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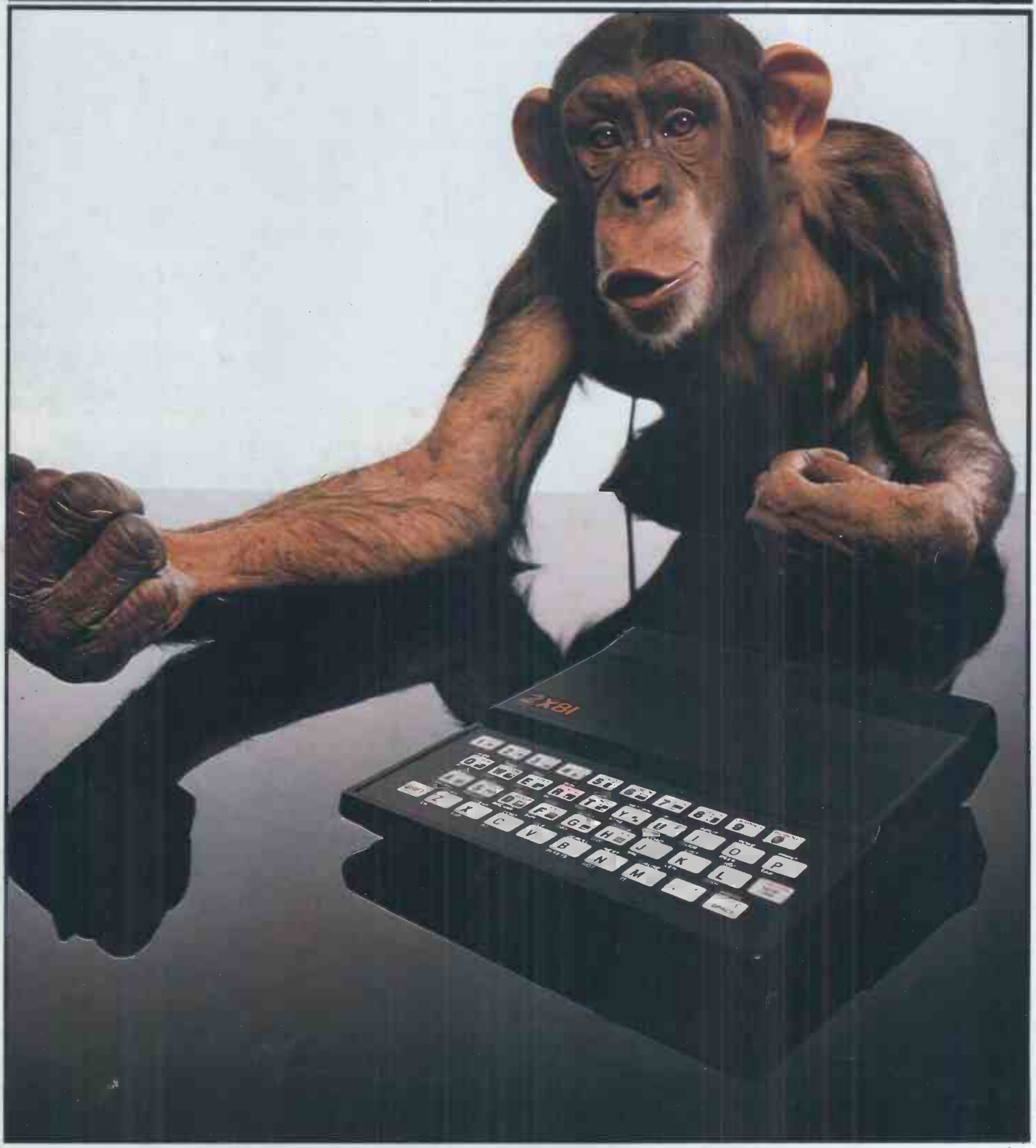

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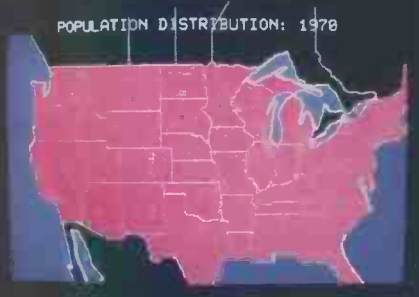
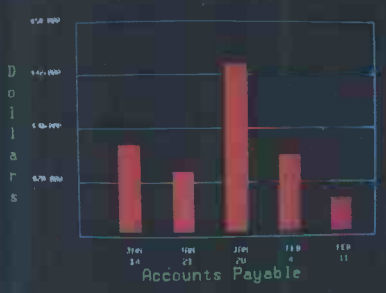
High Resolution Graphics



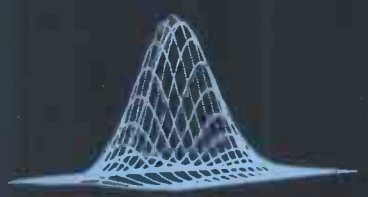
Demographic Display



Management information

Control system display

3-D display with angled labels



3-D plots

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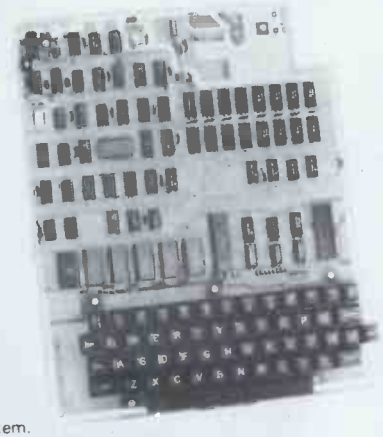

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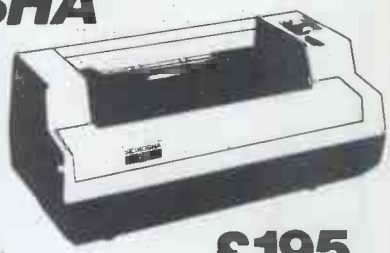

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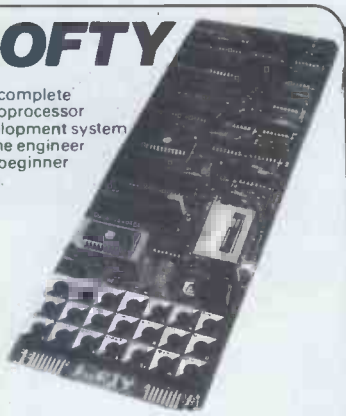

