects too hush-hush to be entrusted to typists.

PCW readers will be particularly interested to hear that software upgrades coming soon will turn the Microwriter into a full RS232 terminal with an ASCII character set. As personal computers become even more widespread, Microwriter terminals could make life easier for people who have difficulty with typewriter-format keyboards. It can also be linked to a voice synthesiser, which could be good news for the blind.

Even more interesting is the possibility of giving the Microwriter intelligence. Thus you would be able to link up to a computer through an RS232 interface or by telephone using an acoustic coupler. You could then download a program and run it locally; apparently this is already being experimented with.

Cy Endfield is particularly keen to see children using the Microwriter and, having seen how quickly kids pick up the basics of computing, I think they'd take to it very quickly. This conjures up a vision of some future society in which handwriting becomes a totally forgotten art and paper becomes just a wrapping material, as everyone Microwrites onto TV screens — unlikely, I'll grant you, but I'm certain that a great many people would find the Microwriter an extremely useful device. Its potential is enormous.

Conclusion

I found the Microwriter easy to both learn and use and, as my expertise with it increased, so did my enthusiasm. It's an addictive device, in fact, and I'm now starting to wonder how I ever managed without one.

There are several small points which need refining. The next software release will cover these and a few more — some of the control sequences will be simplified, there'll be a two-way comminications facility for use with other equipment, such as computers, and jumping about within the text block will be refined, to mention only a few of the proposed enhancements. All the points I put to Microwriter were, in fact, answered with: "We're doing that in the next release," and I'm looking forward to trying the enhanced version.

On the hardware side, the interfaces certainly need tidying up. Trailing wires are dangerous as well as messy and constant plug-swapping is annoying.

On the whole, though, I was thoroughly impressed with the amount of careful, logical thought which has been put into the Microwriter to make it easy to learn and simple to use. Microwriter likes to maintain close links with its customers and encourages feedback; many suggestions from real users have been — or will be — incorporated into the device.

But there's a snag — it's not a cheap device, as you can see from the price list printed elsewhere in this review In fact, I think it's very overpriced, especially when you consider that you can buy, for example, a 16k TRS-80 Level II — a machine of far greater complexity than the Microwriter — for nearly £100 less. The reason is, of course, that Tandy churns out TRS-80s in far greater volume than Microwriters; hopefully, if/when the Microwriter catches on and gets into high volume production, its price will drop. There's a nested snag here, of course, in that some may say that the Microwriter requires a careful learning period before you can use it, and thus isn't suited to volume sales. But this really doesn't hold water — a personal computer requires a lot more effort to learn to use, and in use requires continual mental effort; once you've learnt to use a Microwriter the only skill required in its continued use is a small degree of manual dexterity. In short, volume sales and volume production should be no problem, especially as Microwriter's user manual and teaching cards are far clearer and easier to follow than many personal computer manuals.

Prices

Microwriter with carry case & battery charger	£485
Cassette system	
Interface only	£60
Interface with Lanier recorder	£165
RS232 interface	£60
TV system	
Interface	£165
12-inch monitor	£130
Printers	
Ricoh RP40 daisywheel	£1100
Centronics dot matrix	£550

These prices are one-off end user prices — quantity discounts are available on the Microwriter itself. Prices exclude VAT.

SECRETS OF SYSTEMS ANALYSIS

PART 4

The pace hots up as Lyn Antill relates the user's needs to the various elements of hardware and software.

Do you need a computer?

I almost made the mistake of giving this section the title "Do you *want* a computer?", but that's a silly question — of course you want one, because they're such fun. In serious systems analysis you cannot totally ignore what the user fancies (if only because it provides good motivation to get over the effort of installing a new system) but you do have to put such things into perspective. So, back to the serious business.

Once the user's requirements have been established, there is one question which must be honestly faced: "Will these requirements best be met by a micro?" Some uses will be too small, others too large, some again will be impractical. The Bakery Dept at a London Polytechnic was faced with new EEC regulations that demanded that loaves of bread should have a certain average weight (rather than the minimum weight of UK regulations). To find out whether a lightweight loaf is acceptable some statistical calculations are necessary. To give the students practice in these calculations the teacher needed to generate random numbers to simulate the weights of imaginary loaves. The department wanted to buy a PET for this even though it was pointed out to them that random number tables cost 50p. In this case the computerised solution was 1000 times more expensive. (To be fair, though, the secondary benefit of exposing bakery students to microcomputers more than justified that expense, and the *real* reason is not always the one that is officially given.)

The sorts of factors which indicate that a computerised solution would be appropriate are:
— lots of routine work all to be done in the same way, or at least in a limited number of clearly defined ways;
— repeated calculations using a predetermined formula;
— storage and retrieval of clearly defined data (ie where each record can have the same fields);
— results are wanted quickly (for long calculations or searches through data files);
— special machine features are required.

Factors against a computerised solution are:
— lots of exceptions and one-offs;
— rapidly changing work (it takes time to write programs);
— the effort and expense of creating the computer system and the disruption of implementing it aren't justified by significant improvements in performance.

What size of computer?

It is an underlying assumption of this series that a microcomputer will be required but there is obviously an overlap between what can be done on the largest micros and the smallest minis. (The LSI 11 is designed to imitate the PDP 11, and Superbrains can be linked together to create a distributed network). Also a fairly wide range of sizes and speeds of micro cater for different requirements.

You will need a fast machine with a large memory if:
— you want to program in structured high level languages (eg Pascal or Cobol rather than Basic);
— you want to do regular word processing (this gets much slower if text is continually being stored on disk rather than holding large chunks of it in RAM);
— you want to do hefty calculations on large matrices;
— you want to do file sorting (ie you want to resequence your data).

You can get away with a smaller machine if:—
— you only need short Basic (or assembler) programs;
— you intend buying existing short programs which do not have large storage requirements;
— you wish to play around with the basic model now and expand it later (some micros are readily expandable with plug-in memory and peripherals);
— you're an educational establishment troubled by spending cuts and anything is better than nothing.

With experience a programmer can look at a problem and estimate the size of the program required to solve it. Comparison with showroom samples of which the size is known would also help to give an idea of the sort of size involved. Sizes are measured in k, which stands for 1024. On a micro this is normally a measure of the numbers of characters which can be stored. On an 8k PET the user has 8000-odd characters to allocate between programs and data, with another 8k of ROM holding the Basic interpreter. Other machines don't have Basic in ROM and so require 16k to run the same programs. At the very bottom of the scale, process control programs in assembler or Forth can be fitted into 2k. An 8k machine will serve as well as a large calculator. Business software will range between 16k and 64k, depending on two things — the number of checks and safeguards built into the program and the amount of data held in store at one time (small machines spend more time shuffling data on and off disk). For word processing — Wordstar, for example — 32k is possible but it will work much faster with 48k or 64k.

Different micros actually do their processing at different speeds. This is referred to as the clock speed and is measured in MHz (megahertz). It's the frequency of the clock pulse that determines the speed of the micro; 2 MHz and 4 MHz are common values, 4 MHz being the faster. The 68000 processor promises speeds up to 10 MHz.

If you are going to be doing much searching through data tables, rearranging word processor text, or repeated calculation, then you could be spending a lot of time waiting for answers. If that time is expensive then a faster machine could be cost-justified. But if your speed of operation is governed by the speed of a two-finger typist, then faster computing isn't going to help.

Tapes or floppies?

If your computer is going to do the same job all the time, or at any rate for long periods, then you want to start thinking about getting the program burnt into ROM (ie getting it put permanently into Read Only Memory and plugged directly onto the board). To store programs for more general use, however, or to store data for use on another occasion, the most common choice is between cassette tapes and floppy disks, with disk drives costing a good £500 more than tape decks.

The simplest machines, such as those at the bottom of the PET and Tandy ranges, have a single tape drive. This can be used for storing — and later reloading — programs, and also for storing data from one run to the next. The limitation on the data storage is that it all has to be read in from the input tape, stored in the machine, updated and written out onto a new output tape. This can be perfectly successful where the amount of data is strictly limited so that it can fit into whatever memory space isn't taken up by the program.

One City bank reckons to have stolen a lead over its competitors with such a system. The data in this case are a list of all the interest rates and exchange rates of different currencies against the dollar, perhaps 400 items in all. Now the bank can quickly work out exchange rates and interest rates for trading what it calls 'cocktail' currencies (where a single sum may be composed of several different currencies, such as Special Drawing Rights). Before the bank bought the PET, that information would have been written down on N sheets of paper, or taken from rates chalked up on a blackboard at the end of the dealing room, and the bankers wouldn't have had time to work out all the figures and do the deals before the market shifted and the rates for the individual currencies changed, requiring them to start their calculations all over again (or take an inspired guess).

A dual tape system allows a more general approach. Here, one tape provides the input while the other collects the output. This forms the basis of 'batch processing' which was once the normal thing on mainframes. Files have to be stored in sequence on the tapes with one field being used as a key to determine that sequence (eg, all customers in account number order). The files have to be processed in sequence on that same key. The program reads in the first record, you alter it if necessary (recording such things as a customer paying his bills or ordering more goods) and then you write the record onto the output tape. The limitations of this system are obvious. Even if only one record has to be changed, the whole tape has to be rewritten and you have to collect all the updates and sort them into the right order before running the program to get anything like efficient processing. This system is perfectly suitable for keeping a record of things after they have happened and is probably quicker and more accurate than the corresponding manual record-keeping system. What it won't do for you is allow you to look up and alter records as you go along. Ten years ago people were amazed that a mini could give them figures that were accurate as of close of business the previous night, yet such a system seems really rather inadequate beside the direct access systems now readily available.

Dual floppies?

The most popular and versatile system for business use is based on twin floppy disks. Several files can be stored on one disk, so you can have input and output on just one drive if the files are small enough. The reason for having two drives is that this gives you the chance to copy both programs and data on to spare disks. This 'security copy' means that ruining a disk is not a disaster — you start again with the copy. It also means that there is no particular limitation on the size of the files — one file could, if necessary, run over several floppy disks. (Floppies are also sometimes known as diskettes.)

You can also get triple and even quadruple drives. I rather like the idea of triples myself, because you can have them permanently labelled 'INPUT', 'OUTPUT' and 'PROGRAM'. This makes life much less confusing for the novice operator. (Floppy disk shuffling is an art which takes a bit of mastering.)

Floppies are essential for word processing or for any information storage and retrieval system.

Printers

A printer is likely to cost as much again as the micro. Therefore it's not something to be purchased lightly. So, do you really need one, and if so, do you really need a high quality one?

Most of us are in the habit of writing things down on pieces of paper if we want to remember them or show them to someone else. This leads us to feel that if we want to be sure about something it has to be on paper and, thus, that we have to be able to get printouts of anything in the computer. A lot of the time this isn't really necessary because we can get the same information displayed on the screen. It may be handy to get them printed as well but may not be cost-effective. In the banking example quoted earlier, the dealers had to copy the results of the calculations on to their traditional 'dealing slips' for the deals to be typed up in the normal way but this is no way detracted from the usefulness of the system.

If you decide that you must have information printed, the next question is what quality printing do you need. If you just want an occasional copy of the stock file to check against what's actually in the store room, then your only requirement is that it be legible. If you're producing lots of printout for internal consumption then the printer must be fast as well and possibly more robust. If, however, you are producing documents to send to customers then a clear bold typeface enhances your company image. You may also want to take carbon or Xerox copies of documents and many matrix printers are unsuitable for this.

If you only want occasional copies, it is much cheaper to get a Polaroid camera and photograph the screen; they even make screen hoods for the purpose.

Hard disks

These are also known as Winchester disks (rather in the way that vacuum cleaners are known as Hoovers). One of these will hold up to 10Mb (10 million bytes) compared with between 70, and 500,000 bytes on a floppy. Obviously you will only go in for one of these if you really do have a lot of data that needs to be accessed quickly. For instance, British Relay's Hotelmaster programs use one to hold all the information on every room in a large hotel, including names and addresses of all the guests who have booked, up to three years in advance. They need to have this information permanently available because, at any moment, someone might ring from the States to book a room for next year and they won't hold on while the receptionist goes to find the right floppy, load it, etc.

Since a hard disk is likely to cost you £5,000, you don't buy one if you do have time to retrieve a carefully-labelled floppy from the rack and load the data along with the program.

Turnkey systems and packages

This is where you buy a micro with the programs already in it and you have only to read the instructions, switch it on and go (well that's the theory, anyway). For some common and well defined applications turnkey systems are available: Hotelmaster, mentioned above, is one such. The machine is then dedicated to running that one program and you never have to bother about how it does so. Your operators never have to learn how to find their way round the operating system (for which they are usually grateful) and you don't have the hassle and uncertainty of trying to get your own system working. However, you could find that it's not easy to get alterations to the program, or to use the machine for another application.

The more common solution is to buy a package to run on a specified make of machine, or on any machine using a specified operating system (usually CP/M). There are all sorts of programs and packages available at all sorts of prices. The very best cost as much as £500 while others go for a fiver. How do you know if someone has written a package which does just the job you want? Well, the chances are that they haven't, although there may well be something which satisfies your basic requirements and which is available now rather than in six months when your programmer's finished debugging your custom-made version. I'll be devoting article six to finding and evaluating packages but the one thing to bear in mind is that it is still rather like buying an off-the-peg suit in the days before Marks & Spencer revolutionised that particular market — all right if you fit the pattern, like the style and know how to detect bad workmanship before you part with your money. But beware, there aren't many people making suits who aren't professional tailors, but there are plenty of hams trying to make a fast buck out of writing and selling programs.

Tailor made programs

This is what we all want, at least in our dreams, but it is a solution that can easily turn out to be a nightmare. There are several pitfalls to be overcome over and above those already mentioned in the series. Not only do you have to analyse the problem and your requirements (which you have to do anyway) but you also have to turn those into a specification that a programmer can understand (and get right) or you have to program the machine yourself. Perhaps the greatest problem is that there's no way of trying out the proposed solution to see what it looks and feels like. For many people, the effort of setting it all up in their minds and imagining it in action is just too much. They would really rather wait until it's in front of them. Unfortunately, by that time they have run up several weeks work, so if they don't like it they've either wasted quite a bit of their own time, or someone else's, and that someone else is going to want paying.

So, don't go for custom-written programs unless:
— you've got the time and enthusiasm to develop them yourself (and the willingness to change them if you don't like something);
— you're prepared to spend time and mental effort going through the designs with your programmer before he starts and in supervising him as he gets on with it; or
— you've got money to burn.

Even if you think your application is sufficiently unusual that it is going to need custom-written programs, it is still worth while having a look at packages in the same general area because they will help you get an idea of what is possible and what features you do and don't like. It will also help you to get a feel for the different machines and to get on terms with your local salesman.

Programs and program suites

Whether you go for a package or have your programs specially written, it's as well to have some idea of the way that the job you want to get done *might* be programmed. I stress the word 'might' because you sometimes find that what seems to you like an unconventional solution actually gives better results. While you don't want to go into things with your eyes shut to other possibilities, neither do you want to have your mind empty of all ideas on the subject. A mental sketch of a possible solution at least gives you a starting point in your conversation with salesman or programmer. You must be firm over the user requirements but flexible over possible computerised solutions.

One question you ought to ask yourself is whether you are looking for a program or a suite. Do you have one clearly-defined job to be done, or are there several different things to do with the same data? My banking friend simply wanted a micro to do some calculations. He could have gone in for a more sophisticated suite of programs that did all the book-keeping on the deals as well, but decided against it. He wasn't having book-keeping problems so he left well enough alone. When I was working in a different City bank we took the opposite view of our particular situation and worked slowly through the whole set-up, computerising each function in turn but they had to take me on to their full time staff in order to see the job through. They were having book-keeping problems and it took something like ten different programs to automate the work sufficiently to alleviate them.

Sometimes it is quite arbitrary whether separate functions are written as separate programs or as different aspects of the same program. Many programs are written on the 'menu' principle — you start the program and are then given the choice between several different possibilities, each of these leading to another set of secondary (or lower level) choices until you get into the actual program routines. Figure 1 gives an example of an imaginary menu for an invoicing program, and Figure 2 gives the menu for the 'Create Invoices' option. There is a great advantage to writing all the parts of a job into one program, apart from the fact that you only have one disk and program name to bother about and that is that the program can check that you have done everything in the right sequence — you don't try to post invoices that you haven't corrected, or close the day's work without having taken security copies of your data, or printed totals for your audit records.

```
        Invoicing program

Current date              15.09.80

              Menu

     Start of day         1
     Invoices             2
     Credit notes         3
     Posting              4
     End of day           5
     Your choice          —
```

Fig 1 Program menu.

```
            Invoices
              Menu

     Start new batch      1
     Continue batch       2
     End batch            3
     Your choice          —
```

Fig 2 Menu for the invoice routine

Data files

One other thing to think about is the way in which your data *might* be arranged into files. Again I stress the word 'might'. The Basic language rather encourages the programmer to store lots of things as DATA statements in programs and many versions of Basic have limited file handling, but if you are going for something written in an extended Basic or in Cobol (or indeed Pascal) you can be very much more demanding about what is stored in your files and how that data is arranged. For example, in Pascal you can (and in Cobol you have to) specify the maximum number of characters in a field. So what happens if you currently have seven-figure account numbers and your Cobol package has only allowed for six?

A more general point is how to divide your data between physical files. For example, a college keeping records on its students has basically two types of data — static information such as name, date of birth, address, course of study, and information which is being updated regularly such as marks for essays and tests, attendance, etc. If there are only a few students there would be room to lump all this into one file, but if there are lots of students on lots of courses then perhaps we would be better subdividing it either into two files — one for name and address, etc, and one for marks — or into one name and address file and several small class files for the marks. Alternatively, we may want it in a data base with a variety of different keys so that we can get at the information in different ways; we might need to know how many students we had over 30, or doing HND Computer Studies, or who hadn't yet handed in their third piece of coursework. Indeed we may want to pick out combinations of things — how many women were studying Mechanical Engineering and getting good results in their exams.

A database like this can be very versatile and useful for data which is not changing too much, but inserting and deleting records and changing key fields all require that the program change not only the file itself but also all the index files that it uses to retrieve the data and this inevitably slows down operation. So "you pays yer money and takes yer choice" — either sophisticated retrieval and slow processing, or fast processing and limited retrieval.

Conclusion

It has not been my intention with this article to encourage you to jump to any conclusions about either the machine or the program that you want. Far from it! But the range of products and possibilities is so vast that you need to narrow it down a bit before you start. You should be armed now with enough ideas to be able to start a sensible conversation with a salesman or programmer, aware that they will not understand your requirements unless you spell them out, and able to start them going through their sales pitch on the right sorts of products.

Next month

It's really rather difficult to separate talk about the machine and the programs because you need both together to make the system. Nevertheless for reasons of space and in the hope of reducing confusion I shall be doing just that — asking readers to bear in mind that article five, "Choosing a machine", is closely related to number six on packages and seven and eight on designing program suites.

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PRINTERFACING

Hard copy is an expensive luxury for most hobby computerists while the price of commercial printers remains so high. But with a little work you can interface a basic printer mechanism to most micros, as Peter Faff — in the first part of a series — explains.

Over the past few years a great many ready-built matrix printers have found their way onto the open market. Many of these units give excellent performance and they generally come with an equally amazing price tag. Now, for an industrial user this is no problem since he can usually call it capital equipment and gain tax advantages from it, but the average computerist in the street is not so fortunate. It is with him in mind that I have written this article.

There are two basic printer technologies, which we will call 'digital' and matrix. The main difference between the two is that 'digital' printers use cast type in the form of wheels, drums, bands, daisywheels or golfballs, while matrix printers build up characters and symbols by using an array of dots. Unfortunately the print quality of a matrix printer leaves a lot to be desired when compared with, say, a daisywheel printer but for the average micro-nut who just wants a simple hard copy device this is no problem; anyway it must be difficult to plot high resolution graphs on a daisywheel printer. In this article I will concentrate on matrix printers since I am limited by space, although if sufficient interest is shown I may write a follow-up article that looks at cheap digital printers of the type that can be found living in any recent printing calculator.

There is a fairly large number of matrix printers available. These can be divided into three basic types on the basis of how the print is formed on the paper: thermal, electrosensitive and impact. The operating principle of each type will be explained later in this article.

First, for those of you that have been living in the wilds for the past decade or so, I will give a basic explanation of how matrix printing works and I will also explain the various methods used to build up a line of printed characters. A matrix printer builds up a character or symbol in a rectangular array of cells by leaving some cells empty while printing a dot in others — this is shown in Figure 1. As can be seen, the various letters are built up of a matrix of 5 x 7 individual dots; by printing or not printing the various dots, a whole range of characters and symbols can easily be built up. The 5 x 7 matrix is about the minimum size that gives a legible character shape and vast improvements can be made by using a larger matrix cell, such as 7 x 12 or 12 x 16. These larger matrix sizes mean that the resultant characters are much more legible; they also make it easier to design characters such as 'p' or 'q' with a descender that falls below the line of print. In this article, I will concentrate on 5 x 7 matrix printers, since these are the types that commonly are available.

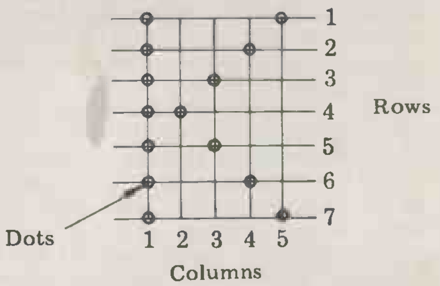

Fig 1

There are several ways that a matrix printer can print dots to form a character and Figure 2 illustrates the four most common methods.

Figure 2 (i) shows a parallel print head. This type of print head generally covers the entire width of the paper and has a separate print element for each individual dot. In use, this type of print head will print an entire line of character dot rows, the paper will then move up and another line of dots will be printed; this continues until the characters are built up. This type of print mechanism is generally very fast — and one unit is theoretically capable of printing at a rate of 40,000 characters per second! Parallel print heads are employed on some types of thermal and electrosensitive printers.

Figure 2 (ii) shows how a character is built up by printing an entire dot column at a time and then moving across to print another column and so on; this is achieved by moving the print head backwards and forwards across the paper. To speed things up, printing is generally carried out on both strokes of the print head. This method is used with all three types of matrix printers and it also crops up when driving dot matrix LED displays.

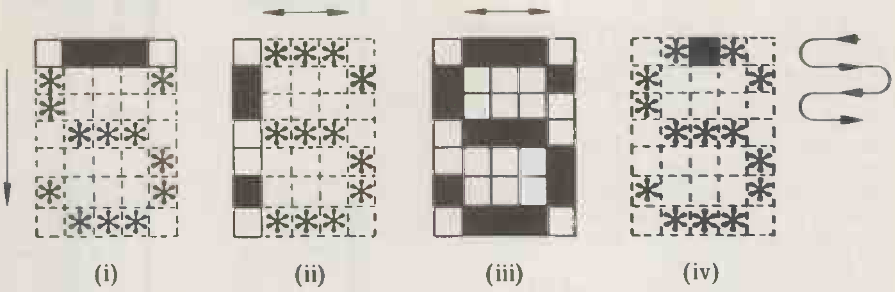

Fig 2

Figure 2 (iii) shows how a line of print is built up one character at a time, before stepping the print head over the paper to form the next character. In the case of a 5 x 7 matrix, the print head will have 35 individual dots but in practice the dots are connected as five rows and seven columns and the character is formed as in Figure 2 (ii). This is done to reduce the number of connections required from 36 to 12 but it does slow things down a little. A variation of this method uses a print head that looks like a standard seven-segment display but the segments emit heat instead of light, thus producing a format similar to a seven-segment LED display. This method of printing is used only with thermal printers.

Finally, Figure 2 (iv) shows how a character is built up one dot at a time. There is usually one dot mechanism per character or group of characters and again the dots are printed bidirectionally in order to speed printing up. This method is a variation of that used by a normal VDU and is used with several types of thermal and impact printers.

To complicate matters even further there are three different ways of making a visible impression on paper: thermal electrosensitive and impact. The first and probably the simplest method is thermal printing. This method uses paper that has a special heat-sensitive coat on one side which changes from white to blue when it is heated — the print heads therefore have to generate heat. To do this, small areas of a hard-wearing resistive compound are bonded to a ceramic substrate; these heating elements are interconnected by thin metal tracks. In some cases diodes are also bonded to the substrate and connected up to cut down problems when the elements are multiplexed. To heat an element it is necessary to pass a short pulse of current through it, thus printing a dot on the paper. The only noise that thermal printers make is generated by the paper feed mechanism and they are therefore suited to work in a quiet environment. The thermal elements are arranged in groups and the most common interconnection patterns are shown in Figure 3. Figure 3 (i) also gives a graphic representation of a thermal print element.

Figure 3 (ii) shows a parallel print head which can print an entire line of dots at one go. Some types have the heating elements arranged in groups of five while others that are intended for graphics use have the elements on a uniform pitch. The ceramic heads can usually be butted together to build up a longer line of print and common sizes have between ten and 20 character groups; as always the elements are multiplexed to cut down the number of connections required.

Figure 3 (iii) shows a serial head that builds up characters by printing an entire column of dots at one go. In use, the head moves across the paper and prints bidirectionally.

Figure 3 (iv) shows a serial print head that builds up a line of characters by printing one character at one go. To cut down the number of connections required, the elements are connected into rows and columns which are strobed during printing to energise the elements; this is faster than moving the print head across the paper to print each column.

Figure 3 (v) shows a serial-parallel print head that has one element per character or group of characters. In use the heads zig-zag down the paper to build up the characters in a similar fashion to a VDU, where, of course, only one dot is used. One readily-available printer of this type uses ten elements to print 20 characters and could possibly be picked up for nothing out of a dead calculator.

In its simplest form a thermal printer consists of a rubber roller that both drives the paper up and also provides a firm surface for the ceramic head to rest on. The paper passes between the roller and the head and is often driven by a stepper motor. A thermal printer with a parallel head is very simple mechanically and could probably be home-made; mechanisms that use serial print heads are much more complex and should be purchased as a ready-built unit. Also, a parallel thermal printer does not generate any timing signals and so the logic required to drive them is generally very simple when compared with a serial type. With a serial printer there is also more to go wrong but, provided that they are not abused, they will give years of trouble-free service.

The second category of matrix printers is the electro-sensitive type. These units are not for the faint-hearted and anyone brought up on good old 5 V TTL should skip the next few paragraphs since electro-sensitive printers require around 60 V to operate — so watch where you put your fingers. On the other hand, electro-sensitive printers are relatively foolproof and, during development, nothing short of a 20 lb hammer will cause much damage to the mechanism. As with thermal printers, electro-sensitive units require special paper which can be expensive. The output from an electro-sensitive printer is black on a silver background. The silver colour is provided by an extremely thin coating of aluminium deposited over a base of black paper and, in order to expose the black, it is necessary to

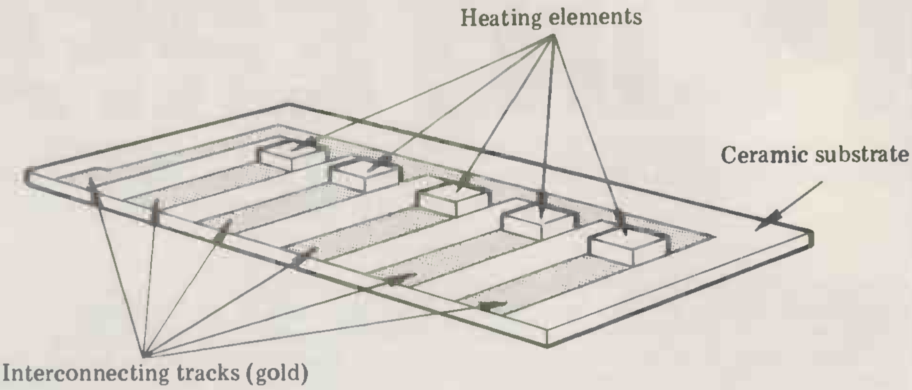

Fig 3 (i)

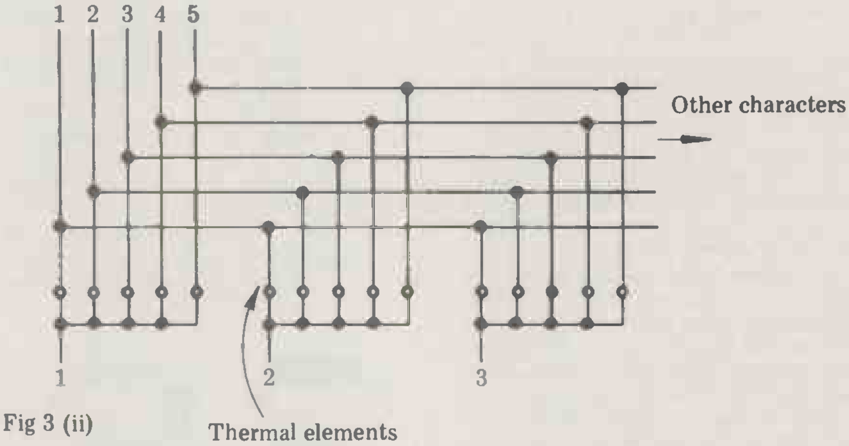

Fig 3 (ii)

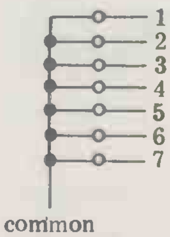

Fig 3 (iii)

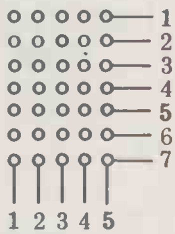

Fig 3 (iv)

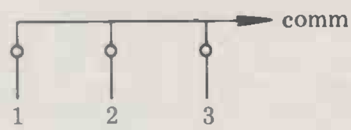

Fig 3 (v)

melt a hole in the aluminium layer. If any of you have ever shorted your favourite screwdriver across a fully charged-up smoothing capacitor you will have a shrewd idea of how this is achieved. By grounding the bulk of the paper roll and putting a high voltage on selected print electrodes a hole is melted in the metal layer, thus exposing the black backing; see Figure 4 (i) and (ii).

As with thermal printers there are several ways in which an electro-sensitive printer can build up characters and the two most common ways are also illustrated in Figure 4.

Figure 4 (iii) shows a serial print head where a vertical array of seven electrodes is moved backwards and forwards across the paper printing characters one column at a time. When a full line is printed the paper spaces up for the next line and the print head reverses direction. This method is reasonably fast but it does call for some exotic mechanics to control the movement of the print head and paper feed; these printers also generate several timing signals which must be taken into account when driving the thing. The timing signals ensure that everything prints in the right place.

Figure 4 (iv) shows a parallel print head which has a line of electrodes stretching across the paper. This head prints one dot line at a time and can easily be used to plot graphs, etc. The mechanism I will describe consists of a fixed electrode head, a motor and a drive roller. No timing signals are generated and the unit is very easy to use, since the group of 100 electrodes is reduced to ten groups of ten by a multiplexed drive circuit incorporated into the printer itself. This unit can also be found in dead calculators.

Finally the third category of matrix printers is the impact type. As the name implies, these use a mechanical impact to print on plain paper using a ribbon; they can also produce copies when used with pressure-sensitive paper. Since impact printers use plain paper they are much cheaper to feed than either of the other types and this may be an important consideration if you intend to do a lot of printing. Apart from the noise, impact printers are very good.

The dots are usually printed by a hardened needle that hits the paper at a rate of knots; the paper is supported by a solid backing roller. There are several ways to accelerate the needles and common methods include a solenoid pulling a plunger, magnetic plungers with spring assistance and a lever rotating cam system; all give similar results and I will look at several exam-

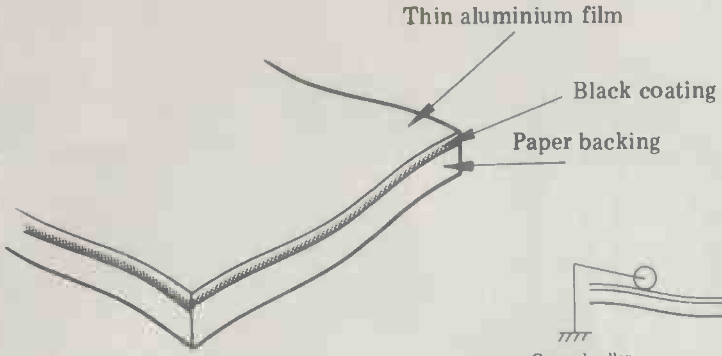

Fig 4 (i)

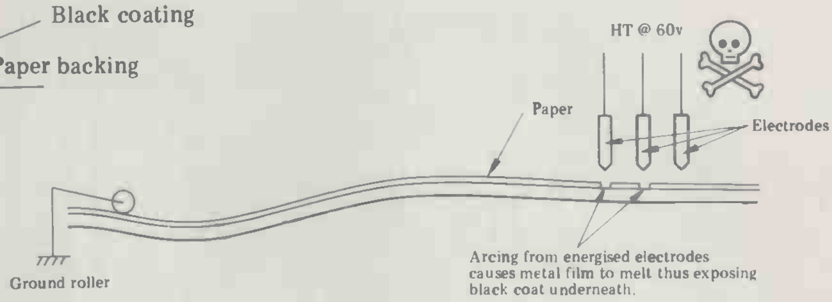

Fig 4 (ii)

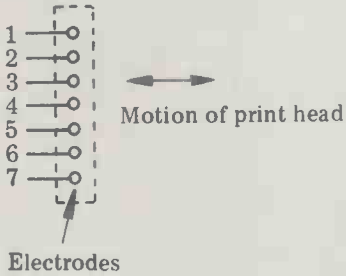

Fig 4 (iii)

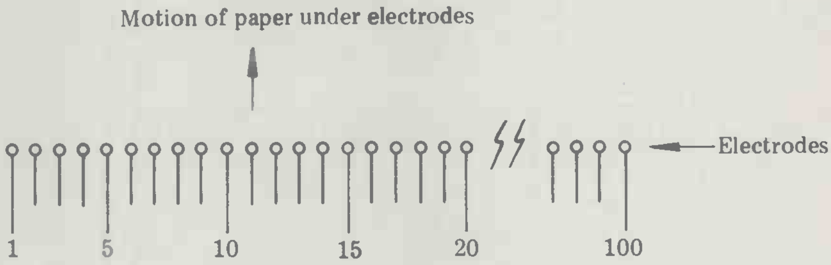

Fig 4 (iv)

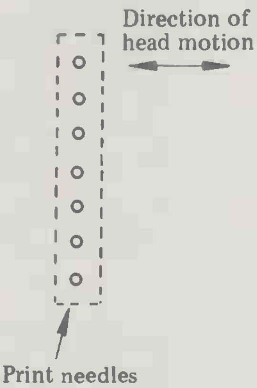

Fig 5 (i)

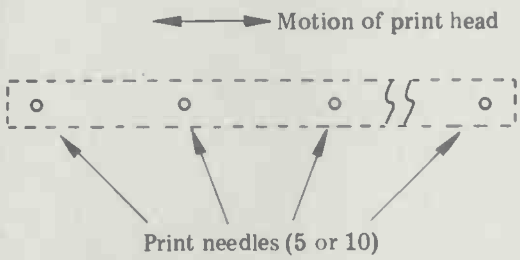

Fig 5 (ii)

ples of impact printers. As with thermal and electro-sensitive printers, there are several configurations of print needles that are used and two of the most common are illustrated in Figure 5.

Figure 5 (i) shows a serial print head that moves across the paper and prints characters one dot column at a time. This is the most common method used by impact printers and I will look at one or two units of this type.

Secondly, in Figure 5 (ii), we have a serial parallel print head which uses one needle to build up a group of several characters one dot at a time; the print head moves backwards and forwards across the paper. I will look at two units that have five and ten print needles respectively. Both types of impact printers generate a variety of timing although this can be reduced to a minimum by letting your micro do all the hard bits.

Now that I have outlined the basic principles of operation of the three types of matrix printers, I will begin to look at several examples of commercial units in greater depth. To aid the DIY person as much as possible, I will give details of the timing signals that the units generate and, with the aid of block diagrams and flowcharts, I will suggest ways that the printer mechanisms can be made to do their thing. The fine details of the interface electronics will be left to the individual constructor, and I will only give suggestions. I hope that what follows will be of use to anybody who requires a printer and has a limited budget. Anybody requiring further information, or even somebody to talk to, can contact me via the Editor.

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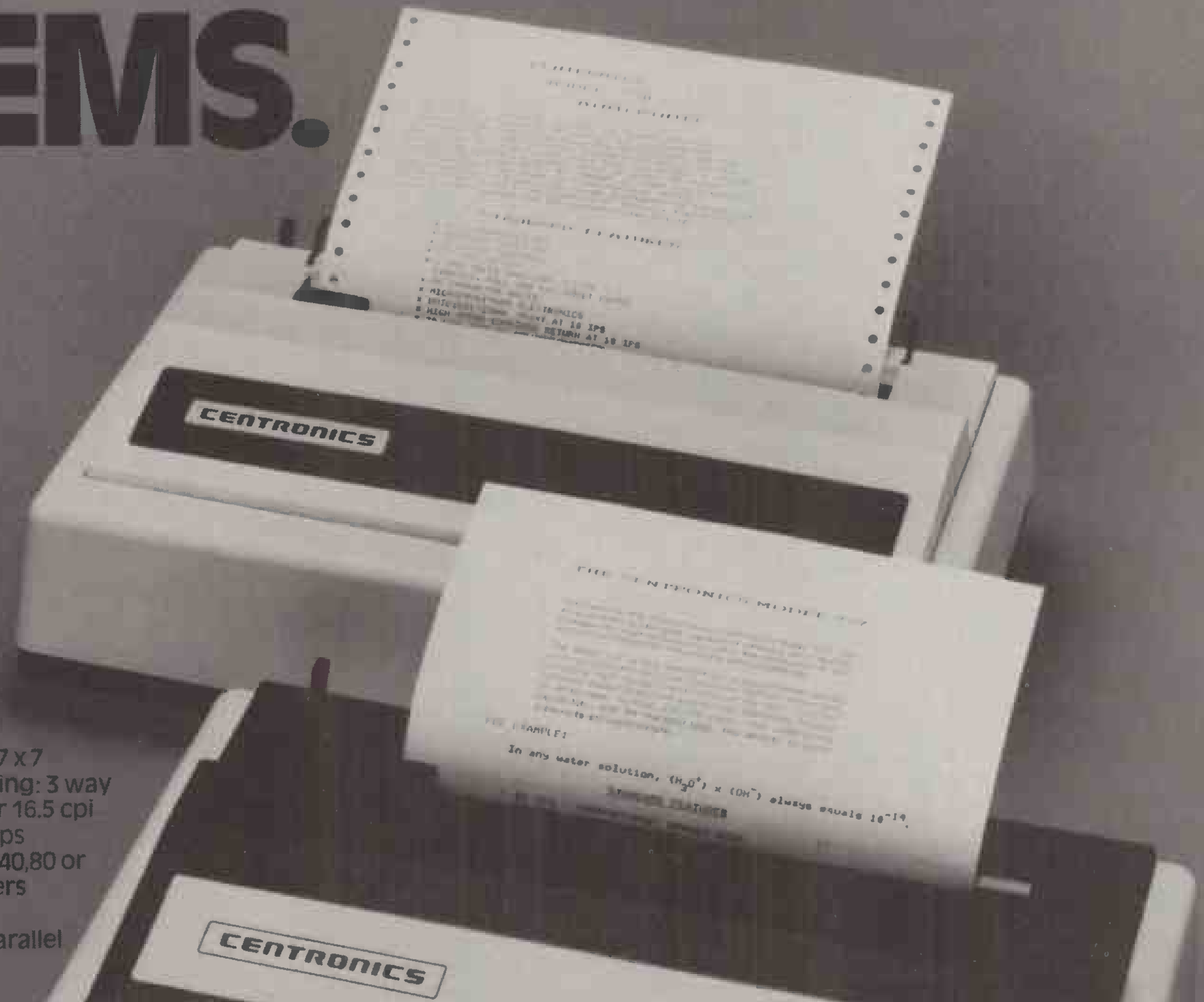

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OPTIMIZING PC1211 EXECUTION TIME

When Dick Pountain tested the Sharp PCI211 last July, his main criticism of the machine was its very slow execution speed. This month Dick hands over to reader Denis Andrews who offers some ways of overcoming this handicap.

The PC1211 stands alone in its professional role, having the flexibility of a computer with the size, immediacy and accuracy of a calculator. However, there will be many others like myself who will wish to explore its full power for satisfaction and amusement.

For programs of more than a few lines, one is likely to encounter unexpected delays much longer than the time required for calculation. The handbooks — which are excellent in most respects — give little guidance about this and are even misleading. This article sets out to provide the missing information.

One program is given to illustrate the points. The chosen problem is fun in its own right — to have the machine play noughts and crosses with variety and skill. This task stretches the machine's logical and memory capacity to the full (and stretched the author too). My first solution took around 70 seconds per move: opponents became impatient! The program below responds in five to 19 seconds, similar to a human player. This has the same logical structure as the first idea, but is now geared to the strengths and weaknesses of the PC1211.

Strenths and weaknesses

These terms are used in respect to timing. The machine is remarkably powerful and easy to program, but execution is slow. The programmer's staple control devices — FOR loop and GOTO — are the slowest to execute. The less familiar logic functions and arithmetic GOSUB provide faster control. The PC1211 allows the construction of logic functions using the logic operators =>, <, >=, <= and <>. Such functions take the value 1 when true and 0 when false. The AND and OR operators don't exist in PC1211 Basic but their function is performed by * and +. So (B>2)*(B<5) takes the value 1 if B lies between 2 and 5, otherwise it's 0. The familiar devices INT, ABS and SGN are extremely fast.

Table 1 shows the execution time for most logical and arithmetic operations. These were calculated using a FOR loop and stopwatch, adding instructions in various combinations. The values are approximate and disguise marginal interdependencies. (Some are given below.) Times are given both in msec and 25 msec units (bracketed). The latter unit aids rapid calculation of execution times, as the most frequently used words or word-pairs then have unit time.

To calculate actual execution times, you need two further facts:
1. Addresses are accessed by upward search through memory, starting either at the current line or at the first line in memory; the address defines which of these searches is made. GOTO is not costly if it names a current or following line, or line 1. The cost accrues if you have to jump back and thereby search through most of the program. Address searches run at about 450 words per second. FOR and GOSUB work differently: they leave an explicit address in an internal stack and no search is required for the return jump.
2. Variables are also accessed serially but in a complex way. On the right of an assignment (fetch) A is fast and Z slow; on the left (store) the reverse is true. Trading A for Z makes a 16 msec difference. For subscripted variables on the right, there are two fetches (symbol and its reference); the time differences add. On the left, there are two fetches and one store; two cancel, leaving just the symbol, so (A) is fast and (Z) is slow. For practical calculation, reckon each symbol reference one unit, and brackets one or ½ each (left and right of '='). The choice of variable name only matters if frequencies of fetch and store are markedly different. The 'flexible' variables take no longer than the fixed ones: A(26) and A(27) take about the same time in any role.

The time required to jump over most code is around 1/8 to 1/4 of the time needed to execute it! This makes the layout of long programs and their subroutines absolutely crucial. All jumps should be forwards or to early addresses. If you need to jump backwards, create a logically unnecessary GOSUB — for the sake of its stacked address (eg L47 in the program).

Stacked functions seem to occupy a fixed time; the fourth level GOSUB takes no longer than the first, and does not slow the earlier orders either. Likewise for FOR loops. Unexpectedly, GOTO D, GOSUB D, A(D) are not observably slower than GOTO 7, GOSUB 7, A(7), etc., when letter and digit correspond. One letter can be faster than two digits. There is no measurable time added in respect of LET, STEP N or addresses, though presumably they must use some.

The programs provided in the applications manual have not been optimised in either space or time. Most of them have long jumps and make no use of the economical logic functions, the equivalence C=A(3), or the implied '*' (which often saves a pair of brackets as well).

In particular, subroutines are commonly placed at the end, so that the whole program must be jumped to access them. The only references to layout (note 7 on the introductory page) gives the wrong reason for putting subroutines at the start! It would of course be easy to rewrite the programs optimally if one used them often.

Useful devices

1. If a result is needed in two forms, store it twice. Transformations of arrays are slow. (In the program A—I, J—R and T (by itself) represent the entire game. Two of these are redundant images, but transformation would be expensive in time and space.)
2. Data can be packed (L.7, L.70) or unpacked (L.3) in one variable. Decoding is slow, but the device allows much data to be preset. (L.71 is equivalent to 19 assignments +five IF statements.)
3. Multiply rather than divide (L.3, L.59), saving 50 msec.
4. Use IF X. . rather than IF X>5. . , saving 30 msec or more.
5. Make use of the logic functions rather than IF when you can. This generally saves one address and one assignment. (L70 and 71 would be twice the size and run at half speed using IF state-

6 (1/4)	12 (1/2)	25 (1)	36 (1.5)	60 (2.5)	75 (3)	250 (10)
SGN	+!	*	IF	GOSUB N	/	FOR—NEXT
ABS	—	implied*	GOTO N	GOSUB 1		(each
INT	E	(	GOTO 1	(all 4		cycle)
$	"	=	RETURN	levels)		
string	1st digit	)	THEN		FUNCTIONS:	
char.	on LEFT of ASSIGNMENT			√ (11)	DMS (4)	SIN (24)
	Z	N	A	X (25)	DEG (5)	ASN (20)
		)		LOG (20)		COS (24)
	(	(		EXP (11)		ACS (23)
	)			LN (25)		TAN (10)
	A	N	Z			ATN (10)
	on RIGHT of ASSIGNMENT					

Table 1 *Approximate execution times, msec (bracketed, 25 msec units).*

ments.)

6. Space saving also saves time; there being less code to jump over.
7. Place subroutines so that they are passed over as seldom as possible.
8. Loop structure is slow however accomplished. Write the inner loop(s) in full if you have space (ends of L.9—17).
9. A fixed string of GOSUBs is appreciably faster than a FOR. . . NEXT loop (and may use less space, too, up to three cycles).
10. Use flexible variables for the ones that must be subscripted anyway. Avoid them if you can.
11. A computation conceived as several successive loops can sometimes be restructured as a single loop with branches (L.9—17 with L.1).
12. Save the early addresses for the most-used subroutines and those which are called from diverse places.

Noughts and crosses

Space is too precious for REM statements in the PC1211! The following remarks stand in lieu and indicate very briefly how the program works.

L.34 — 47 Set arrays to +1 (no move), mirrored "." for display. Decide who starts. Register first move.

L.4 — 7 Make random choice in range 1—Y. Select 1 of Y digits A(27)+. Record move: machine coded —4, "0"; player —1, "X". S = move no.

L.50 — 63 Display position and machine's response. Read player's move. Transpose first move? Traps are coded only for one of eight symmetries.

L.64—71,L.81,L.84—88 Test for precoded traps at machine's second response, (too far from victory or defeat for serial calculation). All wins, losses, alternatives are coded, equivalents played equally often.

L.78 Test for immediate win; enter if any.

L.79 Test for direct threat by player; counter if any.