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7409	20
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7411	25
7412	20
7413	32
7414	38
7416	30
7417	30
7420	19
7421	38
7422	25
7423	28
7425	28
7426	43
7427	32
7428	35
7430	19
7432	27
7433	36
7437	35
7438	32
7440	20
7441	68
7442	58
7443	120
7444	116
7445	105
7446	132
7447	72
7448	75
7450	20
7451	20
7453	20
7454	20
7460	20
7470	40
7472	30
7473	35
7474	34
7475	56
7476	40
7480	52
7481	120
7482	75
7483	90
7484	99
7485	105
7486	33
7489	205
7490	42
7491	84
7492	50
7493	57
7494	85
7495	70
7496	80
7497	176
74100	130
74104	62
74105	62
74107	34
74109	60
74110	54
74111	68
74112	170
74116	170
74118	85
74119	120
74120	75
74121	35
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74177	85
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74180	90
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74182	85
74184	130
74185	130
74188	310
74190	130
74191	120
74192	120
74193	120
74194	102
74195	75
74196	99
74197	88
74198	160
74199	160
74221	150
74246	150
74247	151
74248	189
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LS13	40
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LS15	40
LS20	21
LS21	32
LS22	35
LS26	44
LS27	35
LS28	35
LS30	20
LS32	25
LS33	35
LS37	30
LS38	35
LS40	28
LS42	66
LS47	85
LS48	105
LS49	105
LS51	25
LS54	30
LS55	30
LS63	150
LS73	45
LS74	35
LS75	45
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LS78	50
LS83	105
LS85	80
LS86	38
LS90	50
LS91	125
LS92	75
LS93	60
LS95	115
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LS107	45
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LS112	40
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LS114	40
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LS124	180
LS125	45
LS126	45
LS132	60
LS133	35
LS136	55
LS138	70
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LS145	120
LS147	210
LS148	170
LS151	90
LS153	85
LS155	75
LS156	85
LS157	70
LS158	70
LS160	90
LS161	98
LS162	110
LS163	95
LS164	115
LS165	145
LS166	175
LS168	210
LS169	210
LS170	288
LS173	105
LS174	110
LS175	110
LS181	295
LS183	298
LS189	128
LS190	95
LS191	95
LS192	95
LS193	99
LS194	125
LS195	130
LS196	120
LS197	85
LS200	345
LS202	345
LS221	120
LS240	165
LS241	165
LS242	165
LS243	165
LS244	195
LS245	190
LS247	135
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LS324	200
LS325	320
LS326	330
LS327	315
LS346	185
LS347	150
LS348	190
LS352	185
LS353	185
LS365	65
LS366	65
LS367	65
LS368	90
LS373	150
LS374	150
LS375	150
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LS384	250
LS385	420
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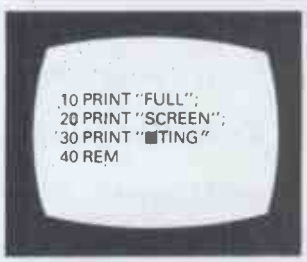

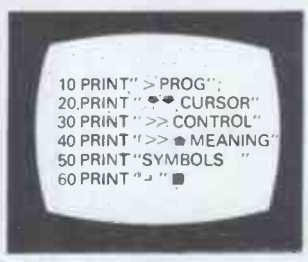

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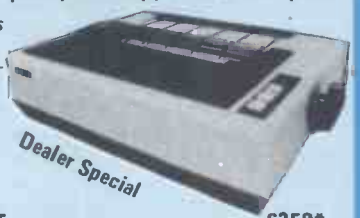

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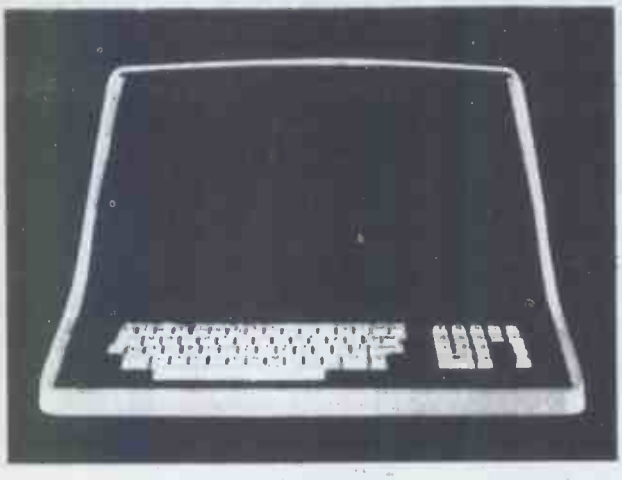

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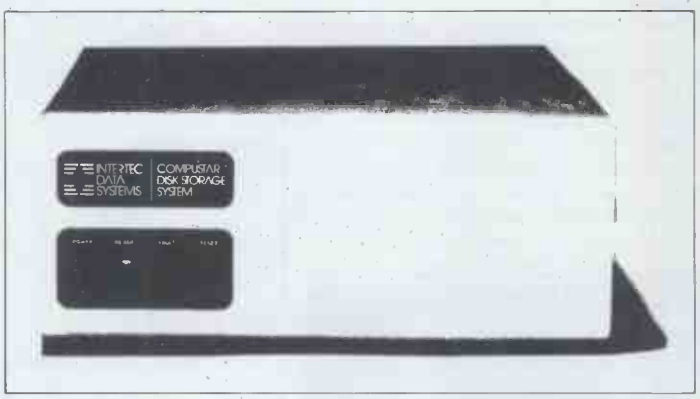

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03= A/C RECEIVABLES
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06= STOCK CONTROL
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10= PURCHASE LEDGERS
11= INCOMPLETE RECORDS
12= USER DATABASE AREA
13= PRINT CUSTOMER STATEMENTS
14= PRINT SUPPLIER STATEMENTS
15= PRINT AGENT STATEMENTS
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18= CHANGE VOCABULARY
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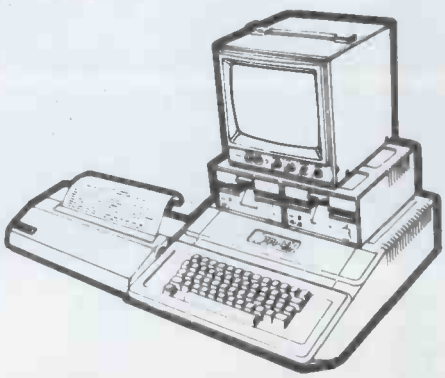

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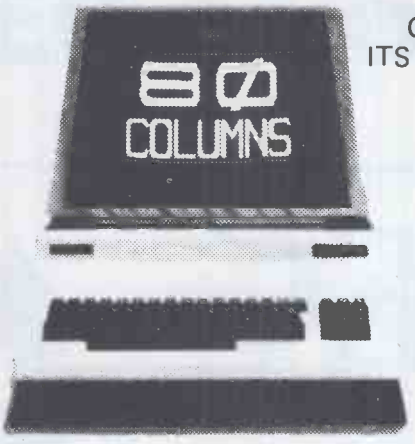

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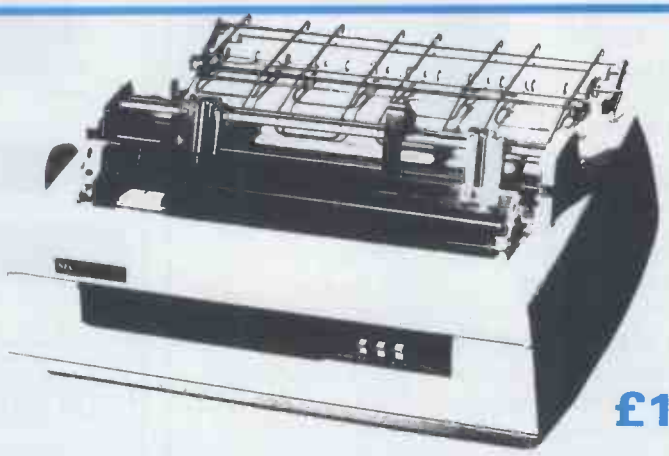

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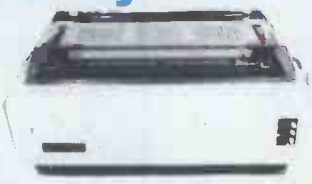