L.82 Test for empty squares, threats, double threats; select randomly within the highest level registered.

L.9 — 18 Test each remaining move in the rows which contain it; X is criterion: —8(two "0")for win, —2(two "X") to counter, —3("0"+".")for threat.

L.1 The inner routine — only successful tests enter. Hits listed at A(27)+. If higher-level hit found, restart list and reset level.

This program is capable of further speed optimising, eg by swapping variables. A quite different approach might be better of course. The hybrid of preset and search seems necessary: a fully intelligent program could easily be written but would run extremely slowly. It also seems necessary to avoid duplicating symmetries. One refinement perhaps worth pursuing is to transpose the display instead of the move. My attempts to do this ran out of space, but only just. The listing here includes some 50 redundant words, expended to buy a little speed when the more elegant solution seemed out of reach. A further 70 words would secure the improvement. Any ideas?

```
 1:Z=Z+1:A(Z)=Y:IF U>WLET Z=26:W=U:GOTO 1
 2:RETURN
 4:V=V+9π-50*(V>200):Z=V-INT (V/Y)*Y+1:RETURN
 5:Y=1+INT LOG W:GOSUB 4:W=W*10∧-INT Z:Y=INT ((W-INT W)*10)
 6:A$(Y)="O":X=-4
 7:T=10T+Y:A(Y+9)=X:S=S+1:RETURN
 9:Z=26:IF JLET U=(X=K+L)+(X=M+P)+(X=N+R):IF U>=WLET Y=1:GOSUB 1
10:IF LLET U=(X=J+K)+(X=O+R)+(X=N+P):IF U>=WLET Y=3:GOSUB 1
11:IF NLET U=(X=J+R)+(X=K+Q)+(X=L+P)+(X=M+O):IF U>=WLET Y=5:GOSUB 1
12:IF PLET U=(X=J+M)+(X=N+L)+(X=Q+R):IF U>=WLET Y=7:GOSUB 1
13:IF RLET U=(X=P+Q)+(X=L+O)+(X=N+J):IF U>=WLET Y=9:GOSUB 1
14:IF KLET U=(X=J+L)+(X=N+Q):IF U>=WLET Y=2:GOSUB 1
15:IF MLET U=(X=J+P)+(X=N+O):IF U>=WLET Y=4:GOSUB 1
16:IF OLET U=(X=M+N)+(X=L+R):IF U>=WLET Y=6:GOSUB 1
17:IF QLET U=(X=K+N)+(X=P+R):IF U>=WLET Y=8:GOSUB 1
18:RETURN
34:"G":S=1:T=0:A$(31)="  I GO:"
35:FOR Z=1 TO9:A(Z+9)=1:A$(Z)=".":NEXT Z:INPUT "TOSS (0=YOU START):"
   ;X:IF XLET W=125:GOSUB 5:GOTO 47
44:GOSUB 56:A$(Y)="X":X=-1:GOSUB 7:W=5*(1=T)+158*(2=T)+1379*(5=T)
   :GOSUB 5
47:GOSUB 50:GOTO 47
50:PRINT A$;B$;C$;"/";D$;E$;F$;"/";G$;H$;I$;A$(31);Y:IF -SEND
52:IF S>8 BEEP 3:PRINT "DRAW!":END
54:GOSUB 56:A$(Y)="X":X=-1:GOSUB 7:GOTO 64
56:INPUT "YOUR X:";Y:IF -A(Y+9)PAUSE "FULL":GOTO 56
57:IF T>9RETURN
58:IF (Y=5)+(Y<3)RETURN
59:IF T=5LET Y=Y-2*INT (.5Y-.5):GOTO 63
60:Z=Y/(5-T):IF Z=INT ZLET Y=Y-2:GOTO 63
61:IF T+Y<>8RETURN
62:Y=3
63:BEEP 1:PAUSE "TRANSPOSED..";Y:RETURN
64:IF S=3GOSUB 73-.1T:IF WGOSUB 5:RETURN
65:GOTO 78
67:W=9745-7Y:RETURN
70:W=15*(4=Y)+(7=Y)+4679*(1=Y)+79*(8=Y)+367*(5=Y):RETURN
71:W=37*(9=Y)+457*(2=Y)+479*(3=Y)+357*(6=Y)+349*(5=Y):RETURN
78:IF S>4LET X=-8:W=1:GOSUB 9:IF Z>26GOSUB 6:S=0:A$(31)=" I WIN:"
   :RETURN
79:X=-2:W=1:GOSUB 9:IF Z>26GOSUB 6:RETURN
81:IF S=4GOSUB 90-.01T:IF WGOSUB 5:RETURN
82:X=-3:W=-1:GOSUB 9:Y=Z-26:GOSUB 4:Y=A(Z+26):GOSUB 6:RETURN
84:W=37*(J+R=-5)+19*(L+P=-5):RETURN
87:W=13*((289=T)+(287=T))+1346*((256<T)*(260>T))+47*(213=T):RETURN
88:W=476*(158=T)+238*(156=T)+2468*(159=T):RETURN
90:INPUT V:END:REM -- DELETE LINE AFTER SETTING RANDOM SEED --
```

Casio Multiple Regression

If you use a Casio fx502p for statistical work and you're not too happy with the Casio stats pack's regression program, then you might be interested in what's claimed to be a better version now on the market. It's produced by Colin Buchanan and Partners and the following is an extract from a letter they recently sent me:

"The Casio program library contains a rather weak simple regression program (for fitting a line between observations of X and Y). Much more interesting and useful is Multiple Regression for estimating relationships between X and more than one other variable. It is a difficult job to do this with only 256 program steps and 22 memories. The program we have written not only does this (for two independent variables), but does so rather elegantly from the user's point of view, with standard errors, t ratios, R^2 and $\sqrt{yz}$ all computed. Moreover, transformations and weighting of the observations can be very simply achieved. In short, we believe the program is ingenious, useful and likely to interest some of your readers, especially college students learning statistics and practitioners in such disciplines as economics, biology, geography, etc, where regression analysis is in common use."

From the documentation which came with the letter (they didn't send a full listing) and program looks quite good. For further details contact Colin Buchanan and Partners at 47 Princes Gate, London SW7 2QE, Tel: 01-589 8841.

Dick Pountain

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GATEWAYS TO LOGIC

Chapter 5 part 2: Electronic logic

Derrick Daines continues his series on teaching microcomputing to others

Gates and logic

Having given our students a taste of the practicalities, we can now demonstrate their use in principle. It's wisest to start off by presenting this work in the form of a few simple problems. Example 1. If a boy steals money or smacks a girl and makes her cry, then he will be punished (Figure 20). Having demonstrated this on the blackboard, the children can try their hand at the next.

Example 2. Mum will fetch the baby in from the garden if it starts to rain, if the baby cries, or if mum has to go to the shops. In any case, she will fetch him in if it's 12 o'clock and she has his dinner ready (Figures 21 and 22).

Example 3. A Ruritanian passport will be granted to those people who have at least one Ruritanian parent, or whose father's parents were Ruritanian. In no case will a passport be granted to those who have lived for any length of time in Agrophobia, Ruritania's deadliest enemy (Figure 23).

Many other problems of this type will be found in abundance on any government form or any insurance policy! At the teacher's discretion such problems may be presented solely as above — or else students may also be provided with the gate outline drawing and be required to fill in the details. The more advanced may be given problems couched in Boolean — for instance to decide on the gate configuration that will produce a certain Boolean output. Alternatively, they can simply work through a given gate configuration (Figure 24).

Bistables and clocks

I have repeatedly said that a computer is nothing but a bunch of gates but now I must qualify this as being only 95 per cent true. Chief amongst the remaining five per cent are register memories and clocks.

The very earliest computers used a type of memory called a bistable (Figure 25). Now, although modern computers use a wholly different technique (and even better ones are still being researched), the bistable offers an extremely good way of demonstrating computer memory — in particular, the type of short-term memory that's still in use inside the microprocessor. What's more, it's extremely easy to assemble.

When the circuit of Figure 25 is wired up and power is applied, one LED will light up while the other remains unlit. Label one of them as output — it doesn't matter which. If you like, the other can be masked with a bit of paper. Now, taking the wander lead shown, touch in turn the bases of the two transistors; the condition of the two lamps changes — that is, the one that was off will come on, and vice versa. What's more, the two lamps will remain as they are, however long we leave them. The circuit is therefore totally stable in either condition — hence its name, bistable.

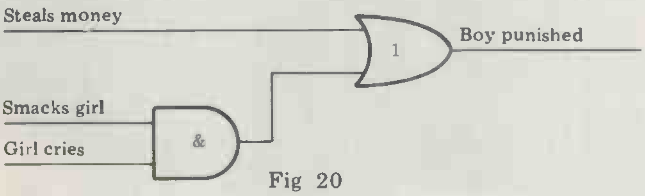

Fig 20

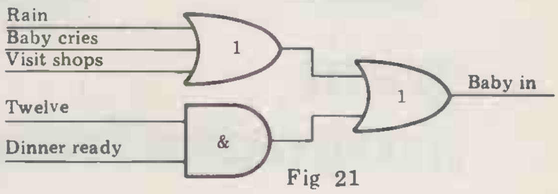

Fig 21

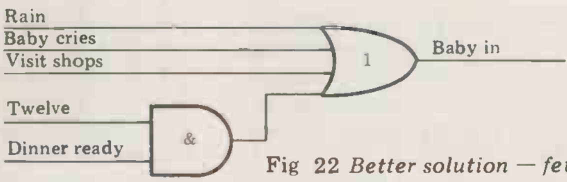

Fig 22 *Better solution — fewer gates*

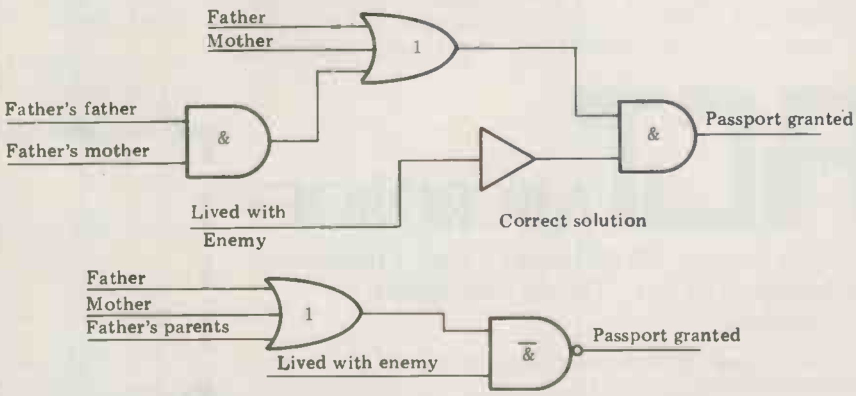

Fig 23 *Can you spot two errors in the logic of this solution? The answer is given at the end of this month's chapter.*

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And here we have a unit of memory. If the output lamp is lit, we can say that it represents a binary '1', while if it is unlit, then of course it represents a binary '0'. This is a very important concept for students to grasp. Computer memory is a term that will not, of itself, convey very much to them, and the uninitiated have some very weird and wonderful ideas about how computers remember anything. Try asking them! They'll doubtless be astonished to learn that computer memory is simply the difference between high and low-voltage states.

In the average home computer, eight such bistables are (or were) needed for each and every computer word — either in the processing unit or in memory; students should begin to appreciate why the bulk of the early computers loomed so large, why they produced so much heat (two valves instead of transistors per binary bit) and why they spent so much time under repair.

It's very important to demonstrate at least one transistorised bistable. Figure 26 is very easily adapted from Figure 25; it simply arranges for the output of the first transistor to change the state of the second, which changes the state of the first, which changes the state. . . The values of the capacitors as well as some of the resistors can be changed within quite wide limits, to affect the rate of oscillation. At the slowest rate, oscillation cycles may take minutes, while at the faster rates the lamps barely seem to flicker.

Technically, the circuit is termed an astable, meaning simply 'not stable', but in computer circles it's universally known as a clock. The clock (or clocks — there can be several) is vital to the computer for it triggers events round the circuitry. For accuracy it often includes a crystal but in our case this is not necessary as the demonstration model which works very much slower. Sometimes it's convenient to use both halves of the clock for triggering different events — it all depends upon the design or architecture of the computer.

I find children, in particular are fascinated by the clock circuit (and there's no reason why it should not be run for hours at a time — battery drain is very light). And not only is it a great attention grabber — there are hundreds of applications where such a handy little circuit will come in useful.

Computer control

We now have all the building bricks of the computer and can therefore begin to put them together to evolve the finished product. No new devices are to be considered in this section; just new or improved ways of utilising those the students have already been shown. There's at least one kit on the market that's designed to teach how a computer is constructed and controlled and no doubt others are on the way; indeed, readers may like to assess their value after reading this section. For some it could be that what is written here will be considered sufficient; other readers (perhaps those with a slightly more specialised interest) will consider the learning experiences offered by such a kit to be well worth the rather heavy outlay.

Figure 27 is part of a hypothetical computer and it adequately illustrates how the earliest of them were controlled. Personally, I've always found a blackboard illustration sufficient — see also Figure 28. Figure 27 shows the basic principle in detail. The data lines run all over the computer, carrying information here, there and everywhere; they may be likened to railway tracks, the gates representing the track points. Inevitably, numerous loops are formed and the clock is necessary so as to keep all the operations in step with one another — rather like a number of trains running on the same railway line loop but without collisions.

Examination of Figure 27 will show that data cannot flow anywhere unless the manual switches are closed — because the AND gates require that all inputs should be high. If switch 1 is closed and data is present, then each time the clock pulses high, one bit of information is passed through the first gate. This is fairly straightforward and nearly all students grasp the idea very quickly, provided the previous work has been carefully covered.

The analogy of the model railway is very apt, for the very earliest computers were entirely controlled by manual switches — indeed the writer built one himself. Of necessity the control panel looked much like the plan of a marshalling yard — something along the lines of Figure 28. A and B are the two temporary registers that we've already met in connection with the cardboard computer, while C to F are long-term memories; each have eight little boxes, each of these representing a bistable memory element of the type just discussed and

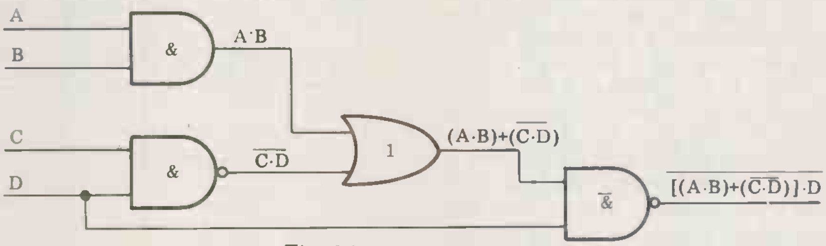


Fig 24

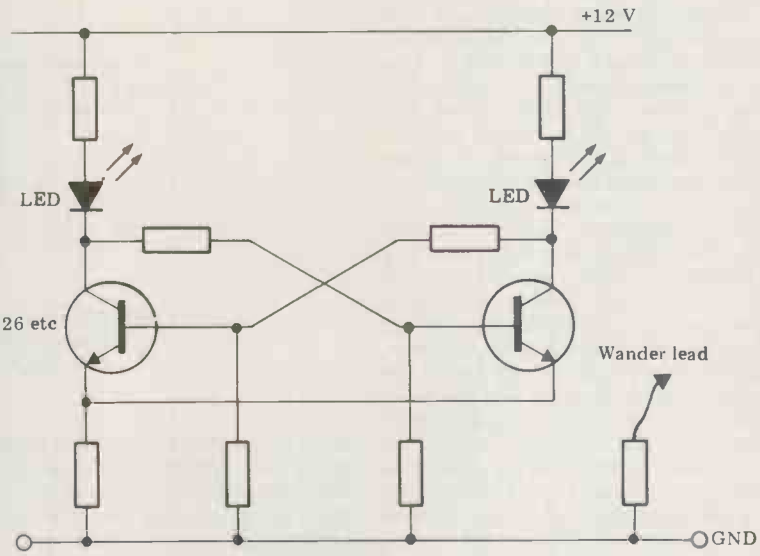


Fig 25 Bistable

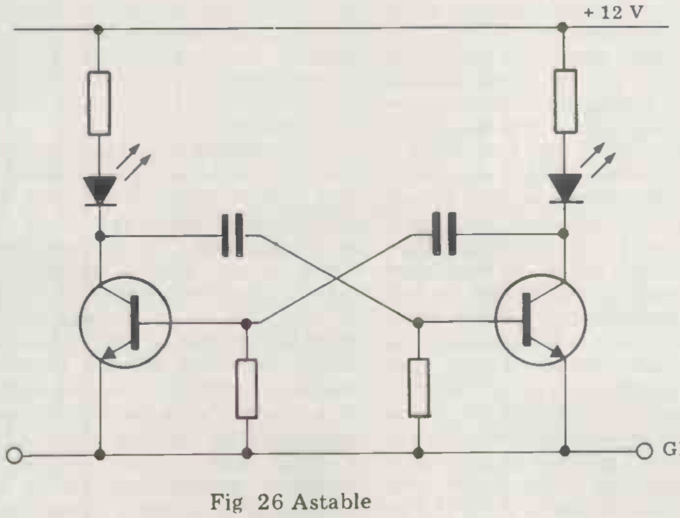


Fig 26 Astable

arranged in a linear fashion as shown. The interconnecting lines are data lines only, the clock and control lines having been omitted for the sake of clarity. AND gates are placed at every junction and each one is fed with synchronous clock pulses. They are numbered 1 — 12 and it's assumed that each one has a manually-operated switch for control, as in the previous diagram.

When explaining the diagram, we must also be careful to stress something that is not there — rather like the hole in the mint. The important thing to notice is that there are no memory elements other than those shown; no little resting-places for data exist along the main lines. . . they are for transfer only.

If we wish to store the contents of Register A in memory store C, then we must switch on gates 3 and 5 and ensure that all other gates are switched off. A train of pulses is applied from the clock and the data is transferred. Similarly, if we now wish to transfer data from store F to register B, we must switch off gates 3 and 5 before opening gates 12 and 2. In practice, operation of those earlier computers was a trifle more complicated than that and, for obvious reasons, laying out the control panel as shown in the Figure was the only way to minimise human error.

Students will have fun with the diagram if they are given starting and finishing conditions — eg, put the contents of A into C; C into B and B into A. This sort of problem allows us to made a few teaching points — especially if we stay with the analogy of the model railway.

Firstly, there is the question of one computer word (or train in our analogy) running into the back of another. Suppose for example we were to transfer a word into Register B where there is a word already — what happens to it? If it were a train, the result would be a mangled mess. . . a combination of the old and the new; in electronics however, the first is simply lost or erased as in the cardboard model. (I don't like the word 'overlaid' because in some minds that's analogous to the mangled mess.) The next question is, suppose we open gate 3 but forget to open any of the gates 5 — 8, what happens to the data shunted out of Register A? This is the reason we should have stressed the absence of any memory resting places other than those shown. In such circumstances, the data is again simply lost.

If they have not asked already, some students will now enquire how the computer knows that the whole word has been shifted. To put the point another way, when the leading bit of the word — or engine of the train — reaches point 'x' marked in Figure 28, why does it not continue blithely on and, as it were, 'crash' into the buffers or the closed gate 3? Well, it would but for a little device known as a counter. This gadget counts the clock pulses — analogous to counting wagons on a train — and when it has counted 8, it simply shuts off the clock. It's not necessary to model this very simple action and students generally accept it readily.

Combinations of gates under automatic and/or manual control can be strung together so as to provide parallel shift (as it is termed); that is, of course, very much faster than the serial shift of Figure 28, but there is no need to stress the point for general students. Figure 29 illustrates the idea. Another combination of gates provides the adding or arithmetic circuit, while yet another gives comparison between two computer words. While they are, of course, enormously important to computer control study, generally speaking they are not necessary for the average student who is merely seeking background information. Such circuits are of necessity rather complex and therefore intimidating. Interested readers are referred to the literature.

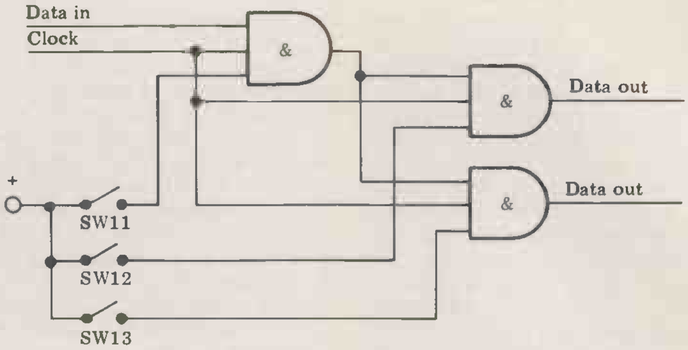


Fig 27

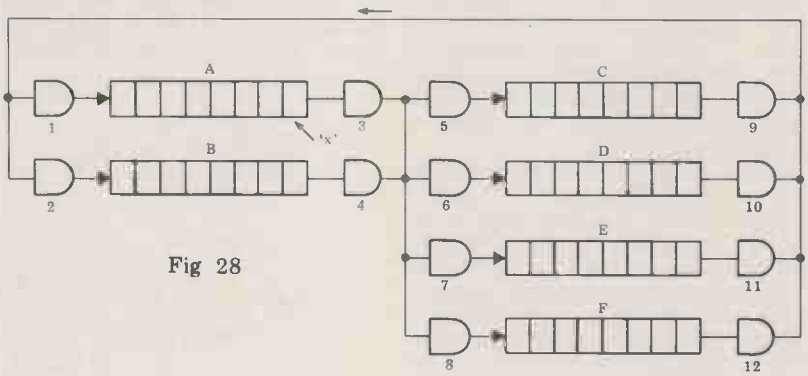


Fig 28

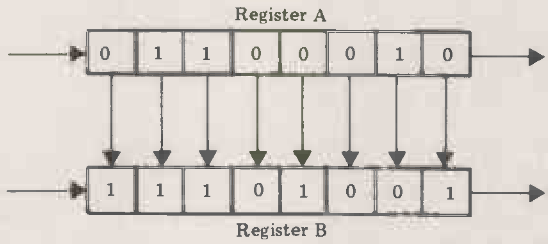


Fig 29 *Simplified parallel-shift (compare with Figure 28). One clock pulse will transfer entire register A, deleting contents of Register B.*

A computer controlled by manually-operated switches in the manner described suffers from two major defects: (1) it's very slow and (2) it has no stored program. The slowness is due entirely to the human operator. It can take a considerable time to set a series of switches — a process that's also extremely prone to error. Once the GO button has been pressed, however, the machine is able to clock off eight pulses in a fraction of a second, so operation comprises an endless series of switch pushing, with constant reference to a series of written instructions. It's the absence of a stored program, however, that classifies the machine as a crude calculator and not a crude computer.

Stored programs

The concept of the stored program goes back a very long way and one of the earliest contenders for the honour of original inventor is one Joseph Jacquard (1752-1834) — an entrepreneur and inventor of a weaving loom automation system. Readers with sufficient skill and patience can make a working model of Jacquard's sytem from Meccano. Leaflets are obtainable from M & W Models, Reading, which give full details of a machine that will weave cloth about 3 in wide, automatically reproducing a pattern over and over. Readers are warned however that this particular model is expensive and not easy to make. Simpler versions to illustrate the method only could be devised that would present a lot less trouble.

Jacquard's system used a series of punched cards that regulated a series of sensing rods. One card was in position at a time and as the rods descended, those opposite a hole were free to move through, while the others were stopped by the card. The difference was sensed and magnified by mechanical linkages,

BINARY				OUT
8	4	2	1	
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9

Fig 30

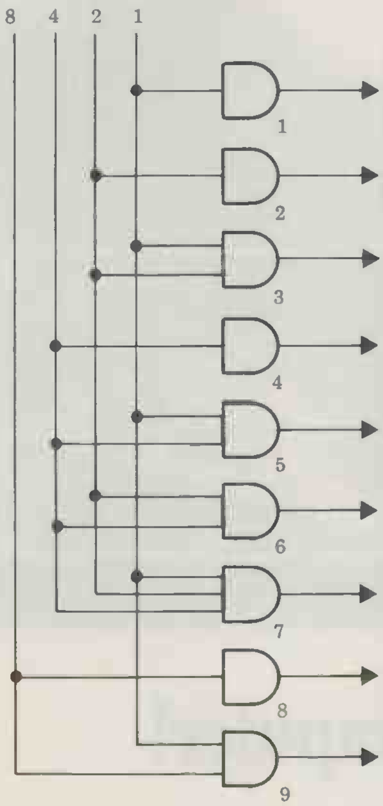


Fig 31

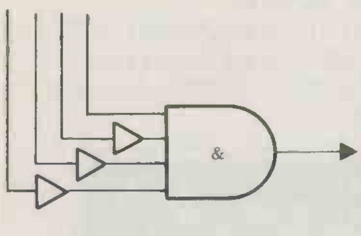


Fig 32

thus affecting the rise or fall of individual threads in the loom. A set number of warps was fed through the shuttle shed in this position before the sensing rods rose, the next card was fed into position, and the whole process was repeated. The cards were bound together in a large loop and thus the program was unending. Obviously, by inserting a different set of cards the machine would weave a different pattern. It was an interesting idea — especially at that time — and the great English mathematician Babbage was working on an adaptation of it to control his 'analytical engine' at the time of his death in 1871.

The method is capable of wide variation and application. One is reminded of the frequently advertised charts that purport to teach the novice how to play the piano in an evening. Such charts are placed over the keyboard and various ingenious colour, numbering and lettering systems harmoniously link keys together. It was something like that which was required to turn the switch-operated calculator into a self-organising computer. What was wanted was some gadget to handle all the switching. The transistor makes a very fast switch and all that was needed was something — anything — to which we could say in effect, "Fred — take whatever you've got in Register A and shove it in memory C." The 'what's-it' would then switch the appropriate gates, the counter would count eight pulses, shifting the data, and the end of the count would signal back to the what's-it that the operation was complete. The what's-it would then fetch the next it that the operation was complete. The what's—it would then fetch the next instruction and the cycle would be repeated, as with the programming already met in connection with the cardboard computer.

An intermediate stage came first, however.

Multiplexing

This is a big word that simply means controlling a lot of lines with a few. Let's imagine that we have 16 gates to control by hand. One way would be to have 16 switches — one for each gate — laid out schematically on a plan. The way forward, however, is to adopt a binary scheme.

Remember the grocer and his weights? When he wished to weigh 5 ounces, he used the 4 ounce weight and the 1 ounce weight, and you will remember that with just four binary bits we may therefore represent 16 numbers. So with switches. With just four switches — and thinking of their output as binary bits — we can control 16 gates. As with the grocer, when we wish to open gate 5, we flip switches 1 and 4.

The method is shown in Figure 31. If you follow the diagram carefully, you'll see that the switch marked 1 opens every other gate; the switch marked 8 opens the last two (only nine have been shown for clarity), and so on. Compare Figures 30 and 31.

Of course, it's not as simple as that! Suppose for example that, wishing to open gate 7, we flipped switches 1, 2 and 4. Doing that we'd find that in addition to gate 7, we'd also opened gates 1, 2, 3, 4, 5 and 6 — not a desirable state of affairs at all. But think back to a similar problem associated with sorting numbered cards in the binary selection box; the two problems are in fact different representations of the same thing. And the solution is the same — the realisation that (eg) decimal 3 is NOT 8 AND NOT 4 as well as 2 AND 1.

What's required therefore is an additional NOT output from each switch, to be taken to every gate not to be opened until the switch requires it — in other words, deliberately and permanently holding the output low until we equally deliberately switch it high.

The method is shown in Figure 32 and, clearly, all the extra lines could not have been drawn into Figure 31 without producing a very daunting diagram.

The next step came when it was realised that numbering individual gates was only a means to an end. What was *really* required was the switching of *sets* of gates, because it's these that perform different functions. The reader will see that an adaptation of Figures 31 and 32 will do this set-switching, while a glance back at Figure 28 will help him her to realise the need.

We are now very close to the modern computer. The final step is for the *computer itself* to do the necessary switch selection — some means whereby it will in effect control itself. Consider — we have gates to take care of the manipulation of data and these are controlled by switches. The data *and* the control switching are binary, so can we somehow bring the two together.

In the event, it proves remarkably easy. First, we provide a special memory location called a Control Register (it's a memory, like any other). The outputs from this memory are paralleled as in Figure 29 and they are coded so as to operate the desired gates in the multiplex mode just described.

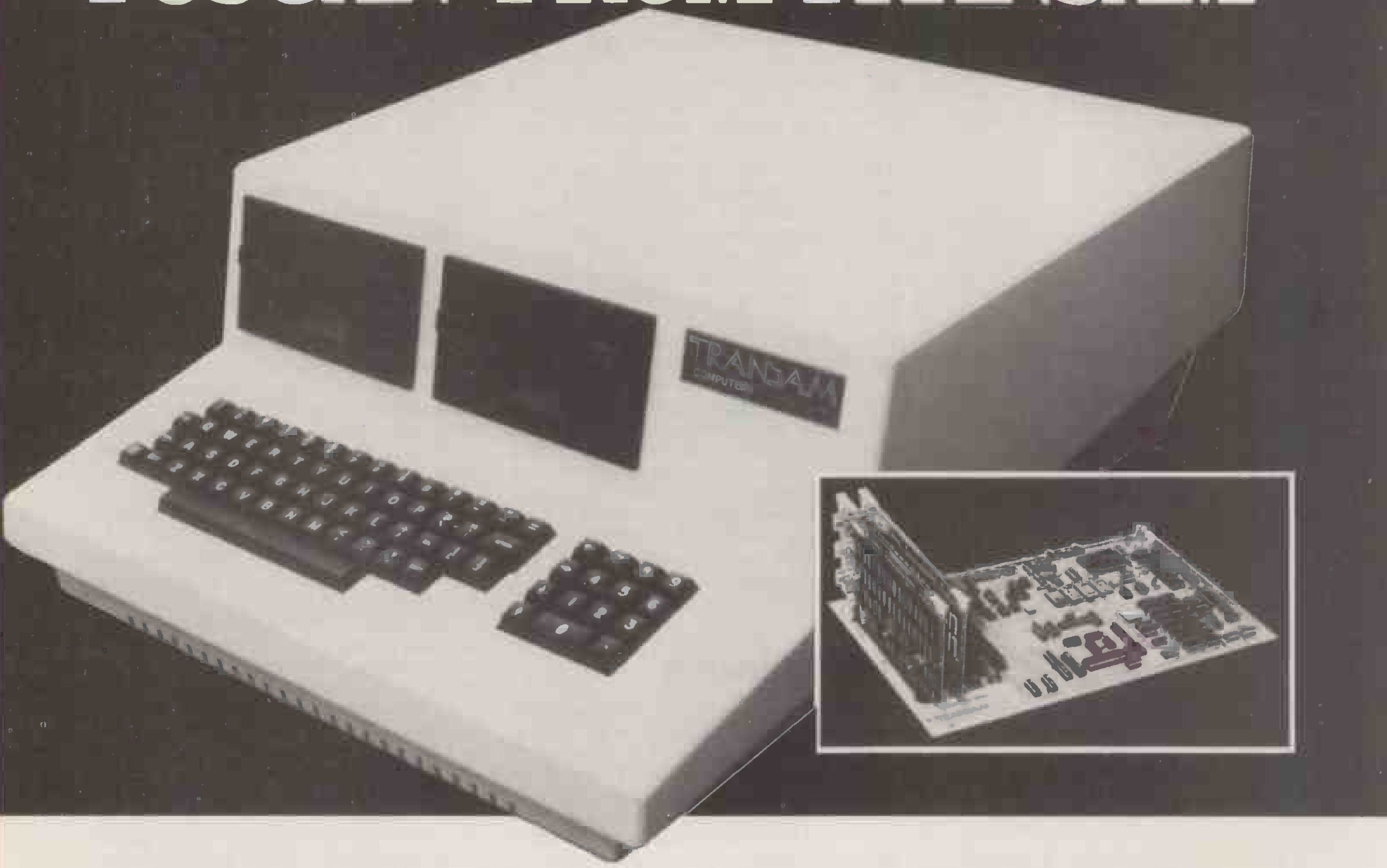
We also provide another special memory called a Program Counter, which keeps track of where the next instruction is coming from. The program Counter points to (say) memory location A07F and the computer fetches the contents of A07F and stores it in the Control Register. The counter is then incremented by 1. As a result of the contents now in the Control Register, gates are opened and the computer does something. When the clock has counted off eight bits, a signal is flashed and the cycle is repeated. The counter now is pointing at A080; the contents are fetched, put into the Control Register and the next operation performed. It really is that breathtakingly simple in concept. *Now* our students should be able to see why we brought in a study of Jacquard's loom, and all the other things!

Consider speed for one moment. The delays introduced by a human operator are totally eliminated; there are no errors of switching and no waiting. We can progressively increase clock speed until the transistors of the multifarious gates are switching as fast as they can go (typically a million times a second) and the whole series of operations can proceed at breakneck speed. Nevertheless, it must be stressed over and over again to our students that, despite the speed, every single thing about it is still proceeding logically and sequentially.

I often regret dismantling my early computers. One in particular was based on a design published by *Wireless World* in 1965 (how far we have come in so few years!) and it had the enormously useful facility of one being able to slow down the clock at will — in order to watch the transfer of binary digits as represented by little lamps. A modern version of this design would have much to commend it as a teaching aid.

The two errors in the second solution of Figure 23 are as follows: (a) no differentiation between father's mother and father's father, and (b) the first OR should be a NOR.

'TUSCAN' FROM TRANSAM



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MORE CHAMPIONSHIPS!

Kevin O'Connell examines the results of two recent major chess tournaments.

US championships

No sooner had the dust settled on the World Microcomputer Chess Championship at the *PCW* show than the results of the first US Microcomputer Chess Championship, played that same weekend, came through.

The North American tournament was played in San Jose, California, and cosponsored by *Personal Computing*, the Mychess team, Applied Concepts and Motorola. Three of the competitors were also present in London at the same time — one of the advantages a micro has over a human.

The results achieved by Boris 2.5 and Chess Champion Super System III were particularly impressive — they have been commercially available for more than a year now. Of course, this is not to detract from the success of the Spracklens' new program in the Challenger hardware, but it will be interesting to see the new programs expected from Applied Concepts and SciSys.

World computer chess championship

After their own two special tournaments, the big guns of the micro world were trained on Linz in Austria, site of the third World Computer Chess Championship (25-29 September). Four 'micros' were among the 18 contestants. Advance 1.0 (UK) and Bebe (USA) were under microprocessor control but also availed themselves of some special chess hardware which, in each case, owed much to bit-slice technology. There were also two pure micros: Mychess (USA), running on a Cromemco, and the ubiquitous Champion Sensory Challenger (USA), victor of both the US and the World Microcomputer Championships.

Advance 1.0, programmed by Mike Johnson and Dave Wilson, played in the World Micro Championship under the guise of Mike 3.0. In Linz only the name (and program!) had been changed. By defeating Sweden's Dark Horse, running on a Univac 1100/81 and programmed by Ulf Rathsman — whose Princhess had competed in the World Micro where it had lost to Mike 3.0 — this was the only microcomputer to win a game. We reproduce that game here:

WHITE: Advance 1.0
BLACK: Dark Horse 1.0

1 e2-e4 e7-e5
2 Ng1-f3 Nb8-c6
3 Bf1-b5 Ng8-f6
4 0-0 (Ke1-g1) Bf8-e7
5 Rf1-e1 Be7-d6??

All beginners know that it is bad to move a piece twice in the opening.

6 d2-d4 Nc6xd4
7 Nf3xd4 a7-a6

Why not? After all, if White has two pieces attacked then Black must be able to take one of them, so there is no rush to capture on d4.

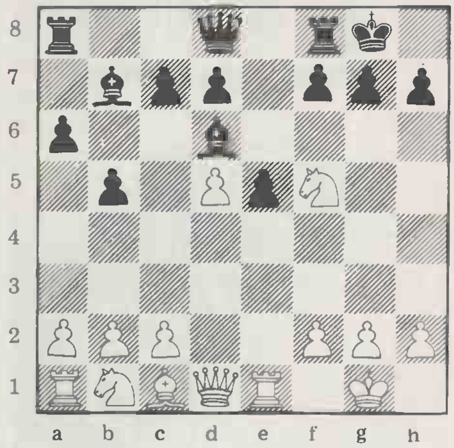
8 Bb5-c4 b7-b5

White still has two pieces attacked.

9 Bc4-d5 Nf6xd5
10 e4xd5

Now Black wants, and needs, to take the knight on d4. That is what it was counting on, but White's last move cleared one more piece from the e-file and now e5xd4 is illegal. Oh well, back to the keyboard!

10 . . . 0-0 (Ke8-g8)
11 Nd4-f5 Bc8-b7



12 Bc1-h6! g7xh6?

Black was lost, but this makes matters worse.

13 Qd1-g4+ Black resigned

The trouble with 13...Qd8-g5 would have been that after 14 Nf5xh6+, Black would be at something of a loss to counter the follow-up 15 Qg4xg5.

The overall performance of the micros in Linz was quite good — of 14 games played against programs running on mainframes the micros scored +1 = 7 — 6 (32%).

See the score table for the full results of the tournament.

World CCC results

1.	BELLE (USA) Ken Thompson; Joe Condon PDP 11/70 with chess hardware	W8	D6	W4	W3	3½
2.	CHAOS (USA) Fred Swartz; Mike Alexander; Jack O'Keefe; Victor Berman Amdahl 470	W17	D4	W6	W7	3½
3.	DUCHESS (USA) Tom Truscott; Bruce Wright; Eric Jensen Amdahl V/8	W18	W12	W7	L1	3
4.	L'EXCENTRIQUE (Can) Claude Jarry Amdahl V/7	W5	D2	L1	W12	2½

GOTO page 135 for remaining results

US results

1 (1)	CHAMPION SENSORY CHALLENGER (USA) Stand-alone device	W6	W5	W2	W4	4
2=(2)	BORIS 2.5 (USA) Stand-alone device	W10	W7	L1	D5	2½
2=(3)	BORIS EXPERIMENTAL (USA) Stand-alone device	W8	D4	L5	W9	2½
2=(4)	CHESS CHAMPION SUPER SYSTEM III (HK) Stand-alone device	W7	D3	W8	L1	2½
2=(5)	MYCHESS 'B' (USA) Cromemco	W9	L1	W3	D2	2½
6 (6)	ATARI 4k 'A' (USA) TV Interface Unit	L1	W10	D7	D8	2
7=(7)	MYCHESS 'A' (USA) Cromemco	L4	L2	D6	W10	1½
7=(8)	SFINKS (USA) TRS-80	L3	W9	L4	D6	1½
9 (9)	ATARI 4k 'B' (USA) TV Interface Unit	L5	L8	W10	L3	1
10(10)	LANE'S TC'86 (USA) Stand-alone device	L2	L6	L9	L7	0

FESTIVE FUN!

With Christmas fast approaching it seems like a good time to review the seasonal offerings of electronic goodies. This report is by PCW *boffins David, Peter and Dick.*

This year's review took us to that world famous toy emporium, Hamley's of Regent Street, to investigate the latest in truly electronic games. Dick Pountain specialised on the card games while editors David and Peter had a go at everything else. Of the 18 games offered only one was rejected, on the grounds that it was electro-mechanical. The remaining 17 were all electronic and most were intelligent, therefore qualifying for inclusion. We adopted a typical consumer's viewpoint, concentrating on questions like "Is it tough?", "What batteries are used?", "Is it fun?" and "Is it value for money?", rather than getting bogged down in technical details. We had a lot of fun and only one nasty moment when Peter sent a racing car on its preprogrammed route which just happened to take in a carefully-arranged toy display. Somehow our intrepid heroes managed to catch all the breakable toys before they hit the deck — phew!

SPACE LASER FIGHT and BOXING
Bambino Inc (Japan)
4 x HP11 batteries
We've grouped these two games together because, in most respects, they're identical. They have the same casing, which is extremely well-made and good to look at, the only difference between them being the colour. The keyboard control buttons are in the same places although they have different functions — in the one case combatants zap each other with laser guns and in the other with boxing gloves. The action takes place on a vacuum fluorescent display and, to be quite honest, it's a bit of a disaster. In the boxing match, for example, if a boxer throws a punch it often involves his arm separating from his body — no way to win a fight really. The spacemen appear to be wearing mediaeval armour, although if the game was worth buying this detail would probably not be noticed.

The games give the option of two speeds and the opportunity to play a real opponent or the computer. We may be wrong but the machine seemed to respond quite randomly to the controls.

This game is claimed to be "the first with a microprocessor unit" — oh! really? The machine's strategy, if you can call it that, is to play only in response to the human input. Really, it wasn't very good. Beautifully made, but dreadful.

BLAST IT
Entex (Japan)
6 x HP7 batteries
This game simulates the well-known arcade (and personal computer) game 'Breakout', in which a brick wall has to be demolished with the aid of an iron ball. As with the arcade game only single bricks are removed from the ball's path. The player must catch the iron ball as it rebounds off the wall in order to send it back. Three balls are allowed in a game. The display is adequate and the sound effects are awful. Mercifully, there's a 'mute' switch which is a most sensible thing to incorporate — other game designers please note. Three controls handle the player's moves — left, right and return. The return button sends the ball forward instead of at an angle. Having hit a brick the ball then resumes its normal diagonal progress. Two skill levels are provided — amateur and professional; professional takes some beating. All-in-all, this game is okay. Not one of the best, but okay.

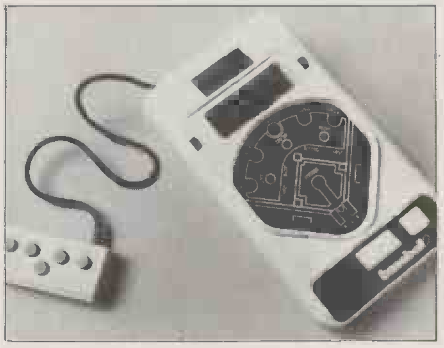
RAISE THE DEVIL
Entex (Taiwan)
3 x HP7 batteries
Here's a quite reasonable machine, especially for pinball addicts. Yes, on reflection, addicts — the game's appeal might diminish after a while. It is, in fact, a simulation of a pintable using LEDs of all things to simulate ball and flipper movement. It sounds crazy but it does work. Raise The Devil is a hand-held game with instructions printed on the back for the forgetful types. It has four skill levels in addition to the expected flipper and shoot controls. Now and again the display got a bit confusing, but in the main it was pretty good. The only problem was that the horizontal bar of the score digits was a bit intermittent. It would be worth trying this one in the shop to see what you think of it before buying.

ELECTRONIC SOCCER
Entex (Taiwan)
3 x HP7 batteries
Well, the less said about this one the better. Frankly, we find our lunch hour games of blow football more entertaining, except when the Editor's been eating garlic, that is! In a hand-held game such as this it's impossible to get enough players on the field let alone cope with player and ball movement. LEDs are used to display the players and ball position, while larger (dim) LEDs give the score. Controls for each player are forward, backward, left, right and kick. If you can't find an opponent then the computer will happily give you a very defensive and apparently random game. We weren't very happy with this one — in current parlance, we found it rather user-unfriendly. Try it and see what you think before buying.

DATACAR
Airfix (Hong Kong)
4 x HP11 and 2 x HP7 batteries
Now here's a real treat for children above about two years old. It's a programmable electric-powered car, and what a car — a BMW 3.5CSL in racing trim with rubber-shod wheels. The car is solidly made and should bash into things with little ill effect (to the car, that is). The only thing we didn't like

about the construction is the way that the PCB is clearly visible through the blue windows together with its inevitable mass of wires. 16 controls under the bonnet allows the operator (programmer?) to move the car in six different directions, hoot a horn and wail a siren. Each operation can be timed in seconds and a program can contain up to 48 such actions. When you consider that one function allows you to repeat the entire program then you'll have some idea of the car's potential.

The noises are superb but, sadly, there's no volume control. The car hurtles around so it's best not to have too many breakable objects in the room — see the comment earlier about Hamley's display. This has got to be one of the best items under review but you pay heavily for the privilege of owning it. We suspect that a lot of people out there won't be able to wait the year or two for the price to fall/inflation to catch up!



ELECTRONIC BASEBALL
Entex (Taiwan)
3 x HP7 batteries
Unless you're American or have an interest in baseball then you've got a bit of a hurdle to overcome before you can even begin to enjoy this game. Maybe the makers should produce a tame version and call it 'Rounders', but then again maybe they shouldn't. The instructions assume that you understand baseball so it's no good looking there for salvation. The game's for one or two players with one pitching and other hitting. Throws can be straight or curved and the hitter has to judge the timing of his hit just like in real life. If another player (rather than the computer) is pitching then he does it from a neat little detachable keypad — a nice idea. This is, of course, still connected to the main game by a cable. The appeal of this game is limited in the UK but if they offered cricket in the same type of device then it could catch on. Electronic Baseball is one of the better thought-out games from Entex.

OTHELLO
Tsukuda Original (Japan)
4 x HP7 batteries or 6V input
This game was undoubtedly our personal favourite but — ouch! — the price. Ignoring that, this electronic Othello is surely an example of the way things must go in the toys and games business. Well made, this game has a liquid crystal board display which can be adjusted for contrast — much more restful on the eyes than some of the other games we've looked at.

It has a fair degree of intelligence with three levels of skill. We played several games at each level and only won one game. Apart from the fact that we're not brilliant Othello players, it does say something for the native intelligence of this machine. Controls comprise the keys A to H and 1 to 8, the skill selector, set, pass, auto, manual, score and on/off. The 'set' key is used when you've stopped messing about and wish to enter your move for real. It is possible to play around with various moves to gauge their effect. The 'pass' key is used when you can't move and it causes the machine to have hysterics: the machine stops you passing if there's a legal move on the board which you can still make and plays a gloating tune if there isn't.

Auto allows you to play against the machine while manual allows you to play a real live human. LEDs are used to indicate whose turn it is. It's a very good game but definitely overpriced.

SAFARI
Bambino Inc (Japan)
4 x HP11 batteries
Like all Bambino games, this is very well made in an attractive green plastic case. It is rugged and very easy to use. The instructions are simple and, just in case you forget them, they're printed on the back. The game is reminiscent of Peter Calver's 'Sweeper' which we published in 'Programs' earlier this year. The idea of the game is to catch as many animals as possible in 90 seconds. Note, we said 'catch' not 'shoot', which we think is great — a significant move in the right direction. Animals appear at random on the display and four cursor control keys allow you to move a cage around the screen. Once you've caged an animal you've got to shut the door before it moves away. The three skill levels ensure that the machine keeps its interest for some time. It's an enjoyable game, well made, but like so many others of this type it's over-priced.

SPACE INVADERS
Entex (Japan)
6 x HP7 batteries
This is a hand-held version of the amazingly popular Space Invader pub game. It is also amazingly popular in Hamley's, where people exhibit severe withdrawal symptoms if the shop happens to run out of stock. Ah well, one man's meat. . . The display is quite faint, being covered by a garish bit of purple plastic with what looks like vacuum fluorescent invaders and so on underneath. Two speeds of play are offered — professional and amateur and, by gum, you don't half have to be quick to knock up a decent score at professional level. One very nice thing about this game is that the noises aren't very loud.