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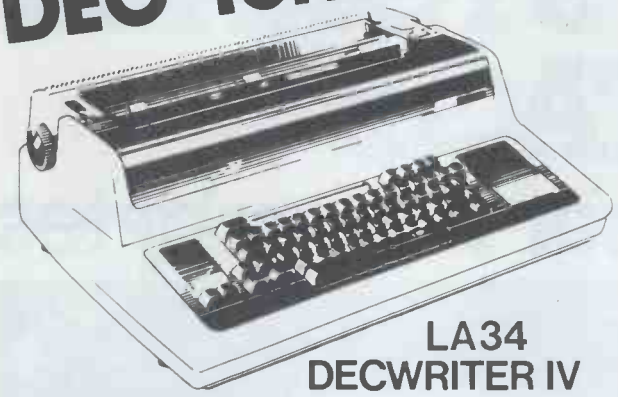

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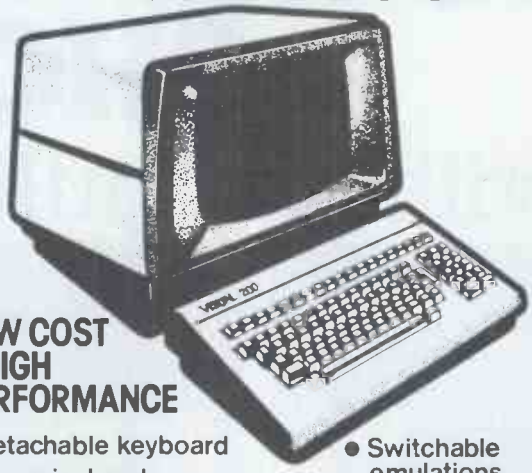

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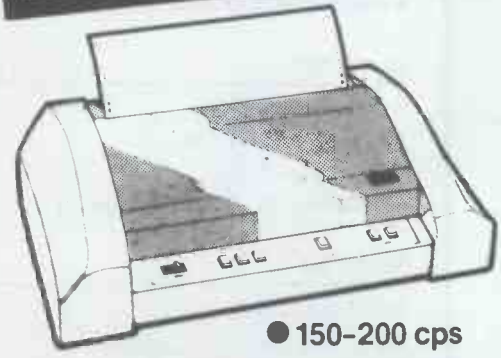

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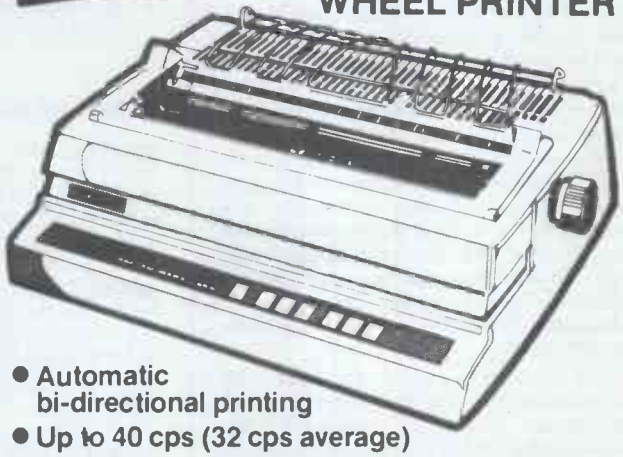

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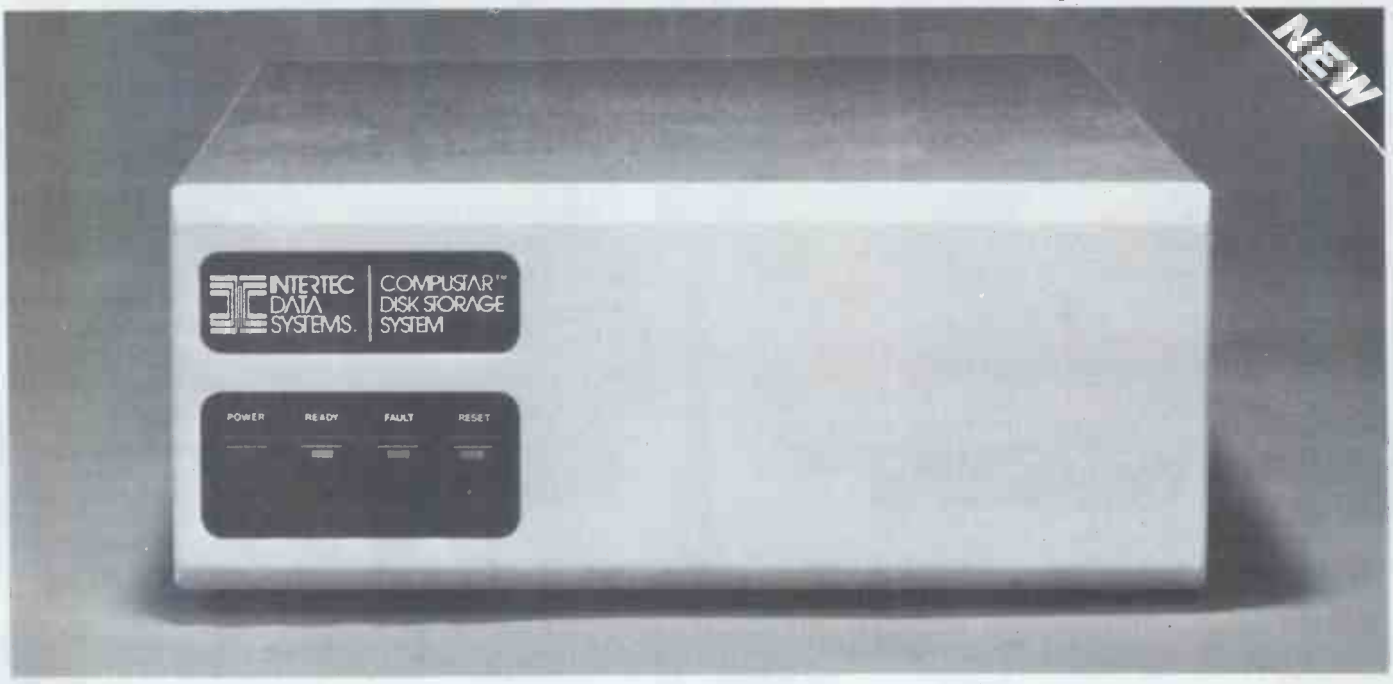

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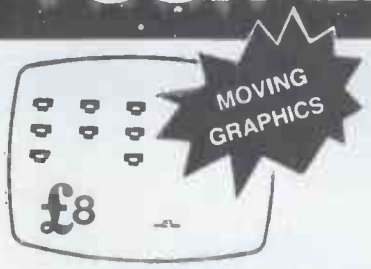

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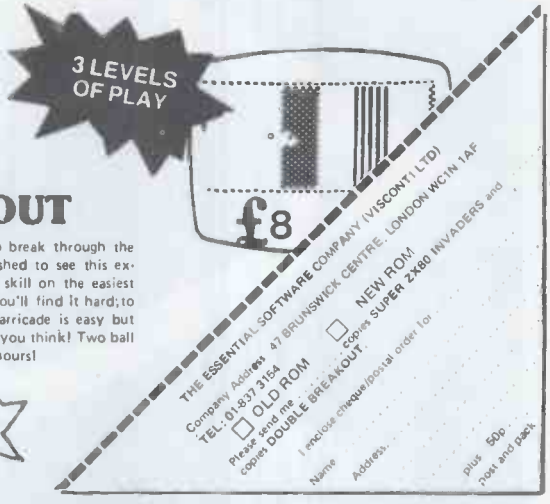