The controls comprise the aforementioned amateur/professional switch, a fire button and two controls to move the rocket launcher from left to right. These were mysteriously labelled "beam force controls". Odd. Mind you it looks impressive, embossed on the case like that. We found the game pretty boring but it clearly has a devout following, as Hamley's sales figures show.

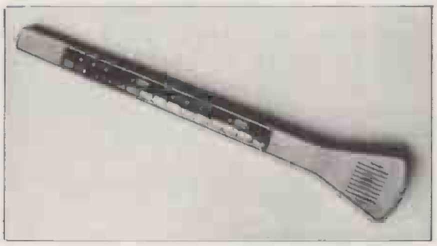
NEW GENERATION COMPUTER ORGAN
Tensai (Singapore)
6 x HP2 batteries
Of the musical instruments reviewed, this was the best but, even so, it wasn't as enjoyable as some of the electromechanical organs which fall outside the scope of this survey.

In its hard red plastic case this organ looks tough. It has two octaves including black keys and each note is numbered to help the little ones. The pitch of the keys is smaller than on a piano and it's not possible to play chords. Three tone control positions are provided — Hi sounds harsh and nasty, Lo sounds as if the loudspeaker is under a pillow and Med is, well, medium. A volume slider gives a progressive range from silence to very loud, while a neat little vibrato switch gives you that option as well.

It is possible to drive this machine from a mains adaptor and there's another socket on the back which isn't mentioned in the manual. It's either an earphone socket (good news) or a loudspeaker socket (bad news).

Now what sets this organ apart from the others in this survey is that it can record up to 48 notes of what you play. You can get instant replay at any of six speeds and if you're not sure of what speed you're at then a metronome has thoughtfully been provided. The only (and in our view serious) problem with the playback is that consecutive notes of the same pitch are played continuously. Try whistling *Jingle Bells* without the proper pauses between notes and you'll see what we mean. Two tunes are also tucked away in ROM inside the machine so it's possible to get a tune without any effort. One is *It's a small, small world* as reviewed in 'Bookfare' recently and we've forgotten the other one.

Conclusion — good for kids but not for parents.



MAGICAL MUSICAL THING
Mattel (USA)
1 x PP3 battery

We really weren't sure whether to include this in the review but it's so weird we thought you ought to be warned. It all starts with the name — whose marketing men really got stuck for an idea then? And if they didn't, have they got any highly paid vacancies? Joking aside, this is a very odd plaything. It has a fun appearance, being sort of long and thin with a multicoloured strip of plastic running almost its entire length. The remaining bits have to be covered with bits of sticky paper kindly supplied with the machine. 25 notes can be played by pressing the touch-sensitive multicoloured piece of plastic in the right places. These are considerately marked rather like a piano keyboard but at a different pitch. The device is about two feet long and can be played (according to the instructions) with elbows, feet or, indeed, any other part of your body. The Editor performed a passable version of 'Greensleeves' with his nose (on the Musical Thing, that is)!

Ah well, it takes all sorts. The 'music' produced has a nasty tone and it's only possible to play single notes — chords can only be achieved by playing more than one of these instruments simultaneously. Please don't do it near the PCW offices though! The only thing that commends it is that it's the cheapest toy in the review.

SINDY COOKER
Sindy
6 x HP7 batteries

If you ignore the price, here's a lovely toy for all those non-liberated little girls. You know, the ones who like to play with dolls and copy mummy. It's a cooker with interesting sound effects. Starting at the top there's a rotisserie with a light in it. It has to be rotated by hand from outside, which is a shame, seeing as there are batteries inside. Then we have the interesting bit — a four-ring hob onto which you may place a selection of pots and pans. And it doesn't matter which ring contains which pot — it makes the right noise! The frying pan sizzles, the saucepan bubbles, the pressure cooker hisses and the kettle whistles to the boil then goes off the boil. The kettle has the highest priority interrupt. . . oh, what are we saying? Just look at it and be mystified like we were, at first. The oven has a timing device which sounds an alarm a little while after anything is placed in it. All good fun, and six to ten year olds will love it.

LITE 'N' LEARN ELECTRONIC ORGAN
Concept 2000 (Hong Kong)
6 x HP7 batteries

Here's a cheap-looking but rugged musical instrument. In a bright red plastic case, the Lite 'n' Learn gives you the ability to learn a tune, listen to a tune or even play your own tune. These miracles (note the tongues in cheeks) are achieved through a ten-key keyboard topped with ten corresponding LEDs. To learn a tune (already in ROM in the machine) you press the learn button, whereupon a LED will glow. Press the appropriate key and another LED will glow, and so on until you've completed the tune. To just listen to the preprogrammed tune you press the auto button, select which of the 12 tunes you want and listen. A manual key allows you to do your own thing. It makes a nasty sound and doesn't allow chords. With these problems and only ten keys, its appeal is bound to be limited and in all probability interest would wane quickly.

STOP THIEF
Palitoy (France)
1 x PP3 battery

We have a small confession to make on this one — we didn't have time to learn the rules and actually play a proper game but we thought it warranted a mention anyway. It's probably the most expensive board game on the market if you ignore tarted-up backgammon and Mah Jong sets. Very similar to Cluedo, the idea is to catch a criminal at the scene of a crime. The board is laid out as a number of buildings and streets with each building having a number of rooms. Various temptations are sprinkled around the board. An Electronic Crime Scanner keeps track of where the criminal is. Cards are drawn which allow the player to do various things, while the roll of the dice dictate the player's movements. Without getting too bogged down the player might find himself asking the calculator-like scanner for a tip or a clue. In the first case the scanner displays the criminal's location and if our memories serve us correctly the clue is a creaking door, breaking glass or one of the other sound clues telling what the criminal is up to. When the player thinks he knows where the criminal is, he keys this into the scanner then tries an arrest. The scanner makes a siren noise, followed by gunshots to warn the criminal. According to the next noise the arrest was either wrongful (a raspberry), a failure (na na-na na na) or successful (a different siren). And so on. We'd love to play it some more because it looks like good fun — a new dimension in board games and something many others are sure to follow. The price, however, is just ridiculous — it should be at least half or maybe a third of the present level.

GIN RUMMY/BLACKJACK AND POKER

Entex Electronics (Japan)
4 x HP7 batteries or mains adaptor

As one who is fond of the rustle of pasteboard, I was quite excited at being offered the task of assessing two computer card games from Entex.

Both come in similar packages, like large pocket calculators, in cheap-looking — but tough — ABS cases. The buttons have a pleasantly positive action and, in both cases, large green fluorescent tube displays are used. A nice touch is that these tubes display the suit symbols in their corners, in addition to alphanumeric representation of the cards. It takes a bit of time to get used to 0 standing for ten, however.

Poker: I found this game very disappointing. Poker is not a game for two and the machine only plays as one opponent. In order to reinject some excitement into this two-player game, Entex has devised a non-standard version of poker which can definitely not be found in Hoyle.

Based on Five-Card Draw, the betting is modified so that three rounds of betting are compulsory; you bet three rounds or drop — no seeing. You always open the betting and the dealer either calls you or doubles, and so on for two more rounds. On the second round, the dealer reveals two of his cards; on the third he reveals a third, introducing an element of stud in a rather disconcerting way. It seemed to me that the randomiser was rigged to provide better-than-average hands to both players; it is rare to pull less than a pair.

As to its skill, the machine plays a good hand quite well, bluffs hard, but is much too sloppy with bad hands, almost always going the distance instead of dropping. As a result I could beat it very soundly over ten or more hands.

To my shock, battery life is less than two hours, rendering it almost as expensive as the real thing! Not good value.

Gin Rummy/Blackjack: Blackjack is a pretty trivial and tedious game, to my mind. This machine plays it as well as a good croupier, playing the standard casino rules, with splitting and doubling down permitted. As a bonus it pays extra on five card tricks.

Flipping a switch converts it to Gin Rummy (most of the non-numeric keys have double functions), which is very good indeed. Again the standard game is played, and it plays like the devil. You have a key to arrange your hand, another to form melds. The 11-digit display shows your hand, plus the machine's discard. A press of a key turns the discard into a card from stock. If the machine knocks first it will automatically lay-off your hand for you and, of course, it keeps all of the scores automatically, including bonuses. As a middling player, I found it consistently beating me; since its memory for my discards is infallible, this is hardly surprising!

The only gripe is that battery life is even lower than the Poker game: less than one-and-a-half hours solid play. This could be improved by using alkaline cells, but it's still insufficient for a long train journey. The adaptor would be a must. Nevertheless, at its price a reasonable buy.

Toy	Make	Batteries	Price*	Fun rating	Value for money
Space Laser Fight and Boxing	Bambino	4 x HP11	£35.00	**	*
Boxing	Bambino	4 x HP11	£35.00	*	*
Safari	Bambino	4 x HP11	£35.00	****	**
Raise the Devil	Entex	3 x HP7	£19.95	***	***
Space Invaders	Entex	6 x HP7	£19.95	***	***
Electronic Soccer	Entex	3 x HP7	£21.25	**	*
Electronic Baseball	Entex	3 x HP7	£31.95	***	**
Blast It	Entex	6 x HP7	£21.95	***	**
Poker	Entex	4 x HP7 *	£22.75	**	*
Gin Rummy/Blackjack	Entex	4 x HP7 *	£27.95	****	**
Datacar	Airfix	2 x HP7 4 x HP11	£37.50	*****	***
Magical Musical Thing	Mattel	1 x PP3	£9.95	***	**
Lite 'n' Learn Electronic Organ	Concept 2000	6 x HP7	£19.95	**	*
New Generation Computer Organ	Tensai	6 x HP2*	£17.95	****	****
Sindy Cooker	Sindy	6 x HP7	£23.75	*****	***
Stop Thief	Palitoy	1 x PP3	£31.95	*****†	*
Othello	Tsukuda	4 x HP7*	£79.95	*****	**

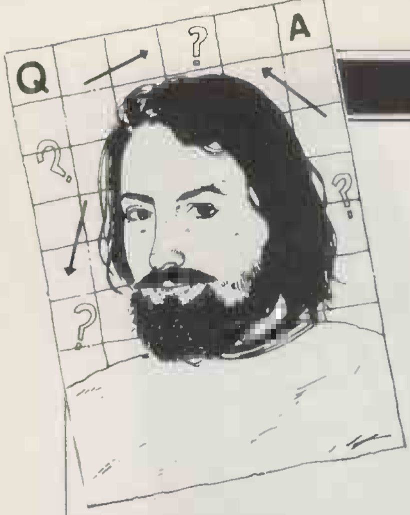
* or mains adaptor

* prices will vary from store to store

***** Excellent
**** Very good
*** Good
** Fair
* Poor

† we think — see text

We would like to thank Hamleys of Regent Street and particularly Mrs Dawn Allen for making these games available to PCW.



COMPUTER ANSWERS

Questions for 'Computer Answers' should be sent to: Sheridan Williams, 35 St Julian's Road, St Albans, Herts.

On the air

My interests include computer analysis of electronic circuits and using the computer as a teleprinter terminal for amateur radio transmission, the latter being the final hurdle before I go out and purchase. Do I have to take any precautions with electro-magnetic fields? The computer would sit next to the transmitter which has an output of 25 watts on frequencies in the 144 to 146 MHz band. Have any of your readers any experience with these problems?
B W Hepburn, NICS, COA, SHAPE, BFPO 26

I have put your full address above so that others interested may write directly to you.

The problems of shielding a microcomputer from interference and from causing interference are similar to shielding a radio or hi-fi set. The two main sources are RF and mains-borne. The former is suppressed by enclosing the components in a well grounded Faraday cage and screening all high speed data lines that leave the cage. Some manufacturers provide such screening as a matter of course but many later models have a plastic chassis which provides none. These would have to be modified by adding an internal wire mesh screen with a hole diameter of 1 cm or less. If you add a RTTY interface this should not produce many problems. It is important to provide good electrical contact at intervals wherever the mesh meets itself. Some indication of the efficiency of the screen can be made by putting an AM radio nearby with the unit in operation, on the principle that if you can't hear it then it can't hear you. Mains interference won't usually cause any problems; if it does then ferrite cores on the power cables where they enter the screen should help, as should extra bypass capacitors on the circuit boards themselves. With luck you should not have to resort to such devices; a well shielded transmitter feeding an external antenna through a good feed should not generate much RF near the computer in the first place. However things are often less than perfect and I would suggest protecting the CPU anyway, as logic glitches are notoriously difficult to trap.

Finally, get in touch with the Radio Society of Great Britain, 35 Doughty Street, London WC1N 2AE, as there are many others with a common interest.
P A F Callow and Gareth Evans, RSGB

Conversion

I have a UK101 and would appreciate some help in converting the HPLOT function used in 'Plotting in Three Dimensions' (*PCW*, July 1980) into a suitable subroutine.
A Katz, Edgware, Middx

The Compukit UK101 uses a 64 by 16 array of graphics pixels, each and any one of which can have placed in it any one of 255 alphanumeric or graphics characters, each made up from an eight by eight matrix of dots. The first six and last ten characters in each row of 64 are not displayed on a normal TV.

A sub-routine that will act as HPLOT is:

```
10000 C = INT(X/8)
10010 C1 = X—C
10020 R = INT(Y/8)
10030 R1 = Y—R
10040 POKE 53248+C+64*R,
  A(R1, C1)
10050 RETURN
```

At the start of the program you will need to set up the array A:

```
100 DATA x, y, z, a, . . .
110 DIM A(8,8)
120 FOR R1 = 1 TO 8
130 FOR C1 = 1 TO 8
140 READ A(R1, C1)
150 NEXT C1
160 NEXT R1
```

The DATA items to go in line 100 are the codes for the graphics characters which correspond to the individual dots in each pixel. The instruction book (p 27) gives a program for displaying and identifying these.

In the sub-routine, line 10040 POKEs into the correct pixel the graphics character most nearly corresponding to a single dot in the location defined by HPLOT.

Instead of line 110 in the published program you will need to renumber so that line 1 becomes 200, and 130 becomes 370. Line 110 will then need to be replaced by:

```
350 X2 = X1—X
352 GOSUB 10000
354 X2 = X1+X
356 GOSUB 10000
```

Don't forget about not going too near the edges of the screen because of the characters you can't display!
P L McIlmoyle

RPN

I am thinking of buying a Powertran Z80 computer but am concerned about the Reverse Polish system used. As most of the programs printed in magazines are not of this type is it easy to convert? If so, how?
P W Stevens, Peterborough

You shouldn't have any real problems once you have understood the Reverse Polish notation, sometimes called postfix notation as opposed to infix notation which we normally use. I can't go into too much detail here so recommend that you buy a recently published book called *Computer Science* by C S French, D P Publications. You will find what you want on page 226.

Briefly, postfix requires no brackets and operation can be performed from left to right through the expression without worrying about operator precedence. Hewlett Packard calculators use Reverse Polish and they sell enough of them to show that people are not too worried about it.

Here are some expressions and their equivalents:

Infix	Postfix
A—B	AB—
(A—B)/C	AB—C/
2 + (A—B)/2	AB—2/2+

In brief, the operator operates on the two immediately preceding operands.
S W

PET replacement

I am considering replacing my two year old PET as it has been back four times for repair. What would you recommend for up to £1500? I require disks but no printer as yet. I wish to develop educational software and process examination results and pupils' records. Games are a secondary use. What about the Apple or Sharp? Are there any other machines worth considering?
P Denbigh, Leeds

You are the first person to ask how to upgrade by changing machines — most people try to make the best of an existing system, which is usually a compromise as the system should be chosen around an application, not made to fit.

With £1500 to spend, you should seriously consider the Superbrain; read the review in a recent issue of *PCW*. Although the reviewer was not over the moon about it, it is certainly one of the best value systems on the market at present. It has either twin single-sided double-density 320k disks or twin double-sided double-density 720k disks; although the latter will take you over your budget, try and negotiate for them as an upgrade later will be extremely expensive. It has no graphics features as standard but does support CP/M, giving you a large range of extra software including word processors and other languages.

If you want to write educational software you ought to consider the Research Machines 380Z also; with two disks it is over your budget but you can buy it with single disks. Many local education authorities recommend it and over 1500 schools and colleges have them. It has superb graphics facilities as an extra but even the standard graphics are quite good. An increasing amount of educational software is being written for it. The 380Z is not very good for data processing as it has very limited disk capacity (single density) and, as yet, not very good DP software.

Finally, the Apple — worth considering for its graphics alone, but you should try and get an 80-character screen version. By the time you've bought the Apple, twin disks and screen, it will, however, have cost you over £1500.
S W

CP/M help

A year ago I purchased in board form an S100 32k 8-inch single disk computer with CP/M. I am having considerable difficulties with configuring CP/M and would like you to recommend a book for teaching me CP/M. Do you know the address of the CP/M Users' Group, who could surely help me?
P G Smart, Coventry

The only book I know of is

The CP/M Handbook with MP/M by Rodnay Zaks, published by Sybex. This book is very good but probably does not go as deeply as you would require into configuring CP/M to your particular system.

As you suggest, by far the most helpful would be the CP/M Users' Group whose address is: D Powys-Lybbe, MML, 11 Sun Street, Finsbury Square, London EC2.
S W

ZX80 printer

I have a ZX80 and have managed to get — very cheaply — an Olivetti TE 318 teleprinter which was previously used as a computer terminal. How do I hook it up to my ZX80?
Steve Dimond, Coulsdon, Surrey

The main hurdle is that Sinclair does not use the standard ASCII code which your printer requires. At the press conference in September for the launch of the new ROM, Clive Sinclair hinted that a ZX80 printer would be available sometime next year but he refused to be more specific. You could follow the lead of one club member who has built an intelligent printer interface using his Mk 14. Although intriguing, this seems an inconvenient and expensive route to follow. There are a number of 20 mA interface units on the market, but you'd need to write software to perform the conversion of letters and numbers to ASCII, plus provide a small lookup table to convert punctuation and special characters. Graphic symbols could not be included. This would enable use of the external device under program control only. To actually LIST programs, further software would be needed to POKE the appropriate locations in memory.

Olivetti says it would cost you £48 for the first hour, and £20 for each subsequent hour, for an engineer to visit you, inspect your Olivetti unit and, assuming it was working correctly, advise you on how to connect it to your ZX80!
Ken Macdonald and Tim Hartnell, National ZX80 Users' Club

Sharp 1

I have recently bought a 20k Sharp MZ-80K computer. The PCB has eight empty sockets labelled RAM (III). I assume these are for expansion. Could you tell me what ICs to fit and what their working capacity would be. Also, two of the programs in the Basic manual don't work; would the expansion cure this problem?
B Wainwright, Wakefield, W Yorkshire

These sockets can indeed be used for expanding the memory. Use either 4027 (4k) or 4116 (16k) and you'll then have a capacity of 48k. Mind you, Sharp doesn't charge too much for its upgraded RAM anyway. This may cure your program errors but without further information I cannot answer this definitely.
S W

Sharp 2

I have just bought a Sharp micro. I cannot find out how to enter a program that has AND and OR in it. Can you help me?
P Stephens, Benfleet

Just replace AND by * and replace OR by +.
S W

UK101 queries

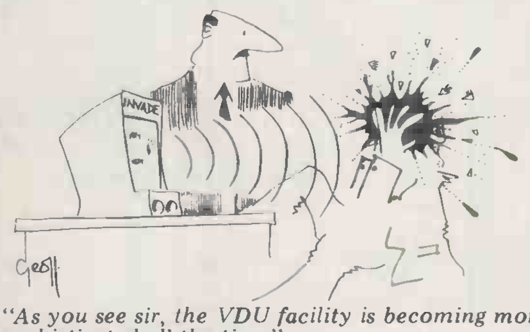
I have received several related questions about the UK101: In trying to choose between the UK101 and the Microtan I notice that a lot of games are advertised for the former, but not for the latter. As both use the 6502 processor, would UK101 programs run on the Microtan? What happens to the mains transformer of the UK101, as it is not attached to the PCB? What are the differences between the UK101 and the Ohio Superboard II, bearing in mind that the assembled UK101 is dearer than the Superboard? How does the Ohio Challenger 1 relate? Should I as a beginner consider buying the UK101 in kit form? Are there any better boards at around the same price?
A J Black, Wrexham; C Dorsman; S L Ward, Poulton-le-Fylde.

The Microtan as a single board operates only in machine code. It is not very likely that machine code programs written for the UK101 would run on it, due particularly to differences in handling I/O and character generation. However, by adding the Tanex board, Basic becomes available. This is a 10k Microsoft Basic and as such should be quite compatible with the 8k Microsoft Basic used by the UK101. That is not to say that you may not have to do some alterations to UK101 programs to get them to run on the Microtan/Tanex but they should be fairly minor. You would probably have to enter the programs from the keyboard, as the cassettes for the UK101 may well not load.

The mains transformer for the UK101 is indeed not mounted on the PCB but is attached to it by leads which you can make of any reasonable length, so that you can put the transformer in a convenient place. This is not an unusual practice with uncased electronics kits. It does raise the question of safety and it would be wise to make sure the mains voltage terminals are well insulated. Even better, mount the transformer inside a plastic box.

There are not many differences between the UK101 and the Superboard, as the former was designed to be a British-made equivalent of the latter. The Superboard as originally imported was of the standard US design, intended to operate on 60 hertz mains rather than 50. The most obvious effect of this is that the standard Ohio Superboard will only display 25 characters per line on a UK TV set, compared with the UK101's 48. Because of the frequency difference, the display may also not be as steady. However, an upgraded version of the Superboard is now available, fully converted to UK standards; this gives 48 characters per line. One of the other main differences is that the UK101 is intended primarily for sale as a kit. This is reflected in the pricing, with the UK101 kit being cheaper than the Superboard, but the Superboard being cheaper than an assembled UK101. No doubt this is related to the UK101 being assembled in the UK! As to whether a beginner should go for a kit, or a ready assembled board, this depends very much on the individual's skills, patience, and wealth!

If you're handy with a soldering iron and interested in the construction, by all means go for a kit. If you don't have these skills, or just want to get on with computing, go for the assembled product. The Challenger 1 is essentially a cased Superboard. Other single board computers that you might like to think about include the Acorn Atom, the Rockwell Aim 65, the Nascom 1, and the Sinclair ZX80.
P L McIlmoyle



"As you see sir, the VDU facility is becoming more sophisticated all the time"

Networking

Could you advise me on the possibility of setting up a system where a fairly powerful central microcomputer (such as a North Star Horizon) can process information stored on cassette by small units at remote locations and posted back to the centre? Bearing in mind the lack of compatability between various Basics, would a special interface or data conversion program be needed?
P M E Hazlehurst, Warley

The simplest, although perhaps not the cheapest, approach would be to select a manufacturer who offers systems in a variety of sizes which are compatible with each other. At the cheaper end of the market, both Acorn and Microtan offer small units suitable for the data collection work, which can be built up into larger systems for the more demanding central work.

Moving up to fully 'packaged' systems, the Tandy TRS-80 range immediately comes to mind. The data recording could be done using the Model 1, level 1 keyboard, while the central system could be a Model 1, level II with expansion interface and disk drives. The Ohio Challenger range also offers similar possibilities, with the C1 for data collecting and the Challenger C4P-MF (or even larger units) for the central work.

It is certainly possible to use special interfaces to allow data recorded in one format to be converted to another and these are indeed used for this purpose with mainframe computers. However, unless you build it yourself, such a unit could easily be as expensive as the central machine you have in mind. This would be the problem with the North Star Horizon. While this is popular for business use, it is very disk orientated, and inputting from cassettes would not be easy unless you could find an S100 card that provided this facility by slotting straight into the Horizon.

Whatever approach you take, it will be most important to check with your supplier that the various units really are compatible before making any commitment. Manufacturers can change their specifications at any time, or even supply what appear to be identical units with subtle differences (this has happened with both PET and TRS-80), perhaps because more than one factory can be involved.
P L McIlmoyle

PCW SUBSET

Continuing PCW's unique series aimed at the serious programmer working in assembler language, Alan Tootill brings more examples of work sent in by readers.

The trouble with a series like this is that not everyone starts at the same time. Having read, in the September issue the rules and documentation for datasheets, Neil Imrie from Bedford writes:

"1. Why this mania for abbreviation? Instead of the near meaningless 'level 0, class 1, I suggest 'This routine calls no other routines and follows such and such a standard.
2. If the level and class classification in 1 above is to be employed, why level 0 & 1, but class 1 & 2?
3. The ACTION section is really unnecessary if the routine is properly commented.
4. The SUBr DEPENDENCIES section is a repeat of the information in the level statement in 1.
5. In my opinion the very first statement for any routine is one indicating machine dependency and naming of the machine where appropriate. This is the general criticism of all program listings in magazines."

He also suggests that a time factor be given, as near as possible, for all routines, whether time critical or not and that the label at the routine entry point be given two colons (global symbol).

Concession

Neil puts some good points. In view of 4, we will dispose of 2 and part of 1 by dropping level and keeping SUBr DEPENDENCE. We will make it optional whether or not Time States, exact or maximum, are given for routines that are not time critical, because if you don't supply them, I'm not going to count them up. I am not convinced that two colons after a routine entry label is commonly understood to distinguish a routine generally available to any application. Will all of you who know it is and all who know it isn't please write in, so that we can sort this out? Meantime its use is optional.

Mania

I like a touch of mania, so will keep class 1 or 2. The technical dictionaries and glossaries should soon catch up with what a *PCW* Class 1 routine is – those who can't wait should go back to the September issue.

Perseverance

The ACTION section is proving difficult. It was proposed that the *main* actions of the routine be shown and you might have noticed that we have been experimenting a bit with this. The idea is that the ACTION section should be independent of the listing, to help anyone to use the routine without needing to understand the code. The concept is a good one and we will persevere with it. Your ideas on strengthening this section will be particularly welcome.

Reshuffle

To me, the most important point about any routine is the job it will do in the real world. The processor on which the idea is executed is less important than the idea. So PROCESSOR stays last, where it is easy to find.

I want eventually to see the ideas of our best routines documented for execution on Z80, 8080, 6800 and 6502 processors. With this in view, a minor reshuffle of the documentation is called for, to put that which is common to all processors first and that which is variable last.

The second part of the documentation is now revised to:

Section 1 gives the class of the routine. Class 1 routines are re-entrant, relocatable and not self-modifying; others are class 2.
Section 5 is the old section 10.
Section 6 is the old section 11.
Sections 7-11 are the old sections 5-9.
Section 12 is optional for routines not time critical and gives the exact total or maximum number of Time States.
Section 13 gives the processor or processors that will run the machine code.
We can't get any better than that. Or can we?

Something different

Look at the graph in Figure 1. Suppose we know the values of X1 and Y1 (500 and 5000 in this illustration) and X2 and Y2 (2000 and 32000) and that the other co-ordinates we might use fall on a straight line between them. For any given value of X, between X1 and X2, we can then read off the corresponding value of Y.

If your microcomputer doesn't draw and read graphs, it can use INTPL, the subject of our first Datasheet this month, sent in by Jim Chance of Birmingham. The virtue of this routine

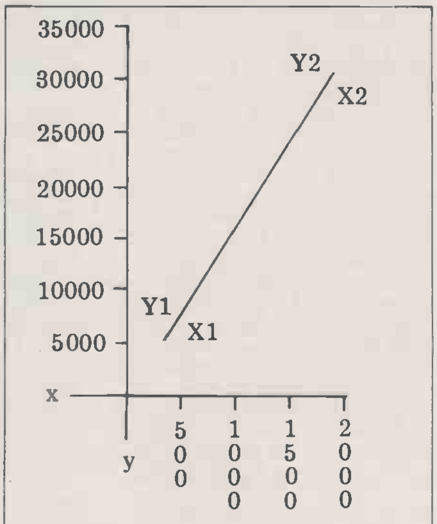


Fig 1

```
        LD      IX,TAB          ; point to fixed co-ordinates
        LD      BC,+1200        ; X value input
        CALL    INTPL           ; get corresponding Y in DE
        RST     20H             ; NAS SYS 1 restart to
                                ; display registers &
                                ; return to monitor
TAB:    DEFW    +500            ; X1 held as F4 01
        DEFW    +5000           ; Y1 held as 88 13
        DEFW    +2000           ;X2 held as DO 07
        DEFW    +32000          ;Y2 held as 00 7D
```

Fig 2

```
        LD      (SAVE + 1),SP   ; save return
        LD      SP, HL          ; set SP to params
        (Main part of subroutine)
        JP      SAVE

SAVE:   LD      SP,_ _          ; recover return
        RET                     ; to main prog
```

Fig 3

is in its speed, so no 'improvements' that take more than 9000 Time States for the worst possible case are allowed.

In this bit of code I used to try out the routine in Figure 2.

Note how the fixed co-ordinates are held in TAB, with the most significant part of a double-byte binary number in the higher addressed byte and the least significant part in the lower. Note, too, that the routine changes the values in TAB, so that TAB has to be restored to its original state each time the routine is run like this.

Now that you have the routine, write in and tell us what you are doing with it. Jim used it to drive a digital to analogue converter, when the X axis was time and the Y was digital values.

Calling all learners

PCW has referred to this series as being for the serious programmer. It certainly, is, in the sense that everyone working in machine code must be keen on programming. But don't let this mislead you into thinking that only the expert can join in. Z80 machine code has not been around all that long and most of us are still learning.

I told you in November about David Yeomans from Halifax. He is not, and has not been, a programmer by occupation. He hasn't even got a microcomputer yet, being short of some parts for the one he is building. But he writes machine code that works and he *sends it in* to share it with other and to learn what the think about it.

David was taken with the idea we discussed in September of supplying parameters to subroutines, in the main program following the CALL and was already working along these lines. He sends our second Datasheet of a routine, ALRET, to alter the return address from a subroutine, to skip over parameters in the main program. The call to ALRET becomes the first instruction of the subroutine using parameters from the main program.

Don't interrupt

ALRET is strictly non-interruptable, as it takes the stack pointer above data that must be saved (the return address from ALRET). This further interesting suggestion of David's makes it even more so:

If a four-byte area of RAM called SAVE is dedicated to this procedure and the call to ALRET in the subroutine is followed immediately by the code in Figure 3, you can get the parameters in the main program area simply by popping them off the stack.

Not just a critic

Neil Imrie, who started us off this month by criticising and improving our documentation, sent converse routines in September's SBNF, better than the BFSN we printed in November. He sent BFSR, leaving the ASCII field right justified and BFSL, leaving it left justified.

BFSR is the subject of our third Datasheet. To get the result left justified, simply alter the machine code given for BFSR as follows:-

1. delete the 1st two bytes
2. alter the 10th byte from F6 to F8
3. alter the 15th byte from 07 to 08.

Datasheet

```
; = INTPL —Linear interpolation
;/ CLASS: 2
;/ TIME CRITICAL?: Not strictly but speed is important
;/ DESCRIPTION: Produces linear interpolation by the successive
;/                    approximation method
;/ ACTION: algorithm follows:
;/         REPEAT
;/         BEGIN
;/         NEWY: = (Y2 – Y1) DIV 2 + Y1;
;/         NEWX: = (X2 – X1) DIV 2 + X1;
;/         IF X < NEWX
;/         THEN BEGIN X2: = NEWX; Y2: = NEWY END
;/         ELSE BEGIN X1: = NEWX; Y1: = NEWY END
;/         END;
;/         UNTIL (X2 –X1) DIV 2 = 0:
;/         Y : = NEWY;
;/ SUBr DEPENDENCE: Local
;/ INTERFACES: None
;/ INPUT:IX points to an eight-byte table in RAM holding the fixed co-
;/          ordinates X1, Y1, X2 and Y2 as double-byte binary numbers,
;/         with the most significant part of the number in the higher
;/         addressed byte and the least significant part in the lower
;/ OUTPUT: DE = corresponding value of Y
;/             Values in the table pointed to by IX, (IX) to (IX + 7),
;/             are altered
;/ REGs USED: AF, BC, DE, HL and IX
;/ STACK USE: 6
;/ LENGTH:70
;/ TIME STATES:< 9000 in worst case
;/ PROCESSOR: Z80

INTPL:  PUSH IX          ; save variable base        DD E5
        PUSH BC          : save X                    C5
        CALL GTNEW       ; get HL = new Y            CD YY YY
        DEC  IX                                      DD 2B
        DEC  IX          ;IX → Y1                    DD 2B
        EX   DE, HL      ; save new Y in DE          EB
        CALL GTNEW       ; get new X                 CD YY YY
        POP  BC          ; BC = X                    C1
        PUSH AF          ; save z flag               F5
        LD   A,L                                     7D
        SUB  C                                       91
        LD   A,H                                     7C
        SBC  A,B         ; compare HL, BC            98
        JR   C,IP1       ; for X1, Y1                38 08
        INC  IX                                      DD 23
        INC  IX                                      DD 23
        INC  IX                                      DD 23
        INC  IX          ; IX → X2, Y2               DD 23
IP1:    LD   (IX + 4),E                              DD 73 04
        LD   (IX + 5),D  ; update Y1 or Y2           DD 72 05
        LD   (IX + 2),L                              DD 75 02
        LD   (IX + 3), H ; update X1 or X2           DD 74 03
        POP  AF          ; z = finished              F1
        POP  IX          ; restore variable base     DD E1
        JR   NZ, INTPL                               20 D1
        RET                                          C9
; GTNEW does the average of Y1, Y2 or X1, X2 which
; it returns in HL, z = set if (2-1)/2 = zero
GTNEW:LD   L,(IX + 6)                                DD 6E 06
        LD   H, (IX +7)  ; HL = X2 or Y2             DD 66 07
        LD   C, (IX + 2)                             DD 4E 02
        LD   B, (IX + 3) ; BC = X1 or Y1             DD 46 03
        OR   A           ; reset carry               B7
        SBC  HL, BC                                  ED 42
        SRA  H                                       CB 2C
        RR   L           ; HL = HL/2                 CB 1D
        LD   A,H                                     7C
        OR   L           ; test z = finished         B5
        ADD  HL, BC      ; HL = mean                 09
        RET                                          C9
```

GOTO page 134

Your favourite

If your favourite routine hasn't been printed yet, why the heck don't you send it in?

Send you contributions to: PCW Sub Set, PCW, 14 Rathbone Place, London W1P 1DE.

The Challenge

If you can buy a quality printer with a better spec than Base 2 - **BUY IT!**

Model 850
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FUTURE PERFECT?

Having explained the theory of forecasting last month, Alan Green now examines the dream of every micro owner -- using a computer to help win the football pools.

All of us at one time or another have dreamed of a jackpot win on the football pools. The problem, naturally, is to find those elusive eight draws from the 55 matches on the coupon. Picking match numbers at random means relying entirely on chance and hoping that, of the 1,217,566,352 possible choices of eight from 55, yours will be the winning one. Even entering a perm (it is really a combination not a permutation) of eight from 11 means that you are doing 165 lines and the chances are still only one in 7,379,190 that you will win.

In order to increase the chances of winning it is necessary to do an analysis of form and make the selections on a basis of informed assessment. With 130 teams in the English and Scottish leagues, this is a problem which is beyond the powers of the mind to handle but is simple for your micro, provided you tell it what type of analysis to perform. In my previous article on forecasting future events I said that any forecasting system needs a base of statistical analysis coupled with an ability on the part of the user to exercise his discretion and intuition. I also explained the principles of exponential smoothing designed to reduce data storage to a minimum and to analyse trends in results. The program Drawmaster listed with this article is a pools forecasting program which applies this technique to the special case of football results and presents a great deal of additional information to allow subjective interpretation to be done if required

Program structure

The program (written for a PET) contains six main elements which will be dealt with separately, in detail. The initial provision is for the entry of all seven league tables either at the start or at some other time through the season. Match results are entered as and when they occur and the league tables are automatically updated precisely as they are in the Sunday newspapers. Forecasts can be made for any match between any of the 130 teams and this forecast contains four elements as detailed below. Provision exists to file and recall the league tables so that you are always working with the latest information when making forecasts. Finally all league tables can be displayed in order to check that your entries are correct and that you have not missed out any results.

Enter league table

For all teams you need to enter the name, win, draw, lose, goals for and goals against for both home and away performances and finally total points. Team names should be limited to 11 characters to allow for better formatting of subsequent displays. The crucial point to watch is that a part of the name to the left must be unique to that team. When forecasting it is not necessary to enter the complete team name, merely a string sufficient to identify it. Team searches are based on substring matching using the LEFT$ statement. So if CLY is entered when forecasting, it would find either CLYDE or CLYDEBANK if the team names have been entered thus at the start of the program. It would be better to use CLYDE and CL'DEBANK, then CLY will only find Clyde and CL' will only find Clydebank. Chester and Chesterfield; Queens Park Rangers, Queens Park and Queen of the South present similar problems. Care at this stage can save time and reduce problems later.

To save on memory space a certain amount of information condensing has been done. When win, lose or draw records are entered they are combined into one number by subroutine 20110. Therefore a record of 12 wins, three draws and eight losses is stored as 120308. The number is broken down again when needed by subroutine 20210.

Similar procedures are adopted for and against in subroutines 20310 and 20410.

When all leagues are entered, an initial forecast performance for each team at home and away is required for exponentially smoothing stages of the forecasting routine. These forecasts must have a value between 0 and 2 and may be decided on subjectively or calculated based on the previous season's results. My own solution was to write a short program to do the following: (2 x proportion of matches won) + (proportion of matches drawn). This gives a forecast based on points scored in matches, the approach used in the program.

For instance, if Norwich City had a home record of seven wins, ten draws and four losses, their forecast home-performance would be

$(2 \times {}^{7}/_{21}) + {}^{10}/_{21} = 1.14$

Enter match results

The identification strings for both teams in the match are entered (lines 11010-11310). It is not necessary to type the whole team name because the search through the tables is done using the LEFT$ statements in lines 11080 and 11090 and, providing the input string is unique to one team, that team will be found. For example, EV would find Everton and CRY would find Crystal Palace. However, to find Bristol City as opposed to Bristol Rovers it would be necessary to enter BRISTOL C. When

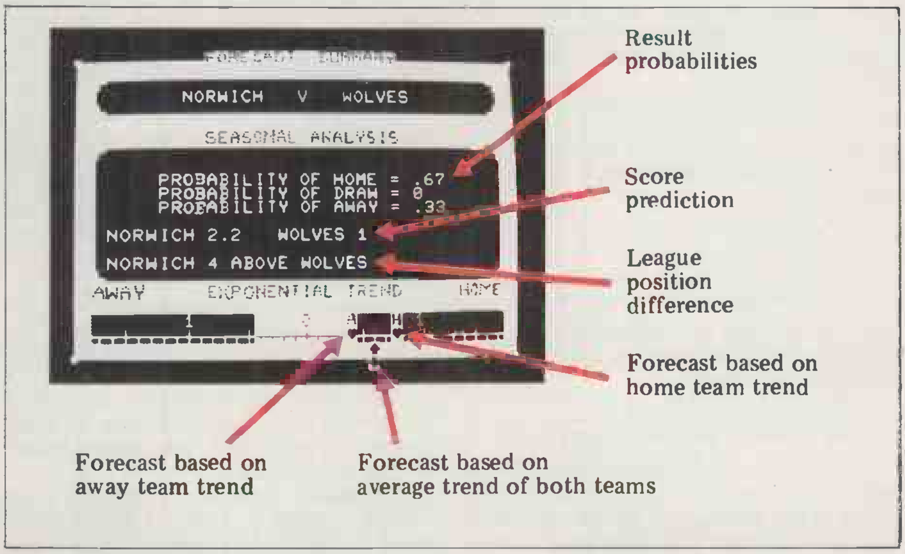

Fig 1 All forecasts are for a home win except away team trend, which marginally favours a draw.

the teams have been found the program prompts for the match result and gives the option to modify any details before final acceptance of the result. On final acceptance the league table details in terms of Win, Draw, Lose, Goals For, Goals Against and Total Points for both teams are adjusted accordingly. When all entries are complete the '*' is typed in place of the home team name and the program moves to the league sort routine in lines 11510—11590. The sorting is done with a standard ripple sort initially by total points but if two or more teams have the same number of points the sort is by goal difference.

File and recall league table

Lines 13010—14150 are standard filing routines but with the addition of a password facility to protect your data files. The program is designed to use a five-letter password but this was only to enable me to use my surname. If a different length password is required then the loop size in line 21220 must be changed accordingly. If, when recalling the league tables, the wrong password is given, the file is closed and the program returns to the option menu. At no time is the password visible on screen and it is only stored as a string variable for enough time to be checked.

League table display

All seven leagues are displayed sequentially and paging to the next one is achieved by pressing the space bar (lines 15010—15120). The details are displayed in condensed form in order to fit a complete table onto the PET's screen. Consequently a number under the WDL column, such as 20104, is interpreted as won 2, drawn 1, lost 4, and a number under the FA column such as 806 is interpreted as Goals For 8, Goals Against 6.

Forcast results

To forecast the result of a match the identification strings for both teams must be entered, eg 'LEE' and 'ARS' are required for the match Leeds United v Arsenal (lines 12010—12510). Having searched for and found the two teams, the forecast is presented as in Figure 1. Four sets of information are presented, three based on total performance for the season to date and one based on the recent trends of both teams. Details of the analyses are:

1. Result probability (lines 12150—12207). The home team's empirical probability of winning at home is based on its previous performances at home, thus:

Probability of win =

$$\frac{\text{No of home wins}}{\text{No of home matches played}}$$

The away team's empirical probability of losing away from home is similarly:

Probability of loss =

$$\frac{\text{No of away losses}}{\text{No of away matches played}}$$

In order for the result to be a home win the home team must win and the away team must lose. As we can calculate two separate probabilities for these events, the overall probability is taken as the average of the two individual probabilities ie:

Prob'y of home result =

$$\frac{\text{Prob'y of home team win + Prob'y of away team lose}}{2}$$

By similar arguments the draw and away win probabilities are calculated.

2. Match score (lines 12240 — 12350). The number of goals scored by the home team is related to its own scoring performance at home but also to the away team's record of conceding goals away from home. Therefore, the home team score is taken as the average of what it scores at home on average and what the away team concedes away on average.

Home team goals =

$$\frac{\text{Home team ave home score + Away team ave away concede}}{2}$$

The away team's score is calculated by similar logic but involving its away scoring record and the home team's record of conceding.

3. Relative league position (lines 12380 — 12410). This is a simple statement of how much higher up the league one team is over the other.

4. Exponential trend (lines 12444 — 12462 and lines 22100 — 22230). This is the most powerful and probably the most useful part of the forecast. It is based on the double exponential smoothing (see my earlier article) of both home and away performance of every team in the leagues. The values of α and β are set at the beginning of the program in line 150. Variable XP corresponds to α and is set at 0.2. XT corresponds to β and is set at 0.07. These settings should not be taken as optimum values but are my personal initial values and should be adjusted in the light of experience. The exponential smoothing is done on the basis of points scored in each match so that if a team has a home record which averages out at a draw, its forecast of points for the next match is one point. If it wins that next match it scores two points and the forecast for the following match is correspondingly higher, say 1.2 points (depending on the values of α and β). That is, it is seen as more likely to win.

Obviously if a sequence of wins occurs the forecast approaches nearer to two, whereas a sequence of losses pushes the forecast towards zero. A run of draws maintains the forecast around one. The actual calculation of forecasts is done immediately following a match

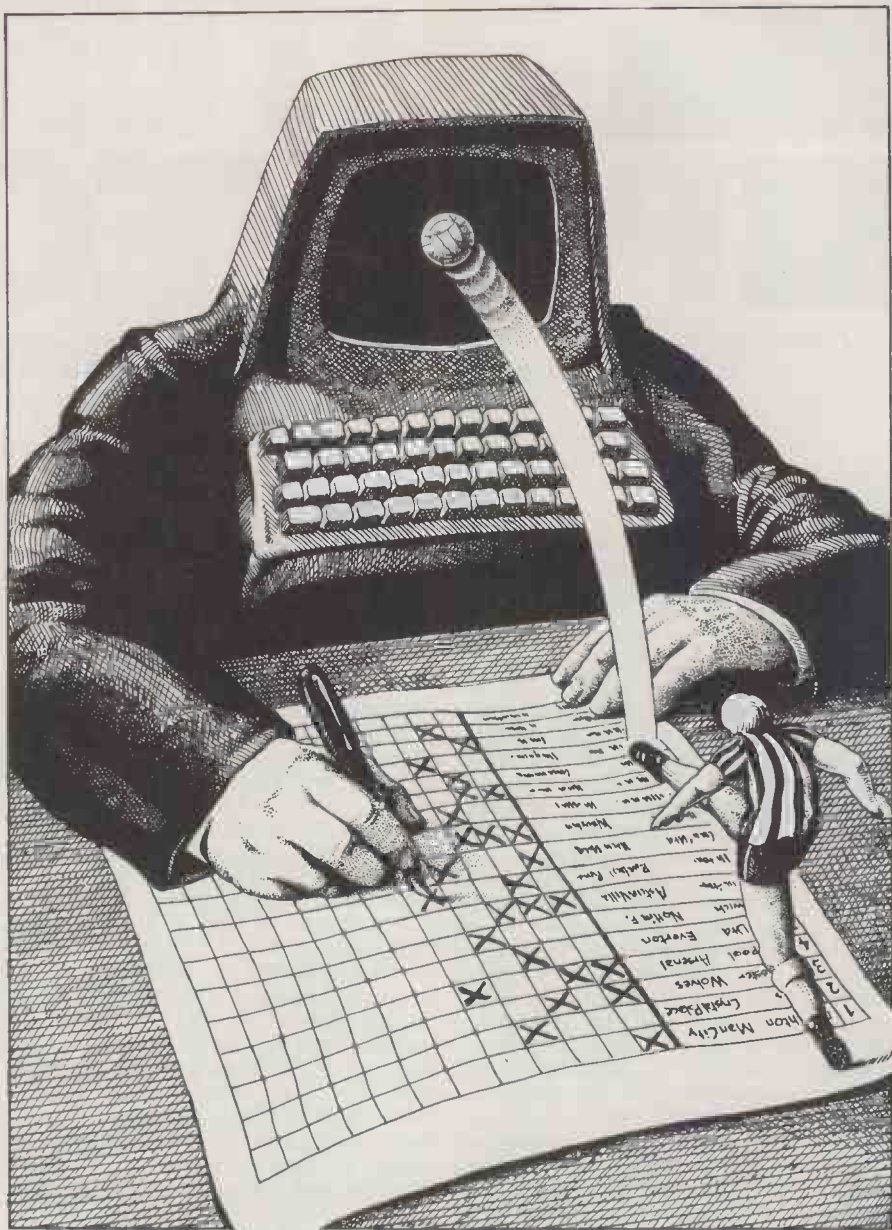

Illustration by Ingram Pinn

result entry in that section of the program (lines 11290 — 1299). A check is incorporated to ensure that the forecast does not go below 0 or above two. Two separate forecasts are given for the match result based on the home team's home trend and the away team's away trend.