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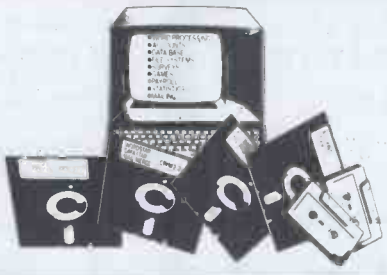

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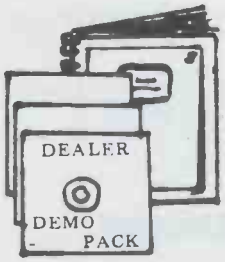

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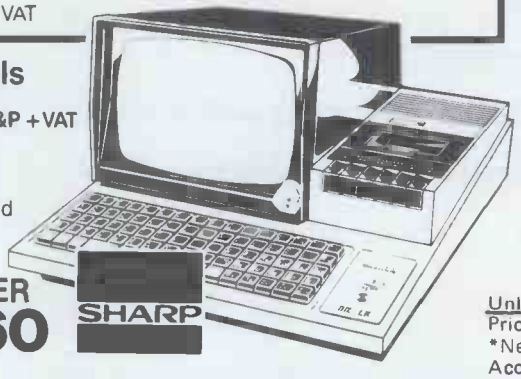

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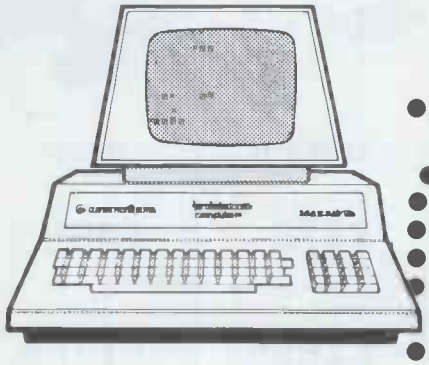

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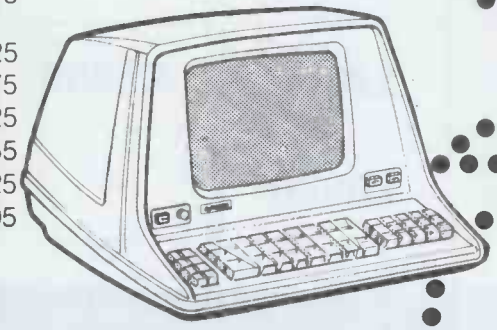

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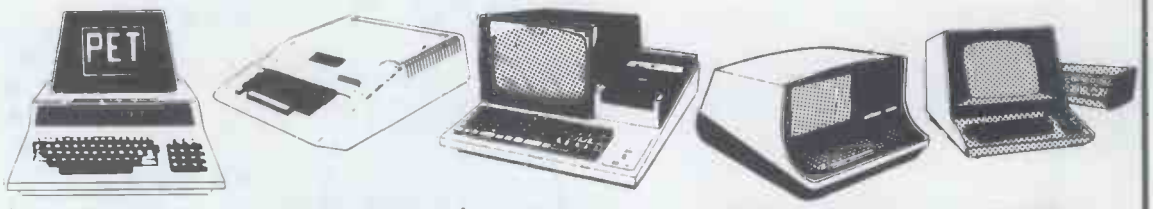

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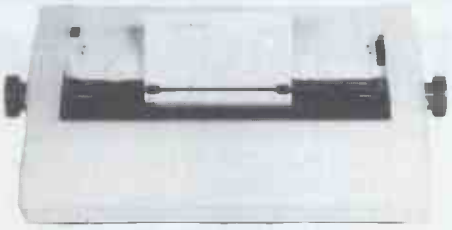

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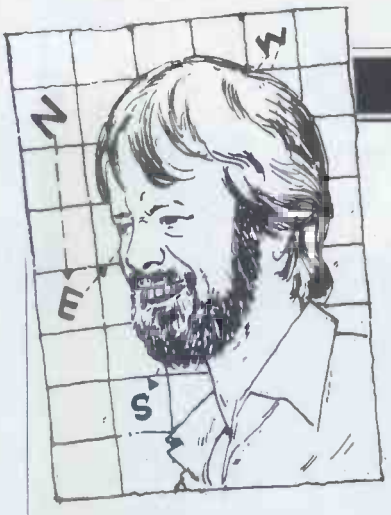


NEWSPRINT

Guy Kewney, editor of Datalink, *presents the latest micro news.*

Schools scheme stirs Sinclair

The Government is to encourage schools to buy microcomputers under a new scheme which will pay half the cost of a machine — provided the school wants either an RML 380Z or a BBC micro.

The £4 million scheme will apply at first to just those schools which don't already have a micro and the Government funding (available from the Department of Industry) only applies to the school's first micro — any school wanting more than one will have to pay the full price for the additional machines.

This means that for £840, a school can buy a 32k RML 380Z with twin disks, a 12in monitor, three blank disks, CP/M, Basic, text editor and assembler. Or, for £130, there's the yet-to-be-produced BBC micro with 16k RAM, 32k ROM, a 12in monitor, cassette recorder, BBC Basic and 6502 assembler.

The schools will have to raise their half of the cash themselves, either from their own funds or those of their LEAs, or from voluntary fund-raising efforts. Next year the scheme will be extended to include schools which already have a micro but want another.

Before the DoI parts with its money, though, it will 'look for evidence' that at least two teachers at each school have undergone — or are about to undergo — a 'period of suitable in-service training.'

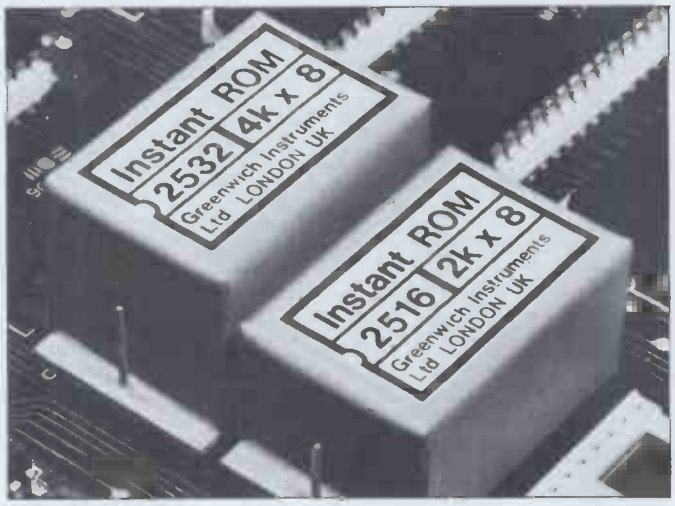
Just how useful all this proves to be to schools is a little debatable, at least for its first few months, because although the scheme starts on 1 June, the BBC micro is not expected to be available until the Autumn.

One person who doesn't think much of it is Clive Sinclair, rapidly becoming a *bete noir* in Establishment eyes and already miffed at being overlooked in the BBC micro saga. The new scheme, he says, 'suffers from having been put together too hastily and without adequate attention having been paid to the needs of schools. Nor has a full enough review been conducted of the latest products available through British technology to allow schools a choice of the most modern equipment available — at the most economical price.'

So he's starting up his own scheme, offering a half-price package to schools for £60, half the cost of the DoI's BBC micro package; for another £30, Clive will throw in one of his new printers, too.

The Sinclair package will include a ZX81 and, presumably, a power supply. Exactly what else will be included hadn't been decided when we went to press but it seems unlikely that Clive could include a TV set in the price; that means that schools buying the Sinclair package would have to fork out an extra £40-50 for a portable TV, although if funds were really tight, I suppose they could scrounge a second-hand one from somewhere.