Finally, an average of the two predictions is given. The individual predictions based on trend are given by the two hearts on the scale in Figure 1 and the average trend prediction is shown by the double spade symbol. If only one heart symbol shows on the scale this is because both individual predictions are identical and one symbol overlays the other. The scale on the display is not intended to represent any actual calculation but is there as an indication of the strength of the forecast. The white area is intended to represent the draw prediction. If you want to increase or reduce this area for your own needs the appropriate lines to be modified are 21130 and 21135.

Interpreting the information

This is obviously a matter of personal opinion but I have checked this program over a number of weeks of the 1979/80 season and my preliminary conclusions are as follows. The individual trend figures are the most important with the away team's trend being slightly more significant. If these predictions are in gross conflict then the average trend figure in conjunction with the total season's analysis is used. Which elements of the season's analysis are more important than others I have not yet determined but careful monitoring should enable you to make a decision on this.

Referring to the match in the photograph, Leeds United's recent home performances indicate a draw bordering on a home win. Arsenal's away record recently indicates a home win. I would see this match as a marginal home win in spite of the seasonal analysis which in my opinion is not strongly against this. On its own the seasonal analysis suggests a draw.

This program will not guarantee eight draws but it will eliminate the majority of the non-draws. Remember, however, that chance and random events such as injury and the weather do play their part.

Finally, I shall be using this program this season and I hope to win. I hope you do too!

Note: as designed, the program requires approximately 14k of RAM. This is mainly because of ten arrays each of 130 elements. If you have a PET with only 8k of RAM then the best approach is to modify the program to handle one league display routine (15010 to 15120) arrays are redimensioned at 24 and the league display routine 15010 to 15120) dispensed with it should fit 8k. Don't forget to adjust all loops which are currently set at 130 cycles.

Disclaimer: Neither PCW nor the author will accept any responsibility if, by using this program, you fail to win your fortune — as the author points out, a great many unforseeable factors can influence the result of a football game. Of course, if you do win a fortune, we hope you'll remember PCW. . .

```
1 IFST<>0THENPRINT" LOADING ERROR    ST =";ST:END
100 PRINT""
105 DIMN$(130),HR(130),HG(130)
110 DIMAR(130),AG(130),PP(130)
115 DIMFH(130),FA(130),TH(130),TA(130)
150 XP=.2:XQ=1-XP:XT=.07:XS=1-XT:TL=(((2/XP)-1)/2)+1
1001 GOSUB21011 GOSUB23000:GOSUB23001
1002 PRINT"  FOOTBALL RESULT FORECASTER  "
1004 PRINT"  OPTION MENU  ":GOSUB23001:GOSUB23002
1010 PRINTTAB(7);"1  ENTER LEAGUE TABLES"
1015 PRINTTAB(7);"2  ENTER MATCH RESULTS"
1020 PRINTTAB(7),"3  FORECAST RESULTS"
1025 PRINTTAB(7) "4  FILE LEAGUE TABLES"
1030 PRINTTAB(7) "5  RECALL LEAGUE TABLES"
1035 PRINTTAB(7);"6  DISPLAY LEAGUE TABLES":IFEN=0THEN1045
1040 PRINTTAB(10);"LEAGUE TABLES LOADED"
1045 PRINT"":GOSUB23003:GOSUB23001:GOSUB23004
1048 PRINT"          ALAN GREEN   1980"
1050 GOSUB20620:OP=ASC(Z$):IFOP>48ANDOP<55THEN1070
1065 GOTO1050
1070 ONOP-48GOSUB10010,11010,12010,13010,14010,15010
1099 GOTO1001
10010 IFEN=1THEN10620
10020 FORI=1TO130:PRINT"":GOSUB20510
10040 PRINT"";D$;"   TEAMS";LS;"-";LF
10050 PRINT"TEAM";I;:INPUT"(11 LETTER MAX) ";N$(I):IFLEN(N$(I))<12THEN10060
10054 PRINT"":GOTO10050
10060 PRINT"HOME RESULTS":GOSUB20710:HR(I)=X:HG(I)=Y
10080 PRINT"AWAY RESULTS":GOSUB20710:AR(I)=X:AG(I)=Y
10100 INPUT"TOTAL POINTS ";PP(I):PRINT
10110 GOSUB20810
10120 IFZ$="Y"THEN10150
10130 IFZ$="N"THEN10040
10140 GOTO10110
10150 NEXTI EN=1
10510 PRINT"FORECASTS FOR EXPONENTIAL SMOOTHING":GOSUB23005
10520 PRINT"    ENTER HOME AND AWAY FORECASTS     ":GOSUB23005
10530 PRINT"0=SURE TO LOSE  1=DRAW  2=SURE TO WIN ":GOSUB23005
10540 PRINT"________________________________________"
10550 PRINT"       TEAM          HOME     AWAY"
10560 FORI=1TO130:PRINT"
10580 PRINT"";I;TAB(6);N$(I)
10590 INPUT"";FH(I)
10600 INPUT"";FA(I)
10610 NEXTI:RETURN
11010 PRINT"", GOSUB23000:GOSUB23001
11015 PRINT"  ENTER MATCH RESULTS  "
11016 PRINT"                         "
11020 PRINT"  TO FINISH TYPE '*'  ":GOSUB23001:GOSUB23004
11040 HT=0:INPUT" HOME TEAM ";H$:HL=LEN(H$)
11050 IFH$="*"THEN11510
11060 AT=0:INPUT" AWAY TEAM ",A$:AL=LEN(A$)
11070 FORI=1TO130
11080 IFH$=LEFT$(N$(I),HL)THENHT=I
11090 IFA$=LEFT$(N$(I),AL)THENAT=I
11100 IFHT>0ANDAT>0THEN11140
11130 NEXTI:PRINT" TEAM NAME ERROR...RE-ENTER    ":GOTO11040
11140 PRINT" ENTER THE MATCH SCORE"
11150 PRINT" ";N$(HT);:INPUTHG:PRINT" ";N$(AT);:INPUTAG:PRINT
11170 GOSUB20810 IFZ$="Y"THEN11210
11190 IFZ$="N"THENPRINT" EDIT ALL MATCH DETAILS    ":GOTO11040
11200 GOTO11170
11210 HG(HT)=HG(HT)+HG*100+AG:AG(AT)=AG(AT)+AG*100+HG
11230 IFHG>AGTHENHM=10000:AM=1:Q1=2:Q2=0:GOTO11260
11240 IFAG>HGTHENHM=1:AM=10000:Q1=0:Q2=2:GOTO11260
11250 HM=100:AM=100:Q1=1:Q2=1
11260 HR(HT)=HR(HT)+HM:AR(AT)=AR(AT)+AM:PP(HT)=PP(HT)+Q1:PP(AT)=PP(AT)+Q2
11290 FX=FH(HT):FH(HT)=FX*XQ+Q1*XP
11291 TX=TH(HT):TH(HT)=XT*(FH(HT)-FX)+(XS*TX)
11292 FH(HT)=FH(HT)+(TL*TH(HT))
11293 IFFH(HT)>2THENFH(HT)=2
11294 IFFH(HT)<0THENFH(HT)=0
11295 FX=FA(AT):FA(AT)=FX*XQ+Q2*XP
11296 TX=TA(AT):TA(AT)=XT*(FA(AT)-FX)+(XS*TX)
11297 FA(AT)=FA(AT)+(TL*TA(AT))
11298 IFFA(AT)>2THENFA(AT)=2
11299 IFFA(AT)<0THENFA(AT)=0
11310 PRINT"THIS RESULT ADDED TO LEAGUE TABLES":GOSUB20910:GOTO11010
11510 GOSUB21011
11511 GOSUB23000 GOSUB23001
11515 PRINT"  ADJUSTING ALL LEAGUE TABLES  "
11516 PRINT"                                "
11517 PRINT"    FOLLOWING LATEST RESULTS   ":GOSUB23001
11521 PRINT""
11522 GOSUB23003:GOSUB23001:GOSUB23004
11525 PRINT""
11530 FORI=1TO130:LS=0:GOSUB20510
11560 IFLS=0THEN11780
11565 PRINT"";TAB(8);D$
11570 FORK=1TO(LF-LS):PRINTTAB(22);"RIPPLE";K:M=0
11590 FORJ=LSTOLF-K
11600 IFPP(J)>PP(J+1)THEN11750
11605 IFPP(J)<PP(J+1)THEN11660
11610 Y=HG(J)+AG(J):GOSUB20410:G1=F-A:Y=HG(J+1)+AG(J+1):GOSUB20410:G2=F-A
11650 IFG1=>G2THEN11750
11660 X$=N$(J):X1=PP(J):X2=HR(J):X3=HG(J):X4=AR(J):X5=AG(J):X6=FH(J):X7=FA(J)
11680 N$(J)=N$(J+1):N$(J+1)=X$
11690 PP(J)=PP(J+1):PP(J+1)=X1
11700 HR(J)=HR(J+1):HR(J+1)=X2
11710 HG(J)=HG(J+1):HG(J+1)=X3
11720 AR(J)=AR(J+1):AR(J+1)=X4
11730 AG(J)=AG(J+1):AG(J+1)=X5
11734 FH(J)=FH(J+1):FH(J+1)=X6
11736 FA(J)=FA(J+1):FA(J+1)=X7:M=1
11750 NEXTJ
11760 IFM=0THEN11775
11770 NEXTK
11775 PRINTTAB(22);"SORTED    "
11780 NEXTI:RETURN
12010 PRINT"";:GOSUB23000:GOSUB23001
12015 PRINT"  RESULTS FORECASTER  "
12016 PRINT"                       "
12020 PRINT"  TO FINISH TYPE '*'  ":GOSUB23001:GOSUB23004
12040 HT=0:INPUT" HOME TEAM ",H$:HL=LEN(H$)
12050 IFH$="*"THEN12510
12060 AT=0:INPUT" AWAY TEAM ",A$:AL=LEN(A$)
12065 PRINT" SEARCH FOR TEAMS"
12070 FORI=1TO130:PRINT"";TAB(18);I
12080 IFH$=LEFT$(N$(I),HL)THENHT=I
12090 IFA$=LEFT$(N$(I),AL)THENAT=I
```

GOTO page 133

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BACKGAMMON

Lady Luck poses more than a few problems for David Levy in this month's look at Backgammon

The game of backgammon introduces special problems into the tree search. Some of these problems are caused by the fact that, before s/he decides what move to make, a player must throw a pair of dice and only then will s/he know which 'moves' are legal. The very fact that two dice can be thrown in 21 different ways gives rise to an enormous branching factor and this is the source of the second major problem. In this month's article we consider how these problems might best be approached. We also examine a strategy for determining when to make or accept a double.

The opening move of a backgammon game is easy for a computer program. Depending on how the dice appear, there are set moves which have been shown by experience to be best. The program merely stores these moves in a table and makes the move corresponding to the particular fall of each die. It is what happens after the first move that is interesting. Let us first consider a program which performs only a one-ply search.

The program need not begin to 'think' until after the dice have been thrown, since it is only then that its possible moves are known. For a one-ply search there is little difference between a backgammon program and a chess program — an evaluation function provides a score for the terminal nodes and the program chooses the move which leads to the highest scored terminal node. We shall discuss the evaluation process in more detail later in this article. Here it is only necessary to comment on the fact that when one player throws a double (1,1) or (2,2), etc, he makes two sets of moves, as though he had thrown four individual dice. This can be accounted for easily enough by calculating every possible way of playing the double throw, and making each of these ways into one branch of the tree.

Probabilistic trees

Once the search extends beyond one ply, the trees become probabilistic. We have already encountered such trees in another form, earlier in this series. The tree in Figure 1 will enable the reader to understand the problem.

Let us assume that it is the program's turn to move from the root of the tree after the dice have been thrown. Berliner has calculated that in an average board position there are roughly 40 possible ways of making each move but that in typical game positions (assuming sensible play) the number drops to around 17. So from the root of the tree the program can choose from the moves M_1, M_2, ..., M_{17}. Let us assume that we first examine move M_1. In a one-ply search we would apply the evaluation function to the resulting position and back up the score S_1 to the root of the tree, assigning to S the value of the best score found so far.

After the program makes move M_1, its opponent throws the dice. The move $M_{1,(11)}$ corresponds to the opponent throwing double 1 after the program has played M_1. The move $M_{1,(12)}$ corresponds to the opponent throwing a 1 and a 2 after the program makes the move M_1. Thus, there are 21 possibilities to consider after the program makes the move M_1. Associated with each of these possibilities there is a probability measure. $P(11)$ corresponds to the probability of the opponent throwing a double 1 (which is 1/36). $P(12)$ is the probability of throwing a 1 and a 2 (which is 1/18). In fact the probability of throwing each particular double is 1/36 and the probability of each of the other possible combinations of the die is 1/18.

Let us see what happens if the program's opponent throws a double 1. He then has the choice of the (roughly) 17 moves which we denote by $M_{1,(11),1}$, $M_{1,(11),2}$ ... $M_{1,(11),17}$. For each of these 17 moves the program applies its evaluation function to the resulting position, and the best of the 17 scores is backed-up to $S_{1,(11)}$. Corresponding to the opponent's throw of a 1 and a 2 there are once again some 17 moves: $M_{1,(12),1}$, $M_{1,(12),2}$ ... $M_{1,(12),17}$, each of which has its own associated score. The best of these scores is backed-up to $S_{1(12)}$.

Once we know the values of the scores $S_{1,(11)}$, $S_{1,(12)}$, ... $S_{1,(66)}$, we would like to back-up these scores to S_1 so that S_1 represents the best of these scores. But the program's opponent cannot choose how the die will fall and so he is unable to choose whether S_1 has the value of $S_{1,(11)}$ or some other backed-up value. The actual merit of the node at a depth of one ply is, therefore, not the merit of the best node at two ply, but a weighted sum of the two ply scores — the weightings corresponding to the probabilities of the various throws of the die. Thus, there is a probability of 1/36 that the program's opponent will be able to choose for his value of S_1 and backed up score $S_{1,(11)}$. There is a probability of 1/18 that the program's opponent will be able to choose for S_1 the value of $S_{1,(12)}$. And so on. The actual score which should be assigned to S_1 is therefore:

$S_1 = (1/36 \times S_{1,(11)}) + (1/18 \times S_{1,(12)}) + (1/18 \times S_{1(13)}) + \ldots$

The size of tree and how to cope with it

It will already be clear that, in order to perform the equivalent of a two-ply search, the program must do a lot of three-ply work. Some of this work is very fast: the moves at the second ply are nothing more than the throw of the die and these remain fixed for the whole game, as do their probabilities; they can be stored in a simple table. But the choice that arises after the throw requires a legal move generator, which may also be table driven but which increases the branching factor to approximately 17 x 21, or 357, though this number *can* rise to over 800. Since it is impossible to choose how the dice will fall, the alpha-beta algorithm has no place in the tree search. The program must examine every possibility from a node before backing-up. There is, however, another method of pruning the tree, which in some ways is analogous to alpha-beta pruning.

Let us assume that M_1 is, in fact, the best move that the program can make. After calculating the scores and backing-up to S_1, the program knows the value of making the move M_1. It then begins to look at the move M_2, and it calculates the score S_2 by adding: $(1/36 \times S_{2,(11)}) + (1/18 \times S_{2,(12)}) + (1/18 \times S_{2,(13)}) + \ldots$ and since M_1 is better than M_2, the score S_1 will be higher than S_2 (I have assumed that we are following the normal convention under which high scores are good for the program and low, or negative, scores are good for its opponent).

To determine that S_1 will be higher than S_2, if we examine M_1 before M_2 it will be necessary to sum all 21 terms in the expression for S_2. But what happens if we examine the moves in the reverse order, with the worst move being examined first? To show that M_{16} is better than M_{17} it will not necessarily, be essential to add all 21 terms in the expression for S_{16}. It might be the case that after adding only 18 of the terms, the score would already be better than that of S_{17}. From that point on it is no longer important in the relationship between M_{16} and M_{17} whether the three remaining terms in the expression for S_{16} add up to a relatively small or large number. We know for certain that S_{16} is larger than S_{17}. Unfortunately, the whole of the pruning process is not this simple. In order to know that S_{15} is greater than S_{16} we *do* need to know the exact total of the 21 terms in S_{16}. So how can we afford to prune certain parts of the tree?

The answer lies in an analogy argument, which involves some approximation and hence some risk. But I doubt that it will give rise to serious errors.

It seems reasonable to argue that if, in position A, the results of n of the 21 possible throws add up to something better than the results of the same n throws in position B, then position A is better than position B. This is certainly true when n=21, and it is least likely to be true when n=1. Readers can experiment to see how low n can become without producing large errors in comparing two nodes. The important thing to remember is that we choose a 'cross section' of possible throws — at least one throw with a 1, one throw with a 2, and so on. The absolute minimum number of throws to be compared is three, for example 1 and 2, 3 and 4, 5 and 6. I would expect it to be true that if
$S_{1,(12)} + S_{1,(34)} + S_{1,(56)} > S_{2,(12)} + S_{2,(34)} + S_{2,(56)}$, then $S_1 > S_2$.

Of course there would be exceptions to this generalisation, but the number of exceptions ought to be a small price to pay for cutting down the possible throws of the dice from 21 to only 3.

When we consider a deeper tree, which takes into account the first two moves by the program and the first reply by its opponent, instead of examining a three-ply sequence we are, in fact, looking at a five-ply probabilistic tree. The number of nodes on this tree will already be so large that, without alpha-beta pruning, it is very doubtful whether a micro-program can search it within an acceptable time span, and alpha-beta pruning is not possible because of the nature of the tree — a player does not have complete freedom of choice because of the dice. The tree in Figure 2 will illustrate the magnitude of the problem. Since none of the scores at any ply can be known until *all* successor moves from that node have been examined, there is no way that alpha-beta can be employed. Of course forward pruning is always possible, using either the apparent merit of a node as measured by the evaluation function or the backed-up merit as determined from an extra ply of look-ahead (which would be slow) but this is all that one can do.

The Evaluation function

Backgammon can be divided into two distinct stages. For most of a game the two sides are 'engaged'. That is to say, there are one or more opposing men standing between one or more men and the inner table. Once this stage is over the two sides are 'disengaged', and the game becomes a race to 'bear off' all of one's men; the first player to do this is the winner.

During the engaged stage there are two features of paramount importance. Berliner, who as well as being a former World Champion at correspondence chess is also the world's leading backgammon programmer, calls these features 'Blot Danger' and 'Blockading Factor'. A blot is a single man on a point, which is liable to be 'hit' by an opposing man landing on the same point. The blot is then sent off the board onto the bar, and must remain there until that player throws a dice in such a way as to allow the man on the bar to move to a point which is not blockaded by the opponent. By hitting many of your opponent's blots you force many of his men onto the bar and thereby slow down his progress around the board. Berliner's blot danger feature finds the optimal way to play every potential roll of the dice so as to hit the greatest number of blots, or to hit the most advanced blot(s) if there is a choice of equally powerful plays.

It is a relatively easy matter for the program to compute the probability of one side or the other landing on a point where his opponent has a blot. Clearly the blot danger feature must use such a calculation in order to arrive at an accurate estimate of danger, which in turn will discourage the program from making moves which leave vulnerable blots. In any game where chance plays a part it is impossible to be sure that a particular strategy will be foolproof, but it makes good sense to play with the odds.

The notion of a blockade is very important in impeding the progress of your opponent's men, since an enemy man cannot land on a blocked point (ie a point with two or more of your own men on it). Setting up a succession of adjacent blockades is a particularly powerful strategy if it can be successively adopted because it prevents the opponent from moving unless he is lucky enough to roll high numbers from a point just on one side of the blockade. Berliner's program considers every combination of from zero to seven blockading points (seven is the maximum number possible, since each side has only 15 men), at a distance of from one to 12 points in front of each man. It employs a table of these blockading patterns to store the number of rolls of the dice that could legally be played by the side who is trying to pass the blockade. This number indicates the extent to which each man is blockaded.

When the two sides' men become disengaged, the 'running game' begins, so called because each player's men run as fast as possible towards the inner (or home) table. At this stage of the game it is possible to estimate fairly accurately the probability that a particular player will win the game by bearing off all his men before his opponent is able to do so. One method of doing this is to 'count' the position — simply add up the number of steps each man must take before he can bear off, assuming no wasted motion. This count can be employed in a simple table to determine the odds of winning, and such tables are found in most backgammon books. For example, the books will tell you that if your count is 60 and your lead over your opponent is four when it is your turn to roll, the odds are eight to five in your favour. Until the last few moves of the game, when special heuristics apply, it is relatively simple for the program to decide which men to move and in many situations it will make no difference. But it is just in this stage of the game that the complication of the doubling cube becomes of paramount importance.

Backgammon is traditionally played for stakes. One of the essential elements of a backgammon set is a cube with the numbers 2, 4, 8, 16, 32 and 64 on the faces. If a player feels that he has a good chance of winning he may put the cube with the 2 face uppermost, at which point his opponent must either resign or agree to play the game for double the usual stake. Having accepted a double a player may, later in the game, double again, by turning the 4 face uppermost.

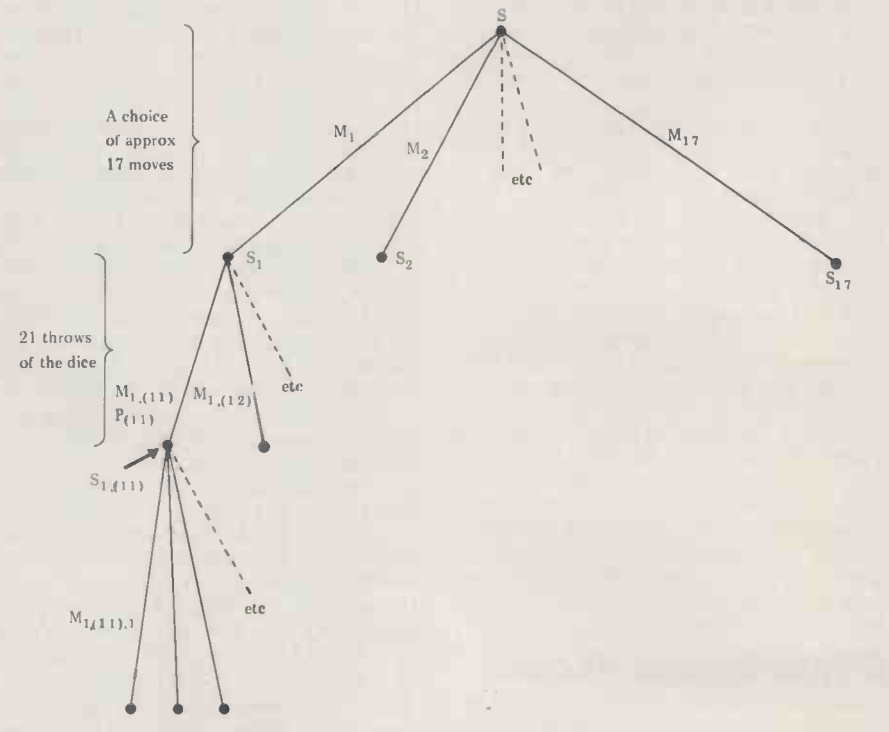

Fig 1 One move by the program and one by its opponent

This process may continue until the players are wagering 64 times the original stake — people have won and lost fortunes through the doubling cube.

Not surprisingly, statisticians have calculated formulae which indicate when a player should double and when a double should be accepted and these formulae are obviously easier for a program to apply than for a human. There is, however, an important psychological aspect to doubling. If most players double when their probability of winning is around 0.6, it will be better to double at 0.7 and keep your opponent in the game (if he assumes that he still has some chance he will be less likely to resign, and you will win twice as much). Of course if both players can calculate perfectly one will always resign when the other doubles, and neither will double until the 'correct' moment.

Backgammon books give quite a lot of useful information on when a player should double and when a double should be accepted. This makes the programmer's task easier, and helps to reduce the element of skill in the game below its normally tiny amount. My own view of the game is that it is rather shallow, with virtually no scope for brilliant or imaginative play but with features that allow a fast mind to score a steady though slight advantage against a player with a lesser facility for calculation. It can be a fun game to program, with plenty of scope for neat graphics work and the problem of coping with the enormous trees certainly makes it a challenge to the serious games programmer.

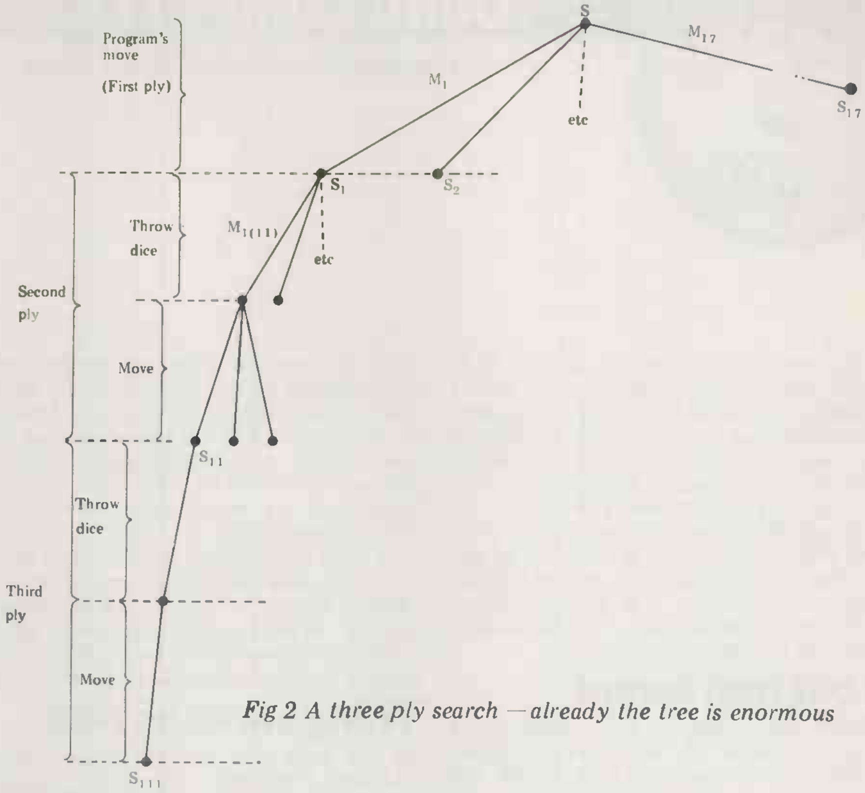

Fig 2 A three ply search — already the tree is enormous

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Berliner, H. *Experiences in Evaluation with BKG — A Program that plays Backgammon. Proceedings of the fifth International Joint Conference on Artificial Intelligence* 1977, pp. 428-433.

Keeler, E.B., & Spencer, J. *Optimal Doubling in Backgammon. Operations Research*, Vol. 23, No. 6, Nov-Dec 1975, pp. 1063-1071.

YOUNG COMPUTER WORLD

Compiled and written by Derrick Daines

I enjoyed my appearance at the *PCW* show immensely, feeling very proud standing beneath a Young Computer World banner and an artist's blow-up of Abigail's 'Computer Kid' design which we adopted. It was great to meet so many readers and contributors — it would take this entire issue of *PCW* to tell you about them, but as the editor is already beginning to mutter darkly about a take-over bid from YCW, I can't be so ambitious. I'll do what I can over the next few months.

Lost and found

Would the character who strolled off with a couple of books please return them? They were on the stand for discussion, not as handouts! They're *Computer Bits And Pieces* and *Man Meets The Computer* and are stamped inside with our school name. We need 'em!

It was very late when I left the Cunard Hotel after the Show closed. The loading bay at the back was deserted and there I met a very lonely computer looking for its owner. If anyone reading this thinks that it's theirs and can provide the type and serial number, I'll be glad to return it.

Superman

One gentleman went out of his way at the Show to give me a comic. I was surprised at first — how young did he think I was? — but he pointed out that the cover burbled about "a complete 28 page bonus Superman story". When you turned to the extra pages, it proved to be true — 28 pages of Superman, daringly doing his duty and devotedly undoing the dastardly deeds of Major Disaster. Wow! But — what's this? — aided by two primary school kids and their TRS-80?????!!

My first reaction was disapproval. Disguising advertising as a bonus story struck me as being rather underhand. However, the advertising was open enough, so I revised my opinion and read it for enjoyment. (Yes — I sometimes pinch my kids' comics!) I finished it feeling only mild disapproval.

Firstly, although the writers had got in some very good teaching points about computers, with Superman doing the explaining, the comic is American — and Americans share with the Russians the conviction that they have invented everything. This comes out in the storyline, which is otherwise quite innocuous.

Secondly, here is Superman saving a plunging airliner and he needs to know acceleration, speed, gravity, kinetic energy, etc, which the kids supply in seconds, aided by their TRS-80. Stirring stuff — but stupid. The punch line is: "Think as fast as Superman with a TRS-80!" No mention of programming time. No mention of the need to know what you're doing before you get a computer to do it. No mention of a data-base on disk or tape — or even printed. There is not even any hint of the time needed to learn how to handle the computer — the kids just grab the thing and do it!

I can't help thinking that if any sales are made because of this form of advertising — which I doubt — the advantage will be offset by disappointment. Still, a 28 page advertisement may earn them a place in the *Guiness Book Of Records*.

Things are moving

By the time that this appears in print, Richard Fothergill will have started work at his new job as the first Director of the £9 million micro-electronics in schools programme. He's got a lot of work to do and just about everything that he does will affect education, the computer manufacturing industry and, eventually, society at large. That's a king-sized job, but judging by his past record, Fothergill is just the man to do it. We wish him luck. We mustn't, however, expect too much too soon. It's extremely difficult to overcome entrenched attitudes and time-consuming to call vital meetings. We must also face the fact that £9 million is not much in view of the need. Perhaps one of Fothergill's first tasks should be to prepare a case for more lolly.

Programs received

Multiplication Spaceships by Ian Dickinson (15) of Whitby.
Racetrack by M N Darby (16), of Dudley.
Compukit Derby by Richard Freeman (14), of Welwyn Garden City.
Track Race and Blockade by Torstein Kongshem of Oslo.
Bank Account Reminder, History Quiz and Electronics Calculator by Simon Meldrum (8), of Ipswich. (Isn't he too young to have a cheque book of his own?)
Gomoku by Christopher Burrows (15), of Maldon.

May I make a point here? You will see that three of our readers have sent in very similar games, which underlines what I wrote last month — devising *new* games or applications is extremely difficult. Don't get me wrong — I love getting all these programs, but if you can manage something new, you have a much greater chance of your program being published and paid for.

Finally for this month, several people at the *PCW* Show asked me if it was possible to obtain listings of programs which we have mentioned but not published. This is not possible for a number of reasons, chief among them being the sheer size of the administrative task this would entail. Besides, it would be illegal for us to distribute copies of listings that we have not paid for!

What I can do is to put enquirers in touch with authors, so starting from this month I shall compile a book of names and addresses of young authors. If you would like to get in touch with them, send me a stamped addressed envelope and I will let you have the address of the youngster concerned. Conversely, if any of my young correspondents do *not* wish to be bothered by other mail, they can let me know and I will respect their privacy.

PET Simon

by Jonathan J Dick

```
190 DIM A(4),B(4),C(4),S(4),W(4),KY(9),SQ(50)
200 POKE59468,12:REM*GRAPHICS MODE*
210 PRINT"J":REM*CLEAR SCREEN*
220 A(1)=0:B(1)=128:A(2)=20:B(2)=128:A(3)=224:B(3)=129:A(4)=244:B(4)=129
230 C(1)=160:C(2)=127:C(3)=102:C(4)=81
240 REM
250 REM POKE IN MACHINE-CODE SUBROUTINE
260 REM
270 FORI=826TO855:READA:POKEI,A:NEXT
280 REM
290 REM
300 REM
310 REM DATA FOR MACHINE-CODE SUBROUTINE WHICH INSTANTLY FILLS A QUARTER
320 REM OF THE SCREEN WITH A SPECIFIED CHARACTER
330 REM
340 REM
350 DATA 162,12,160,0,165,180,145,177,200,192,20,208,249,24,169,40,101,177,133
360 DATA 177,169,0,101,178,133,178,202,208,229,96
370 REM
380 REM
390 REM
400 REM A() AND B() ARE SCREEN POSITION ARRAYS
410 REM C() HOLDS THE CHARACTERS FOR EACH QUARTER
420 REM S() HOLDS THE SOUND FOR EACH QUARTER
430 REM RN() HOLDS THE VALUES FOR THE DEMO OF GAME
440 REM KY() HOLDS THE DECODING VALUES FOR THE NUMBER KEYS
450 REM W() HOLDS THE PATTERN FOR THE SCREEN CLEAR OF THE TITLE
460 REM SQ() HOLDS THE SEQUENCE SO FAR
470 REM 'SO' IS ADDRESS TO POKE SOUND NOTE TO
```

GOTO page 135

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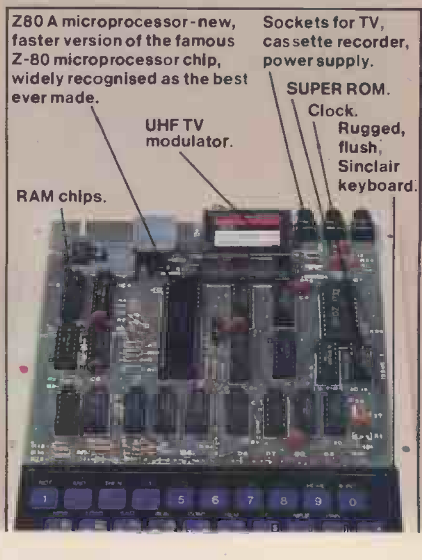

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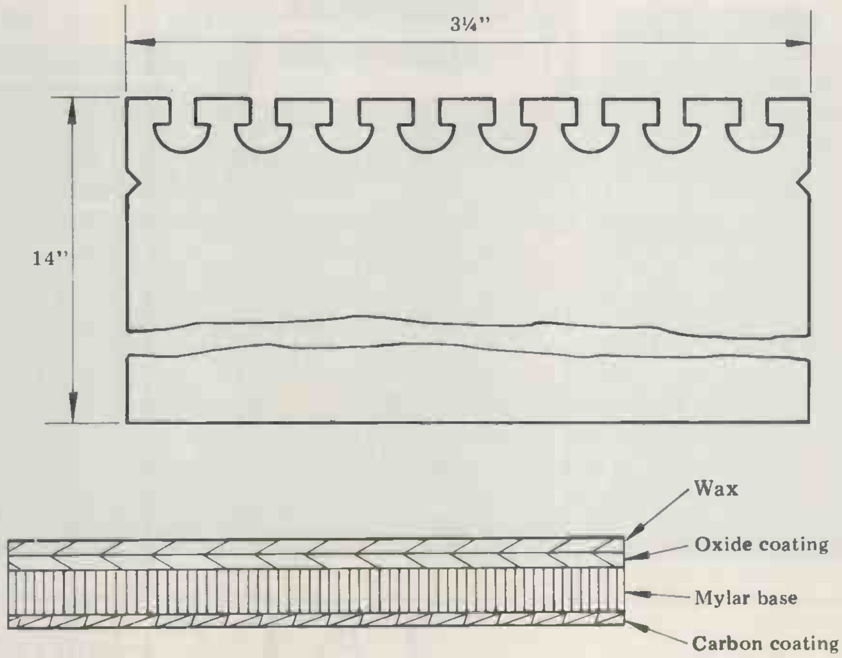
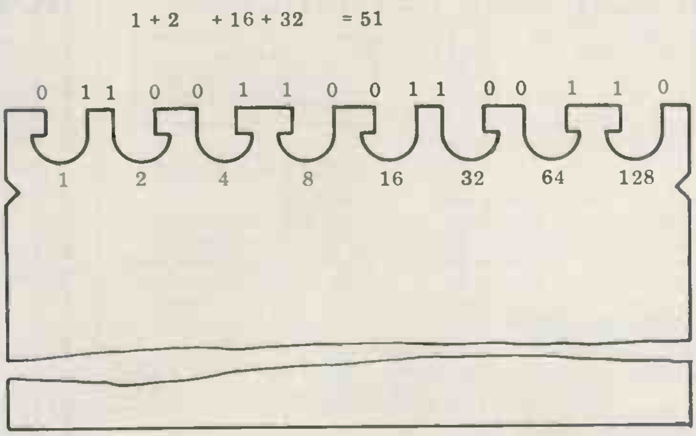
CRAM

Followers of our series 'Gateways to Logic' may remember a passing reference to Granny's red flannel nightie. This reminded David Tebbutt of a fearsome device he encountered many years ago. . .

Derrick Daine's description of a binary selection box ('Gateways to Logic', PCW Oct 1980) reminded me of a similar technique used in the early sixties on large mainframe computers. In those days mass data storage tended to be on magnetic drums or magnetic tape. The disadvantage of a drum was that it couldn't be exchanged, so as the database grew the only option was to increase the number of drums. The advantage of a drum was that each track possessed its own read/write heads so access to data was never more than the time taken for a single drum revolution. The disadvantage of a magnetic tape was that to access a single record it was necessary to pass over all the records between the previous position and the new record. Many system design courses spent a large proportion of their time describing how files should be designed and manipulated to minimise the effect of this problem. In the end the answer was to sort records into the same sequence for each of the tapes being processed and then to run the program, pulling the records in order and skipping over those not required. Effective but slow and tedious.



CRAM card



Card number 51 encoded

In the late fifties someone in NCR had the bright idea of a card-based Random Access Memory device (CRAM) which combined the rapid access of the drum with the high volume, exchangeable storage offered by tape. The 6cwt CRAM unit simulated a drum by wrapping a sheet of magnetic material around a revolving capstan and exchanging one sheet for another under program control. The sheets, or cards as they were called, were made of mylar material coated on one side with carbon to help dissipate static electricity and on the other with a magnetic oxide covered with wax. Each card measured about 3¼in x 14in x .005in and was supplied in a 'deck' varying in content between 128 and 384 cards. Each card could be imagined as a number of strips of magnetic tape laid side by side along the length of the card. The number of tracks varied according to the method of data recording, parallel encoding having seven tracks and serial either 56 or 144.

At the top of each card was a series of notches which, according to their shape, represented a binary 0 or 1. In this way a card containing eight notches could be made to represent any value between 0 and 255 — a familiar fact to most PCW readers. This then gave the programmer the ability to address any individual card regardless of its physical location within the pack. Some later packs contained 384 cards, achieved by having nine slots but only using eight of them — slot eight being zero whenever slot nine had a value of 1.

As mentioned earlier, the data were arranged in either serial or parallel form on the face of the card depending on the particual CRAM model concerned. In the early days data were held on eight bit wide tracks, six bits for data, one for parity and one for 'clocking' and each card contained seven such tracks. Later models recorded data on 56 or 144 single bit tracks in 14-bit 'words'. Clocking on these models was automatic and parity was taken care of by two of the 14 bits — ie six bits plus one parity bit, twice.

In this way the largest and most recent CRAM deck was capable of holding 145,041,408 data characters. Not bad for an exchangeable fast access device, huh?

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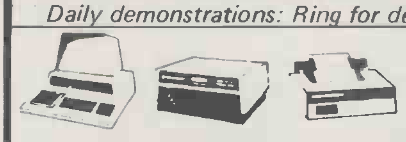

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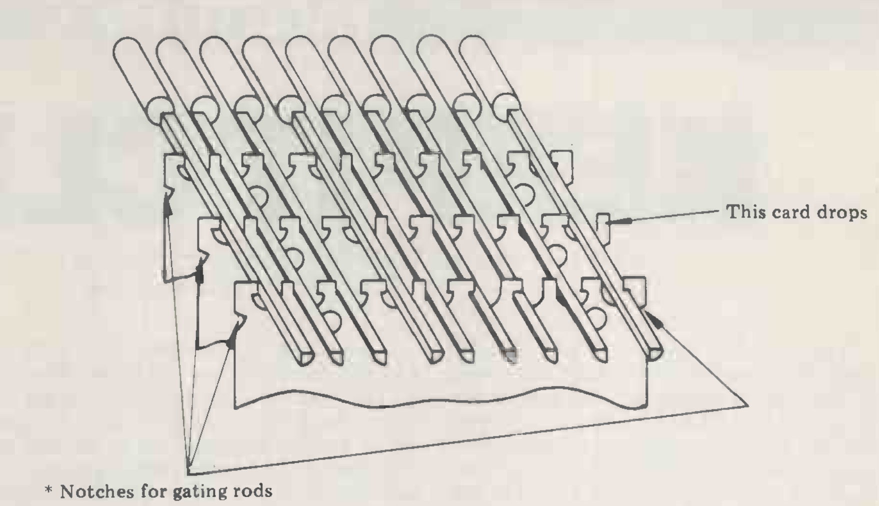
of cards was held at its edges by a pair of rods called gating rods. These fitted nicely into notches cut into the sides of each card. While the deck was held thus, a series of selection rods were rotated in the notches at the top of the card deck. Each slot contained a single rod which positioned itself either to the slot's left or right. Perhaps I should digress slightly at this point to explain that every slot started off life with two flanges. In the card number encoding process one of these flanges was removed, depending on whether a binary 0 or 1 was to be coded. This left one flange either to the right or the left of the slot.

Now, returning to the selection rods, once these had positioned themselves then the gating rods were released, allowing any cards to fall which were not supported by at least one of the selection rods. With any luck only one card could be released — the card called for by the programmer. It wasn't unknown for people to make mistakes when punching up the slots, or for flanges to tear, in which case a 'double drop' would occur, causing much aggravation for all concerned. A 'hanger' alarm would sound if a card failed to reach the capstan within a reasonable time. This could be the result of a jam or a missing card.

On a good day, though, only one card would drop, thus beginning a very interesting journey. It would fall (courtesy of gravity in the earlier models but assisted by 'accelerator rollers' in later models) into the drop ramp which would guide the leading edge of the card to the rapidly spinning aluminium capstan. Now the capstan was a curious affair because it revolved around a series of fixed internal chambers which either contained a vacuum or ambient air pressure. To enable these chambers to operate on the card the capstan was perforated.

The card was sucked to the capstan at the foot of the drop ramp, thus enabling it to pick up to the capstan's rotational speed of 380in per second. When the card reached the read/write head area the chamber was at ambient pressure but the read/write head assembly contained its own vacuum chamber thus pulling the card away from the capstan and into contact with the heads. Having passed the heads and the influence of their vacuum, the next chamber was once again a vacuum thus pulling the card back to the capstan. The choice left now was either to allow the card to continue for another revolution with the capstan, or for it to be replaced on the selection rods. This was easily accomplished by making the next chamber either a vacuum or ambient pressure. A vacuum caused the card to stick to the capstan while ambient pressure caused the card to fly off up the 'raceway' over the top of the entire assembly and back onto the selection rods. The card was always replaced at the right hand side of the deck which didn't cause any selection problems — it just meant that the cards were never in any particular physical sequence.

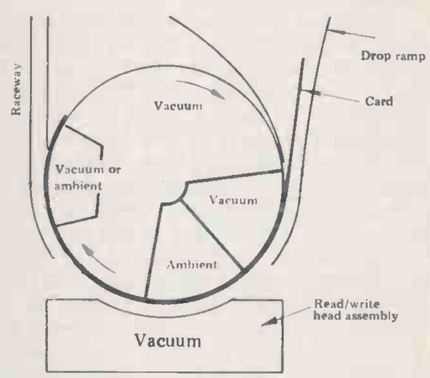
As time went by the design changed but the basic principles remained the same. Things like movable read/write heads allowed more data to be packed on the cards but without significantly increasing access times. This was because the heads could be moved while



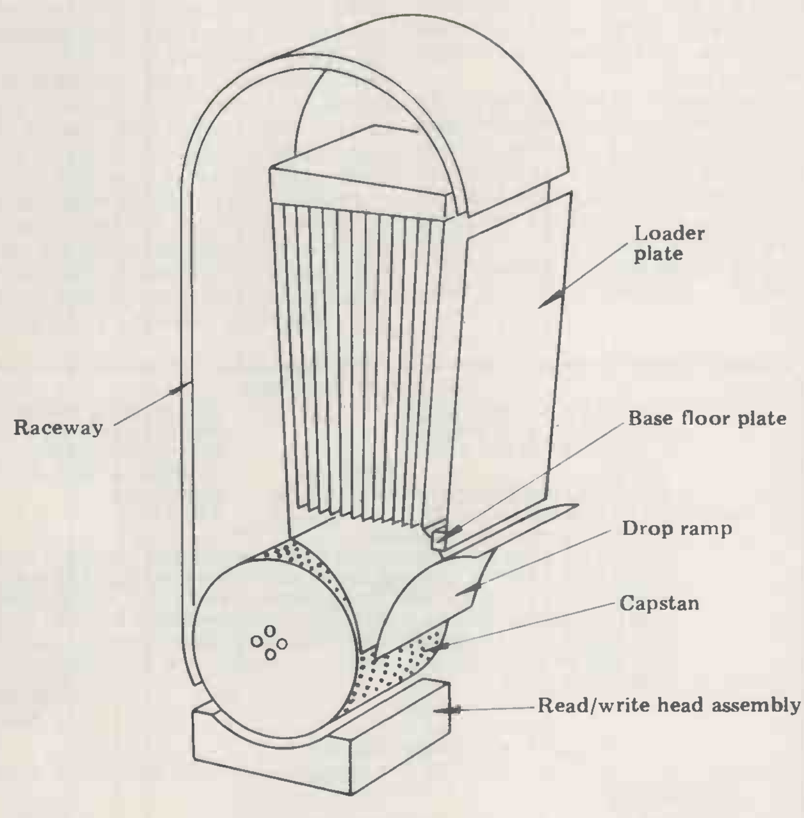
Selection rods in action

the card was dropping. On that particular model 36 heads could be moved to four different positions, allowing 144 tracks per card.

Anyone who ever worked with CRAM remembers it with affection and tall stories abound. My particular favourite is that NCR was so keen to prevent imitations that it tried to patent the use of gravity to feed cards to the drum. Whether this is true or not, the fact is that the like of CRAM hasn't been seen anywhere else and it was soon overtaken by disk storage. In its time, though, it had much to offer and was an ingenious solution to the problems of its day.



Capstan and internal chambers



Complete assembly

KEEP IT CLEAN!

This month David Hebditch looks at a typical VDU screen layout and doesn't like what he sees.

The last two 'Face-to-Face' articles were concerned with the basic concepts of formatted dialogues and with some of the programming techniques which can be used to implement them. This month we shall discuss some of the essential principles of design which will contribute to the effectiveness and user-friendliness of this important method of interacting with computer systems.

Designing a screen format (for input or output) is much more difficult than designing, say, a file record or the layout of a punched card. The essential difference, of course, is that real live end-users don't get to see file formats. Symptoms of this problem may be the overcrowding of screens, unneccessary coding of information and so on. Perhaps the key to this is the fact that screen design does involve a large element of 'graphic design' and that this 'artistic' element is not taught as a specific subject on system courses. It is therefore, perhaps, somewhat ambitious to attempt to teach these rather nebulous skills in the space of one article. The most I can probably achieve is to increase the reader's sensitivity to the problem and then hope that the 'new consciousness' will perpetuate more and more new ideas on how to approach the design of screen layouts.