Also, buying a BBC micro will give a school access to the telesoftware which will soon be available on Ceefax, Oracle and Prestel.



One of the biggest potential money-spinning areas of the microworld has got to lie in memory devices whose contents can be altered by the computer at will but which retain their contents when you trip over the mains lead and pull the plug from the wall socket. Bubble memories can do this but they're very expensive; EAROMs (electrically alterable ROMs) could also be used, but they need inconvenient power supplies (like −30V) to program them. So until we get cheap bubbles and/or single-rail EAROMs, we're going to have to use devices like these, produced by Greenwich Instruments, a British company. The 'Instant ROMs' aren't ROMs at all, actually — they contain CMOS memory with battery back-up which permanently powers the memory chips, enabling them to retain their contents. They come in 2 and 4 kbyte versions and are directly pin-compatible with the 2516/2176/2532/2732 ROMs. Greenwich Instruments says they're meant more as a 'programming aid' than for production use, but with a claimed battery life of six years I'll bet quite a few are found in production machines. More on 01-853 0868.

Basic translator

A new way to get around the incompatibility of the Basics used by different micros has been developed by the Schools Council under its Computers in the Curriculum project.

It's called a 'library of routines' and it works like this: you buy the library, as a cassette or disk, to suit your machine and you then feed in a program written for some other micro. The library translates the program into your machine's Basic by stripping out the machine-dependent parts and replacing them with instructions which are 'universal for computers fitted with the library'. Neat, huh?

Initially the library is available for the 380Z and Apple; later versions will cater for the PET and Sorcerer. It costs £25 and development has been financed by the Government's Microelectronics in Education Programme. More from the project's head office at Chelsea College, University of London, Manresa Road, London SW3 6LX.

Solid disk

Unlike cars, computers will not go faster just because you put in a new engine, adjusted the compression and painted a checkered stripe down the side, yet there are plenty of people who would dearly like to speed their beast up.

One way to do it is to ignore all the promises of super-speed next-generation 16-bit hyphen-ated super-chips and use a faster memory. Disk memory, for example, is quicker to yield up its data than tape cassette; hard disk is quicker than floppy; and after that?

After that, according to JK Systems Research, you go back to silicon. Tape and disks are only cheaper substitutes for the real thing, designed to overcome the awkward fact that today's micros mostly get into a sweaty knot if asked to sort through more than the 65,536 memory items which we refer to as 64 kbytes of memory — and the real thing is what we really want.

JK's answer to the sweaty knot problem is a disguise.

If we take a chunk of add-on memory and disguise it as a floppy disk, then the computer can carry on running its CP/M disk operating software. It just shouldn't notice that the information is coming back 'from 100 to 500 times faster than floppies.'

There are two problems. The first is price: JK's system starts at £295 for 16 kbytes of add on — it would buy you ten times as much floppy capacity.

Second, CP/M can tell the difference between memory and floppies and it needs clever fooling. In JK's package, this is taken care of by an 'intelligent loader' which can detect, and act upon, the differences between the many available CP/M implementations.' This loader actually writes a bit of itself over the CP/M program instructions, and sorts out where information intended for various sectors of the imaginary disk is actually going.

Up to eight megabytes of add-on store can be plugged on like this and, according to JK, it is well worth the cost because of the speed.

The figures given are: on a typical floppy disk based system, a single 128 byte sector can be written (or retrieved) in 0.05 to 0.5 seconds from the 'go'. A hard disk will run about three times to eight times as fast while the JK Silicon Disk System can respond from 100 times to as much as 500 times as fast. Full range of prices and other details from 01-580 9792.

Go CMOS

Watch the chip inside your favourite microsystem. It may not be changing at all in the way it obeys instructions but it might be on the point of a total change in technology, because the tried and tested n-channel silicon chip is losing out in the race against the complementary metal-oxide semiconductor chip. Originally, people got excited about this second technology, CMOS, because it looked great for battery-powered portable systems, using a tiny fraction of the power required by NMOS. Now, however, it turns out that cleverly used, CMOS chips can be smaller and there therefore cheaper for the same amount of circuitry. And they can run faster than n-channel — even though sometimes, to do that, they use more power. Experts have been emerging mentally scarred from a recent technology conference in America (the International Solid State Circuit Conference) most impressed by Japanese advances in CMOS.

One of the most interesting uses of fast CMOS, however, is not the Japanese fast memory chips that so upset the Yankees at ISSCC; it was the previously-announced family of micros from US company National Semiconductor, which 'imitates' both Zilog and Intel micros. Officially they are rivals, in private there are admitted to be so many point points in parallel that Intel and Zilog are quite glad of each other's presence, in boosting the market for what has become a standard personal product range, that using the S100 bus and the CP/M operating system.

Every pound spent on components in a system is critical to its end price and the Nat Semi chips are still not cheap enough for people building ultra-cheap systems — they would have to sacrifice too much profit margin. But the prices are now into the level of practicality for the slightly more 'luxury' products. And when you look at the number of big corporations which have standardised on the 8085 (such as British Telecom) or on the Z80 (a great deal of private industry in the UK) a lot of them must be wishing they could have their cake and eat it. Have both, Nat Semi will soon be saying to them and the triumph of the Japanese with fast CMOS at ISSCC will give the company a boost in credibility and prestige which should see orders moving in — barring accidents.

There are three or four thousand micros made by South West Technical Products, alive and well in the UK. They were the very first micros available through the very first store, Computer Workshop. Today, the sort of thing one buys is this far more 'up-market' installation, shown here installed as a multi-user, multi-tasking mini computer at the offices of King Brothers, a Peterborough food wholesaler. Cost per installation of this high performance machine appears to compensate the Workshop adequately for the fact that it was once the leading supplier of micros in this country, before it went up the market. But it is a thought to make one think that it grew not at all last year, during which time Uncle Clive went from nothing to top in numbers of machines, while Apple, also concentrating on sub-£1000 machines, grows by more than doubling each year. You do get a very nice system from SWTPC, with a 16-bit operating system called Uniflex but you have to pay for it.

This very neat machine is called the Caltext, a British-made word processor from Computer Ancillaries Ltd, which costs an amazing £3995, complete with 64k RAM, twin disks and a daisywheel printer. But the Caltext isn't quite what it seems, for it runs Wordstar under CP/M, which means you've only got to slot in a different disk and you can run all sorts of other CP/M-based software. More on Egham 36455.

Another association

He is a rogue: you are a grey importer, and I make damn sure that I look after my customers and have adequate stocks even if it means going outside normal channels. Similarly, he blatantly advertises products he doesn't have, you place too much trust in your supplier's delivery date promises, while I like to get the feel of the market before committing myself to putting an order on paper.

This entertaining game called Ourselves, Each Other and Them is the real reason nothing actually ever gets done in trade associations. They are set up when times are good by traders who think that some brash newcomer is rocking the boat — for example, offering kit which he's managed to get hold of through the back door and we can't yet — and they then vanish into a haze of self-congratulation, designed to hide identical ploys inside.

It should come as no surprise to learn that a Software Producers Association has now followed the Computer Retailers Association into existence. Delight isn't the word here in the *PCW* ivory tower — I'm ecstatic. For example, here is a small arithmetic problem with an ethical framework: 'At a recent meeting of the SPA council, four new members were appointed to the association, thus extending the geographical area covered by the organisation representing software producers for small business computers. A large number of companies showed initial interest in SPA but it was decided that only four companies met the strict criteria of the association.'