The approach I plan to adopt is to take a 'before-and-after' situation and use that to highlight a checklist of pros and cons. Now just so that I am not accused of making things too easy for myself (perish the thought) I am going to take an example which is by no means easy to fit into a standard 80 x 24 screen — especially if it is to look good.

Let's start by looking at Figure 1 which must be an all-time disaster in the history of dialogue design. I don't seriously believe that anyone could design anything quite as bad as this, but it does have the advantage of embodying a lot of 'nasties' in quite a little space. Most of these are already marked on the figure, but let's go through them fairly systematically.

From an overall view, the screen looks *unbalanced;* some parts are overcrowded and other areas completely clear of text. The overall effect is that the screen is 'top heavy'. From the user's view, finding a particular item of data among all the clutter in the middle must be quite difficult. There is no obvious and clear grouping of data according to its meaning and/or use. Furthermore, the sequence does not have any apparent logic and in one case actually appears to be wrong (in the list of invoice numbers).

Another omission is the absence of any lower-case text. Lower-case looks a lot neater than upper-case and is actually easier to read (because of the greater variety of shapes rather than anything to do with the size of the characters). It is also a convenient way of distinguishing between the formatting text and the actual data being displayed. The absence of lower-case on your VDU or in your micro does not count as an excuse as far as I'm concerned. There are no longer any cost reasons why every system should not have a full upper- and lower-case capability.

Looking at the screen more closely, a number of other problems come to light. For example, the dates are not in a consistent format and in two cases the format lacks delimiters: 230680. Even with delimiters, I would argue that this type of date format is unclear because it involves unnecessary coding — 1 for January, 2 for February and so on. I think that 23Jun80 is more legible (and requires one less character).

A perennial problem with screens in general (and this one in particular) is *the unneccessary use of coding.* In interactive dialogues, coding should only exist for the efficient and convenient input of data by users through the keyboard. The use of coding on output displays is an admission of failure except where the complexity of the encoded data is such that more explicit representation is not really practical. If you have the space to do it then the use of a code as well as the expanded meaning may well help to familiarise the users with the codes in general.

In some cases, data is shown with hardly any explanatory legend (eg ageing) or with no units (eg P/Class Sales). The use of the equals signs (=) is not recommended (the resulting 'algebra' can be intimidating) and the designer should also take care to avoid the use of computer jargon. For the average user a 'character' is someone like Steptoe's dad and a 'field' is where cows masticate grass. So the message is: *avoid jargon, unless it is the user's own.*

The screen doesn't have a title and, whereas this might not be a problem in this case, it could be if the application has a lot of fairly similar screens. Any screen should always *make clear the next actions* available to the user. The '???' in the bottom left corner is inexcusably sloppy.

So much for the bad news. Figure 2 shows essentially the same thing done in a much more tidy and effective

```
CUST.NUM 432567                       DEL.NAME & ADDRESS:
STAT.NAME & ADDRESS:                  BROWN'S OFFICE SUPPLIES
J. G. BROWN & CO. LTD.                29 HIGH STREET,
UNIT 5,                               PUDDLETWITCH NEW TOWN,
TANBOW INDUSTRIAL ESTATE,             RUTLAND,
GREATER MENSHOLM,                     RU12 9TR.
WEST YORKSHIRE LS34 2MQ.
DELIVERY INSTRUCTIONS: CLOSED WEDNESDAY AFTERNOONS.
DATE OF LAST INV: 230680 DATE ACCOUNT OPENED: 2FEB1966 SPEND LAST YEAR: 12000
LIMIT: 1000 LIMIT2: 1500 CURRENT BALANCE: 750.50 TELEPHONE NUMBER: RUT 2435
AGEING: 195.50 225.00 0.00 0.00 OUTSTANDING ORDERS: Y L/PAY: 12.05.80
TERRITORY: 12 REP:DGT  CUSTOMER CLASSIFICATION: G4 LAST REVIEWED: 150379
P/CLASS SALES:  C1=56   C2=22   C3=02   C4=14   C5=06
DISCOUNTS:   1   5
             2   7.5
             3   10
             4   12.5
             5.  15          LAST 5 INVOICE NUMBERS:  34231
                                                      35807
                                                      35992
                                                      35671
                                                      36108
  ???:_
```

No use of lower case
No screen title
Unbalanced screen
Inconsistent date formats
Too cluttered
No units
Poor sequencing and grouping
Unclear abbreviations
Unusual symbols
Unnecessary coding
Out of sequence
Next action not clear

Fig 1 A screen layout incorporating some undesirable features

FACE TO FACE

```
Next action: _              Customer Information Display                  16:55 11SEP80
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Customer Number          Customer Class           Territory        Sales Representative
    432567               MULTIPLE RETAIL             12               D G TOMLINSON
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Statement Name & Address                         Delivery Name & Address
    J. G. BROWN & CO LTD.                            BROWN'S OFFICE SUPPLIES
    UNIT 5,                                          29 HIGH STREET
    TANBOW INDUSTRIAL ESTATE,                        PUDDLETWITCH NEW TOWN,
    GREATER MENSHOLM,                                RUTLAND,
    WEST YORKSHIRE LS34 2MQ.                         RU12 9TR.
Delivery Instructions: CLOSED WEDNESDAY AFTERNOONS/BEWARE OF FIERCE DOG.
Contact: MRS CLAIRE HARVEY                       Telephone Number: 0234 6543

Date Account Opened:    2FEB66   Date Last Payment:     12MAY80  !     Last   34231
Date of Last Invoice:  23JUN80   Outstanding Orders:        YES  !     Five   35807
Normal Credit Limit:      1000   Discount for invoices up to     !  Invoice   35671
High Season C/Limit:      1500    500,1000,2000,5000 & above     !  Numbers   35992
Limits Last Reviewed: 15MAR79     5%  7.5%  10%  12.5%  15%      !            36108
Ageing of Invoices:
    Current Balance      One Month      Two Months      Three Months    More than 3 Months
       750.50             195.50          225.50           330.00              0.00

Next Action: Type 'M' for Main Menu, 'C' for Customer Information again.
```

Fig 2 Some improvements made to the screen in Fig 1

manner. However, the screen is still somewhat crowded but I have assumed that the user is (as they often do) insisting on a certain minimum amount of data appearing on each display. So it is still not a simple layout, but I would be pleased to publish any improvements on this that readers may like to try. (Not just suggestions — I would want the whole screen re-drafted please.)

The screen now looks more balanced and tidy. It has a title and a clear indication of what the user may do next. Note that the 'next action' character is entered in the top left corner of the screen. It is a good idea always to have this 'next action' and for it always to appear in the same place. I prefer the top left because, in the case of data entry dialogues, it is the easiest place to get to from any other part of the screen (by pressing HOME or whatever). The layout is now more clearly segmented into logical areas and lines of hyphens have been employed to augment this. Obviously this would look much better if the display had a simple line-drawing extension to its character set. This would also make a much better job of the vertical lines than columns of exclamation marks!

Lower case has been used to differentiate the formatting text from the data and this may be improved even further through the use of a screen facility such as half-intensity. But don't overdo it! Inverse video and blink can have a negative effect, so *use 'attention-attracting' devices sparingly*. In the example shown in Figure 2, I have omitted completely the P/Class Sales figures on the grounds that the screen is already over-crowded. Arguably, even more should be left out and placed on a second display which the user could 'flip' to if required. Where information was previously coded (eg discounts and ageing) this is now shown in clear. All the dates are shown in a standard format. In the case of input screens, it is a good idea to reserve a line or two (always in the same place, of course) for error messages.

Next month, we will look at natural language dialogues and consider how easy it is to get these wrong as well as the benefits of getting them right.

NEWCOMERS-START HERE

This is our unique quick-reference guide, reprinted every month to help our new readers pick their way through the most important pieces of (necessary) jargon found in PCW. While it's in no way totally comprehensive, we trust you'll find it a useful introduction. Happy microcomputing!

Welcome to the confusing world of the microcomputer. First of all, don't be fooled; there's nothing complicated about this business, it's just that we're surrounded by an immense amount of necessary jargon. Imagine if we had to continually say "numbering system with a radix of sixteen in which the letters A to F represent the values 10 to 15" when instead we can simply say "hex". No doubt soon many of the words and phrases we are about to explain will eventually fall into common English usage. Until that time, PCW will be publishing this guide — every month.

We'll start by considering a microcomputer's functions and then examine the physical components necessary to implement these functions.

The microcomputer is capable of receiving information, processing it, storing the results or sending them somewhere else. All this information is called data and it comprises numbers, letters and special symbols which can be read by humans. Although the data are (yes, it's plural) accepted and output by the computer in 'human' form, inside it's a different story — they must be held in the form of an electronic code. This code is called binary — a system of numbering which uses only 0s and 1s. Thus in most micros each character, number or symbol is represented by eight binary digits or bits as they are called, ranging from 00000000 to 11111111.

To simplify communication between computers, several standard coding systems exist, the most common being ASCII (American Standard Code for Information Interchange). As an example of this standard, the number five is represented as 00110101 — complicated for humans, but easy for the computer! This collection of eight bits is called a byte and computer freaks who spend a lot of time messing around with bits and bytes use a half-way human representation called hex. The hex equivalent of a byte is obtained by giving each half a single character code (0—9,A—F): 0=0000, 1=0001, 2=0010, 3=0011, 4=0100, 5=0101 ...... E=1110 and F=1111. Our example of 5 is therefore 35 in hex. This makes it easier for humans to handle complicated collections of 0s and 1s. The machine detects these 0s and 1s by recognising different voltage levels.

The computer processes data by reshuffling, performing arithmetic on, or by comparing them with other data. It's the latter function that gives a computer its apparent 'intelligence' — the ability to make decisions and to act upon them. It has to be given a set of rules in order to do this and, once again, these rules are stored in memory as bytes. The rules are called programs and while they can be input in binary or hex (machine code programming), the usual method is to have a special program which translates English or near-English into machine code. This speeds programming considerably; the nearer the programming language is to English, the faster the programming time. On the other hand, program execution speed tends to be slower.

The most common microcomputer language is Basic. Program instructions are typed in at the keyboard, to be coded and stored in the computer's memory. To run such a program the computer uses an interpreter which picks up each English-type instruction, translates it into machine code and then feeds it into the processor for execution. It has to do this each time the same instruction has to be executed.

Two strange words you will hear in connection with Basic are PEEK and POKE. They give the programmer access to the memory of the machine. It's possible to read (PEEK) the contents of a byte in the computer and to modify a byte (POKE).

Moving on to hardware, this means the physical components of a computer system as opposed to software — the programs needed to make the system work.

At the heart of a microcomputer system is the central processing unit (CPU), a single microprocessor chip with supporting devices such as buffers, which 'amplify' the CPU's signals for use by other components in the system. The packaged chips are either soldered directly to a printed circuit board (PCB) or are mounted in sockets.

In some microcomputers, the entire system is mounted on a single, large, PCB; in others a bus system is used, comprising a long PCB holding a number of interconnected sockets. Plugged into these are several smaller PCBs, each with a specific function — for instance, one card would hold the CPU and its support chips. The most widely-used bus system is called the S100.

The CPU needs memory in which to keep programs and data. Microcomputers generally have two types of memory, RAM (Random Access Memory) and ROM (Read Only Memory). The CPU can read information stored in RAM — and also put information into RAM. Two types of RAM exist — static and dynamic; all you really need know is that dynamic RAM uses less power and is less expensive than static, but it requires additional, complex, circuity to make it work. Both types of RAM lose their contents when power is switched off, whereas ROM retains its contents permanently. Not surprisingly, manufacturers often store interpreters and the like in ROM. The CPU can only read the ROM's contents and cannot alter them in any way. You can buy special ROMs called PROMs (Programmable ROMs) and EPROMs (Erasable PROMs) which can be programmed using a special device; EPROMs can be erased using ultra-violet light.

Because RAM loses its contents when power is switched off, cassettes and floppy disks are used to save programs and data for later use. Audio-type tape recorders are often used by converting data to a series of audio tones and recording them; later the computer can listen to these same tones and re-convert them into data. Various methods are used for this, so a cassette recorded by one make of computer won't necessarily work on another make. It takes a long time to record and play back information and it's difficult to locate one specific item among a whole mass of information on a cassette; therefore, to overcome these problems, floppy disks are used on more sophisticated systems.

A floppy disk is made of thin plastic, coated with a magnetic recording surface rather like that used on tape. The disk, in its protective envelope, is placed in a disk drive which rotates it and moves a read/write head across the disk's surface. The disk is divided into concentric rings called tracks, each of which is in turn subdivided into sectors. Using a program called a disk operating system, the computer keeps track of exactly where information is on the disk and it can get to any item of data by moving the head to the appropriate track and then waiting for the right sector to come round. Two methods are used to tell the computer where on a track each sector starts: soft sectoring where special signals are recorded on the surface and hard sectoring where holes are punched through the disk around the central hole, one per sector.

Half-way between cassettes and disks is the stringy floppy — a miniature continuous loop tape cartridge, faster than a cassette but cheaper than a disk system. Hard disk systems are also available for microcomputers; they store more information than floppy disks, are more reliable and information can be transferred to and from them much more quickly.

You, the user, must be able to communicate with the computer and the generally accepted minimum for this is the visual display unit (VDU), which looks like a TV screen with a typewriter-style keyboard; sometimes these are built into the system, sometimes they're separate. If you want a written record (hard copy) of the computer's output, you'll need a printer.

The computer can send out and receive information in two forms — parallel and serial. Parallel input/output (I/O) requires a series of wires to connect the computer to another device, such as a printer, and it sends out data a byte at a time, with a separate wire carrying each bit. Serial I/O involves sending data one bit at a time along a single piece of wire, with extra bits added to tell the receiving device when a byte is about to start and when it has finished. The speed that data is transmitted is referred to as the baud rate and, very roughly, the baud rate divided by 10 equals the number of bytes being sent per second.

To ensure that both receiver and transmitter link up without any electrical horrors, standards exist for serial interfaces; the most common is RS232 (or V24) while, for parallel interfaces to printers, the Centronics standard is popular.

Finally, a modem connects a computer, via a serial interface, to the telephone system allowing two computers with modems to exchange information. A modem must be wired into the telephone system and you need British Telecom's permission; instead you could use an acoustic coupler, which has two obscene-looking rubber cups into which the handset fits, and which has no electrical connection with the phone system — British Telecom isn't so uppity about the use of these.

IN STORE

The British-made Newbrain is one of the three new entries this month. A low-priced dual cassette machine, it gives users the choice between a battery-operated system with 2-4k static RAM and a mains system with 16k RAM. I'm told that all current orders will be fulfilled before Christmas and that full production is scheduled for March next year. Also new is the Macro; MicroAPL is promoting this as an alternative to commercial timesharing, based on the APL language. The third newcomer is the 79/09 single board from Newbear, a 6809 upgrade for the 77/68. By popular demand, 'In Store' now gives the month and year in which machines have been Benchtested by PCW (indicated by BT in the misc. column). Finally, note that both the Attache and Megamicro now boast a full range of business software. Send updates for In Store to me, **Dick Olney, at PCW, 14 Rathbone Place, London W1P 1DE.**

Machine (Price from)	Main Distributor/s (No. of Dealers)	Hardware	Software	Miscellaneous (Documentation)
ABC 80 (£738)	Datormark Ltd: 09322 44896	16-40k RAM; Z80A; C; 12", 16x40 b&w VDU; 4680 bus; IEEE 488; RS232 port.	DOS; Basic (16k ROM); *Fortran; Pascal; A; Multi user Basic.*	Colour video graphics with UHF output. Viewdata compatible. Loudspeaker. Numeric keypad. Options: dual 5¼" F/D (160k) £895; dual 8" F/D (2 Mb). BT 1/80. (I)
ACT System 800 (£3950)	ACT: 021-455 9898 (50)	48k RAM; 6502; dual 5¼" F/D (800k); 12", 30x64 VDU; 1 S/P; 1 P/P; Multi-screen int.	MDOS; Basic; A; *CBasic; PL/M; Forth; Fifth; Cesil; Pilot; Fortran.*	IBM compatible K/B. High resolution graphics. Available with dual 8" F/D (2.4 Mb) £4950 — 4.8 Mb maximum. BT 2/80 (E).
Alpha Micro (£5650)	Alpha Micro (UK) Ltd: 01-250 1616 (TBA)	64k — 1 Mb RAM; 16 bit; dual 8" F/D (2.4 Mb); 6 S/P.	Multi-user OS; Basic; M/A; Pascal; U.	Modular. Expands to 1200 Mb, 24 terminals or multiprocessor system. (E)
Altos ACS 8000 (£3398)	Logitek: 02572 66803 (33)	64k RAM; Z80; 1k EPROM; dual 8" F/D (1Mb); 2xRS232 ports; 1 P/P.	CP/M; *Basic; CBasic; Cobol; Pascal; Fortran.*	Expandable to 4-user system with 58Mb H/D. Maintenance contracts avail; BT 5/80 (S&H).
Apple II (£695)	Microsense: 0442 41191 (190)	16-48k RAM; 6502; 8 I/O slots.	O/S; Basic; *Pascal; Fortran.*	280x192 high resultion graphics; Integer Basic in 6k ROM; Option: single 5¼" F/D (116k) £349.
Athena 8285 (£5694)	Butel-Comco Ltd: 0703 39890 (TBA)	64k RAM; 8085A; dual 5¼" F/D (644k); 12", 25x80 VDU; 150 cps printer; RS232 port.	AMOS; T/E; Basic; *Cobol; Fortran; Pascal; APL; M/A.*	Extended ASCII K/B with numeric pad; graphics. Options: dual 8" F/D (2Mb); up to 1200 Mb H/D
Atom (£120)	Acorn: 0223 312772 (N/A)	2-11k RAM; 6502; Full K/B; C int; TV int; 20 I/O lines; 1 P/P.	Basic in 8k ROM; A; Cass O/S.	High resolution graphics on bigger model; colour monitor O/P. Loudspeaker. Note also, systems based on Acorn SBC. BT 7/80 (B).
Attache System II (£8000)	Friargrove Systems Ltd: 01-572 3784 (10)	64k RAM; Z80; dual 8" F/D (1.2Mb); 12", 24x80 VDU; 180 cps printer.	Basic; *Fortran; Cobol.*	Upgradable to multiuser system with 34Mb H/D. Full range of business packages included software dealers TBA. (S).
Billings BC-12 FD: (£3995)	Mitech: 04862 23131 (TBA)	64k RAM; Z80A; dual 5¼" F/D (640k); 12", 24x80 b&w (or b&g) VDU.	DOS; Basic; *Fortran; Cobol; A.*	With dual 8" F/D (2Mb) £5995. Additional dual 8" F/D £3000. (S).
C/09 (£3975)	SWTP Ltd: 01-491 7507 (16)	56k RAM; 6809; dual 8" F/D (2Mb); 8", 16x80 VDU; 1 S/P.	TSC FLEX; *Basic; Pascal; A; Dis A; T/E; U.*	VDU is intelligent. Option: 15Mb H/D £3575; with dual 5¼" F/D (350k) instead of 8", £3000. (H)
Challenger 1P & C4P (£220 & £395)	CTS: 0706 79332. Millbank Computing: 01-549 7262. Mutek: 0225 743289. U-Microcomputers: 0925 54117 (18)	4-32k RAM; 6502; C int; RS232 port. Options: dual 5¼" F/D (160k) £550; for C4P dual 8" F/D (1.15Mb) and 20MB H/D.	O/S; Basic (8k ROM) *Ex Basic; A.*	D/A conv; colour capability. Runs OSI business software on 8" F/D Plato educational software avail. soon. BT 4/80. (S).
Challenger 2 (£1500)	As above	48k RAM; 6502; dual 8" F/D (0.5Mb); RS232 port.	OS65U; Ex Basic; A.	Designed as low cost business system (S).
Challenger C3 (£2334)	As above	32-56k RAM; 6502; 6800; Z80; dual 8" F/D (1.15Mb); 2-16 S/P.	OS65U; Basic; *CP/M; Fortran; Cobol.*	Expandable to multi-user (8) system. Options: C3B & C3C H/D units, 74Mb for about £8500. (S&H).
Clenlo Conqueror System B (£1950	Clenlo Computing Systems Ltd: 01-670 4202 (TBA)	64k RAM; Z80; dual 8" F/D (1Mb); 3 S/P; 2 P/P.	CP/M; CBasic-2; Pearl 1; *U.*	With four 8" F/D £2850. (S&H)
Clenlo Conqueror System D (£5150)	As above	64k RAM; single 8" F/D (500k); 10Mb H/D; 3 S/P; 2 P/P.	CP/M; CBasic-2; Pearl 11; *U.*	With 26Mb H/D and no F/D £5950.
Compucolor II (£995)	Dyad Developments: 08446 729 (TBA)	8-32k RAM; 8080; 13" 32x64 8-colour VDU; single 5¼" F/D (51k); RS232 port.	DOS (ROM); Ex-Basic (ROM); A.	16k version £1078, 32k £1198. High resolution graphics. 6-month subscription to user magazine inclusive BT 9/79. (S)
Compucorp 625 (£6000)	Compucorp: 01-952 7860 (17)	60k RAM; dual 5¼" F/D (630k); 9", 16x80 VDU; 40 col printer; RS232 port.	Basic; A; *Fortran; Pascal;* U.	Various systems available with 320k — 2.4Mb F/D and 9", 12" or 20" VDU.
Computermart 2000 DS (£1500)	Computermart: 0603 615089	32-256k RAM; 8085; dual 8" F/D (1-2Mb); S/P; P/P.	CP/M; *Cis Cobol; Basic; Fortran.*	Expandable to multi-user, multi-tasking, multi-processor 96Mb H/D system (around £15000).
Cromemco System 2, System 3, System Z2H. (£2100/ £3730/£5340)	Datron: 0742 585490. Comart: 0480 215005. MicroCentre: 031 556 7354 (18)	64k RAM; Z80; dual 5¼" F/D (346k) on System 2 & Z2H; dual 8" F/D (1.2Mb) on Sys 3; 10Mb H/D on Z2H; S/P; P/P.	CDOS; *Basic; Cobol; Fortran; RPG II; Lisp; A; W/P; Multi-user Basic.*	All systems expandable to multi-user (max 7) £6408 Sys 2, £8304 Sys 3. Options: dual 8" F/D (996k); 11-22Mb H/D. BT 10/79 (E).

List of Abbreviations

A Assembler	F/D Floppy disk	M/A Macro assembler	S/P Serial port
BT Bench Tested	G/C Graphics card	N/A Not available	T/E Text editor
C Cassette	H Hardware	N/P Numeric pad	TBA To be announced
E Extensive	H/D Hard disk	O/S Operating system	U Utility
	I Introductory	P/P Parallel port	
	Int Interface	S Software	

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

DIRECT ACCESS

IN STORE

Machine (Price from)	Main Distributor/s (No. of Dealers)	Hardware	Software	Miscellaneous (Documentation)
DAI (£998-48k)	Data Applications (UK): 0285 2588 (TBA)	12-48k RAM; 8080; C int; 24x 60 VDU int; RS232 port; over 20 industrial ints.	Basic (ROM); U.	Colour graphics up to 255x 335; 3 notes & noise generator; PAL O/P to TV; Paddle int; H maths option. (I). BT 10/80
Diablo 3000 (£8950)	Business Computers Ltd: 01-207 3344 (TBA)	32k RAM; 8085; dual 8" F/D (1.2Mb); 12", 24x80 b&w VDU; 45cps printer.	DOS; Basic; DACL; A; U.	Selection of business packages included (S).
Digital Micro-systems DSC-2 (£3525)	Modata: 0892 41555 (10)	64k RAM; Z80; dual 8" F/D (1.14Mb); 4xRS232 ports; EIA port.	CP/M; Basic-E; CBasic; *Cobol; Fortran; Pascal.*	14 or 28Mb H/D available or additional F/D units (H).
Digital Micro-systems DSC-4 (£6045)	As above	128k RAM; Z80A; single 8" F/D (500k); 11Mb H/D; 4x RS232 ports; 2 P/P.	CP/M; Basic-E; CBasic; *Cobol; Fortran; Pascal.*	Also DSC-3 with 64k RAM. Options: 128k RAM £1295; up to 4Mb F/D and 29Mb H/D. (H).
Durango F-85 (£7500)	Comp Ancillaries: 0784 36455 (12)	64k RAM; 8085; dual 5¼" F/D (1Mb); 9", 16x64 green VDU; 132 col 165 cps printer; N/P.	O/S; DBasic; *CP/M; CBasic; Micro Cobol.*	Up to 5 work stations; fully integrated system. Options: additional dual 5¼" F/D (1Mb); 12-24Mb H/D. (S).
Dynabyte DB8/1 (£1500)	Dynabyte UK/ Europe Ltd: 0723 65559 (6)	32-64k RAM; Z80; S100 bus; 2xRS232 ports; 1 P/P.	CP/M; Basic; Cobol; *Pascal.*	Expands to multi-user system. Options: dual 8" F/D (1Mb) £2000; Also DB8/2 with dual 5¼" F/D (400k) £3000. (E).
Equinox 200 (£7500)	Equinox: 01-739 2387 (N/A)	64-256k RAM; Z80; 10Mb H/D; 1 S/P; 1 P/P.	CP/M; CBasic; *Cobol; Fortran.*	Multi-user MVT/FAMOS available in place of CP/M. (S&H).
Euroc (£7995)	Euroc: 01-729 4555 (TBA)	64k RAM; 8080A; dual 8" F/D (1Mb); 15", 25x80 b&w VDU; 132 col 140 cps printer.	CP/M; CBasic; A; U.	Financial software available. Supply of stationary included.
Executive Mini-computer (£378)	Binatone Int: 01-903 5211 (N/A)	16k RAM: Z80; 500 bps C; 32x64 TV int; extra C int; 1 P/P.	Basic (12k ROM); *M/A; Fortran.*	Graphics avail. F/D under development. Also 4k version called 'Oxford minicomputer'.
Exidy Sorcerer (£749)	Liveport Data Products: 0736 798157 (27)	16-48k RAM; Z80; RS232 port; 1 P/P; S100 connector; 30x64 VDU int.	O/S: Basic (ROM); *T/E; A; CP/M; Algol; Fortran; Basic; 80.*	High resolution graphics capability; user programmable character set. 32k version £799; 48k £849. Option: single 5¼" F/D (315k) £600.
HP 85 (£1830)	Hewlett Packard Ltd: 0734 784774 (16)	16-32k RAM; C.P.U.; 5", 16x32 VDU; C (200k): 64 cps printer; 4 P/P. Options: dual 5¼" F/D (540k) £1408; dual 8" F/D (2.4Mb) £3744.	Basic (ROM)	Full dot matrix graphics. Complete range of interfaces, peripherals and application packages avail. 16k RAM £222. (S).
IMS 5000 (£1935)	Equinox: 01-739 2387 (20)	32-64k RAM; Z80; dual 5¼" F/D (320k)	CP/M; CBasic; *Cobol, Fortran.*	3 drives option: (S&H).
IMS 8000 (£3515)	As above	64-256k RAM; Z80; dual 8" F/D (1MB).	CP/M; CBasic; *Cobol; Fortran; MicroCobol.*	Multi-user MVT/FAMOS available in place of CP/M. (S&H).
ITT 2020 (£867)	ITT: 0268 3040 (15)	16-48k RAM; 6502	Monitor; A; ExBasic; Dis A.	360x192 high res graphics. ExBasic in 6k ROM: Options — single 5¼" F/D (116k), £425; 16k RAM, £110; RS232 port, £96: 32k system, £931: 48k system. £995. (B).
LX-500 (£3500)	Logabax Ltd: 01-965 0061 (13)	32k RAM; Z80; dual 5¼" F/D (180k); 12" 25x80 b&w VDU; 100cps printer.	DOS; Basic; A.	Other printers available. (S).
LSI M-One (£5995)	LSI Computers 04862 23411 (20)	8k RAM; 8080; dual 8" F/D (1.2Mb); 12", 24x80 b&w VDU.	FMOS; A.	Choice of standard business packages included in price. (S).
LSI M-One Model 5. (£9900)	As above	16k RAM; 8080; dual 8" F/D (2.4Mb); 2x12", 24x80 VDUs; 120 cps bidirectional printer.	FMOS; A.	One VDU is for inquiry only. (S).
Macro 1 & 2 (£3750 or £280 pm).	Micro APL Ltd. 01-834 2687 (TBA)	64k RAM; Z80; dual 8" F/D (1 Mb); 4xRS232 ports.	CP/M; APL; U; *Basic; Fortran; Cobol; Wordstar Algol; Pascal; Forth.*	Designed as timesharing replacement. (S).
Megamicro (£6080)	Bytronix: 0252 726814 (5)	56k RAM; Z80; dual 8" F/D (500k); 12", 20x80 green VDU; 180 cps printer; 2 S/P; 2 P/P.	CP/M; U; *Basic; A; M/A.*	Range of bus. packages now avail. from Ludhouse of Streatham. (H&B).
Mikro 1000 (£3950)	Airamco: 0294 57755 (TBA)	64k RAM; Z80; dual 8" F/D (1Mb); 12", 24x80 VDU; S100; RS232; 1 P/P.	CP/M; Basic; Cobol; Fortran.	Also word processor with 44 special function keys & NEC Spinwriter printer £4450. (S&H)
Microstar 45 Plus (£4800)	Data Efficiency Ltd: 0442 63561 (30)	64k RAM; 8085; dual 8" F/D (1.2Mb); 3 S/P; RS232 port.	Stardos; CP/M; Basic; Cobol; Fortran.	(E).
Microtan 65 (£69)	Tangerine: 0353 3633 (6)	1k RAM; 6502; TV int; Exp up to 277k RAM.	1k TANBUG monitor; 2k A, disassembler, cassette firmware; *10k Microsoft ExBasic.*	Options: bulk I/O modules, hi-def colour graphics, DOS, system racking, ASCII keyboard. (S&H)
MS5001 (£8250)	BMG Ltd: 0793 37813 (N/A)	64k RAM; 8085; dual 8" F/D (1Mb); 12", 80x24 VDU; 160 cps printer; RS232.	CP/M; *Basic; Cobol; Fortran; MP/M.*	Price includes desk mounting and one computer. Hardware & software support. Leasing arrangements available. (E)
MSI 6816 (£1200)	Strumech: 05433 4321 (5)	16-56k RAM; 6800; 9" 16x64 b&w VDU; C int; 1 S/P; 1 P/P.	Basic; A.	Graphics & PROM programmer available. (S&H).
MSI System 7 (£3500)	As above	56k RAM; 6800; dual 5¼" F/D (160k); 9", 16x64 VDU; 1 S/P; 1 P/P.	FDOS; Basic; A; U.	As above. Multi-user O/S avail. Options: 10Mb H/D.

List of Abbreviations

A	Assembler	F/D	Floppy disk	M/A	Macro assembler	S/P	Serial port
BT	Benchtested	G/C	Graphics card	N/A	Not available	T/E	Text editor
C	Cassette	H	Hardware	N/P	Numeric pad	TBA	To be announced
E	Extensive	H/D	Hard disk	O/S	Operating system	U	Utility
		I	Introductory	P/P	Parallel port		
		Int	Interface	S	Software		

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

DIRECT ACCESS

IN STORE

Machine (Price from)	Main Distributor/s (No. of Dealers)	Hardware	Software	Miscellaneous (Documentation)
MSI System 12 (£8000)	As above	56-184k RAM; 6800; 10Mb H/D; 9", 16x24 VDU; 1 S/P; 1 P/P.	SDOS; Basic; CBasic; U.	As above. Business packages avail. (H & S).
Nanocomputer NBZ80S (£420)	Midwich: 0284 701321	4k RAM; 2k ROM; Z80; C int; 8 digit LED; Calc K/B; RS232 port; 2 P/P.	Machine language; *Basic; A; T/E.*	Designed for hardware education. Full training manuals included. Fully expandable. (E).
Newbrain MB £219	Newbury Labs. 021-707 7170. Newbear. 0635 30505 (N/A)	2-4k RAM; Z80A; Nat 420; 14x 16 VDU; 2xC int; TV int; V24 port. Option: C (50k) £60.	C Basic (16k ROM)	Graphics. Battery or mains. Mains only with 16k RAM £269. (low power battery version £299). (I).
North Star Horizon (£2230)	Comart: (7) 0480 215005. Comma: 0277 811131. Equinox: 01-739 2387 (20)	48-56k RAM; Z80A; dual 5¼" F/D (360k); 15", 24x80 VDU; 150cps printer; 2 S/P; 1 P/P.	DOS; Basic; CP/M; *Cobol; Fortran; Pascal.*	With 32k and single F/D £1495. Options: 18Mb H/D.
Panasonic JD 800U, JD 840U (£4275, £4950)	Panasonic Business Equipment: 01-262 3121 (10 regional dist)	56k RAM; 8085A; 2-4k PROM; dual 8" F/D, JD800 U (500k), JD840U (2Mb); 12", 24x80 green VDU; 3xRS232 ports.	CP/M; Basic; *Micro-Cobol.*	Also available with 5¼" F/D; JD740U (570k) £4095. BT 3/80 (S).
Pascal Microengine (£2295)	Pronto Electronic Systems Ltd: 01-554 6222	64k RAM; MCP 1600; 2x RS232 ports; 2 P/P.	Pascal.	CPU instruction set is P-code; no interpreter needed. Available with dual 8" F/D (2Mb) £3900.
Periflex 630/48 (£2500)	Sintrom: 0734 85464 (5)	48k RAM; Z80; dual 5¼" F/D (630k); 2xRS232 ports; 1 P/P.	CP/M; *Basic; Fortran; Cobol; A.*	One-day installation training on site included in price. Option: dual 5¼" F/D (630k) £859; dual 8¼" F/D (1Mb) £1025. BT 6/80 (S&H).
Periflex 1024/64 (£3300)	As above	64k RAM; Z80; dual 8" F/D (1Mb); 2xRS232 ports; 1 P/P.	As above.	As above.
PET 8k, 16k, & 32k (£450, £550, £695)	Commodore: 01-388 5702 (150)	8-32k RAM; 6502; C; 9", 25x40 VDU; IEEE-488 port; Options: dual 5¼" F/D (353k) £695; same but (950k) £895.	O/S; Basic (in 8k ROM); *Forth; Pilot; Pascal.*	Disk controller for 8k version £30. New 8032 with 80-col screen (32k) £895.(I).
Powerhouse 2 (£1125)	Powerhouse Micros: 0422 48422 (TBA)	32-64k RAM; Z80A; 5", 29x96 VDU; RS232 port; external bus.	4k Monitor; *FDOS; Basic; ExBasic (14k EPROM)*	VDU has flexible screen logic. Options: FDOS & Basic £210; graphics card £200. (H)
Powerhouse 3 (£2600)	As above	32-64k RAM; Z80A; dual 5¼" F/D (350k); 5", 29x96 VDU; RS232 port; external bus.	As above.	VDU as above. With 1.2Mb F/D £3500. ExBasic & FDOS in 14k EPOMs £300. (H)
Rair Black Box (£2250)	Rair: 01-836 4663 (N/A)	32-64k RAM; 8085; dual 5¼" F/D (260k); 2x RS232 ports.	CP/M; Basic; Cobol; Fortran; M/A.	16k RAM expansion £250 10Mb H/D £2500.
Research Machines 380Z (£1123)	Research Machines 0865 49791 (N/A)	16-56k RAM; Z80A; 2xC; RS232 port.	ExBasic; A; T/E; U; *CP/M; Fortran; Cobol; Algol; Cesil.*	Limited graphics. Many possible systems. With 48k RAM & dual 8" FD (1Mb) £3394.
S/09 (£5350)	SWTP Ltd: 01-491 7507 (16)	128k RAM; 6809; dual 8" F/D (2Mb); 8", 21x92 VDU; 2xS/P; 1 P/P.	TSC FLEX; *Basic; Pascal; A; Dis A; T/E; U.*	VDU is intelligent. Expands to 60Mb H/D multi-user system. Option: 15Mb H/D £3575. Maintenance contracts. (S&H)
SBS 8000 (£1449)	Manhattan Skyline Ltd: 08012 3442 (TBA)	64k RAM; Z80A; 12", 16x64 VDU; 1 P/P; RS232 port (extra £133).	ExBasic (24k ROM); *DOS.*	Options: disk control card £237; dual 5¼" F/D (368k) £795; dual 8" F/D (2Mb) £1400. (S)
SEED System 1 (£2000)	Strumech: 05433 4321 (4)	32-64k RAM; 6800; dual 5¼" F/D (160k); 9", 16x24 VDU; RS232 port.	DOS; Basic; U; *Fortran; A; Pilot; Strubal; T/E.*	Several F/D options. With 64k RAM & dual 8" F/D (1.2Mb) about £3000. (E).
Sharp MZ-80k (£480) (22)	Sharp electronics (UK) Ltd: 061-205 2333	6-34k RAM; Z80; C; 10", 24x 40 VDU; Option: dual 5¼" F/D (280k) £780.	Basic (14k ROM); A.	Graphics; loudspeaker. 18k RAM version £529; 22k £549; 34k £599. BT 10/79 (B).
Sinclair ZX80 (£100)	Science of Cambridge: 0223 311488 (N/A)	1-16k RAM; Z80A; C int; TV int; full K/B; 44-pin expansion port.	Basic (4k ROM).	Kit £80. Mains adaptor £9. (S).
Smoke Signal Chieftan (£1807)	Systems Implementation Ltd: 06924 5666 (TBA)	32-64k RAM; 6800; dual 5¼" F/D (160k); 12", 24x80 VDU; RS232 port.	DOS; *68/FLEX; Basic; Fortran; Cobol; U.*	With dual 8" F/D (2Mb) £2712. Designed as development system for industrial control. (H)
Solitaire WP & BS200 (£6750 & £8200)	Solitaire KPG: 01-995 3573 (TBA)	64k RAM; 8085; 14" VDU (with own CPU); 45 cps printer; CPU port; dual 5¼" F/D (700k) 8" F/D (1.02Mb) with BS200.	DOS; Basic.. dual	All solitaire systems are compatible; graphics on 11x13 dot matrix.(S).
Sord M100 (£795)	Midas Computer Services Ltd: 0903 814523 Exleigh Bus. Mach. 0736-66577. (8)	48k RAM; Z80; 8k ROM; 12", 24x64 green VDU; RS232 port; S100 bus; N/P.	O/S; Basic; *A; Fortran; Pascal.*	M100 ACE with single 5¼" F/D (143k) £1850. Up to 3 drives possible. Colour graphics avail. (I).
Sord M223 Mk II-VI (£3950)	As above	64k RAM; Z80; 8k ROM; single 5¼" F/D (350k); 12", 24x80 green VDU; RS232 ports; S100 bus; N/P.	O/S; ExBasic; *CBasic; Multi-User Basic; Fortran; Pascal; Cobol.*	Expandable to 4Mb F/D, 32Mb, H/D, 5 screens, 2 printers. M243 with 192k RAM & dual 8" F/D £7000.
SPC/1 (£3770) (TBA)	Digital Data: 01-573 8854	64-1024k RAM; 8085A-2; dual 5¼" F/D (90k); 12", 24x80 VDU; 2xRS232 ports; Option: single 8" F/D (1Mb) £1090: 20Mb H/D £7000.	Mikados; Comal; Pascal; A.	With 32k RAM and single F/D (Comal only) £1995. Expandable to multi-user system (8 users). BT 7/80 (S).
Superbrain (£1995)	Icarus: 0632 29593 (TBA)	64k RAM; 2xZ80; dual 5¼" F/D (320k); 12", 25x80 VDU; S100 bus; RS232 port.	CP/M; A; *Basic; Cobol; Fortran; APL; Pascal.*	Limited graphics. Mainframe int avail. Options: dual 5¼" F/D (320k); dual 8" F/D (2.4 Mb); 8-120Mb H/D. BT 8/80 (S&H).

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C	Cassette	H	Hardware	N/P	Numeric pad	TBA	To be announced
E	Extensive	H/D	Hard disk	O/S	Operating system	U	Utility
		I	Introductory	P/P	Parallel port		
		Int	Interface	S	Software		

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

DIRECT ACCESS

IN STORE

Machine (Price from)	Main Distributor/s (No. of Dealers)	Hardware	Software	Miscellaneous (Documentation)
System 80 (£1355-48k)	Nascom: 02405 75155 (32)	16-48k RAM: Z80A; dual 5¼" F/D (560k); TV int; RS232 port.	CP/M; Basic (8k ROM).	EPROM firmware avail. Colour graphics card £165. Many configurations possible. (S&H).
Tandberg EC10 (£4000)	Tandberg: 0532 35111 (N/A)	64k RAM; 8080A; single 8" F/D (250k); 12", 25x80 VDU; 7x RS232 ports; printer int.	CP/M; ExBasic (24k) *Multi-user Basic; Pascal; Cobol*; A; U;	Up to 7 terminals. Includes V28 comms port. (S & H).
Tandy TRS80 Level 1 (£335)	Tandy: 021 556 6101 (200)	4-16k RAM; Z80; C; 12", 16x64 VDU.	Basic (4k ROM); A.	Expandable to Level II. Many extras available. (I).
Tandy TRS80 Level II (£408)	As above	4-48k RAM; Z80; C; 12", 16x 64 VDU; RS232 port; 1 P/P.	Basic (4k ROM); *M/A; Fortran.*	16k machine includes N/P. 4-16k upgrade £87, 48k system £620; Option: single 5¼" F/D (78k) £295, (subsequent £277; up to 4. BT 6/80 (I).
Tandy TRS80 Model 2 (£1999)	As above	32-64k RAM; Z80A; single 8" F/D (500k); 12", 24x80 VDU; 2 S/P; 1 P/P; N/P.	DOS; Basic.	64k version £2249. Expandable to four F/D drives, single drive expansion £799: three drive £1589.
TECS (£1200)	Technalogics Computing Ltd: 061-793 5293 B&B Computers Ltd 0204 26644 (TBA)	4-56k RAM; 8k PROM; 6800/6809; 2xC; TV int; 2xRS232 ports; internal viewdata modem & printer port.	FLEX; Basic; *Pascal; TDOS*; A; *T/E; Pilot; Fortran; Cobol.*	Fully viewdata compatible. Options — dual 5¼" F/D (320k) £850; dual 8" F/D £120 £1200. (S&H).
Terodec DPS 64/1 (£3099)	Terodec (Micosystems) Ltd: 0734 664343 (8)	64k RAM; Z80; dual 8" F/D (1Mb); 12", 24x80 VDU; 2 S/P; 3 P/P. Options: dual 8" F/D (1Mb) £1150; with 2Mb £1455.	CP/M; *Basic; Cobol; CBasic; Fortran; Algol; Pascal.*	TMZ 80 enhanced model in integral workstation £5595 (with 4Mb F/D). DPS 64/2 with 2Mb F/D £3404. (S&H).
TI 99/4 (£750)	TI: 0234 67466 (TBA)	16k RAM; 26k ROM; 9900; 24x32 VDU; 2x C int; TV int; RS232 port.	OS; Basic.	Can run 16-colour TV screen. BT 5/80 (S).
Triton L8.2 (£611)	Transam: 01-405 5240 (N/A)	32k RAM; 8080; C int; 16x64 VDU int; 1 S/P; 1 P/P.	4k monitor; Pascal (20k ROM); *CP/M; Pascal.*	Graphics; 5¼" or 8" F/D are available; L7.2 with 2k monitor and Basic (no Pascal) £409. (S&H).
Vector MZ (£2595)	Almarc: 0602 62503 (3)	56k RAM; Z80A; dual 5¼" F/D (630k); 3 S/P; 2 P/P.	CP/M; Basic; *Algol; Cobol; Pascal; Fortran; Coral; CBasic*; A.	High resolution graphics. Also system B with video board & terminal £3195. (E).
Vector System 2800 (£4195)	As above	56k RAM; Z80A; dual 8" F/D (2.4Mb); 3 S/P; 2 P/P.	As above.	High-res graphics. Also System 3030 with 32Mb H/D and single 5¼" F/D £7500. (E)
Video Genie EG3003 (£330)	Lowe Electronics: 0629 2817 (N/A)	16k RAM; Z80; 500bps C; 32x64 TV int; extra C int; 1 P/P.	Basic (12k ROM); *M/A; Fortran.*	Graphics available.
WH8 (£352)	Heath 0452 29451 (N/A).	16-64k RAM; 8080A (or Z80); 4 S/P. Option: single 5¼" F/D (102k) £241.	OS; HDOS; CP/M; *Fortran; Pascal; Basic*	Kit. 3 drives max. Colour graphics avail. (S&H) BT 2/80.
Zentec (£4838)	Zygal Dynamics: 02405 75681 (TBA)	32-64k RAM; 2x8080; dual 5¼" F/D (256k); 15", 25x80 VDU; RS232 port.	O/S; A; U; *Basic*; Cis Cobol.	User programmable character se set. Option: dual 8" F/D (1Mb). (S).
Zenith WH-11A (£2673)	Heath Ltd: 0452 29451 & 01-636 7349 (N/A)	LSI 11; 16-32k RAM; 25x80 VDU; S/P; P/P.	*O/S; Basic; Fortran*; A; U.	PDP 11-compat. Option: 2x8" F/D 2.2Mb. £1717 (S&H).
Zenith Z89 £1570-£1710	As above	16-48k RAM; Z80; single 5¼" F/D (102k); 12" 25x80 b&g VDU; RS232.	*Basic*; A; *HDOS*; CP/M; *MBasic; CBasic: Fortran.*	3 x 5¼" F/D possible. Options: dual 8" F/D (2.2Mb) £1717, 20Mb H/D.
Zilog MCZ 1/05 (portable): MCZ 1/20A (£3250)	Micropower: 0256 54121. Memec: 084421 5471 (N/A)	64k RAM; Z80; dual 8" F/D (600k); RS232 port; MCZ 1/20A only 1 P/P; Option: 10Mb H/D £7100	RIO; O/S; *Cobol; Basic; Fortran; Pascal; M/A*; *U.*	Available desk top or rack mounted. Debug in 3k PROM. 1/20A runs multi user Cobol, up to 5 terminals with 40Mb H/D.(S&H).
Z-Plus (£3950)	Rostronics Ltd: 01-874 1171 (16).	64k RAM; Z80; dual 8" F/D (1Mb): 4 S/P; 2 P/P.	CP/M; A; U; *Basic; Cobol; Fortran; Pascal; APL; PL/1; Algol;*	Available with 2Mb F/D. Option: 20Mb H/D £4000. BT 12/79 (S&H).

SINGLE BOARDS

Machine (Price from)	Main Distributor/s (No. of Dealers)	Hardware	Software/ Firmware	Miscellaneous (Documentation)
Acorn System 1 (£65)	Acorn: 0223 312772 (10)	11/8k 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.*	Kit. Programmable address linking. On-board 5 V regulator. Available assembled £79. Can be expanded to disk-based system. (S& H).
Aim 65C (£285)	Pelco: 0273 722155 (7)	1-4k RAM; 6502; 4-20k ROM: Full K/B; 2xC; 20 char LED; 20 char thermal printer; RS232 port.	A. Dis A; T/E; 8k monitor; *Basic (8k ROM); PL65.*	Power supplies and two types of case avail. Can be expanded to disk system. (E).
Cromemco SC (£260)	Comart: 0480 215005 (17)	1k RAM; Z80A; 8k EPROM sockets; RS232 port; 3 P/P. Option: S100 bus.	Monitor; *Basic.*	5 program interval timers. Can put own Basic programs in EPROM.(E).
Elf II (£60)	Newtronics: 01-348 3325 (N/A)	¼-64k RAM; RCA 1802; Hex K/B; 2-digit LED; TV int; C int; RS232. Options: Full K/B; VDU card.	1k monitor; A; Dis A; T/E; Elf-bug; *Tiny Basic; Basic.*	TTY, N-line decoders. Low resolution graphics (high res avail). Kits or built. (H).
Explorer (£82)	As above	4-64k RAM; 8085; Hex K/B; RS232 port; S100 bus; C int; 1k video RAM.	2k monitor; *Basic; CP/M.*	Supplied in kit or built. Full range of peripherals including F/D. (H).

List of Abbreviations

A	Assembler	F/D	Floppy disk	M/A	Macro assembler	S/P	Serial port
BT	Bench Tested	G/C	Graphics card	N/A	Not available	T/E	Text editor
C	Cassette	H	Hardware	N/P	Numeric pad	TBA	To be announced
E	Extensive	H/D	Hard disk	O/S	Operating system	U	Utility
		I	Introductory	P/P	Parallel port		
		Int	Interface	S	Software		

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

SINGLE BOARDS

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.	Can be upgraded with 6809. (H).
Hewart 6800 Mk III (£152)	As above	1k RAM; 6800; VDU board.	1k monitor.	Options: single 5¼" F/D (75k) £350; PROM programmer £32. (H).
Microtan 65 (£69)	Tangerine: 0353 3633 (6)	1k RAM; 6502; 16x32 TV int; Options: 64x64 Pixel graphics £6.50; 16k RAM £56.	1k monitor; *Basic*.	TANEX expansion kit with 7k RAM; 4k EPROM sockets; 10k Basic; 4 S/P; 32 P/P £145. (E).
Nascom 1 (£125)	Nascom: 02405 75155 (20)	4k RAM; Z80; Full K/B; TV int; 2 P/P; 1 S/P. Options: 16k RAM £140; single 5¼" F/D (250k) £240 (4 disk controller £127).	2k monitor; *BBasic; Tiny Basic; A; T/E; U.*	Kit. Built verstion £140. Also Nascom 2 with 8k Microsoft Basic in ROM £225 (no RAM). (S&H).
77/68 (£90)	Newbear: 0635 30505 (N/A)	4k RAM; 6800; LED; C int; VDU int.	1k monitor; *Basic*.	Expandable to 64k RAM with F/D. (B).
79/09 (£65)	As above	1k RAM; 6809; P/P; S/P.	2k Monitor.	Designed to upgrade 77/68. (H).
SBC 100 (£135)	Airamco: 0294 57755 (TBA)	1k RAM; Z80; 8k ROM; S100; 1 S/P; 1 P/P.	*1k monitor; DOS in ROM.*	Kit. Available assembled £196. (E).
Superboard (£188)	(as Challenger)	4-8k RAM; 6502; 10k ROM; full K/B; VDU int; C int.	Basic (8k ROM).	Options: RS232 port; single 5¼" F/D (100k) £316; 8k RAM £188. (S&H).
Smoke Signal SCB 68 (£174)	Systems Implementation Ltd: 06924 5666 (TBA)	1k RAM; 6800/6809; 10-20k EPROM; 1 S/P.	2k monitor.	Many expansion boards available including F/D. (H)
SYM-1 (£160)	Newbear: 0635 30505 (N/A)	1-4k RAM; 6502; C int; VDU int; 2x6522 ports. Option: TV int.	4k monitor; *Basic; A*.	Expandable to 64k RAM with F/D. (B).
Triton L5.2 (£294)	Transam: 01-405 5240 (N/A).	1-3k RAM; 8080; 1k VDU RAM full K/B; 16x64 VDU or TV int; C int; 1 S/P.	1½k monitor; 2½k Basic.	64-char graphics. Disk int running CP/M about £200. (S&H).
Tuscan (£195)	As above	8k RAM; 8k ROM; Z80A; 5xS100 slots; RS232 port; TV int; C int; 1 P/P.	*2k monitor; 8k Basic; CP/M; Pascal.*	High res graphics available. Can be expanded to F/D system. (S&H).
UK101 (£179)	Comp Shop: 01-440 7033 (4)	4k RAM; 6502; full K/B; 16x48 VDU or TV int; C int; RS232 port, Options: 4k RAM £29.	1k monitor; 8k Basic; *Dis A; U.*	Graphics. Will run Superboard software. New monitor EPROM with enhanced U £22. (S&H).
ZCB (£260)	Almarc: 0602 625035 (3)	1k RAM; Z80A; 3 PROM sockets; RS232 port; 3 P/P.	*Will take any 2708/ 16/32 software.*	S100 bus compatible. Expandable to full system. (E).

DIARY DATA

Birmingham, England	(NEC) Which Computer? Show. Contact Clapp & Poliak Europe Ltd., 01-995 4806	25 — 28 Nov
Brighton, England	(Metropole Exhib. Hall) Semiconductor Int. Exhib. Contact: Kiver Communications SA, 171/185 Ewell Rd., Surbiton, Surrey KT6 6AX	25 — 27 Nov
London, England	(Royal Hort. Hall) Breadboard. Contact: Modmags Ltd., 145 Charing Cross Road, London WC2H 0EE	26 — 30 Nov
Nottingham, England	(Novotel) Electronic Business Equip. Exbn — BIZTRONIC. Contact: Groundrule Exbn Co, 7 Market St, Altrincham, Cheshire. 061-928 0406	2 — 3 Dec
Birmingham, England	(Edgbaston Cricket Ground) Electronic Business Equip. Exbn — BIZTRONIC. Contact: (as above)	27 — 29 Jan
Bahrain	Middle East Electronic Comms. Show & Conf — MECOM. Contact: Arabian Exbn. Management, 49-50 Calthorpe Rd., Edgbaston, Birmingham. 021-454 4416	2 — 5 Feb
Eindhoven, Holland	Int. Microelectronics Sub. Systems Trade Fair — Microelectronica. Contact: Golden Gate Exbns Inc, PO Box 428, Los Altos, CA94022, USA	4 — 6 Feb
Glasgow, Scotland	(Albany Hotel) Computermarket. Contact: Couchmead Ltd., 42 Gt Windmill Street, London W1. 01-437 4187	17 — 19 Mar

USER GROUPS INDEX

Here are the details of additions and changes recently notified. If we have failed to include YOUR group (or have published incorrect information) either here or in the complete listing, then please address changes/additions to: PCW (User Groups Index), 14 Rathbone Place, London W1P 1DE. Finally, the next complete listing will appear in our February issue.

NATIONAL

Anyone interested in forming a Texas TI99/4 Users' Club with a magazine and a software library, should contact Mr P Dicks, Data Processing Manager, Pershke Price Service Organisation Ltd, Dover House, 141 Morden Rd, Mitcham, Surrey CR4 4XB, tel. 01-648 7090

Sharp PC-1211 Users' Club. Also open to TRS-80 Pocket Computer owners and anyone else with or without a computer. Membership costs £5 p/a which includes a newsletter containing programs etc. Contact: Jonathan Dakeyne, 281 Lidgett Lane, Leeds LS17 6PD.

Apple/ITT2020 Users' Group. Just started up, with plans to hold monthly meetings on Sunday afternoons. Contact: John Sharp, 20 The Glebe, Garston, Watford WD2 6LR, tel. Garston 75093.

A user group specifically for Level 1 TRS-80 owners has recently been set up. We've no further details, other than that a newsletter is planned. Contact: N Rushton, 123 Roughwood Drive, Northwood, Kirkby, Merseyside L33 9UG.

SOUTH

IPUG South East Regional Group. Meets third Thursday each month, 7.30 pm at Charles Darwin School , Jail Lane, Biggin Hill. Bi-monthly newsletter. Contact: W Cdr M Ryan, 164 Chesterfield Drive, Sevenoaks, Kent TN13 2EH, tel (0732) 53530.

CAMBRIDGESHIRE

Peterborough Computer Club. Recently formed, meets on first and third Mondays each month at Adult Education Centre, Brook Street, Peterborough. Contact: T Marchant, tel Peterborough 76681 after 6 weekdays, anytime weekends.

EAST MIDLANDS

East Midlands TRS-80 Users' Group. For owners/would-be owners of TRS-80s or Video Genies. For free newsletter and further details contact: Mike Costello, 17 Langbank Avenue, Rise Park, Nottingham NG5 5BU.

LANCASHIRE

PET Users' in West Lancs. Meets monthly on third Thursday each month at Arnold School, Blackpool. Contact: David Jowett, 197 Victoria Road East, Thornton, Blackpool FY5 3ST, tel Cleveleys 869108.

SCOTLAND

Central Scotland Computer Club. Meets first and third Thursdays each month at Falkirk College of Technology, Grangemouth Rd., Falkirk. Contact J Lyon, 78 Slamannan Rd, Falkirk FK1 5NF, tel. 22430.

Grampian Amateur Computer Society. Meets second Monday monthly at local hotel, looking for own premises. Sub £4 p/a (£1 for junior members), monthly. About 50 members. Club owns an ICL 1902! Contact: Alan Hird, 20 Harcourt Rd, Aberdeen, Grampian, tel (0224) 33102.

SUFFOLK

Anyone interested in forming a Suffolk Computer Users' Club should contact Ian on Ipswich 831353 eves/weekends.

DIRECT ACCESS

TRANSACTION FILE

The classified service that's free to non-commercial readers. Advertisements (50 words max) to: PCW Transaction File, 14 Rathbone Place, London W1P 1DE.

For sale

Litton/Monroe VRC. . . serial printer, tape read/write progs & manuals, large quant paper tape & paper rolls, all working, suitable for invoicing, ledgers, stock control, £500 the lot or swap for Apple, TRS-80, PET with disks. Ward. 01-486 9893 day.

PET 2001. . . 8k, exc cond, dust cover, games progs & doc, £350. Tel: Chipping Sodbury 311779 eves.

Sorcerer. . . 32k, S100 exp unit, monitor, dual Micropolis disks (630k total), Basic & Word Processing pacs, CP/M software & manuals, can split, reasonable offers. Tel: 061-928 8507 eves or w/ends.

T159. . . as new, with marine nav module & spare cards, £160. Tel: Chesterfield (0246) 34898.

Eight inch. . . disk drive (GSI FDD110). 220/50 mains motor, S100 s/dens controller (Wameco FDC1), inc onboard 2708 firmware, spare drive PCB, hard/software doc inc, untried, so £240 the lot inc carriage. Andrews, Templecombe (Somerset) 70587 eves.

Kim 1. . . 1k RAM, 2k ROM, monitor, tape, cassette int, 2 8-bit I/O ports, hex keypad, 6-digit 7-seg display, user manual & connector, fully expandable, £60. N Brazier, Trilleck, Cliff Road, North Patherton, Bridgewater, Somerset. Tel: 0278 662244 eves.

TRS-80 L2. . . 16k, VDU, c/recorder. Tbug, debounce & renumber tapes, Z80 assembler lang, Intro to Basic, Tandy instruction manuals, £400 ovno. Tel: 0273 733774 day, 0273 35627 eves.

Sorcerer 32k. . . 8k Basic, development pac, manuals, much software, £650 ono. A Wood, 47 Crick Rd., Hillmorton, Rugby CV21 4DU. Tel: 0788 846220 after 4.30.

Brand new. . . ZX80, bought assembled, with PSU, unused, boxed, cost £108, accept £80. Tel: Leatherhead 74674.

ZX80. . . inc leads, mains adaptor, etc, 2 months old, £70. Tel: Welwyn Garden City 33485.

New TRS-80. . . 16k level 2. Good reason for selling. Tel: Bilston 402869 after 7pm not Thursday or Sunday. Ask for Dave.

Teletype 33 KSR. . . ASCII coded. RS 232 I/O. With stand. Good condition, £180 ono. Tel: 0629 834426 (Darleydale) evenings.

ZX80. . . plus 3k RAM, circuit diagram, manuals, mains adaptor and 44 programs on tape + other literature. Tel: Witham (Essex) 516335.

Nascom 2. . . 32k RAM, 8k Basic, 4k ZEAP in EPROM, 4k Toolkit, 2400 Baud cassette interface, manuals tapes and programs. £470. Tel: 0326 72207 evenings/weekends. Can deliver West Country & London.

PET. . . 32k, Large Keyboard, new ROMs, Green Screen, 7 months old with cassette deck and spare tapes, manuals and books. Offers around £625. Tel: Saffron Walden (0799) 24244

Acorn System One . . . Excellent introduction to microprocessing and machine code programming. £55. Contact James Movecroft, 107, Fulham Palace Road London W6.

MK14 . . . Issue 4, extra RAM. I/O, new keyboard, cassette interface, working £40. Tel: 01-542 0089 after 5pm. weekdays (Wimbledon Chase)

UK 101 . . . New, cased and working plus new monitor. 5k RAM, 8k ROM. All cables attached. New monitor allows on screen editing. Several programs (including Invaders) thrown in. £275 ono. Tel: 01-690 6085 between 9.30 and 10.30 any evening.

Sinclair ZX-80. . . inc leads, mains adaptor and Basic manual. Tel: 01-572 5582 ask for Dave.

SYM 1. . . 4k, 8k Basic in ROM, alphanumeric keyboard (v. good quality). Tangerine 1648 VDU. Full set of manuals. 6 amp psu. Cash crisis forces sale. First £260 takes the lot. (cost around £700). Tel: Millom 3591

TRS-80. . . Level 2, 16k CUP plus adaptors for mains, video and cassette. Also some cassettes (inc Invaders) and manuals. Only 2 months old. £380 or swap for 8k PET. David Watson — Tel: Hatfield Heath (027977) 292.

Boris. . . Walnut cased master chess computer. Unwanted gift from USA. Different from UK model. Extra features — rechargeable batteries, memory switch for saving board position. £140 Plus JVC am/fm/sw radio vhf/uhf 3" TV, ideal for micros —£60 or exchange one/both for good oscilloscope. Tel: Radnage (024026) 3765.

PET 2001 8k. . . small keyboard, integral cassette, usual extras inc games, manual, sound box etc. Offers around £399 to Kevin Pretorius, tel 01-360 9576 (Enfield)

Superboard II. . . perfect working order, 8k RAM, wood case, PSU, TV modulator, leads, manuals, software inc screen editor, galactic warfare, man many other progs, £220. Tel R. Staerck, Ingrebourne 70681 after 4

Softy. . . EPROM programmer & development board, built & working with PSU & details of mods to program; for single rail EPROMs, £93. Tel 0325 313853

PET 2001 8k. . . 10 months old, as new, £450. Inc toolkit, green screen, sound box, TIS workbooks, manual, utilities, games (Microchess) etc. Tel Bradford 675775 after 6.

PET 2001 8k. . . green screen, sound box, TIS workbooks, tapes, collection of magazines, little used, 11 months old, £330 ono. Tel 01-597 4364

S100. . . system with Z80, 104, ROM board, 16 x 64 VDU board, 64k DRAM board, full RS232 keyboard, 9-slot motherboard, PSU, cased. Tel Geoff 0632 651707

UK101. . . new monitor, used cond with all doc, £18. Tel 0535 607525, ask for David

Exchange. . . Panasonic video recorder with 11 tapes (24 hours) & cabinet for TRS-80 (16k) L2 or PET 16k. Marin Cook, 16 Reynolds Court, Kingsway, Oldbury, Warley, W Midlands, or tel 021-422 6019 & leave phone no. to contact.

77-68 CPU. . . (ex switches/LEDs) £20. VDU, £20 Mon-2 (with T-Bug), £20; 4k RAM (with 2k), £20 all 4 boards £50. Tel Denis Field, St. Albans 60432 eve. 01-950-4030 ect 219 day.

MSI 6800. . . computer, 8k RAM, par & serial cassette ints, SWTP CT6155 graphics board, SWTP CT64 terminal, V/C case, 2 pages memory, TV modulator, £595. Tel 092 82 2929

Diablo 1550. . . daisywheel printer/typewriter, RS232, friction/tractor feed, papaer tra tray, integral stand, £595 ono. Tel 01-989 0430

Apple II Plus. . . 38k, single disk drive, wide range of software, unemployment forces sale, £850 Tel Hitchin 31761

Cassette storage. . . RDL recorder model GED460, tech & op manuals, needs new EOT lamp otherwise perfect, elaborate data & control logic in desktop steel case, unusual item £60. Tel. 01-977 4389 eves.

UK101. . . 8k RAM, 8k Microsoft Basic, assembled & cased, manual, games, extended monitor, assembler/editor, working, Tel Lee, 01-328 2444 or call 18 Plympton Rd. London NW6 eves

TRS-80 Level II. . . 16k VDU, cassette, 2 speed switchable processor (1.77 MHz/2.66 MHz), manuals, dust covers, books, tapes inc Space Invaders, Adventure games, chess, spare tapes & case, £550 ono. Tel Chester 672961 day or 051-336 6446 after 7, ask for Phil

TI PC100B. . . print cradle for TI59/58, £110. Interface for old style 8k PET to MTU hi-res graphics board as sold by IJJ Design, £50. Tel Burton-on-Trent (0283) 217373

PET 2001 32k. . .large keyboard, new ROMs, ext cassette, some progs, 9 months old, impulse buy, rarely used, £450 ono for quick sale, buyer collects. Tel . Littlehampton (09064) 4477 ext 4 day, 09064 6591 eves.

63-key ASCII. . . keyboard, cased with Newbear Petitevid CRT ctrllr board & PSU; add monitor/TV for self-cont'd ASCII terminal. UHF modulator free if req. Prefer buyer inspects & collects, £90 ono. S. Hunt, 21 Green St., Milton Malsor, Northampton NN7 3AT

Nascom 2. . . 32k RAM, video monitor, large PSU, PIO board (up to 10 PIOs + CTC), 16 channel ADC, ICL 7075 printer, Zeap 2, Nasdis, Debug, Basic + Toolkit all in ROM, 4½ digit DVM, all in 19" rack, working with full doc & many extras, best offer over £1000, buyer collects. Tel John. 01-351 3044 eves.

PET 2001 8k. . . £400 Tel 0494 33164

Nascom 1. . . T2 monitor, PSU all doc, cassettes & progrs. ideal for begineer or exp person, £90 ono. Tel Chris (0782) 622164 after 5

Sorcerer. . . 48k, almost new, working, with 10 months warranty left, owner decided to buy video game machine due to lack of serious use; inc TV modulator, software manual & other extras, £536 ono. Also Chess Challenger 7, around £35. Tel P Koh 01-205 3521

TRS-80 Level II. . . 16k, + cass rec (CTR—80), numeric keypad, latest video monitor, some software (eg games, Tbug, Edtsam, Micromusic etc), almost new, perfect cond, only £500 inc packing — unwanted birthday present. Tel G. Kilpatrick (0772) 732169

PET 2001-8. . . vgc, 8k old ROM, software, manuals, PETsoft soundbox, £400 ono. Tel Brege, Newcastle 744299 after 4

SWTP 6800. . . comprising 6800 processor, par & serialints, SWT Bug, 40k RAM, CT64 terminal, AC30 cassette int, MF68 twin minifloppy drive unit (170k), PR40 40-col prnter, system may be seen working, £1350. Tel Ware 2864 day, Ware 870300 eves

MZ-80K. . . 24k RAM, perfect cond, bought 15 Aug this year, inc Basic tape, manual, 50 progs (Othello, music, Space Invaders etc), £500 A. Mewes, 11 Barid Gdns, London SE19, Tel 01-670 1828

Nascom 1. . . 40k RAM (2 boards) control + hex keyboard (Bits PCs), hi-res graphics card (Bits PCs), EPROM programmer for 2708s, dual monitor board (NasSys + T4), case unit has fitted VDU & keyboards, interfaced to Creed 7B teleprinter, CUTS 300, 600, 1200 & 2400 baud, software inc Naspen, Zeap, toolkit, Naschess, Nasdis, Revas C, all for £600, possible split. Tel. Mountain Ash (Glamorgan) 476040 ask for Paul

UK101. . . new monitor ROM, 8k RAM, assembler editor tape, Microcase, cased transformer, fully tested, full doc & 6502 assembler & applications books £260. Tel Steve Griffiths, 01-997 3311 ext 2087 day

UK101. . . prof built, 8k RAM, cased with cooling fan & mains switch, TV monitor & cass output sckts, 2 mini mains sckts on rear panel, £300 ono. Mr C Bevis, 136 Talbot Rd, Southsea, Hants or tel Portsmouth 731151 after 7.30

T159. . . prog clac & PC100C printer, maths, stats, master & leisure modules, many mag cards & spare rolls pinter paper, 7 TI books, instruction manuals, perfect con, £250. Tel Wokingham (0734) 788023

Datem modem. . . ex GPO model 2A, working Yhas been used as am RTTY terminal) with literature & spare boards, £48. 9 channel tape data recorder, mechanics working + int boards (Singer), £35, no literature. Tel Dr. Bulger. 01-985 1314.

ZX80. . . full working order, assembled, inc all leads, PSU & manual, vgc, £75. Timothy Place, The Coppice, The Green, Thornborough, Nr. Buckingham, tel Buckingham 3796

Nascom 2. . . 16k memory exp, built & working, tape recorder & leads, 110, 300, 1200 or 2400 baud, Zeap 2 & some games inc 12k m/c code Sargon Chess, offers. Tel Peterborough (0733) 222588.

UK101. . . 5 months old, vgc, cased with 8k RAM & dis-assembler oncass, £240 ono. Tel West Drayton 21197 after 6.30 or w/ends.

Triton. . . motherboard with PSU & connectors fitted, 8k RAM card 8k EPROM card, 2 spare card connectors, 2 x 2114L RAM chips (board minus memory chips), £110 ono. Tel Mr Rees, 01-802 8502 eves, 01-580 4468 ext 2172 day

PET 8k. . . old ROM, internal cassette, owner getting 32k, £370 Tel 01-449 7812

Genuine reason. . . for give-away price of £400 for new TRS-80 Level II, 16k inc VDU & cassette, all manuals & software. Will offer some basic instruction if required. Tel 021-455 7413 after 5.30 or w/ends.

Wanted

Toolkit for PET 2001 (old ROM) Shafe, Apartamento 411, Edificio Cap Negret, 27 Altea (Alicante), Spain.

PET, TRS-80 level II or Sinclair, with cassette and manuals. Large keyboard essential. Telephone 0492 67288 after 8pm.

Future Perfect continued from page 111

```
12100 IFHT>0ANDAT>0THEN12130
12110 NEXTI
12115 PRINT"                "
12120 PRINT" TEAM NAME ERROR...RE-ENTER":HT=0:AT=0:GOTO12040
12130 GOSUB21011:GOSUB21050
12135 PRINT"";TAB(16-LEN(N$(HT))),N$(HT);TAB(18);" V ";TAB(23);N$(AT)
12150 PRINT X=HR(HT):GOSUB20210
12160 HW=W:HL=L:HD=D:HS=W+L+D:IFHS=0THENHS=1
12170 X=AR(AT):GOSUB20210
12180 AW=W:AL=L:AD=D:AS=W+L+D:IFAS=0THENAS=1
12190 PH=((HW/HS)+(AL/AS))/2
12195 PRINTTAB(7);"PROBABILITY OF HOME =";INT(PH*100+.5)/100
12200 PD=((HD/HS)+(AD/AS))/2
12202 PRINTTAB(7);"PROBABILITY OF DRAW =";INT(PD*100+.5)/100
12205 PA=((HL/HS)+(AW/AS))/2
12207 PRINTTAB(7),"PROBABILITY OF AWAY =";INT(PA*100+.5)/100
12240 PRINT:Y=HG(HT):GOSUB20410:F1=F:F2=A:Y=AG(AT):GOSUB20410:F3=F:F4=A
12300 SH=((F1/HS)+(F4/AS))/2:SA=((F2/HS)+(F3/AS))/2
12350 PRINTTAB(3);N$(HT);INT(SH*10+.5)/10;"  ";N$(AT);INT(SA*10+.5)/10:PRINT
12380 IFHT<ATTHEN12410
12390 PRINTTAB(3);N$(AT);HT-AT;"ABOVE ",N$(HT):GOTO12444
12410 PRINTTAB(3);N$(HT),AT-HT,"ABOVE ",N$(AT)
12444 GOSUB22100
12445 TT=INT(((2-FA(AT)+FH(HT))/2)*20+.5)-1
12447 IFTT>36THENTT=36
12448 IFTT<2THENTT=2
12462 PRINTTAB(TT);"":GOSUB20620:GOTO12010
12510 RETURN
13010 PRINT"LOAD EXPO-LEAGUES TAPE":GOSUB20615:PRINT""
13030 OPEN1,1,1,"EXPO-LEAGUES"
13040 PRINT"LEAGUE TABLES FILE OPENED":GOSUB21210
13046 PRINT#1,Q$:Q$=""
13050 FORI=1TO130
13060 PRINT#1,N$(I)
13070 PRINT#1,HR(I)
13080 PRINT#1,HG(I)
13090 PRINT#1,AR(I)
13100 PRINT#1,AG(I)
13110 PRINT#1,PP(I)
13114 PRINT#1,FH(I)
13116 PRINT#1,FA(I)
13117 PRINT#1,TH(I)
13118 PRINT#1,TA(I)
13120 PRINT"TEAMS FILED =";I:NEXTI
13150 CLOSE1:PRINT"ALL TEAMS FILED":GOSUB20615:RETURN
14010 IFEN=1THEN14170
14015 PRINT"LOAD EXPO-LEAGUES TAPE":GOSUB20615:PRINT"PASSWORD ?"
14023 GOSUB21215
14030 OPEN1,1,0,"EXPO-LEAGUES"
14040 PRINT"LEAGUE TABLES FILE OPENED"
14042 INPUT#1,QQ$:IFQQ$=Q$THEN14050
14046 PRINT"WRONG PASSWORD GIVEN !":Q$="":QQ$=""
14048 CLOSE1:PRINT"FILE CLOSED":RETURN
14050 Q$="":QQ$="":FORI=1TO130
14060 INPUT#1,N$(I)
14070 INPUT#1,HR(I)
14080 INPUT#1,HG(I)
14090 INPUT#1,AR(I)
14100 INPUT#1,AG(I)
14110 INPUT#1,PP(I)
14114 INPUT#1,FH(I)
14116 INPUT#1,FA(I)
14117 INPUT#1,TH(I)
14118 INPUT#1,TA(I)
14120 PRINT"TEAMS RECALLED";I:NEXTI
14140 CLOSE1
14150 PRINT"ALL TEAMS RECALLED":EN=1:GOSUB20615:RETURN
15010 PRINT"DIVISION 1",TAB(12),"W D L  F A  W D L  F A PT"
15030 FORI=1TO130:GOSUB20510:IFLS<2THEN15080
15060 GOSUB20620:PRINT"";D$;TAB(12),"W D L  F A  W D L  F A PT"
15080 PRINTN$(I);
15085 Y$=STR$(HR(I)):PRINTTAB(18-LEN(Y$));Y$;
15090 Y$=STR$(HG(I)):PRINTTAB(23-LEN(Y$)),Y$;
15095 Y$=STR$(AR(I)):PRINTTAB(30-LEN(Y$));Y$;
15100 Y$=STR$(AG(I)):PRINTTAB(35-LEN(Y$));Y$;
15110 PRINTTAB(35);PP(I)
15120 LS=0:NEXTI:GOSUB20620:RETURN
20110 X=L+D*100+W*10000:RETURN
20210 W=INT(X/10000):D=INT(X/100)-W*100:L=X-D*100-W*10000:RETURN
20310 Y=F*100+A:RETURN
20410 F=INT(Y/100):A=Y-F*100:RETURN
20510 IFI=1THEND$="DIVISION 1":LS=1:LF=22:RETURN
20520 IFI=23THEND$="DIVISION 2":LS=23:LF=44:RETURN
20530 IFI=45THEND$="DIVISION 3":LS=45:LF=68:RETURN
20540 IFI=69THEND$="DIVISION 4":LS=69:LF=92:RETURN
20550 IFI=93THEND$="SCOTS PREM":LS=93:LF=102:RETURN
20560 IFI=103THEND$="SCOT DIV 1":LS=103:LF=116:RETURN
20570 IFI=117THEND$="SCOT DIV 2":LS=117:LF=130:RETURN
20580 RETURN
20610 PRINT""
20615 PRINT"      TO CONTINUE PRESS 'SPACE' BAR"
20620 GETZ$:IFZ$=""THEN20620
20630 RETURN
20710 INPUT"MATCHES WON  ";W:INPUT"MATCHES DRAWN";D:INPUT"MATCHES LOST ";L
20740 GOSUB20110:INPUT"GOALS FOR    ";F:INPUT"GOALS AGAINST";A
20770 GOSUB20310:RETURN
20810 PRINT"  ARE DETAILS CORRECT ?":GOSUB20620:RETURN
20910 FORXY=1TO25:ZZ=SQR(7):NEXTXY:RETURN
21011 PRINT""
21030 FORJ=1TO20:PRINT"                                        ":NEXTJ:RETURN
21050 PRINT"__________FORECAST  SUMMARY__________":GOSUB23001:GOSUB2300.
21070 PRINT:GOSUB23003:GOSUB23001
21081 PRINT"       SEASONAL ANALYSIS        ":GOSUB23002
21100 PRINT"":GOSUB23003
21110 PRINT" AWAY    EXPONENTIAL TREND    HOME":GOSUB23001
21130 PRINT"        1       0        1        "
21135 PRINT" +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+ ":GOSUB23001:GOSUB23004
21150 RETURN
21210 PRINT"WHAT IS PASSWORD TO BE (5) "
21215 Q$=""
21220 FORJ=1TO5:GOSUB20620:Q$=Q$+Z$:NEXTJ:RETURN
22100 TT=FH(HT):GOSUB22200:PRINTTAB(TT);"H"
22120 TT=2-FA(AT):GOSUB22200:PRINTTAB(TT);"A":RETURN
22200 TT=INT(TT*20+.5)-1
22210 IFTT>36THENTT=36
22220 IFTT<2THENTT=2
22230 RETURN
```

```
23000 PRINT"                                              ":RETURN
23001 PRINT"                                              ":RETURN
23002 PRINT"                                              ":RETURN
23003 PRINT"                                              ":RETURN
23004 PRINT"                                              ":RETURN
23005 PRINT"                                              ":RETURN
READY.
```

PCW Sub Set continued from page 107

Datasheet

```
; = ALRET — Skip parameters
;/ CLASS:2
;/ TIME CRITICAL?: No
;/ DESCRIPTION: Alters the return address from a subroutine to skip
;/              over parameters in the main program and leaves
;/              HL pointing to the lowest addressed parameter
;/ ACTION:  HL  ←  (SP + 2)
;/          (SP + 2)  ←  (SP + 2) + (DE)
;/ SUBr DEPENDENCE: None
;/ INTERFACES: None
;/ INPUT: The DE register must have been set in the main program to
;/        the number of bytes to be jumped over
;/ OUTPUT: HL points to the location following the main program call,
;/         which is the first of the parameters.
;/         The return from subroutine address on the stack has been
;/         increased by the value in DE on input.
;/ REGs USED: DE and HL
;/ STACK USE: 0
;/ LENGTH: 10
;/ TIME STATES: 91
;/ PROCESSOR: Z80 and 8080
ALRET:INC  SP         ; bypass return address      33
      INC  SP         ; to calling subroutine      33
      EX   (SP),HL    ; HL = initial SP contents   E3
      EX   DE, HL                                  EB
      ADD  HL,DE      ; HL = new return address    19
      EX   (SP),HL    ; SP = new return address    E3
      EX   DE,HL      ; HL = initial SP contents   EB
      DEC  SP         ; reset SP for return        3B
      DEC  SP         : from this routine          3B
      RET             : to calling subroutine      C9
```

Datasheet

```
; = BFSR — Packed BCD/ASCII
;/ CLASS: 1
;/ TIME CRITICAL?: No
;/ DESCRIPTION: Converts packed BCD digits into ASCII decimal
;/              bytes; leaves the BCD field unchanged;
;/              suppresses leading zeros, but not the least significant
;/              nibble of an all zero field.
;/ ACTION: Not given, as not helpful
;/ SUBr DEPENDENCE: None
;/ INTERFACES: None
;/ INPUT: DE contains the address of the most significant ASCII byte
;/        HL contains the address of the most significant packed
;/        BCD byte
;/        B contains the number of BCD bytes to be converted
;/ OUTPUT: The ASCII field is created and the BCD field is unaffected
;/ REGs USED: A,B,DE,HL
;/ STACK USE: 0
;/ LENGTH: 35
;/ TIME STATES: Approximately 200 per packed BCD byte
;/ PROCESSOR: Z80
BFSR1: INC   DE       ; increment DE               13
       INC   DE       ; increment DE               13
       INC   HL       ; bump packed byte pointer   23
BFSR:  LD    A,(HL)   ; pick up packed byte        7E
       AND   FFH      ; is it = 0?                 E6 FF
       JRNZ  BGSR2    ; if not go to convert it    20 03
       DJNZ  BFSR1    ; cont if not end BCD field  10 F6
       INC   B        ; bump byte counter          04
BFSR2: AND   FOH      ; upper nibble = 0?          E6 F0
       JR    Z,BFSR4  ; jump if yes                28 07
       LD    A,30H    ; load A with 30 hex         3E 30
BFSR3: RLD            ; get high nibble            ED 6F
       LD (DE),A      ; store ASCII                12
       RRD            ; restore packed byte        ED 67
BFSR4: INC   DE       ; bump ASCII pointer         13
       LD    A,30H    ; load A with 30 hex         3E 30
```

RRD		; get low nibble	ED 67
LD	(DE),A	; store ASCII	12
RLD		; restore packed byte	ED 6F
INC	HL	; bump packed byte pointer	23
INC	DE	; bump ASCII pointer	13
DJNZ	BFSR3	; decr B & continue if not 0	10 EF
RET		; return	C9

Microchess continued from page 69

5.	CHESS 4.9 (USA) Lawrence Atkin; David Cahlander CDC Cyber 176	L4	D9	W11	W10	2½
6.	NUCHESS (USA) David Slate; William Blanchard CDC Cyber 176	W16	D1	L2	D9	2
7.	KAISSA (USSR) V L Arlazarov; M V Donskoy IBM 370/168	W14	W13	L3	L2	2
8.	BCP (UK) Don Beal PDP 11/70	L1	D10	D14	W15	2
9.	BEBE (USA) Tony Scherzer Bebe chess machine	D10	D5	D12	D6	2
10.	SCHACH 2.3 (BRD) Matthias Engelbach Burroughs 7800	D9	D8	W13	L5	2
11.	AWIT (Can) T A Marsland Amdahl 470 V/7	L13	W17	L5	W18	2
12.	MASTER (UK) Peter Kent; John Birmingham IBM 3033	W15	L3	D9	L4	1½
13.	OSTRICH (Can) Monroe Newborn Data General Nova 4	W11	L7	L10	D14	1½
14.	MYCHESS (USA) David Kittinger Cromemco	L7	D15	D8	D13	1½
15.	PARWELL (BRD) Thomas Nitsche; Elmar Henne; Wolfram Wolff Siemens SMS 2 plus 128 8080s in parallel	L12	D14	W16	L8	1½
16.	ADVANCE 1.0 (UK) Mike Johnson; Dave Wilson 6502 plus chess hardware	L6	D18	L15	W17	1½
17.	DARK HORSE (SWE) Ulf Rathsman Univac 1100/81	L2	L11	W18	L16	1
18.	CSC (USA) Dan & Kathe Spracklen; Ron Nelson; Frank Duason; Ed English Champion Sensory Challenger	L3	D16	L17	L11	½

Belle defeated Chaos in the play-off for the title

YCW program continued from page 116

```
480 REM
490 REM
500 FOR Y=1 TO 10 READ RN(Y) NEXT
510 DATA 1,4,3,2,4,4,1,2,3,1
520 REM
530 W(1)=1 W(2)=4 W(3)=2:W(4)=3
540 REM
550 S(1)=50 S(2)=100:S(3)=150 S(4)=200 S0=59464
560 REM KEY CONVERSION TABLE
570 FOR Y=1 TO 9:READ KY(Y):NEXT
580 DATA 3,0,4,0,0,0,1,0,2
590 REM ENABLE SOUND O/P
600 POKE59467,16:POKE59466,15
610 REM PRINT TITLE
620 PRINT""
630 PRINT" "
640 PRINT" "
650 PRINT" "
660 PRINT""
670 PRINT" "
680 PRINT""
690 PRINT"      WRITTEN BY JONATHAN J DICK"
700 PRINT" SOUND ON PINS 'M' AND 'N' ON USER PORT"
710 FORU=1TO3000:NEXT
720 REM CLEAR SCREEN IN QUARTERS
730 FORI=1TO4:POKE177,A(W(I)):POKE178,B(W(I)):POKE180,32 SYS826 FORU=1TO500
740 NEXT:NEXT
750 FOR U=1 TO 500:NEXT:PRINT""
760 FORT=1TO2 POKESO,100:FORU=1TO50:NEXT:POKESO,0:FORU=1TO50:NEXT:NEXT
770 PRINT"DO YOU WANT INSTRUCTIONS?"
780 GETW$:IFW$=""THEN780
790 IFW$="Y"THENPRINT"":GOTO830
800 IFW$="N"THEN1140
810 GOTO780
820 REM INSTRUCTIONS
```

```
830 PRINT"■SIMON IS A GAME OF MEMORY.  TO PLAY,"
840 PRINT"■YOU WATCH THE SCREEN WHILE GRAPHIC"
850 PRINT"■BLOCKS FLASH IN A SEQUENCE IN ANY OF THE"
860 PRINT"FOUR CORNERS OF THE SCREEN, CHOOSEN AT"
870 PRINT"■RANDOM.  THIS IS HOW THEY APPEAR......"
880 FOR U=1 TO 8000:NEXT
890 PRINT"■"
900 FOR T=1 TO 10:SQ=RN(T):D=300:GOSUB1730
910 FOR U=1 TO 150:NEXT:NEXT
920 PRINT"■THEN YOU HAVE TO REPRODUCE THE SEQUENCE"
930 PRINT"■USING THE NUMERIC KEY PAD FOR THE FOUR"
940 PRINT"■QUARTERS LIKE THIS -"
950 PRINT"■■                   ┌───┬───┐"
960 PRINT"     QUARTER─────── 7 │ 9 │"
970 PRINT"                    │   │   │"
980 PRINT"                    ├───┼───┤"
990 PRINT"     KEY─────────── 1 │ 3 │"
1000 PRINT"                   └───┴───┘"
1010 PRINT"■■":GOSUB1590
1020 PRINT"■WHEN YOU ARE KEYING IN WHAT YOU THINK"
1030 PRINT"■THE SEQUENCE IN, DON'T TAKE TOO LONG"
1040 PRINT"■THINKING OR YOU WILL LOSE!!!"
1050 PRINT"■■YOU START WITH ONLY FIVE FLASHES IN A"
1060 PRINT"■SEQUENCE, BUT IF YOU WIN THEY INCREASE"
1070 PRINT"■BY TWO EVERY TIME UNTIL YOU LOSE OR YOU"
1080 PRINT"■MANAGE TO REMEMBER A SEQUENCE OF 50!!!"
1090 PRINT"■YOU CAN SET THE DIFFICULTY OF THE GAME"
1100 PRINT"■FROM 1-20. THIS MAKES THE GAME SLOW OR"
1110 PRINT"■FAST. 1 IS SLOW 20 IS FAST."
1120 GOSUB1590
1130 PRINT"■"
1140 INPUT"■HOW DIFFICULT (1-20)   ■■■";D$:IFD$=" "THENPRINT"■■":GOTO1140
1150 D=VAL(D$):D1=INT(D)
1160 IFD<1ORD>20ORD<>D1THENPRINT"■MUST BE INTEGER BETWEEN 1 AND 20":GOTO1140
1170 FORT=1TO5:SQ(T)=INT(RND(1)*4)+1:NEXT:REM*SETUP FIVE FLASHES*
1180 D=(21-D)*50:NS=5:REM*NUMBER OF FLASHES AFTER 5*
1190 REM DO RANDOM SEQUENCE
1200 PRINT"■GET READY........":FORU=1TO2000:NEXT:PRINT"■"
1210 FOR Y=1 TO NS:SQ=SQ(Y)
1220 GOSUB1730
1230 NEXT
1240 PRINT"■NOW REPEAT THE SEQUENCE WHEN THE SCREEN"
1250 PRINT"■                 CLEARS"
1260 FORT=1TO1000:NEXT:PRINT"■":CO=1
1270 POKE158,0:REM*CLEAR BUFFER*
1280 TI$="000000"
1290 POKE158,0:REM*CLEAR BUFFER*
1300 GETW$:IFW$=""THEN1400
1310 KY=VAL(W$):IFKY=0THEN1300
1320 SQ=KY(KY):IFSQ=0THEN1300
1330 IFSQ<>SQ(CO)THEN1440
1340 GOSUB1730
1350 CO=CO+1:IFCO=NS+1THEN1480
1360 GOTO1280
1370 PRINT"■■YOU HAVE COMPLETED THE GAME BY MANAGING"
1380 PRINT"■TO REMEMBER 50 FLASHES. THAT IS AMAZING!"
1390 GOTO1650
1400 IFTI$<="000004"THEN1300
1410 FORI=1TO320:POKESO,20:POKESO,30:NEXT:POKESO,0
1420 PRINT"■YOU TOOK TOO LONG THINKING!!!":GOTO1650
1430 REM LOSE GAME
1440 POKE177,A(SQ):POKE178,B(SQ):POKE180,C(SQ):SYS826:FORU=1TO100:POKESO,250
1450 POKESO,100:NEXT:POKE177,A(SQ):POKE178,B(SQ):POKE180,32:POKESO,0:SYS826
1460 POKE158,0:REM*CLEAR BUFFER*
1470 PRINT"■■YOU LOSE THAT ONE":GOTO1650
1480 FORA=1TO10:FORU=50TO100:POKESO,U:NEXT:NEXT:POKESO,0
1490 PRINT"■OKAY!! YOU HAVE REMEMBERED "NS"FLASHES":NS=NS+2:IFNS=52THEN1370
1500 PRINT"■■PRESS ANY KEY TO QUIT.  OTHERWISE GAME"
1510 SQ(NS-1)=INT(RND(1)*4)+1:SQ(NS)=INT(RND(1)*4)+1:REM*SET UP NEXT 2 FLASHES*
1520 PRINT"■      CONTINUES IN FIVE SECONDS."
1530 TI$="000000":POKE158,0
1540 GETW$:IFW$=""ANDTI$<="000005"THEN1540
1550 IFW$=""THEN1200
1560 POKE59467,0:END
1570 REM
1580 REM SUBROUTINE TO WAIT FOR KEY PRESS
1590 PRINT"■______________________"
1600 PRINT"■ PRESS ANY KEY TO CONTINUE "
1610 POKE158,0
1620 GETQQ$:IFQQ$=""THEN1620
1630 RETURN
1640 REM SUBROUTINE TO ASK WHETHER YOU WANT ANOTHER GAME
1650 PRINT"■■______________________"
1660 PRINT"■ WANT TO PLAY AGAIN? "
1670 GETW$:IFW$=""THEN1670
1680 IFW$="Y"THEN1140
1690 IFW$="N"THENPOKE59467,0:END
1700 GOTO1670
1710 REM
1720 REM SUBROUTINE TO FILL A QUARTER OF THE SCREEN
1730 POKE177,A(SQ):POKE178,B(SQ):POKE180,C(SQ):POKESO,S(SQ):SYS826:FORU=1TOD
1740 NEXT
1750 POKE177,A(SQ):POKE178,B(SQ):POKE180,32:POKESO,0:SYS826:FORU=1TO150:NEXT
1760 RETURN
```

Submitting programs to PCW

Our programs section thrives on contributions from you, the readers. In particular we're looking for original ideas (no more Nim, decimal-hex conversions, Masterminds, digital clocks, etc please!) and we're not just interested in games — if you've a handy business/scientific/educational program then we'd be interested to hear from you.

Once you've written and *thoroughly* debugged your program, send it to us on cassette or disk with, if possible, a clear printout made with a new ribbon on plain (not lined) paper. Write a covering letter stating briefly what the program is, *exactly* which machine it's for (ie old/new ROM PET, or TRS-80 Level I or II) and how much memory it requires. On a separate sheet list any special instructions which aren't included in the program and write your name and address on each piece of paper you send us as well as on the cassette/disk. If you'd like your cassette/disk returned then enclose a suitable SAE.

Send your programs to: PCW Programs, Personal Computer World, 14 Rathbone Place, London W1P 1DE.