The full list of SPA members was published with that announcement. It contained six names.

Question: how many producters were there originally? Second question: the phrase 'showed initial interest' is: a) very specific, b) deliciously vague, c) actually misleading, d) deliberately so. Pick one. Third: a council can consist of a minimum of how many people? How many previous members of the association were not on the Council? And fourth: who would you nominate as a producer of software competent enough, unbiased enough and knowledgeable enough, to sit in judgement on his fellow producers?

Finally, on a general note: apart from the fact that one or two of the people who put the CRA (Computer Retailers Association) stamp on their ads are obviously very good, what do you actually know that the others have had to prove they don't do, to be allowed to use it?

One always feels slightly guilty about ridiculing the CRA, because it does have so

many well-meaning members. Pouring scorn on such good will seems churlish, yet the truly ethical ones will remain so only as long as their companies are solvent and the kindest thing to say about the rest is that, if they are ever caught being unethical, they will at once make sure that I know how thoroughly they put the matter right. Even if they don't.

If you feel that you are just the sort of person who is needed to make sure the Software Producers Association becomes a hard-hitting, scrupulous watchdog with Teeth, then get in touch with Peter Wills on Bristol (0272) 312079 at Mercator Consultants, or with David West in Manchester on 061-832 6792. They are still looking for 'further potential members.'

NCC opens centre

The National Computing Centre is the place to go for advice. They keep lists of products, software packages and suppliers. They know which consultants can handle your problem. They are, in a word, invaluable; but — until they opened their first micro centre — they knew little about micros.

That has now started to change. The first National Micro Centre, in the NCC's building at 11 New Fetter Lane, London, aims to provide anybody walking in with a chance to play with a micro system, and get advice from the resident micro consultants without being 'sold to'.

According to Eric Bird, the wily old, er, chap in charge, the idea is to set up another such centre in Manchester very soon and then to expand gradually until the whole country is covered 'without anybody being more than 20 miles from a centre.' Since the venture is funded by the Department of Industry, that ambition is probably best regarded as 'long term.'

In the meantime, for £20, you can get two reports from the NCC on computer hardware. The first covers small to medium storage (floppy disks up to the smaller hard disk systems) and the second covers large storage. Details given include price, maintenance, compatibility and specification on virtually every product available in the UK. Details given include price, maintenance, compatibility and specification on virtually every product available in the UK. Details from Roger Brady on 061-228 6333.

Sort out

Network analysis has nothing to do with networks of computers; it is the process of sorting out priorities for action in a highly complex project. The process may be marginally less complex than the project itself but it does need a data processing system to handle it.

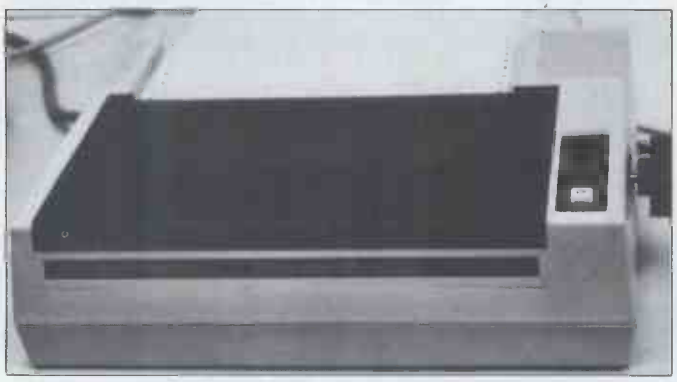
For around £3000 a system of a computer, the necessary peripherals and a new software program called Trendplan 1, is available. Trendplan 1 is the new product and you can pick your own hardware from a wide variety of small computers. It comes from Microtrend; details on 0423 711878.

Although the VIC-20, making its European debut, was the star of Commodore's stand at the recent Hanover Trade Fair, the company had a few other products on show, too. Most spectacular of these was the Micromainframe, developed with the University of Waterloo, Canada. This is basically an 8032 but has 96k of RAM and an extra processor, a 6809. As well as running PET Basic, it can run Fortran, APL, Business Basic, Pascal and assembler and has a high-speed RS232 interface and terminal emulation capabilities to enable it to talk to mainframes.

Also on show was a curious 'sawn-off' PET, intriguingly labelled 'Colour Computer' (above). Details were scarce and the model on the stand had had its keyboard disabled, but it's basically an 8032 with soft- and hardware enhancements to give it colour, which emerges as RGB signals for a monitor.

Although Commodore says you can expect both products to be available, there's no indication yet of when this will be and how much they'll cost.

Also on show were three new printers, the new daisy-wheel, the 8024 dot matrix (which gives 132 char/line) and the 4022 Tractor Printer (below) which is, in fact, an Epson MX-80, suitably modified and disguised.



Atom software

Acorn has started supplying software for its cheap Atom computer. By far the most useful is one called Soft VDU, which uses the machine machine's higher resolution graphics to provide a really nice display of letters, both upper case and lower case, plus letters that you can design yourself. There are also games: the Game of Life, mentioned here once before, is very good: there is a game called Rat Trap where two rats run round the screen trying not to bump into each other's trails, a version of breakout where the paddle moves at a constant speed (no good for a game arcade expert — you have to start afresh) plus my own favourite, Black Box. This gives an eight by eight chess-board type matrix, inside which are invisible atoms. By directing radiation into the box, you can deduce their positions.

All are available on cassette for around £10 per cassette, and while they don't seem to be standardised they do seem easy to load and run and not too easy to crash. Black Box does have a little bug which I can't fix — the speed of operation varies unpredictably — and a cursor which has been marching steadily round the edge of the square suddenly flits madly past the point where you want it. But it doesn't stop you using the game. Soft VDU would be better if I could find a way of interfacting other programs to it.

All available from Acorn direct, or through retailers. The company is about to announce a printer. It will be the GP 800M, an 80 column matrix printer made by Watson, Burton and Associates in Japan (?) and sold in the US for $430 — Acorn hopes to have it ready to plug into the Atom for just over £200. It's quite nice, with upper and lower case, but it makes one heck of a noise.

New Brit micro

People are sceptical when a new micro appears. They were sceptical a year ago when Sinclair and Acorn were preparing the ZX80 and Atom, and now that the inventor of the Nascom has gone into the business of designing a computer to sell on his own account, they are saying it again: 'The market is now too stable to allow a newcomer to break in.'

It may be true that the space for another Apple, worldwide, is getting cramped, but after that, the market still seems wide open. In the case of Chris Shelton, who did design the Nascom 1 originally and the Nascom 2 subsequently, he claims that the computer itself is only a red herring, anyway.

Shelton's new product is put together as a system with two diskettes, a Zilog Z80 with the maximum 64 kbytes on a board, plus a ROM module with any permanent language or operating system you really want, plus a display or output module — all in some kind of box or group of boxes for around £1,500. It looks as though he could sell it for less. He describes the modules as 'building blocks for other equipment designers' connected in a ring, rather than on a system bus.

The key to lower costs on Shelton's Sig-Net is that he doesn't have a standard-shaped circuit board with plug-in connections along one edge, designed to slot into a massive 'mother board' holding several different function circuits.

Instead, he connects all his cards together with ribbon cable, which can be plugged

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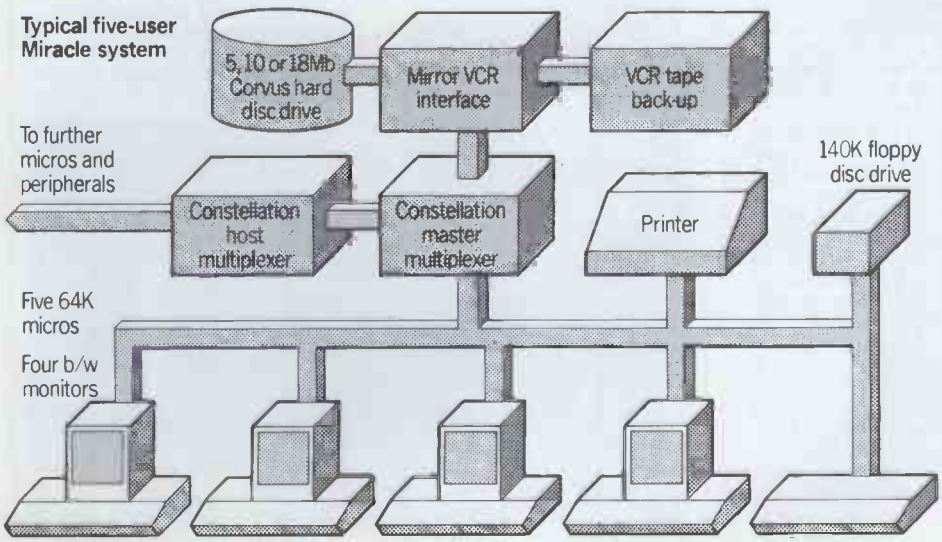

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into the circuit board wherever is most convenient. Shelton reckons the extra cost of putting edge connectors on a board is about 30 percent to 50 percent over his method. The idea of having a processor with 64 kbytes of user memory looks silly at first, because it means that things like Basic in permanent memory are out.

Well, logically, they are: in fact, the system uses an idea already well known to hobbyist users who remember Mike Lord and the Amateur Computer Club's System 77/68 — where the permanent programs were read from permanent memory into user memory when the system started up.

The advantages are enormous. Anybody who has ever loaded Pascal into the little memory remaining after Basic in an Apple will realise that the machine has almost no space for actual Pascal code. Shelton's machine will have no Basic blotting out a large chunk of the memory map.

The other nice thing is that Shelton gives multi-user systems without making users share processors. Up to nine modules can be shared on one Signet ring; other Rings can be linked in, by ring to ring modules. Such expansion potential, remarks Shelton, 'will have particular appeal to very large groups like schools and colleges, or those demanding massive storage.'

Shelton and his colleague Nigel Haringey expect to sell thousands of systems in their own standard form, not to mention the potential for other system builders putting their circuits in different boxes.

The price is somewhat under the market average — but still not quite down with John Marshall's planned Gemini (but that was still screwed up solid at press time) or Osborne's briefcase machine, both of which come under the £1000 mark. However if Shelton isn't kidding about the board overhead, then he can respond to those products when they appear.

Details from Shelton or Haringey on 01-278 6273 — or try writing on Shelton Instruments Ltd, 22-26 Copenhagen Street, London N1 0JD, leaving a big gap between the 1 and the 0, or it'll go to N10. Clever old Post Office!

CBM v BBC

Just as the dust was beginning to settle on the BBC programming programme saga, Commodore has stepped in to kick it up again.

You will remember that, after months of speculation over the Newbury Labs Newbrain, Acorn won the contract to supply the low-cost micros which will form part of the BBC course. The BBC micro will sell for £260 plus VAT and will come with 16k RAM, 32k ROM, cassette interface and plug into a domestic TV. It will have something called BBC Basic and it is this which has aroused Commodore's interest.

The Beeb has chosen to have a Basic interpreter developed especially for its micro and there are those who say this isn't a wise move. Producing a new interpreter from blank paper to the fully debugged final version takes a *lot* of time — and time is just what the BBC doesn't have a lot of, for it intends to have these machines on the market by the Autumn. If it's not careful, the Beeb could be heading for the debugging 'philosophy' so often used by the British motor industry in the past: get it nearly right then let the first few thousand buyers to discover the niggly defects for you.

Enter Commodore, which has just launched its VIC-20 home computer in Europe, with an expected UK retail price of around £200. The VIC has colour, sound, 5k RAM, 32k ROM and plugs into a domestic TV set. It runs PET-compatible Basic and Commodore expects to sell 100,000 of them in the first year. By the time the BBC series starts, VICs will be on sale 'in every High Street', says Commodore.

What Commodore would like is for the VIC and the BBC micro to have 'maximum software compatibility' so that owners of either machine could have access to the large amount of software already written for the PET. What Commodore doesn't say, of course, is that some people might then prefer to save money by buying the VIC instead of the BBC machine.

Making the two machines software compatible could pose problems which means that all those tapes of ready-written PET programs will probably be totally incomprehensible to the BBC micro, unless Acorn can come up with a built-in translating device, which could add to the problems of getting BBC Basic running in time. Or unless the BBC negotiates a licence to use Commodore's Basic and writes off the money spent on developing BBC Basic.

No, it isn't a joke, nor is it an attempt to make fun of the briefcase computer. It's not portable, but 'transportable' and the real point of putting a PET plus printer plus disk drive into a coffin like this is that few offices have a spare table big enough to put all that paraphernalia on when you take it round for a demonstration. And, although you can't see it, this wonderful bit of oak has legs, which turn it into a trestle table. Mind you, in my office it would be a waste of time because all that carpet illustrated here is covered with fellow-workers sitting at desks. . .

Mega handler

Very big disk storage of over 100 million characters needs a rather different controller to sort out the flow of data between the disks and the computer, than is needed by a single floppy disk. Intel has harnessed one of its biggest chips to the task: it is the 8089 input/output processor and it has the advantage over floppy controllers of feeding its data not to the microprocessor, but to the main memory of the micro direct. Here, it looks at first as if Intel has gone a bit overboard. Its new iSBC 215 controller will feed data like this direct into a megabyte of memory a lot more than most microsystems can use. However, by the time this product is in high sales numbers, it may well be that customers are saying 'only a megabyte?' in tones of disappointment.

A second version of the controller handles bigger drives than the Winchesters handled by the 215, says Intel. Cost is over $2000.

Clicker

How truly it has been said that a bug can be turned into a feature by documenting it. A major irritation about cheap keyboards is the fact that the easiest way to build them is to put a sheet of plastic over a set of springs and push each spring down until contact has been made. The springs are cheap, built out of a snapper material that goes click when it can't resist the pressure of your finger any more. Here we see some such keyboards from Advanced Input Devices of the US, described by their UK agent Quiller components as 'producing an

Commodore's new VIC — see 'CBM v BBC'

audible click when depressed, eliminating the need for expensive artificial bleepers and lights.' This is 'tactile and audible evidence of a successful contact.' Details on Bournemouth (0202) 291015.

Speed trial

Here's another piece of useless information for you, courtesy of Blandford Computers: the 30-ton ENIAC computer was recently fired up at the Smithsonian in Washington and set to work calculating the squares of all integers from 1 to 10,000 to see how its performance compared to a TRS-80. The Tandy was 18 times quicker.

School comp

Another schools competition has been announced. It's the Micro Peripherals Ltd National Educational Computing Trophy Competition and will be won by the school which submits the best program 'to assist industry'. The competition opened on 14 April and entries close three months before the 1982 London Computer Fair, at which the prize will be awarded. The prize will be a 'hand-cut, suitably engraved, crystal Rose Bowl', which is a dramatic break from the traditional award of some much less ornamental item of computer gear. Details entry forms from Micro-Peripherals Ltd, 61 New Market Square, Basingstoke, Hants; tel (0256) 56468.