TRS-80 Tarot

by Simon Williams

This interesting program runs on a 16k machine.

```
10 RANDOM:CLEAR140:GOSUB530
20 DIML(2,10):FORN=0TO9:READL(0,N),L(1,N):NEXT
30 '***INFORMATION/INSTRUCTIONS
40 CLS:PRINT@465,"COPYRIGHT 1980, SIMON WILLIAMS":FORN=1TO1000:NEXT
50 CLS:PRINT"THE TAROT IS AN ANCIENT METHOD OF FORTUNE TELLING WHICH MAKES   USE
 OF A PACK OF 78 CARDS. THESE ARE DIVIDED INTO TWO SECTIONS, THE MAJOR & MINOR '
ARCANAS'. THE MAJOR ARCANA IS A SET OF 22"
60 PRINT"PICTORIAL CARDS DEPICTING PEOPLE AND OBJECTS. THE MINOR ARCANA  IS SIMI
LAR TO AN ORDINARY PACK OF PLAYING CARDS WITH AN EXTRA   CARD IN EACH SUIT, THE
'PAGE'. THE FOUR SUITS ARE NAMED WANDS,"
70 PRINT"CUPS, SWORDS AND PENTACLES. THE MAJOR AND MINOR ARCANAS ARE     SHUFFLE
D TOGETHER AND DEALT OUT, FACE DOWN, IN ANY OF SEVERAL   ARRANGEMENTS KNOWN AS '
LAYS'. THE CARDS ARE THEN REVEALED, ONE"
80 PRINT"AT A TIME, AND READ ACCORDING TO THEIR INDIVIDUAL MEANINGS AND  THEIR P
OSITIONS IN RELATION TO THE OTHER CARDS. I SHALL READ    FROM THE TEN CARD OR 'C
ELTIC CROSS' LAY.
90 PRINT"BEFORE WE START, I NEED TO KNOW SOME THINGS ABOUT YOU, IN ORDER TO ASSI
GN YOU ONE OF THE COURT CARDS AS YOUR 'SIGNIFICATOR'.    ARE YOU MALE OR FEMALE?
 ANSWER M OR F."
100 S$=INKEY$:IFS$()"M"ANDS$()"F"GOTO100
110 PRINT@896,"ARE YOU OVER 40? ANSWER Y OR N - PLEASE BE HONEST."
120 A$=INKEY$:IFA$()"Y"ANDA$()"N"GOTO120
130 PRINT@896,"WHAT COLOUR IS YOUR HAIR? A = VERY FAIR, B = GRAY, C = LIGHT    B
ROWN, D = DARK BROWN, E = BLACK";
140 H$=INKEY$:IFH$()"A"ANDH$()"B"ANDH$()"C"ANDH$()"D"ANDH$()"E"GOTO140
150 A$=S$+A$:IFA$="MY"THENA$="KING OF ":A=14:GOTO180
160 IFA$="FY"THENA$="QUEEN OF ":A=13:GOTO180
170 IFA$="MN"THENA$="KNIGHT OF ":A=12ELSEA$="PAGE OF ":A=11
180 IFH$="A"ORH$="B"THENH$="WANDS":H=64:GOTO210
190 IFH$="C"THENH$="CUPS":H=50:GOTO210
200 IFH$="D"THENH$="SWORDS":H=36ELSEH$="PENTACLES":H=22
210 CD(0)=A+H:CLS:PRINT@320,"THANK YOU. YOUR SIGNIFICATOR IS THE "A$+H$"."
220 PRINT"THIS CARD IS PLACED FACE UP ON THE TABLE AND THE FIRST TWO CARDSOF THE
 LAY ARE PLACED ON TOP OF IT AS THEY ARE DEALT."
230 PRINT@896,"PLEASE CONCENTRATE ON ANY MATTER OF CONCERN BEFORE PRESSING THE S
PACE BAR TO BEGIN THE READING.";
240 IFINKEY$()" "THENR=RND(0):GOTO240
250 '***READING
260 CLS:PRINT@320,"THE FIRST CARD IS LAID ON TOP OF THE SIGNIFICATOR AND SHOWS T
HE GENERAL SURROUNDINGS OF YOUR ENQUIRY. THE CARD I TURN UP IS ":GOSUB380
270 CLS:PRINT@320,"THE SECOND CARD IS PLACED ACROSS THE FIRST AND INDICATES ANY
   CURRENT PROBLEMS. FAVOURABLE CARDS MEAN SMALL PROBLEMS. I DRAW ":GOSUB380
280 CLS:PRINT@320,"THE THIRD CARD, WHICH INDICATES YOUR AIMS AND IDEALS, IS PLAC
ED ABOVE THE SIGNIFICATOR. IN THIS CASE THE CARD IS ":GOSUB380
290 CLS:PRINT@320,"THE FOURTH CARD, PLACED BELOW THE SIGNIFICATOR, SHOWS THE BAC
K- GROUND TO THE PRESENT SITUATION - WHAT LED UP TO IT. I TURN UP ":GOSUB380
300 CLS:PRINT@320,"LEFT OF THE SIGNIFICATOR, THE FIFTH CARD SHOWS THE IMMEDIATE
   PAST - WHAT IS 'BEHIND' YOU. THIS CARD IS ":GOSUB380
310 CLS:PRINT@320,"THE SIXTH CARD, LAID TO THE RIGHT OF THE SIGNIFICATOR, SHOWS
THEIMMEDIATE FUTURE - WHAT IS 'BEFORE' YOU. THE CARD DRAWN IS ":GOSUB380
320 CLS:PRINT@320,"THE SEVENTH CARD, PLACED TO THE RIGHT OF THE SIXTH, SHOWS YOU
R  ATTITUDE TO THE MATTER. IF A COURT CARD IS DRAWN, YOU ARE SHOW- ING SOME OF T
HE FEATURES OF THAT CHARACTER. I TURN UP ":GOSUB380
330 CLS:PRINT@320,"THE EIGHTH CARD, WHICH INDICATES THE ENVIRONMENT IN WHICH YOU
'REWORKING, IS LAID ABOVE THE SEVENTH. I DRAW ":GOSUB380
340 CLS:PRINT@320,"THE NINTH CARD SHOWS YOUR HOPES AND FEARS AND IS PLACED ABOVE
   THE EIGHTH. THIS CARD IS ":GOSUB380
350 CLS:PRINT@320,"THE LAST CARD, THE TENTH, INDICATES THE FINAL OUTCOME OF THE
   MATTER - WHAT WILL BE - AND IS LAID ABOVE THE NINTH. IT IS ":GOSUB380
360 CLS:PRINT@454,"THIS COMPLETES THE READING. I WISH YOU GOOD FORTUNE.":FORN=1T
O2000:NEXT
370 RESTORE:GOSUB530:PRINT@832,:END
380 '***CARD/MESSAGE SELECTION & PRINT
390 R=RND(156):IFR)78THENN$="    REVERSED":R1=R-78ELSEN$="":R1=R
400 IFR1)64THENR2=R1-64:N$=" OF WANDS"+N$:GOTO450
410 IFR1)50THENR2=R1-50:N$=" OF CUPS"+N$:GOTO450
420 IFR1)36THENR2=R1-36:N$=" OF SWORDS"+N$:GOTO450
430 IFR1)22THENR2=R1-22:N$=" OF PENTACLES"+N$:GOTO450
440 RESTORE:FORN=1TOR1+194:READNM$:NEXT:N$=NM$+N$:MM$="MAJOR":GOTO460
450 RESTORE:FORN=1TOR2+216:READNC$:NEXT:N$="THE "+NC$+N$:MM$="MINOR"
460 IFN1(11THENIFR=CD(N1)THENN1=0:GOTO380ELSEN1=N1+1:GOTO460ELSEN1=0
470 CD(CN+1)=R:RESTORE:FORN=1TOR+230:READT$:NEXT
480 PRINTN$:PRINT"THIS CARD IS OF THE "MM$" ARCANA & IMPLIES "T$
490 FORN=0TO9:SET(L(0,N),L(1,N)):NEXT:PRINT@960,"PLEASE PRESS SPACE BAR TO CONTI
NUE READING";
500 F=F+1:IFF/15=INT(F/15)GOSUB520
510 IFINKEY$=" "THENCN=CN+1:RETURNELSE500
520 IFPOINT(L(0,CN),L(1,CN))RESET(L(0,CN),L(1,CN)):RETURNELSESET(L(0,CN),L(1,CN)
):RETURN
530 '***TITLE GRAPHICS
540 CLS:FORN=1TO10:READC0,C1,C2,C3,C4,C5
550 FORI=C0TOC1:SET(I,C2):NEXTI:FORI=C3TOC4:SET(I,C5):NEXTI,N
560 FORN=1TO6:READC0,C1,C2,C3:FORJ=C0TOC1:SET(C2,J):SET(C3,J):NEXTJ,N
570 FORN=1TO6:READC0,C1,C2,C3,C4
580 FORJ=C0TOC1:SET(C2,J):SET(C3,J):SET(C4,J):NEXTJ,N
590 FORN=1TO5:READC0,C1,C2,C3,C4,C5,C6,C7,C8,C9,CA,CB
600 SET(C0,C1):SET(C2,C3):SET(C4,C5):SET(C6,C7):SET(C8,C9):SET(CA,CB):NEXT
610 FORI=36TO39:SET(I,30):SET(I,35):NEXT:FORI=82TO89:SET(I,25):SET(I,36):NEXT
620 FORJ=11TO13:SET(4,J):SET(5,J):SET(30,J):SET(31,J):NEXT
630 FORI=71TO75:SET(I,25):NEXT:SET(91,16):FORN=1TO1500:NEXT:RETURN
640 DATA48,59,9,6,27,10,46,49,10,32,47,11,16,17,13,6,15,14,46,52,25,44,47,26,38,
53,36,56,57,36,76,79,34,92,95,34,78,81,35,90,93,35,92,99,15,98,101,16,105,111,17
,105,106,35,113,117,35,103,113,36
650 DATA10,15,28,29,14,30,26,27,17,33,24,25,32,34,22,23,33,35,20,21,35,36,18,19
660 DATA31,34,35,36,37,24,35,53,54,55,24,36,62,63,64,29,33,74,75,76,29,33,95,96,
97,9,35,102,103,104
670 DATA38,29,39,29,40,28,41,28,42,27,43,27,65,28,66,28,67,27,68,27,69,26,70,26,
76,28,77,28,78,27,79,27,80,26,81,26,90,26,91,26,92,27,93,27,94,28,95,28,80,36,81
,36,90,36,91,36,112,16,113,16
680 DATA62,7,62,7,62,5,62,9,58,7,66,7,72,7,72,5,72,3,72,1
690 DATATHE MAGICIAN,THE HIGH PRIESTESS,THE EMPRESS,THE EMPEROR,THE HEIROPHANT,T
HE LOVERS,THE CHARIOT,JUSTICE,THE HERMIT,THE WHEEL OF FORTUNE
700 DATASTRENGTH,THE HANGED MAN,DEATH,TEMPERANCE,THE DEVIL,THE TOWER,THE STAR,TH
E MOON,THE SUN,JUDGEMENT,THE WORLD,THE FOOL
710 DATAACE,2,3,4,5,6,7,8,9,10,PAGE,KNIGHT,QUEEN,KING
720 DATAEITHER THE NEED FOR  OR THE SKILLS OF DIPLOMACY.,MYSTERY & THE FUTURE OR
 A WOMAN WITH PSYCHIC POWERS.,FRUITFULNESS IN ALL  ITS ASSOCIATIONS.INITIATIVE.,
STABILITY IN LIFE.   THE AID OF A POWERFUL PERSON.
730 DATAASSOCIATIONS WITH    OTHERS AND PARTICULARLY MARRIAGE.,ALL FORMS OF LOVE
 ANDATTRACTION TO BEAUTIFUL THINGS.TRIUMPH ONLY THROUGH PERSEVERENCE AND DOGGEDN
ESS.THE JUST OUTCOME OF  PROBLEMS.
740 DATACORRUPTION. OTHERS   MAY TRY TO BETRAY YOU.,THE FORCES OF LUCK   AND THE
REFORE SUCCESS.,A TIME FOR TAKING    COURAGE AND ACTING ENERGETICALLY.,INTUITION
. YOUR OWN  OR ADVICE FROM ONE WHO HAS.
750 DATATHE END OF A CYCLE OFEVENTS. CHANGE AND RENEWAL.,A NEED FOR ECONOMY & GO
OD MANAGEMENT.,THE EFFECT OF EXTRA  EFFORT. POSSIBLY VIOLENCE.,ADVERSITY & DISTR
ESS.MISERY CAUSED BY CONFLICT.
760 DATALOSS BY THEFT OF MAT-ERIAL OR SPIRITUAL THINGS.,A WARNING OF HIDDEN  ENE
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PROGRAMS

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MIES WHO WILL DECEIVE.,MATERIAL HAPPINESS.  CONTENTMENT THROUGH GOOD MARRIAGE.
770 DATACHANGE OF POSITION.  RENEWAL AND REBIRTH.,ASSURED SUCCESS VIA AVOYAGE OR
 CHANGE OF PLACE.,A TIME TO CONSIDER   YOUR CAREER. CONSOLIDATION.
780 DATAPERFECT CONTENTMENT. ALSO FINANCIAL REWARD.,A TIME FOR GAIETY ANDRECREAT
ION. PERHAPS GOOD NEWS.,CRAFTSMANSHIP AND THENEED TO USE PRACTICAL GIFTS.,GIFT O
R LEGACY. THE  AQUISITION OF NEW POSSESSIONS.
790 DATAMATERIAL DIFFICULTIESBUT LOVE IS WELL LOOKED ON.,GRATIFICATION THROUGHGI
FTS OR OTHER PLEASURES.,INGENUITY IN BUSINESSAND MONEY MATTERS.,A CREATIVE PERIO
D IN CRAFT OR BUSINESS.
800 DATAPRUDENCE. SAFETY AND ACCOMPLISHMENT FROM THIS.,GAIN IN MONETARY OR  FAMI
LY MATTERS.,A TIME FOR SCHOLAR-  SHIP OR REFLECTION. LOOK TO YOUR AFFAIRS.,THE E
FFECT OF SOMEONEWITH YOUR AFFAIRS AT HEART.
810 DATATHE EFFECTS OF AN    OPULENT THOUGH GENEROUS WOMAN. SECURITY.,INTELLECT
AND PARTIC-ULARLY MATHEMATICS. LOOK TO BUSINESS.
820 DATAGREAT FORCE IN LOVE  OR HATE. TRIUMPH THROUGH THIS.,CONFORMITY AND THE
 STABILITY THIS MAY BRING.,A FEELING OF LOSS OF SOMEONE OR SOMETHING.,THE NEED F
OR SOLITUDE. A TIME FOR CONTEMPLATION.
830 DATALOSS OR DESTRUCTION  OF SOMETHING CLOSE TO YOU.,A JOURNEY WHICH MAY  INC
LUDE TRAVEL BY OR OVER WATER.,ANNOYANCE AT THE FAIL-URE OF A PLAN THROUGH DISAGR
EEMENT., BAD NEWS OF AN ILL-  NESS OR OTHER CRISIS.
840 DATADEEP DISAPPOINTMENT  POSSIBLY THROUGH DEATH.,PAIN AND SADNESS. ALLIS NOT
 WELL.,EXAMINATION. THE ABIL-ITY TO STUDY DETAILS NORMALLY MISSED.,SKILL AND BRA
VERY.   THE TIME TO USE SUCH VIRTUES.
850 DATASADNESS OR EMBARRASS-MENT FOR YOU (IF FEMALE) OR A WOMAN CLOSE TO YOU.,T
HE EFFECTS OF ONE   WITH AUTHORITY TO MAKE DECISIONS.
860 DATACONTENTMENT WITH ALL RELATIONSHIPS.,LOVE AND PASSION. THEINTER-RELATION
OF THE SEXES.,A HAPPY CONCLUSION.  MERRIMENT AND FULFILMENT.,TIREDNESS AND IMAGI
N-ARY WORRIES CAUSED BY A STRICT ROUTINE.
870 DATARECEIPT OF A GIFT.   THIS RESULTS IN ANOTHER LOSS.,REFLECTIONS ON THE
PAST AND CHILDHOOD.,IMAGINATION. A GOOD  TIME FOR CREATIVE WORK THOUGH TRANSITOR
Y.,DEJECTION OVER THINGSAS THEY ARE. THIS WILL PASS.
880 DATAA VICTORY IN SOME-   THING YOU DESIRE.,CONTENTMENT WITH YOURPRESENT SURR
OUNDINGS AND THINGS AS THEY ARE.,THE EFFECTS OF A FAIRAND STUDIOUS YOUNG MAN. HE
 MAY HELP YOU.,A PROPOSITION OR IN- VITATION.
890 DATATHE EFFECTS OF A FAIRWOMAN. SHE IS DREAMY BUT VISIONARY.,"THE EFFECTS OF
 A      CREATIVE MAN IN BUSINESS, LAW OR THE CHURCH."
900 DATATHE BEGINNING OF NEW THINGS - CREATION. POSSIBLY A BIRTH.,PHYSICAL SUFFE
RING ORSADNESS. DISSATISFACTION WITH POSSESSIONS.,STRENGTH IN TRADE ANDDEALINGS
WITH PEOPLE.,A HAPPY LIFE. PEACE  AND PROSPERITY.
910 DATAIMITATION OR SHAM. A SUPERFICIAL VIEW.,SUCCESS IN UNDERTAK- INGS OR GREA
T NEWS.,A NEED TO WORK BY DIS-CUSSION AND NEGOTIATION. FINAL SUCCESS.,HASTE TOWA
RDS A FAV- OURABLE OUTCOME. CHANGE.
920 DATADELAY CAUSED BY      OPPOSITION TO YOUR IDEAS.,FINANCIAL GAIN BUT   OPPO
SITION IN LAW.,THE INFLUENCE OF A   DARK YOUNG MAN. HE MAY BRING NEWS.,DEPARTURE
 OR ABSENCE.A MOVE OR EMIGRATION.
930 DATATHE INFLUENCE OF A   COUNTRY WOMAN WHO IS LOVING AND HONOURABLE.,THE INF
LUENCE OF A   FRIENDLY COUNTRYMAN WHO IS HONEST AND CONSCIENTIOUS.
940 DATADISQUIET & A FEELING THAT ALL IS NOT RIGHT.,THE PHYSICAL SIDE OF LOVE. P
ASSION. A VERY STRONG CARD.,LIGHT AND TRUTH IN   MATTERS.  COMPLEX PROBLEMS REVE
ALED.,BENEVOLENCE OF OTHERSTOWARDS YOU.
950 DATAAN INCREASE IN YOUR  UNDERSTANDING OF SOCIETY.,CERTAIN PROJECTS MAY BE F
OOLISHLY THOUGHT OUT.,A DISPUTE. POSSIBLE  LITIGATION.,A TENDENCY TO BIAS.  WATC
H AGAINST BIGOTRY.
960 DATAAN OVERCAUTIOUS ATT- ITUDE. THINK THINGS OUT - THEN ACT.,ABUNDANCE OF TH
E GOODTHINGS IN LIFE. ENJOY THEM.,AN ABUSE OF POWER    THROUGH WEAKNESS.,OBSTRUC
TION THROUGH  SELFISHNESS. TAKE HEED.
970 DATALETHARGY. INACTION   COULD CAUSE PROBLEMS.,CONNECTIONS WITH THE CHURCH O
R RELIGION LOOK WELL.,BLINDNESS TO WHAT IS RIGHT. PETTINESS.,PROBLEMS CAUSED BY
  ARGUEMENT OR DISAGREEMENT.
980 DATAA TENDENCY TO ARRO-  GANCE WHICH MAY CAUSE ALIENATION.,INSTABILITY AND I
N-  CONSTANCY OF THOSE ABOUT YOU.,CONTENTMENT ON MATER-IAL AND SPIRITUAL PLANES.
990 DATAWEAKNESS THROUGH AN  OVERSIMPLIFICATION OF EVENTS.,INERTIA OR FIXITY MAY
CAUSE STAGNATION.,FOLLY THROUGH EXTRA- VAGENCE OR PLEASURE-SEEKING.
1000 DATABAD INTELLIGENCE. THEEVIL SIDE OF WEALTH.,A FACADE OF ENJOYMENTTO KEEP
OTHERS HAPPY.,MEDIOCRITY IN WORK.  A TENDENCY TO PETTINESS.,DELAY TO SOME PROJEC
TDUE TO OTHERS' OPPOSITION.
1010 DATADISORDER OR CHAOS. ITMAY SPELL RUIN FOR SOME PROJECT.,ENVY AND JEALOUSY
    WHICH LEAD TO ILLUSORY DESIRES.,QUARRELS OVER MONEY  OR POSSESSIONS.,A TENDE
NCY TO VANITY.THIS MAY STAND AGAINST AMBITION.
1020 DATADECEPTION. BEWARE OF OTHERS KEEPING BAD FAITH.,MONETARY LOSS THROUGHGAM
BLING OR ROBBERY. TAKE NO CHANCES.,UNFAVOURABLE NEWS    CAUSING WORRY.,IDLENESS
AND LACK OF ENERGY. STAGNATION.
1030 DATASUSPICION AND MIS-   TRUST MAY EFFECT YOUR REASONING.,THE TEMPTATION OF
    VICE. WATCH FOR WEAKNESS.
1040 DATAGREAT FORCE IN LOVE  OR HATE. NOT TO THE  GOOD.,LIES AND DISLOYALTY. BE
WARE UNTRUTHS.,CONFUSION AND A FEEL-ING OF INTELLECTUAL ISOLATION.,PRECAUTION. B
E CARE- FUL WHAT YOU DO.
1050 DATALOSS OR DESTRUCTION  OF SOMETHING CLOSE TO YOU.,A PROPOSAL OF LOVE OROT
HER DECLARATION.PUBLICITY.,GOOD ADVICE FROM A   WISE PERSON. TAKE HEED.,DIFFICUL
TIES AND OPP-OSITION. TREACHERY.
1060 DATASUSPICION CAST ON YOUOR A FEELING OF SHAME.,TRANSITORY PROFIT OR ADVANT
AGE. MAKE HAY...,THE USE OF OBSERVAT- ION TO BAD ENDS. SPYING.,FOOLISHNESS. THE
IN- ABILITY TO THINK SOUNDLY.
1070 DATAA CLOSED MIND. WATCH AGAINST BIGOTRY OR DECEIPT.,A TENDENCY TO CRUELTYO
R PERVERSITY. WATCH THIS.
1080 DATADISCONTENT. THE DE-  SIRE TO PUT RIGHT YOUR PROBLEMS.,LOVE AND PASSION.
 THEINTER-RELATION OF THE SEXES.,A NEW VENTURE OR HOLI-DAY. ACHIEVEMENT FROM THI
S.,NEW RELATIONSHIPS ANDA DELIGHT IN NOVELTY.
1090 DATATHE CHANCE OF NEW    ALLIANCES. BUSINESS LOOKS WELL.,THE CHANCE OF FRES
H  EXCITEMENTS. RENEWAL.,A DESIRE TO SUCCEED. YOUR FORCE OF WILL.,GREAT JOY AND
HAPPI- NESS. A CELEBRATION.
1100 DATALOYALTY OF OTHERS TO YOU. HONESTY AND GOOD ADVICE.,INDIGNATION AT AN
 AFFRONT IN LOVE. A VIOLENT RESPONSE.,A TASTE FOR RISK     COULD LEAD TO DECEPTI
ON.,A TRICK OR FRAUD. BE ON YOUR GUARD.
1110 DATATHE INFLUENCE OF A   DISTINGUISHED WOMAN. DON'T TRUST HER.,THE EFFECT O
F A ROGUEOR SCANDAL-MONGER. HE IS DISHONEST.
1120 DATAA FALL IN FORTUNE.   RUIN OF SOMETHING ESTABLISHED.,SURPRISE AND WONDER
  LEADING TO DISQUIET.,THE END OF TROUBLES. ADVERSITY IS OVER.,PROSPERITY AND IN
-   CREASE. AN APPRECIATION OF BEAUTY.
1130 DATACONTRADICTION AND THETENDENCY OF OTHERS TO TRICK YOU.,APPREHENSION AND
THE FEAR OF DEFEAT.,PERPLEXITY. EMBARRASS-MENTS AND WORRIES.,QUARRELS ARISING FR
OMJEALOUSY OR ENVY.
1140 DATAOBSTACLES TO YOUR    IDEAS. POSSIBLE CALAMITY.,DIFFICULTIES AND THE INT
REGUE OF OTHERS AGAINST YOU., BAD NEWS OR ANNOUNCE-MENTS. INDECISION.,DISCORD. I
NTERRUPTIONOF THE PRESENT STATUS QUO.
1150 DATAPROBLEMS OF JEALOUSY - DECEIPT OR INFIDELITY.,"THE INFLUENCE OF A   GOO
D BUT SEVERE MAN. HE IS AUSTERE, YET TOLERANT."
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Listing courtesy London Computer Centre

PET Rebound

by Angus Watkinson

This version of the board game runs on a new ROM, 8k PET.

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4 GOSUB1500
5 PRINT"[illegible]":T1=0:T2=0
6 P=INT(2*RND(1))+1:V2=0:P1=0:P2=0:TY=0:TH=0
10 Q$="[illegible]"
12 R$="[illegible]"
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15 PRINT"▯▯▯   REBOUND   ■"
20 PRINT"________________________________________
30 PRINT"1▪
40 PRINT"2▪
50 PRINT"3▪
60 PRINT"4▪
70 PRINT"5▪
80 PRINT"──────────────────────────────────
85 PRINT"__________________________________
90 PRINT"▒
100 PRINT"▒
110 PRINT"▒
120 PRINT"▒
130 PRINT"▒
140 PRINT"────────────────────────────────────────
150 PRINT"|    |    |    |    |
160 PRINT"▯ 100 80  60  40
162 PO(1)=33391:PO(2)=33393:PO(3)=33432:PO(4)=33471:PO(5)=33473
165 FORN=1TO5:POKEPO(N),81:NEXT
167 FORN=1TO5:POKEPO(N)+6,87:NEXT
170 PRINT"▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯PLAYER 1'S SCORE";P1;"▶▶▶▶TOTAL";T1
172 PRINT"▯PLAYER 2'S SCORE";P2;"▶▶▶▶TOTAL";T2
190 FORQ=1TO10
200 PRINT"▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯PLAYER■:";P;"▶▶▶▶▶▶ROW ?:";
234 IFP=1THENR=81:TH=TH+1:GOTO236
235 TY=TY+1:R=87
236 POKE158,0:D=0:H=0
240 GETA$:IFA$=""THEN240
242 IFVAL(A$)=V2THEN240
250 S=VAL(A$):IFS>5ORS<1THEN240
257 V2=S
258 IFR=81THENPOKEPO(TH),209:GOTO260
259 POKEPO(TY)+6,215
260 PRINTS:C=0:F=32810
270 D=S*40:D=D+F:POKED,R
280 PRINT"▯▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶PRESS THE ='S KEY■"
288 Y=PEEK(155)-255:IFY=0THEN288
300 PRINT"▯▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶                    "
310 Y=PEEK(155)-255
314 IFY=-128THENC=C+1:GOTO310
315 IFC=0THENG=0:GOTO400
320 IFY=0THENC=INT(C/3):G=1
321 H=H+1:J=1
323 IFPEEK(D+G)=102THENH=C:POKED,32:POKED+G,81:POKED+G,102:GOTO335
324 IFPEEK(D+G)=81THENR=81:C=INT(C/4):H=0:GOTO334
325 IFPEEK(D+G)=87THENR=87:C=INT(C/4):H=0:GOTO334
327 IFPEEK(D+G)=77THENG=40:GOTO324
328 IFPEEK(D+J)=78THENG=-1:J=0:GOTO324
329 IFPEEK(D)=77THENG=40:GOTO334
330 IFPEEK(D)=78THENG=-1:GOTO334
333 POKED,32:POKED+G,R
334 IFPEEK(D)=102THENPOKED+2,R:POKED,102
335 D=D+G
337 IFH<CTHEN321
405 IFP=2THENP=0
410 P=P+1:POKE33551,32:C=0:H=0
420 X=0:J=33128:B=100:P1=0:P2=0
430 FORN=1TO16
440 H=J+N
445 X=X+1
450 FORM=1TO5
460 IFPEEK(H)=81THENP1=P1+B:GOTO500
470 IFPEEK(H)=87THENP2=P2+B:GOTO500
500 H=H+40
510 NEXTM
515 IFX=4THENX=0:B=B-20
520 NEXTN
530 GOSUB1040
540 NEXT
550 T1=T1+P1:T2=T2+P2:GOSUB1040
560 PRINT"▯":FORN=1TO1000:NEXT
570 PRINT"▯▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▯   CARRY ON ? ■";
580 GETA$:IFA$=""THEN580
590 IFA$="Y"THEN6
600 IFA$="N"THEN620
610 GOTO580
620 PRINT"▯"
630 IFT1>T2THENPRINT"▯▯▯▯▯▶▶▶▶PLAYER 1 BEAT PLAYER 2":END
640 IFT1=T2THENPRINT"▯▯▯▯▯▶▶▶▶PLAYER 1 DREW WITH PLAYER 2":END
650 PRINT"▯▯▯▯▯▶▶▶▶PLAYER 2 BEAT PLAYER 1":END
1040 PRINTQ$P1;"▮  ";R$T1
1050 PRINTQ$"▯▯";P2;"▮  ";R$"▯▯";T2
1060 RETURN
1500 PRINT"▯▯   REBOUND   ■"
1510 PRINT"▯▯▯▯▯PROGRAMMED BY ▯▯A.WATKINSON"
1520 PRINT"▶▶▶▶▶▶▶▶▶▶▶▶▶▶──────────────────"
1530 PRINT"▯▯▶▶FOR AN 8K PET"
1540 PRINT"▯▯▶▶▶▶TAKING UP 3492 BYTES"
1570 FORN=1TO4000:NEXT
1600 PRINT"▯▯  INSTRUCTIONS  ■"
1610 PRINT"▯▯THIS IS A GAME FOR TWO PLAYERS."
1620 PRINT"▯THEY EACH HAVE FIVE SHAPES-"
1630 PRINT"▯PLAYER '1' HAS THE '●' SHAPES."
1640 PRINT"▯PLAYER '2' HAS THE 'o' SHAPES."
1650 PRINT"▯THE PET WILL ASK A PLAYER FOR THE "
1660 PRINT"▯ROW IN WHICH ONE SHAPE IS TO BE PLACED."
1670 PRINT"▯THEN, YOU PRESS THE ='S KEY AND"
1680 PRINT"▯YOU'LL BE TIMED FOR HOW LONG YOU HOLD
1690 PRINT"▯IT DOWN .THE SHAPE WILL THEN"
1700 PRINT"▯MOVE THAT DISTANCE."
1710 PRINT"▯   ▯   PRESS ANY KEY TO CONTIUE   ■"
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MICROMART


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1720 GETA$:IFA$=""THEN1720
1730 PRINT"YOU CANNOT GO ON THE SAME ROW AS
1740 PRINT"THE PLAYER BEFORE YOU."
1750 PRINT"     PRESS ANY KEY TO START   "
1760 GETA$:IFA$=""THEN1760
1770 RETURN
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Listing courtesy Euro-Calc

MZ 80 Alligator Swamp

by Norman Webster

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20 PRINT"":GOSUB3000:GOSUB4000:GOTO100
30 A=INT(X)+INT(Y)*40+53248:RETURN
40 IFPEEK(A)=0THENRETURN
45 S=PEEK(A):IFS=205THENRETURN
50 IFS=204THENRETURN
55 IFS=85THENP=P+10:PRINT"";P:MUSIC"E1":GOTO70
60 IFS=85THENRETURN
65 Y1=-7:MUSIC"C1":RETURN
70 MO=P-INT(P/170)*170:IFMO=0THENGOSUB7000:RETURN
75 RETURN
80 GETV:IFV=0THENV=5
85 X=X+V-5:IFX>38THENX=38
90 IFX<1THENX=1
95 RETURN
100 P=0:N=5
110 X=INT(37*RND(1)+1):Y1=-6:Y=14:GOSUB30:A1=A:GOSUB6000
120 GOSUB80:GOSUB80:Y=Y1*Y1/4:Y=INT(Y+4):GOSUB30:Y1=Y1+1:IFY1>9THEN2000
130 GOSUB40:POKEA1,0:POKEA,M(Y1+10):A1=A
140 GOTO120
2000 GOSUB5000:GOTO110
3000 DIMM(19):FORI=0TO19:READM(I):NEXT:TEMPO7:GOSUB10000:RETURN
3010 DATA202,203,205,204,202,203,205,204,202,203,205,204,202,203,205,204
3020 DATA202,203,205,204
4000 PRINT"———— Alligator Swamp ————"
4005 PRINT"Score          Hi Score";H :GOSUB7000
4010 POKE53248,92:POKE53287,93
4020 FORI=53288TO54208STEP40:POKEI,121:POKEI+39,121:NEXT
4030 RETURN
5000 A2$="   OO   "
5001 D$="    OO   "
5002 A$="   OO   "
5003 D1$="    OO   "
5010 A1$="         "
5020 B$=""
5030 C$=""
5040 POKEA1,0:POKEA,202:N=N-1
5050 IFX>21THEN5200
5070 GOSUB8000:FORI=26TOX+1STEP-2:PRINTB$;LEFT$(C$,I);A$;:MUSIC"_C2"
5075 PRINTB$;LEFT$(C$,I-1);A2$;:MUSIC"C1"
5080 NEXTI:GOSUB9000:PRINTB$;LEFT$(C$,X);A1$;:IFN>0THENRETURN
5090 PRINT"":Z$="":PRINTZ$;"    "
5091 PRINTZ$;"    "
5092 PRINTZ$;"    "
5093 PRINTZ$;"    "
5094 PRINTZ$;"    "
5095 PRINT:PRINTZ$;"    "
5096 PRINTZ$;"    "
5097 PRINTZ$;"    "
5098 PRINTZ$;"    "
5099 PRINTZ$;"    "
5100 IFH<PTHENH=P
5110 PRINT"";
5120 INPUT"   Another Game  ?";Z$:IFLEFT$(Z$,1)="Y"THEN5140
5130 END
5140 Z$="":FORZZ=9TO21:PRINTLEFT$(Z$,ZZ);SPC(36)
5150 NEXT:GOSUB4000:GOTO100
5200 GOSUB8020
5210 FORI=1TOX-12STEP2:PRINTB$;:PRINTLEFT$(C$,I);D$;:MUSIC"_D1"
5220 PRINTB$;LEFT$(C$,I+1);D1$;:MUSIC"D1":NEXT:GOSUB9040
5300 PRINTB$;LEFT$(C$,X-11);A1$;:IFN>0THENRETURN
5400 GOTO5090
6000 FORI=1TO4:FORJ=1TO4:POKEA,M(J+4):MUSIC"‾B1":NEXTJ,I
6010 PRINT"Lives";N:RETURN
7000 POKEA,0:     FORI=1TO100:NEXT
7001 PRINT"   @   @   @   @   @   @   @   @";
7002 PRINT"   @   @   @   @   @   @   @   @";
7003 PRINT"        "
7004 PRINT"        "
7010 PRINT"";
7020 A=0:  A1=0:Y1=-6:RETURN
8000 FORK=1TO6:POKEA,M(K):MUSIC"‾F1":PRINTB$;LEFT$(C$,X);"Help!!";
8010 POKEA,M(K+1):PRINTB$;LEFT$(C$,X);"       ";:NEXT:RETURN
8020 FORK=1TO6:POKEA,M(K):MUSIC"‾F1":PRINTB$;LEFT$(C$,X-5);"Help!!";
8030 POKEA,M(K+1):PRINTB$;LEFT$(C$,X-5);"       ";:NEXT:RETURN
9000 PRINT"";LEFT$(C$,X);"gulp";
9010 MUSIC"C6R2C4R1C4R1C6R1#D4R1D4R1D4R1C4R1C4_B4R1C6":PRINT"     ";
9030 RETURN
9040 PRINT"";LEFT$(C$,X-3);"gulp";
9050 MUSIC"C6R2C4R1C4R1C6R1#D4R1D4R1D4R1C4R1C4_B4R1C6":PRINT"     ";
9060 RETURN
10000 PRINT"":PRINT"Do you want instructions ?"
10010 INPUT"Press Y for YES, N for NO  ";Z$
10020 IFZ$="N"THENPRINT"":RETURN
10025 IF Z$="Y" THEN 10030
10027 GOTO 10000
10030 PRINT"Alligator Swamp"
10031 PRINT"———————— ————"
10040 PRINT"In this game you have to knock the"
10050 PRINT"coconuts off the trees before the swamp"
10060 PRINT"covering disintegrates."
10070 PRINT"Using the keys 1 to 9 you can control"
10080 PRINT"the lateral movement.Keys 1 to 5 "
10090 PRINT"for leftwards movement.Keys 6 to 9"
10100 PRINT"for rightwards movement."
```

```
10110 PRINT"If you fall into the swamp,you"
10120 PRINT"should look out for the ALLIGATORS !!!"
10130 PRINT"Press any key to Start"
10140 GET Z$:IF Z$="" THEN 10140
10150 PRINT"": RETURN
```

Listing courtesy Sharp Electronics

PET Connect

by T Bell (YCW)

```
100 PRINT"THE GAME OF CONNECT 4":PRINT"────────────────────────────"
110 REM ******CONNECT 4*******
120 REM *PROGRAMMED BY T.BELL*
130 REM ******CONNECT 4*******
140 PRINT:PRINT"DO YOU WANT INSTRUCTIONS (Y/N)? ";:GOSUB620
150 IFA$<>"Y"ANDA$<>"N"THEN140
160 PRINTA$:IFA$<>"Y"THEN230
170 PRINT"THE OBJECT OF THE GAME IS TO GET A ROW"
180 PRINT"IN ANY DIRECTION OF FOUR PIECES."
190 PRINT"WHEN ASKED 'MOVE FOR ',TYPE THE COLUMN "
200 PRINT"INTO WHICH YOU WANT TO PLACE YOUR PIECE."
210 PRINT"THE PIECE WILL DROP TO THE BOTTOM OF "
220 PRINT"THE COLUMN."
230 FORI=1TO2:PRINT"NAME OF PLAYER "I"(";CHR$(203+6*I)")? ";
240 GOSUB620:IFA$=""ORA$=""ORA$=""ORA$=""ORA$=""THEN240
250 IFA$<>CHR$(13)ANDA$<>CHR$(20)THENPRINTA$;:A$(I)=A$(I)+A$:GOTO240
260 IFA$=CHR$(20)ANDLEN(A$(I))>0THENA$(I)=LEFT$(A$(I),LEN(A$(I))-1):PRINTA$;
270 IFASC(A$)=20ORLEN(A$(I))=0THEN240
280 PRINT" ":NEXT:C(1)=81:C(2)=87:PRINT"":FORI=1TO7:POKE32852+4*I,I:NEXT
290 A$="        ╭───┬───┬───┬───┬───┬───┬───╮"
300 B$="        ╰───┴───┴───┴───┴───┴───┴───╯"
310 D$="        │   │   │   │   │   │   │   │"
320 C$="        ├───┼───┼───┼───┼───┼───┼───┤"
330 T=2:FORI=1TO9:IFI=1THENPRINTA$:PRINTD$:NEXT
340 IFI=9THENPRINTB$:NEXT:GOTO360
350 PRINTC$:PRINTD$:NEXT
360 C=C+1:T=3-T:POKE32807,C(T):IFC>56GOTO540
370 PRINT"MOVE FOR "A$(T)"                     ";:GOSUB620:B=ASC(A$)-64
380 IFB<1ORB>8THEN370
390 IFA(B)>7THEN370
400 PRINTA$:A(B)=A(B)+1:B(A(B),B)=C(T):GOSUB650:POKE32807,32
410 E=0:FORI=B-3TOB+3:IFI<1ORI>8THENE=0:GOTO440
420 IFB(A(B),I)<>C(T)THENE=0:GOTO440
430 E(E,1)=A(B):E(E,2)=I:E=E+1:IFE>3GOTO560
440 NEXT:E=0:FORI=A(B)-3TOA(B)+3:IFI<1ORI>8THENE=0:GOTO470
450 IFB(I,B)<>C(T)THENE=0:GOTO470
460 E(E,1)=I:E(E,2)=B:E=E+1:IFE>3GOTO560
470 NEXT:E=0:J=B-4:FORI=A(B)-3TOA(B)+3:J=J+1:IFI<1ORJ<1ORI>8ORJ>8GOTO500
480 IFB(I,J)<>C(T)THENE=0:GOTO500
490 E(E,1)=I:E(E,2)=J:E=E+1:IFE>3GOTO560
500 NEXTI:E=0:J=B+4:FORI=A(B)-3TOA(B)+3:J=J-1:IFJ<1ORJ>8ORI<1ORI>8GOTO530
510 IFB(I,J)<>C(T)THENE=0:GOTO530
520 E(E,1)=I:E(E,2)=J:E=E+1:IFE>3GOTO560
530 NEXTI:E=0:FORI=1TO10:GETA$:NEXT:GOTO360
540 PRINT"IT IS A DRAW!":GOSUB610:RUN
550 PRINT""A$(T)" WON!":GOSUB610:RUN
560 J=0
570 J=J+1:FORI=0TO3:POKE33572-E(I,1)*80+E(I,2)*4,C(T)+128:NEXT
580 FORK=1TO50:NEXT
590 FORI=0TO3:POKE33572-E(I,1)*80+E(I,2)*4,C(T):NEXT:IFJ>19GOTO550
600 FORK=1TO50:NEXT:GOTO570
610 FORI=1TO1000:NEXT:RETURN
620 PRINT"";:FORX=1TO110:GETA$:IFA$<>""THENRETURN
630 NEXT:PRINT"";:FORX=1TO110:GETA$:IFA$<>""THENRETURN
640 NEXT:GOTO620
650 FORI=8TOA(B)STEP-1:IFI<8THENPOKE33492-80*I+4*B,32
660 POKE33572-80*I+4*B,C(T):FORK=1TO10:NEXTK,I:RETURN
```

Listing courtesy Euro-Calc

UK 101 Minefield

by Deric Ellerby

The program draws a map on which 20 mines are hidden. You have to move from the South West corner to your base in the North East. To help you, you have a mine detector which looks at all eight squares around you but be warned — the detector 'fails' after 20 moves and then you're on your own!

```
10 DIMA(11,11):M=181:C=187:T=11:Y=29:IN=57088:TR=53400
20 E=0:F1=128:F2=135:F3=147:POKE530,1:GOSUB980
30 INPUT"Instructions needed";H$:IFLEFT$(H$,1)<>"N"THEN700
40 INPUT"Are you an expert";H$:IFLEFT$(H$,1)="Y"THENE=1
50 GS=INT(RND(T)*4+1):GOSUB980
60 H$="MINEFIELD - by Deric Ellerby.":FORA=1TOLEN(H$)
70 POKE53333+A,ASC(MID$(H$,A,1)):NEXT
75 REM*********MAP
80 FORI=2TO32:POKETR+I,F1:POKETR+I+704,F2:NEXT
90 FORI=65TO704STEP64:POKETR+I,F3:POKETR+I+31,F3:NEXT
100 POKETR+122,46:POKETR+C-1,29:POKETR+C,92:POKETR+C+1,F1
110 POKE54043,29:POKE53494,15:POKE53775,85:POKE53777,68
120 POKE53779,76:POKE53781,82:POKE53783,63
125 REM*********MINES
130 FORH=1TO20:A=RND(Y)
140 J=INT(RND(T)*10+1):K=INT(RND(M)*10+1)
150 IFA(J,K)<>0THEN140
160 IFJ=10ANDK=1THEN140
170 IFJ=10ANDK=2THEN140
```

```
180 IFJ=9ANDK=1THEN140
190 IFJ=1ANDK=10THEN140
200 IFJ=1ANDK=9THEN140
210 IFJ=2ANDK=10THEN140
220 A(J,K)=M:IFA>.5THENA(J,K)=C:GOSUB960
230 IFA(J,K)=CTHENPOKEF-1,C-1:POKEF,C:POKEF+1,C-2
240 NEXT:J=1:K=10
245 REM********MINE DETECTOR
250 M1=0:G1=0:G=53443+64*K:IFN>20THENPOKETR+190,M:GOTO300
260 FORJ1=J-1TOJ+1:IFJ1<1THENJ1=1
270 FORK1=K-1TOK+1:IFK1<1THENK1=1
280 IFA(J1,K1)=MTHENM1=M1+1
290 NEXTK1,J1:POKETR+190,M1+48
295 REM********KEY IN
300 POKEIN,239:G1=G1+1:IFPEEK(IN)=223THEN380
310 IFPEEK(IN)=251THEN410
320 POKEIN,223:IFPEEK(IN)=191THEN440
330 POKEIN,247:IFPEEK(IN)=191THEN470
340 IFE<1ORINT(G1/GS)<>G1/GSTHEN300
345 REM********GUN
350 G=G-1:G2=PEEK(G):POKEG,22:FORA=1TO60:NEXT:POKEG,G2
360 IFPEEK(G-1)=YTHENL=2:GOTO530
370 GOTO300
375 REM********RIGHT
380 J=J+1:IFJ<=10ANDA(J,K)<>CTHEN400
390 J=J-1:GOTO300
400 POKETR+3*(J-1)+64*K,T:GOTO500
405 REM********UP
410 K=K-1:IFK>=1ANDA(J,K)<>CTHEN430
420 K=K+1:GOTO300
430 POKETR+3*J+64*(K+1),T:GOTO500
435 REM********LEFT
440 J=J-1:IFJ>=1ANDA(J,K)<>CTHEN460
450 J=J+1:GOTO300
460 POKETR+3*(J+1)+64*K,T:GOTO500
465 REM********DOWN
470 K=K+1:IFK<=10ANDA(J,K)<>CTHEN490
480 K=K-1:GOTO300
490 POKETR+3*J+64*(K-1),T
500 IFA(J,K)=MTHENL=INT(RND(T)*4+3):GOTO530
510 IFJ=10ANDK=1THENL=1:GOTO530
520 POKETR+3*J+64*K,Y:N=N+1:GOTO250
530 ONLGOTO540,570,580,590,600,610
540 FORA=1TO10:POKE53494,161:GOSUB970
550 POKE53494,15:GOSUB970
560 NEXT:H$="SAFE IN YOUR BASE!!...well done!":GOTO650
570 H$="Missile strike!!..you're wiped out!":GOTO620
580 H$="BOOM!!! YOU'RE DEAD!!":GOTO620
590 H$="WHAT HEAVY FEET YOU HAD!!!":GOTO620
600 H$="GOODBYE, DAISY PUSHER!!":GOTO620
610 H$="IT'S NOT YOUR LUCKY DAY!!"
620 GOSUB960
630 FORA=1TO8:POKEF,15+A:GOSUB970
640 NEXT:POKEF,219
650 FORA=1TOLEN(H$):POKE54160+A,ASC(MID$(H$,A,1)):NEXT
660 FORJ=1TO10:FORK=1TO10:IFA(J,K)<>MTHEN690
670 GOSUB960
680 IFPEEK(F)<>219THENPOKEF,M
690 NEXTK,J:END
700 PRINT:PRINT"YOUR MISSION - to cross a dangerous minefield!!"
710 PRINT:PRINT"You are symbol ";CHR$(Y);" and your objective ";
720 PRINTCHR$(15);" . Avoid"
730 PRINT"the flooded craters ";CHR$(C-1);CHR$(C);CHR$(C-2);
740 PRINT" where previous"
750 PRINT"contestants perished. Your mine detector ";
760 PRINTCHR$(92);CHR$(F1)
770 PRINT"will tell you how many mines are immediately"
780 PRINT"around you, but cannot indicate direction."
790 PRINT"Also its batteries do not last forever!!"
800 PRINT"You may move UP, DOWN, LEFT or RIGHT by keying"
810 PRINT"U, D, L or R."
820 PRINT:PRINT"                    ....Good luck!!":PRINT
830 PRINT:INPUT"  Ready";H$:IFLEFT$(H$,1)<>"Y"THEN830
840 GOSUB980
850 GOTO40
960 F=TR+3*J+64*K:RETURN
970 FORX=1TO60:NEXT:RETURN
980 FORA=1TO16:PRINT:NEXT:RETURN
```

PET Cat and mouse

by Richard Warner

This program is written for new ROM PETs but can easily be converted for old ROMs — see line 121.

```
100 P=RND(-TI):PC=0:MC=0:D=0:M=0:T=0:S=0
110 SP=32:SS=96:WC=160
120 IN=166
121 REM FOR OLD ROM'S, IN=515
130 CC=102:C=81
140 TP=32768
150 C$="                                    "
160 DEFFNP(X)=TP+V*80+H*2
180 DIMT(3),M(200)
190 GOSUB2000
200 GOSUB1000
210 PRINT"          COUNTDOWN:5";:TT=TI:D=5
```

PROGRAMS

```
220 IFTI-TT<60THEN220
230 PRINT"▮ ";:IFD=0THEN250
240 D=D-1:POKETP+18,D+48:TT=TI:GOTO220
250 PRINTC$
260 T=0:M=0
300 IFTTHENT=0:GOTO360
310 T=1:MC=MC-1:IFMC<0THENMC=3
320 D=PEEK(PC+T(MC))
330 IFD=SPORD=S1ORD=CTHEN360
340 IFMC<3THENMC=MC+1:GOTO320
350 MC=0:GOTO320
360 POKEPC,SP:PC=PC+T(MC):POKEPC,CC
370 IFP=PCTHEN700
400 FORF=1TOS:GOSUB500:NEXT
410 POKEP,SP:P=P+M:IFPEEK(P)=WCORP=BETHENP=P-M:M=0
420 IFP=PCTHEN700
430 POKEP,C
440 IFP<>HOTHEN300
450 GOTO600
500 D=PEEK(IN)
510 IFD=255THENM=0:RETURN
520 IFD=18THENM=40:RETURN
530 IFD=42THENM=-1:RETURN
540 IFD=41THENM=1:RETURN
550 IFD=50THENM=-40:RETURN
560 RETURN
600 T(0)=1:T(2)=-1:T=0:S=1
610 FORF=0TO29:NEXT:POKEP,32
620 IFPEEK(P+T(S))=WCTHEN660
630 IFP+T(S)=BETHEN660
640 IFT=3THENZ$="●":GOTO800
650 T=T+1:S=S+1:IFS=4THENS=0
660 P=P+T(T):POKEP,C:GOTO610
700 PRINT"▒";TAB(HM);"YUM YUM"
710 FORF=0TO300:POKEP,C:POKEP,CC:NEXT
720 PRINTC$:PRINTTAB(HM);"▒BERP"
730 IFMT=1THENFORF=0TO799:NEXT:GOTO760
740 FORF=TPTO33685:IFPEEK(F)=S1THENPOKEF,SP
750 NEXT
760 PRINTC$:Z$="▒"
770 POKEPC,SP
800 FORF=0TO9:GETT$:NEXT:PRINT"▒";
810 N$="  NEW GAME? "
820 FORF=1TOLEN(N$)
830 PRINTMID$(N$,F,1);Z$;"▮";
840 FORD=0TO29:NEXT:NEXT
850 PRINT:PRINT"▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒"
860 PRINT"( PRESS RETURN FOR NEW MAZE TYPE )▒"
870 PRINT"▒";N$;
900 T=0
910 GETT$:IFT$<>""THEN960
920 IFT=0THENPRINT" ";:GOTO940
930 PRINTZ$;
940 PRINT"▮";:T=1-T
950 FORF=0TO199:NEXT:GOTO910
960 IFT$="N"THENPRINT"▒":END
970 IFT$=CHR$(13)THENGOSUB2500:GOTO200
980 IFT$="Y"THEN200
990 GOTO920
1000 REM DESIGN MAZE
1200 PRINT"▒":FORF=0TO2*VM
1210 PRINTLEFT$(" ▒                                        ",2*HM+3):NEXT
1211 REM          0123456789012345678901234567890123456 7
1220 H=INT(HM*RND(1)+1):V=INT(VM*RND(1)+1)
1230 P=FNP(X):M=0
1300 POKEP,S2:T=0
1310 IFPEEK(P-80)=WCTHENT(T)=-40:T=T+1
1320 IFPEEK(P-2)=WCTHENT(T)=-1:T=T+1
1330 IFPEEK(P+80)=WCTHENT(T)=40:T=T+1
1340 IFPEEK(P+2)=WCTHENT(T)=1:T=T+1
1350 IFT>1THEND=T(T*RND(1)):M(M)=P:M=M+1:POKEP+D,S1:P=P+2*D:GOTO1300
1360 IFT=1THEND=T(0):POKEP+D,S1:P=P+2*D:GOTO1300
1400 IFM=0THEN1500
1410 M=M-1:P=M(M)
1420 IFPEEK(P-80)+PEEK(P-2)+PEEK(P+80)+PEEK(P+2)=ASTHEN1400
1440 GOTO1300
1500 V=INT(VM*RND(1))+1:H=HM:HO=FNP(0)+1:POKEHO,SS
1510 V=INT(VM*RND(1))+1:H=1:BE=FNP(0)-1:POKEBE,SS
1520 P=BE+1:POKEP,C
1530 PC=HO-1:POKEPC,CC:MC=INT(RND(1))*4
1540 T(0)=1+(RND(1)<.5)*2
1550 T(1)=40:T(3)=-40:T(2)=T(0)*-1
1599 RETURN
2000 PRINT"▒           ▒CAT AND MOUSE"
2010 PRINT"▒THE OBJECT OF THE GAME IS TO GET THE"
2020 PRINT"MOUSE OUT OF THE MAZE, WITHOUT BEING"
2030 PRINT"EATEN BY THE CAT."
2040 PRINT"▒▒TO MOVE THE MOUSE USE"
2050 PRINT"  4 - TO MOVE LEFT"
2060 PRINT"  6 - TO MOVE RIGHT"
2070 PRINT"  8 - TO MOVE UP"
2080 PRINT"  2 - TO MOVE DOWN"
2090 PRINT"▒KEEP YOUR FINGER ON THE KEY."
2100 PRINT"▒▒THE CAT IS SHOWN AS '▒'."
2110 PRINT"THE MOUSE IS SHOWN AS '●'."
2200 PRINT"▒▒▒PRESS ANY KEY TO CONTINUE"
2210 GETZ$:IFZ$=""THEN2210
2500 PRINT"▒PLEASE SPECIFY TYPE OF MAZE:"
2510 PRINT"▒  1:ORDINARY"
2520 PRINT"  2:JAILBREAK"
2530 PRINT"  3:HAYFIELD"
2540 PRINT"▒▒TYPE";:T=3:GOSUB2900
2550 MT=T:ONMTGOTO2560,2570,2580
2560 S1=SP:S2=SP:GOTO2590
2570 S1=224:S2=SP:GOTO2590
2580 S1=224:S2=224:GOTO2590
2590 AS=4*S2
2600 PRINT"▒PLEASE SPECIFY SPEED:"
```

PROGRAMS

```
2610 PRINT" 1 (SLOW) - 5 (FAST)"
2620 PRINT"▒▒SPEED";:T=5:GOSUB2900
2630 S=(5-T)*2+1
2700 PRINT"▒PLEASE SPECIFY MAZE SIZE:"
2710 PRINT" 1 (SMALL) - 3 (LARGE)"
2720 PRINT"▒▒SIZE";:T=3:GOSUB2900
2730 RESTORE:FORF=1TOT:READHM,VM:NEXT
2740 FORF=0TO999:NEXT:RETURN
2800 DATA 10,7
2810 DATA 14,9
2820 DATA 18,11
2900 PRINT"?▀ ";:FORF=0TO9:GETZ$:NEXT:R=0:T$="▒"
2910 TT=TI+45:R=1-R
2920 IFRTHENPRINTT$;"▌";:GOTO2940
2930 PRINT" ▌";
2940 GETZ$:IFZ$>""THEN2970
2950 IFTI<TTTHEN2940
2960 GOTO2910
2970 F=ASC(Z$)-48:IFF<1ORF>TTHENT$="?":R=0:GOTO2910
2980 T=F:PRINTZ$:RETURN
```

LEISURE LINES

Well, we had a really mediocre response to Puzzle No 13. I suppose everyone was on holiday because I can't believe it was too difficult. Anyway, 25 out of the 27 entries received were correct and, just for a change, the winner turned out to be a foreign competitor, Karl Veverka of Vienna, Austria. Well done, Karl — we'll be sending your prize in due course.

There were several possible solutions, and the winning one was:

1600	000	000
1101	111	489
1254	222	225
3333	330	225
4434	494	464
4555	575	025
4666	665	969
7907	477	776
3828	886	884
2909	199	969

Quickie

As usual, no prizes for this one so no answers required. If a hen and a half lay an egg and a half in a day and a half, how long will it take 12 hens to lay 12 eggs?

Prize puzzle

This month's problem is all about check digits, so we'd better make sure we all agree on the definition first.

To find the check digit of modulo 97 for a six-digit number, proceed as follows:
— multiply the first digit of the number by the first weight, W1;
— multiply the second digit of the number by the second weight, W2;
— etc;
— add the six products so formed to give a single total;
— divide this total by 97 and the remainder is the required check digit.

For example, suppose our weights are 10, 20, 30, 40, 50 and 60 respectively, and suppose we wish to find a check digit for the number 987654. Then we calculate 9x10+8x20+7x30+6x40+5x50+4x60=1190, which leaves a remainder of 27 when divided by 97. Hence the required check digit is 27.

Right, now for the problem. We are given eight numbers and their respective check digits. You have merely to calculate the check digit for the ninth number.

So here are the numbers, with their check digits in brackets:

1.	693847	(16)
2.	264315	(27)
3.	927064	(32)
4.	472289	(14)
5.	838521	(73)
6.	741318	(69)
7.	553846	(14)
8.	385132	(10)
9.	123456	(??)

I'll give you a little more information, however. All weights are positive integers between 0 and 99 inclusive; and from left to right across the six digits, the weights are multiples of successive prime numbers (unity is not considered 'prime' for this purpose). For example, if weight W1 is five then W2 is a multiple of seven, W3 is a multiple of 11, W4 is a multiple of 13 and so on. This information should render the problem almost trivial.

I want to know the check digit of the ninth number, then, together with the weights W1 to W6. Answers on a *postcard* (letters are filed in the bin) to *Puzzle No 16*, PCW, *14 Rathbone Place, London W1P 1DE*, to arrive no later than *31 December*. Prize (yawn) is a book token, as usual.

BLUDNERS

Quite a few readers were thrown into confusion by the ZX80 Breakout program. The problem lies in line 130, at the end, in fact; instead of a space between the inverted commas there should be a shaded square. And in lines 140 and 320, there's only a single space between the inverted commas.

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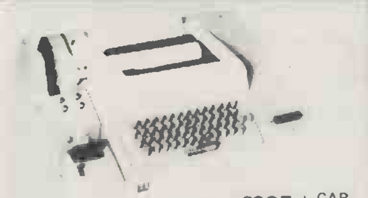

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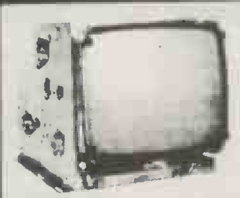

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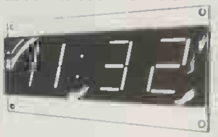

The same module, NATIONAL MA1012, used in most alarm clock/radios on the market today, the only difference is our price! GIANT ½" LED characters give extremely clear viewing and readability. All electronics are self-contained on a P.C.B. measuring only 3"x 1¼". By addition of a few switches and 5/16 volts A.C. you have a multi-function alarm clock at a mere fraction of cost. Dozens of functions include snooze timer, am-pm, alarm set, power fail indicators, flashing seconds cursor, modulated alarm output, dimmer control, etc, etc. Supplied brand new with full data at only £5.25

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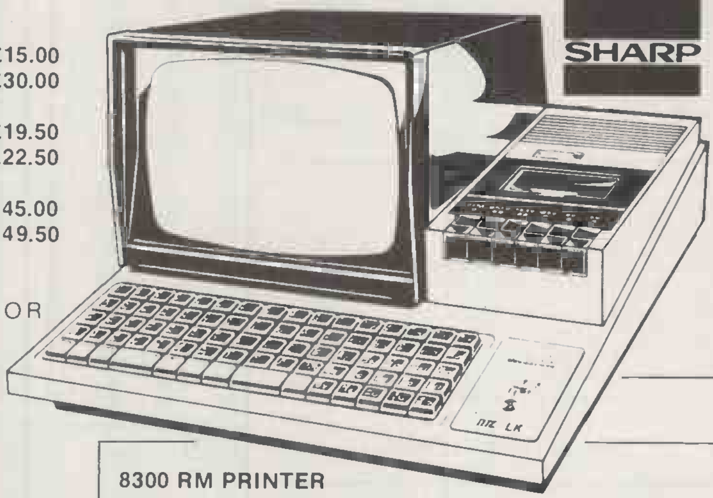

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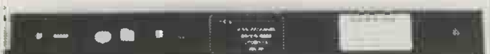

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4024	78p	4068	27p	40174	£1.54	4510	99p	4566	£1.59
4025	27p	4069	27p	40181	£5.03	4511	£1.50	4568	£2.38
4026	£3.25	4070	30p	40182	£1.90	4512	80p	4569	£2.50
4027	50p	4071	25p	40192	£2.41	4514	£2.65	4572	40p
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DATA

Note: in this section all data books are subject to 0% VAT. For postage see 'Terms' at top of page.

113 page Electronic Projects Index 72-77 (North Tyneside Libraries) £1.50
c650 page COSMOS Databook (RCA) £4.95
c31 page 'A Guide to SC/MP Programming' by Dr. Drury (Kemitron) £3.75
c20 page 'A Guide to Kilbug' (Kemitron) 75p
c24 page NIBL Reference Guide (National) £3.45
Data for 4116 (Mostek) 50p
c6 page data for Mk 4118 25p
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20-page data for SC/MP II (National) 50p
c100 page CDP 1802 MPU User Manual (RCA) £4.50
c45 page Fixed Point Binary Arithmetic Routines for COSMAC £4.50
c31 page Floating Point Arithmetic Routines for COSMAC (listings excluded) £4.50
c43 page COSMAC MPU Product Guide (RCA) 75p
c15 page CDP 1802 Instruction Summary 25p
c70 page Understanding CMOS (RCA) £1.50
1 page COSMOS Pocket Selection Guide (RCA) 25p
c21 page COSMOS Digital Integrated Circuits (RCA) 75p

Please check availability of Z80 data Pack before ordering
Z80 DATA PACK £14.95
This contains all the data we can obtain on the Z80 CPU and related chips, and the Z80 Programming Manual. Depending on our own supplier, the data is either loose sheets photocopies or bound volumes, or a combination of both. The weight of the set of data is about 1½ kilos and some information on other processors, memories and systems is often included

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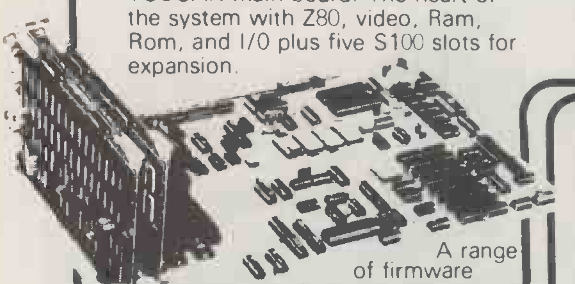

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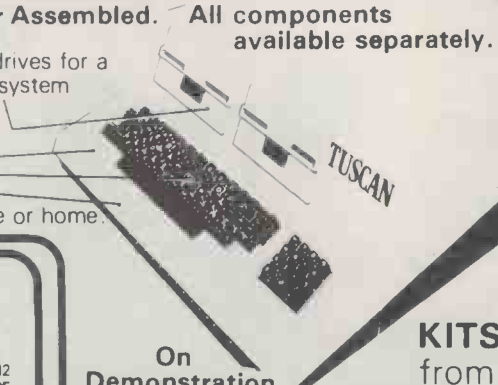

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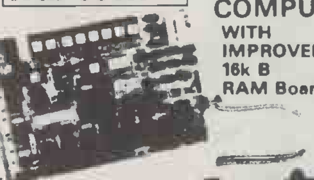

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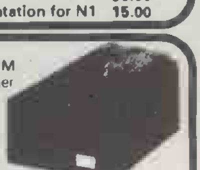

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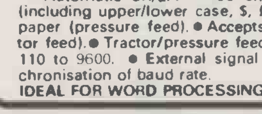

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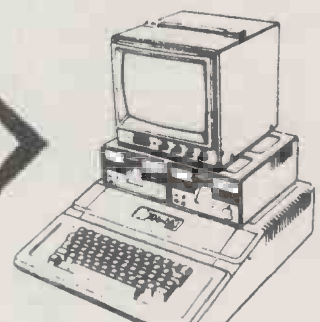

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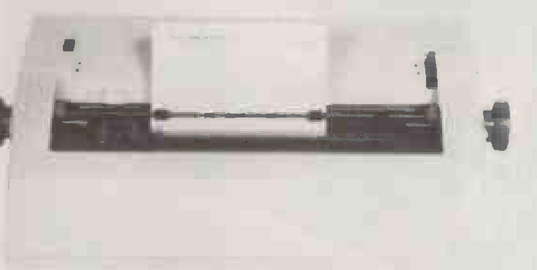

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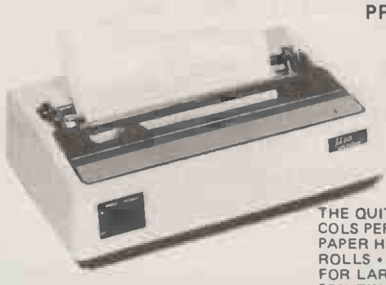

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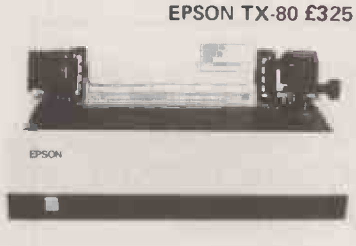

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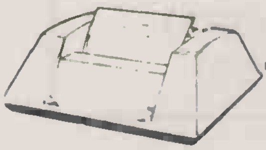

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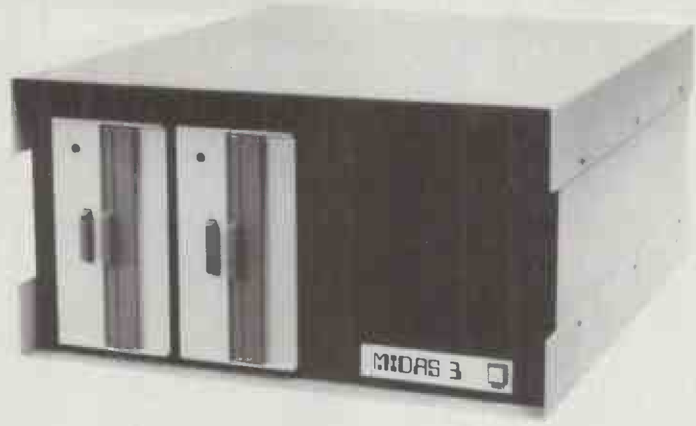

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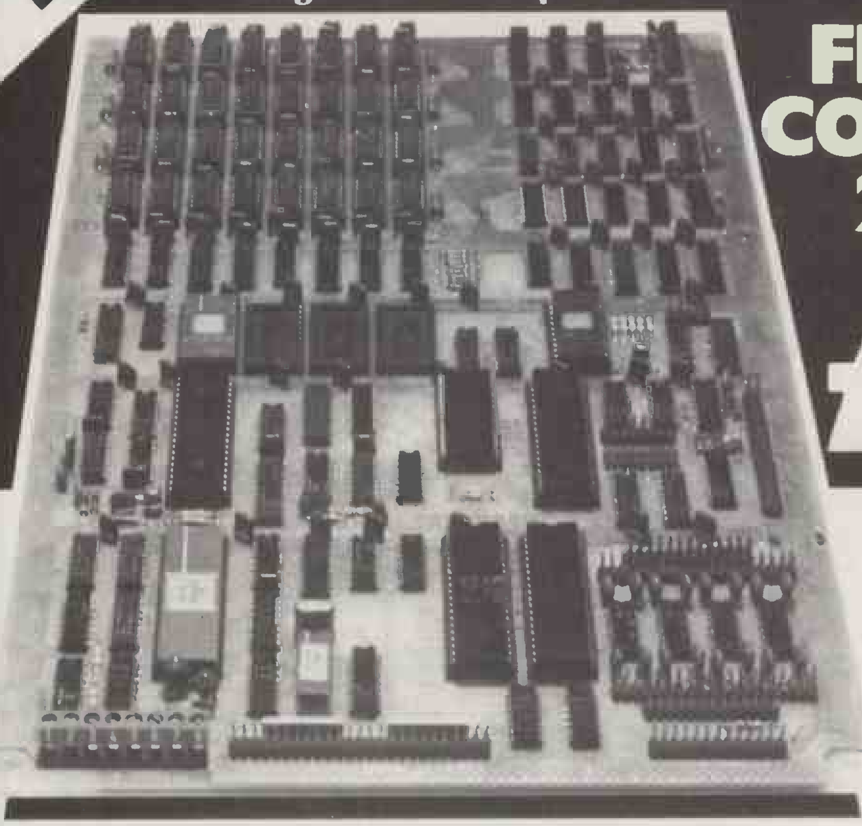

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Size 8½ x 13¾ inches. Requires + 5V @ 3 Amps +/– 12V @ 0.5 Amps.

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Z-80 CPU	Handles *all* 4116 RAM refresh *and* supports all MODE 2 INTERRUPTS. Fully buffered, the Z-80 runs all 8080 software.	**Basic I/O**	A separate parallel port (Z80 P10) for use with an ASCII encoded keyboard for input. Output on the 80 x 24 character video display.
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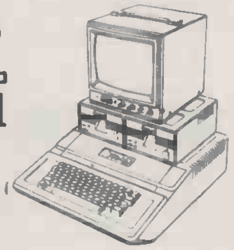

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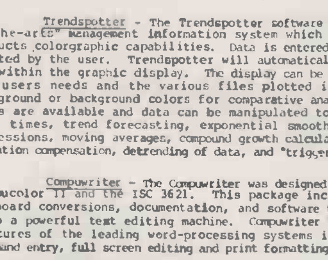

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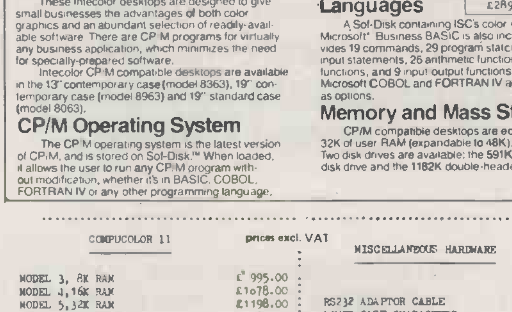

Intecolor 8964 features 19" display CP/M operating system and 1182K byte storage capacity

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The CP/M operating system is the latest version of CP/M, and is stored on Sof-Disk.™ When loaded, it allows the user to run any CP/M program without modification, whether it's in BASIC, COBOL, FORTRAN IV or any other programming language.

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COMPUCOLOR "EXECUTIVE" MODEL	TBA

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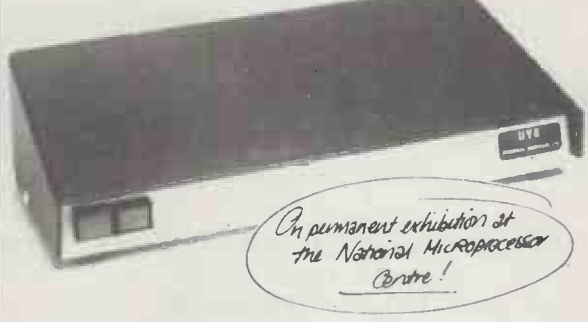

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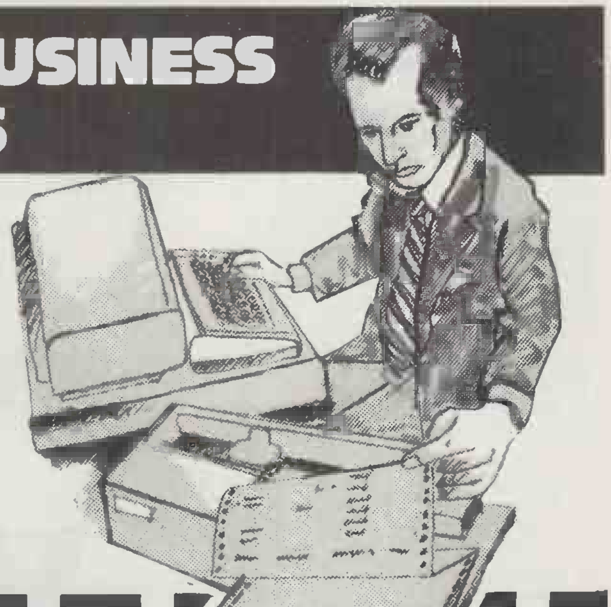

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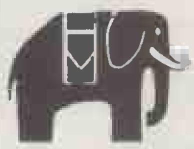

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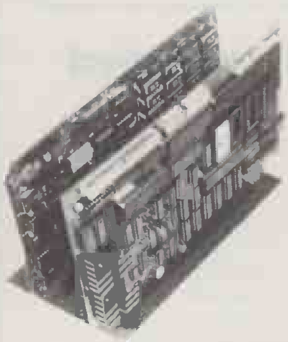

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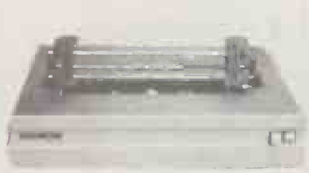

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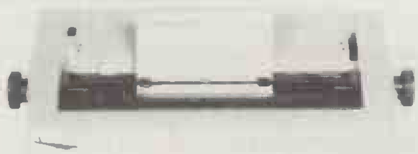

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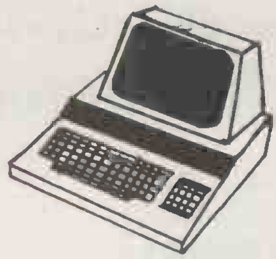

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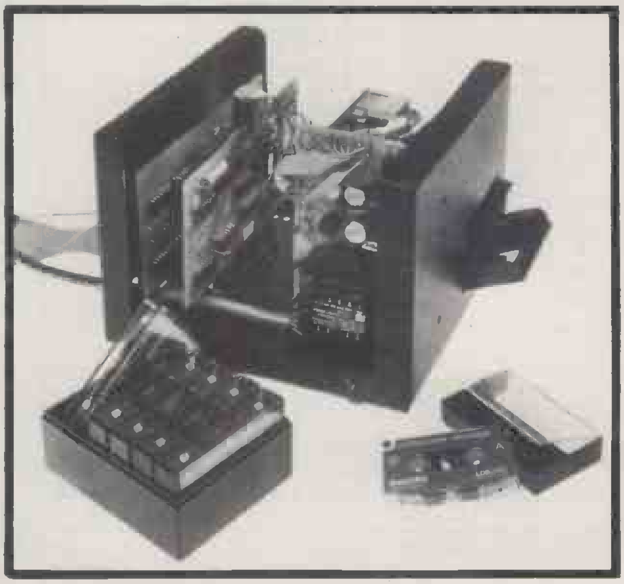

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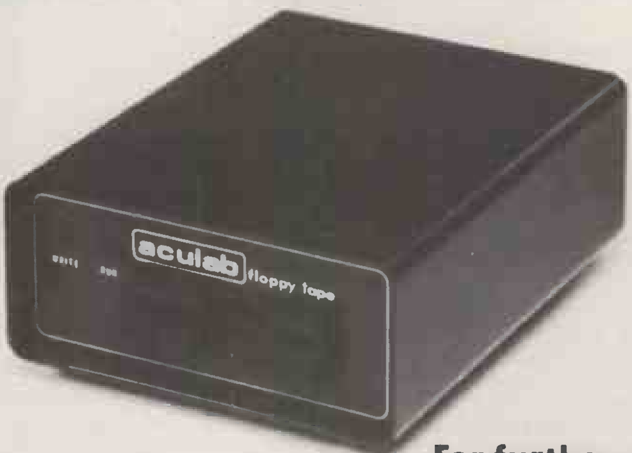

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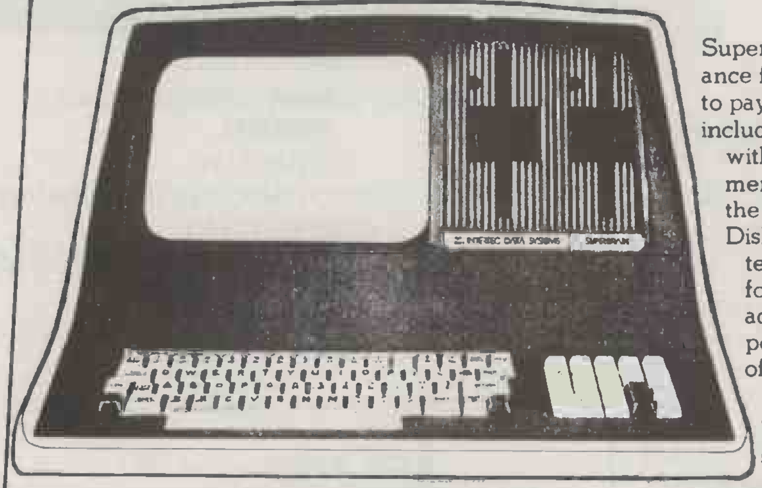

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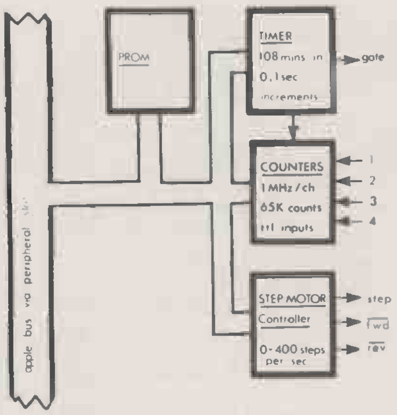

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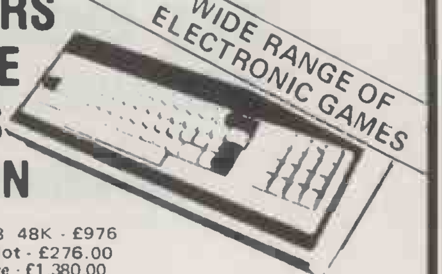

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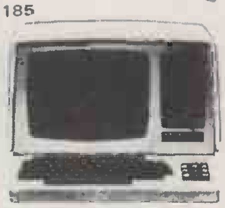

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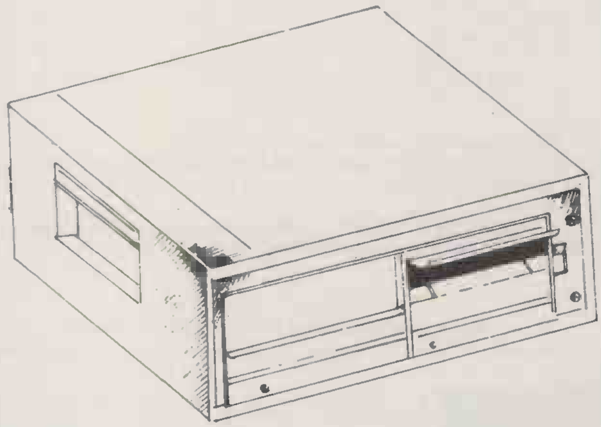

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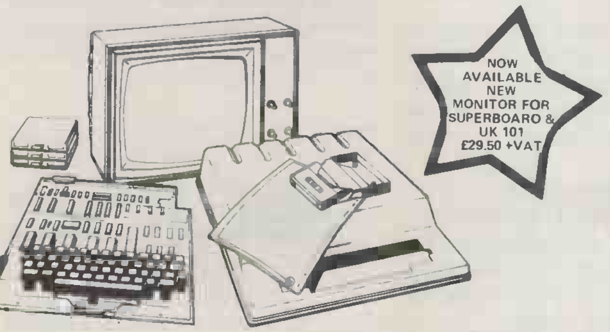

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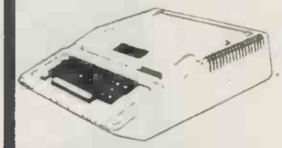

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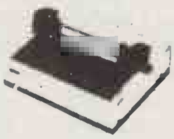

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The Sinclair ZX80 is innovative and powerful. Now there's a magazine to help you get the most out of it.

Get in sync

SYNC magazine is different from other personal computing magazines. Not just different because it is about a unique computer, the Sinclair ZX80 (and kit version, the MicroAce). But different because of the creative and innovative philosophy of the editors.

A Fascinating Computer

The ZX80 doesn't have memory mapped video. Thus the screen goes blank when a key is pressed. To some reviewers this is a disadvantage. To our editors this is a challenge. One suggested that games could be written to take advantage of the screen blanking. For example, how about a game where characters and graphic symbols move around the screen while it is blanked? The object would be to crack the secret code governing the movements. Voila! A new game like Mastermind or Black Box uniquely for the ZX80.

We made some interesting discoveries soon after setting up the machine. For instance, the CHR$ function is not limited to a value between 0 and 255, but cycles repeatedly through the code. CHR$ (9) and CHR$ (265) will produce identical values. In other words, CHR$ operates in a MOD 256 fashion. We found that the "=" sign can be used several times on a single line, allowing the logical evaluation of variables. In the Sinclair, LET X=Y=Z=W is a valid expression.

Or consider the TL$ function which strips a string of its initial character. At first, we wondered what practical value it had. Then someone suggested it would be perfect for removing the dollar sign from numerical inputs.

Breakthroughs? Hardly. But indicative of the hints and kinds you'll find in every issue of **SYNC**. We intend to take the Sinclair to its limits and then push beyond, finding new tricks and tips, new applications, new ways to do what couldn't be done before. **SYNC** functions on many levels, with tutorials for the beginner and concepts that will keep the pros coming back for more. We'll show you how to duplicate commands available in other Basics. And, perhaps, how to do things that can't be done on other machines.

Many computer applications require that data be sorted. But did you realize there are over ten fundamentally different sorting algorithms? Many people settle for a simple bubble sort perhaps because it's described in so many programming manuals or because they've seen it in another program. However, sort routines such as heapsort or Shell-Metzner are over 100 times as fast as a bubble sort and may actually use less memory. Sure, 1K of memory isn't a lot to work with, but it can be stretched much further by using innovative, clever coding. You'll find this type of help in **SYNC**.

Lots of Games and Applications

Applications and software are the meat of **SYNC**. We recognize that along with useful, pragmatic applications, like financial analysis and graphing, you'll want games that are fun and challenging. In the charter issue of **SYNC** you'll find several games. Acey Ducey is a card game in which the dealer (the computer) deals two cards face up. You then have an option to bet depending upon whether you feel the next card dealt will have a value between the first two.

In Hurkle, another game in the charter issue, you have to find a happy little Hurkle who is hiding on a 10 X 10 grid. In response to your guesses, the Hurkle sends our a clue telling you in which direction to look next.

One of the most ancient forms of arithmetical puzzle is called a "boomerang." The oldest recorded example is that set down by Nicomachus in his *Arithmetica* around 100 A.D. You'll find a computer version of this puzzle in **SYNC**.

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By selecting the ZX80 or MicroAce as your personal computer you've shown that you are an astute buyer looking for good performance, an innovative design and economical price. However, selecting software will not be easy. That's where **SYNC** comes in. **SYNC** evaluates software packages and other peripherals and doesn't just publish manufacturer descriptions. We put each package through its paces and give you an in-depth, objective report of its strengths and weaknesses.

SYNC is a Creative Computing publication. **Creative Computing** is the number 1 magazine of software and applications with nearly 100,000 circulation. The two most popular computer games books in the world, *Basic Computer Games* and *More Basic Computer Games* (combined sales over 500,000) are published by Creative Computing. Creative Computing Software manufactures over 150 software packages for six different personal computers.

Creative Computing, founded in 1974 by David Ahl, is a well-established firm committed to the future of personal computing. We expect the Sinclair ZX80 to be a highly successful computer and correspondingly, **SYNC** to be a respected and successful magazine.

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Needless to say, we can't fill up all the pages without your help. So send in your programs, articles, hints and tips. Remember, illustrations and screen photos make a piece much more interesting. Send in your reviews of peripherals and software too—but be warned: reviews must be in-depth and objective. We want you to respect what you read on the pages of **SYNC** so be honest and forthright in the material you send us. Of course we pay for contributions—just don't expect to retire on it.

The exploration has begun. Join us.

The magazine for Sinclair ZX80 users

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ADVERTISERS INDEX

CHIP CHAT

"HHHHHHH, HHHHH, HHHHHHHHHHHH, HHH, HHHHHHHH — (HEAVY BREATHING)."
This was the text of a telex which arrived at our office the other day from, unbelievably, the States. Will the joker who sent this please identify him/herself, as our receptionist, the lovely Sara, is now scared to lift the lid on the machine each morning. Whatever next? Obscene letters by carrier pigeon, perhaps?. . .
Remember our moan last month about Commodore's persisting in billing us for the SuperPET we Benchtested? Incredibly, despite long phone calls, the bills still pour in. Maybe somebody should sell them an improved invoicing package . . . On its way from Commodore, a 4000 series with Basic and disk-handling compatible with the 8000 series, correcting the RENAME bug and giving features like relative record handling; you'll be able to upgrade your 3000 series by buying new ROMs, one for the Basic and one for the disks, costing £38 each. Wonder if they'll invoice us if we decide to Benchtest the new machines?. . .
Amiable Henry Budgett had his holiday ruined this year. Seeking to escape the pressure of running *Computnig Toady*, he jetted to Athens, got a taxi to the port, hopped onto a passing fishing boat and ended up on a tiny Greek island with just one street and a handful of goats. His Hellenic idyll was ruined, however, when, coming across the only shop in the village, he saw a rack of magazines among which he found the latest editions of *PCW* and a certain other micro magazine but — horror! — no *Toady!!!* He instantly boated, taxied and jetted back to Charing Cross Road to berate his hapless circulation manager. . .
Will Mr R M Yorston please contact us to hear something to his advantage. . . A semi-grovel to Ingersoll — thanks for lending us the Ataris to Benchtest; pity we forgot to say that Ingersoll is the sole UK distributor for Atari equipment. . . Have *you* booked for our West Coast Trip yet? Our budgeting department (sorry Henry) has worked out that two people sharing would save £100 each on the cost of doing it independently, so hurry now while stocks last (see page 115). . .
Some friends of ours (yes, we do have some) kept getting the engaged tone when ringing a local school. After a thorough investigation, British Telecom announced that the line was out of order. Subsequent investigation by our friends revealed that in fact the school had been on line to Prestel for one-and-a-half hours and then attached to a mainframe at Trent Poly via an acoustic coupler for two hours. . .
Tandy rang us in response to our recent comments about their TRS-80 hand-held thing ('Newsprint', October), when we mentioned that we couldn't tell the difference between it and the Sharp PC-1211. "But it's got 1.9k of memory while the Sharp has only .9k!" said Tandy. Oh, well, yes, but everyone we spoke to is selling a 1.4k version of the Sharp. It's the PC-1210 which has .9k and it's not sold in Britain . . . On a recent visit to the Softwarehouse we came across a weird object in an unusual, hand-crafted case. Turned out it was Tim Hartnell's personal ZX80 which, for reasons best known to himself, he'd fitted into a case with a proper keyboard and a clever switch to un-reverse the reversed display, if you see what we mean *(I don't and I wrote it — Ed)*. . . The new word processor from Nexos sports a 'bronze on black' display, because, they claim, this is all the rage among ergonomically-conscious Scandinavians. But the Scands use orange on brown, we countered, at Nexos' recent launch. "We've adapted it slightly — pretty, innit?" came the reply. Actually it is, very pretty.

Some say they're elephants, some say they're Male Chauvinist Piglets, we say they're Space Invaders. Whatever they are, they belong on the tie of David Low, who's recently displaced Peter Oldershaw as MD of ACT Microsoft. Peter's still with the group, concentrating on setting up a countrywide maintenance organisation.

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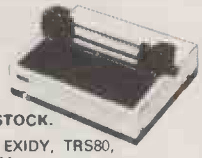

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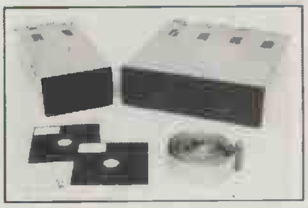
TEAC DISK DRIVES



- TEAC FD-50A has 40 tracks giving 125K Bytes unformatted single density capacity.
- The FD-50A can be used in double density recording mode.
- The FD-50A is Shugart SA400 interface compatible.
- Directly compatible with Tandy TRS80 expansion interface.
- Also interfaces with Video Genie, SWTP, Heathkit, North Star Horizon, Superbrain, Nascom, etc, etc.
- Address selection for Daisy chaining up to 4 Disks.
- Disks plus power supply housed in an attractive grey case.

Single Disk Drive £225 + VAT Double Disk Drive £389 + VAT

COMP POCKET COMPUTER GREATEST BREAKTHROUGH YET

£99.90
+ VAT

COMPUTER POWER THAT ONCE FILLED A ROOM CAN NOW BE CARRIED IN YOUR POCKET!

● Programs in BASIC ● "QWERTY" Alphabetic Keyboard ● 1.9K Random Access Memory ● Long Battery Life.

Computer power that once filled a room can now be carried in your pocket! It's easy to load with ready-to-run software from cassette tape (interface and recorder optional) or program it yourself in easy-to-learn BASIC. 24-character liquid crystal readout displays one line at a time. Special feature is advanced non-volatile memory allows you to power on and off without losing the contents of memory. Note: Memory must be transferred to tape before changing batteries. Automatic statement compaction squeezes every ounce of memory space. Features power-off retention of programs and data. Powerful resident BASIC language includes multiple statements, math functions, editing, strings, arrays and much more. Multiple program loading capability subject to RAM availability. Carrying case and batteries included.

Program	Each	Program	Each
Real Estate	£13.95	Games 1	£8.95
Civil Engineering	£13.95	Business Statistics	£10.95
Aviation	£13.95	Business Financial	£10.95
Math Drill	£8.95	Personal Financial	£10.95

EXATRON STRINGY FLOPPY FOR TRS80

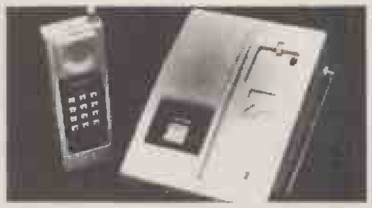
EXTENDED WARRANTY BY COMPUCARE

(Expansion interface not needed)

only £169 + VAT

High Speed storage medium that is cheap and reliable. Includes 20 wafers - M/C monitor - BUS EXPN cable. £169

YOU NEED NEVER MISS AN IMPORTANT CALL AGAIN TWO CORDLESS TELEPHONE SYSTEMS — DIRECT FROM USA



THE ALCOM

only £147 + VAT

Base station connects to your telephone line. Remote handset clips to your belt and gives you push-button dialling — Bleeps when call arriving — Nicad rechargeable batteries. Charger in base unit.

LOW COST TELEPHONE ANSWERING MACHINE

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Microprocessor controlled answering machine. Plug into your phone line. Records any phone call messages. Remote bleeper enables you to listen to your messages from anywhere in the world. Uses standard cassettes. Comes complete with mains adaptor, microphone, remote bleeper, base unit, cassette with 30 sample pre-recorded messages.

COMMERCIAL ● EXPANDABLE ● COMPLETE TRS 80 · MODEL II

EXTENDED WARRANTY BY COMPUCARE

COMING SOON
26 megabyte Hard Disc multi-user DOS

This new unit from the world's most successful micro company is now available immediately with software.

The basic unit comes complete with 64 thousand characters (bytes) of Memory. The built in 8" Floppy disc adds another ½ million extra characters including the disc operating system. More disc expansion is now available.

The Model II is a complete unit with a full keyboard including a numeric pad and 12" screen which gives 24 lines of 80 characters. The computer is supplied with both the disc operating system and the Level III Basic.

A full self test routine is written into the power up procedure to eliminate incorrect operation. Both serial and parallel expansion sockets are standard. A printer is a plug-in operation.

Both hardware and software necessary to talk to a mainframe are included. Terminal usage is very possible. With the addition of CPM2 you can operate with COBOL, FORTRAN, MBASIC, CBASIC in which languages are many other applications packages i.e. accounting, payroll stock etc.

WE USE THIS MACHINE IN OUR BUSINESS

1 DISK EXPANSION Room for 3

500K per Drive gives total of 1.5M Byte — 1 Drive plus Cabinet £799 + VAT

64K 1-Disk Model II £1995.00 + VAT
RRP £2250.00

CP/M2	£95.00	C BASIC	£75.00	FORTRAN	£220.00
CIS COBOL	£400.00	M BASIC	£155.00	WORDSTAR	£255.00

EPROM 2716 £12.50 + VAT

EXTENDED WARRANTY BY COMPUCARE

only £325 + VAT

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Fully converted to UK T V Standard Comes complete with easy to follow manuals UK Power Supply — Cassette Leads — Sample tapes. Special box to enable you to plug into your own TV Recommended for first time-buyers Just plug in and go Full Range of Software Available

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Expand your TRS80 by 32K
32K Memory on board
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Disk controller card Real time clock Requires Level II Basic Interface for 2 cassette decks complete with power supply

THE VIDEO GENIE SYSTEM EG3000 Series

16K
£289
+ VAT

WITH ● 16K user RAM plus extended 12K Microsoft BASIC in ROM ● Fully TRS-80 Level II software compatible ● Huge range of software already available ● Self contained, PSU, UHF modulator, and cassette ● Simply plugs into video monitor or UHF TV ● Full expansion to disks and printer ● Absolutely complete — just fit into mains plug.

COMING SOON

THE MARTELL TV GAME

We are now entering our fourth financial year of dealing solely in the personal computer market – in fact, we started it! Over this period, Personal Computers Limited have formed a group of graduate specialists who will help you in the fields of word processing, financial planning, statistics, economic modelling, forecasting, accounting systems, foreign exchange, banking and oil exploration.

We also do rather well with computer graphics and highly recommend the graphics tablets and our plotter for Apple.

We can also offer two excellent items of software – Format 40 and Visicalc – at a combined price of ONLY £189, and the Super Sound Generator for only £90! (excl. V.A.T.)

8" Disk Drive *(above left)*
Our 8" disks are still as popular as ever – 2 drives give you 1.2MB with all the reliable security of Shugart Technology. Easily interfaced to Apple, uses the same D.O.S.

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Three hand-shake lines (R.T.S., C.T.S. and D.C.D.). Firmware for serial interfaces on-board, software for parallel printer available, 2 bi-directional 8 bit parallel ports, plus 4 additional interrupt and hand-shaking lines.

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A much sought after product which we introduced to the U.K.

80 Character Card *(below left)*
. . . opens up the real commercial world for all Apple owners.

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132 character line, plus graphics, 8 character sizes, ordinary paper, mutliple copy, upper and lower case 96 character, parallel/serial, form control.

Centronics 730 *(Below right)*
A substantial, robust printer from a major manufacturer. 3 way paper handling system, 100 character per second. Special low-cost including interface. 96 characters.

Items pictured

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A new generation of personal computer, self contained, versatile and starting at only £570 (excl. VAT). Explore the Zilog Z80 now the easy way. Disks and printer available shortly.

Numeric Keypad
. . . with 8 function keys is a must in all financial applications.

TCM 100 & TCM 200
. . . both now have graphics as well as their own power supply, essential with this type of printer.

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The quality word processing printer. Clean, clear executive reports the way you want them. Can print up to 5760 points per square inch – or even print in 2 colours.

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