Data manager

Be warned that data management systems are the things which, when incautiously used, send your customers angry reminders to pay the £0.00 bill which they have sent three consecutive month months now because you have incautiously asked the data management system to send threatening notes to all clients who are not in credit. This sort of thing gets winnowed out of the software after the first 20 users get the first 200 angry letters back from clients. So it is reassuring to know that the 'new' data management system now arriving on platform three from Compsoft is in point of fact the two-year-old DMS that has been available on the Commodore 32k PET and has merely been converted to run on 'any CP/M based machine.'

Compsoft's DMS gets a lot of its nicer features from the fact that it links to the Wordstar letter composing program, so can actually turn all the lists it finds into documents. Details on Guildford 39665/505918.

Frisco frolics

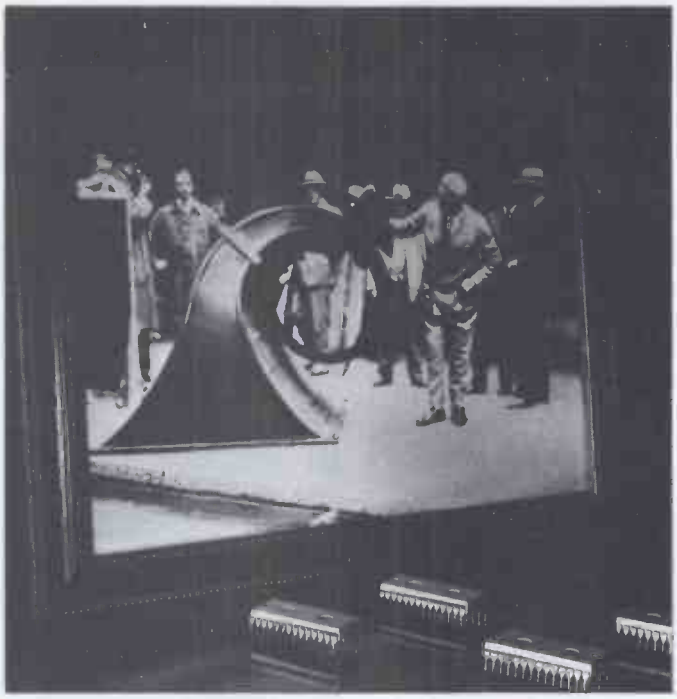
Like the editor, I, too, went to the West Coast Computer Faire. Like a good boy, I tried not to waste time playing computer games, but I did lapse and start playing The Wizard & The Princess, a version of the Adventure or Dungeons type of game, where the room you go in is not merely described, but drawn on the computer screen in high resolution graphics (and colour if you have it).

For example, you are (imagine this, please) facing a scene showing a fragile wooden bridge across a river gorge, with the mountains on the other side. You have to cross the bridge to get to the mountains (Why? To destroy the giant, of course, that's why) but the program warns you that the bridge will not take a heavy weight. Taking the hint, you ask for an inventory of what you are carrying: it turns out you have a shovel, a harp, a rope, a stone, a knife and a few other trivial magic articles.

Elegant though this bar code reader may be in the way it fits into the wire between computer and terminal, it is a bit disappointing to find that a) it costs £450, and b) it can't be reprogrammed from the central processor to read different codes. You get it pre-programmed to the type of bar-code you want and if another type comes along you get another unit. Presumably this can be modified by special request, at further cost — so don't plan on using it for reading old PaperByte programs. Details on (0403) 710101.

You throw them down, one by one, and the computer faithfully draws them on the screen as they drop; finally, you cross the bridge and find yourself in the mountains. The computer draws the mountains. And the giant. Apparently the game includes 'hundreds' of such pictures and can be run for months because it's quite hard to beat.

And it has been picked up from the Faire and imported by a UK software retailer: SBD Consultants, 15 Jocelyn Road, Richmond, Surrey; tel 01-940 5194. Its US producers are On-Line Systems.



In the picture (in the picture) there is a thing for making sounds for the early talking films in the 1920s. Under the picture (in the picture) are four talking chips. They are the Nat Semi 'Digitalker' synthesisers, now available for £185 in an S100 standard card with 128 kbytes of permanently stored data which generate 144 'natural sounding words'. Details from High Technology Electronics, Southampton (0703) 581555.

You remember the London Marathon, don't you? This is the team who used an Olivetti P6066 ('the cleverest system of its size') to do a strange job. They used it to keep track of a whole bunch of running bibs. A running bib is something worn by a runner at the start of a race and covered in a computer-readable bar-code number. You read it at the beginning of the race, and at the end and deduce that the person wearing it at the end was the same one who wore it at the beginning. Right? Well, how dare you suggest anybody would cheat! This is sport, and they wouldn't. That's whywe keep tabs on them with the computer.

Sorry

Grovelling apology time again. The price of Sharp's

MZ80FD twin minifloppy disk unit has, in fact, been reduced to £675, not £615 as I reported a couple of months ago. The latter price is, in fact, the new, reduced cost of the MZ80FDK, which is an *additional* twin disk unit with a confusingly similar name — well, it confused me, anyway.

Super ROM

Supersoft has just launched another plug-in ROM for the PET. But, unlike other plug-ins, the new one — called ROM-X — actually replaces one of the PET's own ROMs instead of taking up a spare ROM socket. It retains the features of the PET's original ROM but adds a few, such as auto repeat on all keys, an escape key, scroll pause and a protected keyboard buffer. More on 01-866 3326.

Zilog's biggie

Zilog has announced a system based around its Z8000 chip. It's called the Z-Lab 8000, it runs ZEUS, Zilog's version of Unix and it can handle up to 16 users. As its name implies, it's intended as a software development tool, for the Z8000 itself and for Zilog's Z8 and Z80 processors. How much does it cost? Well, £16-20,000, depending on the configuration you order. Don't all rush at once, though; it won't be available until December. More on (0628) 36161.

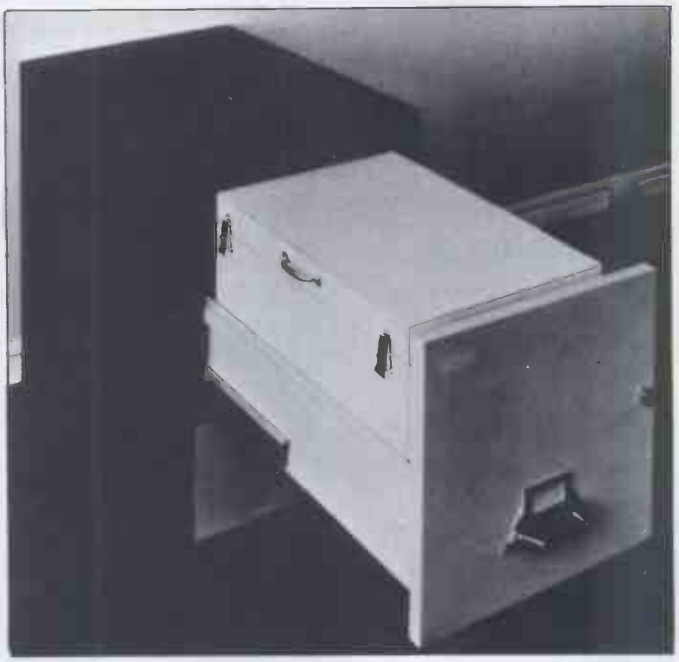
Digico's micro

After years of living in the doldrums, one of the country country's oldest computer makers has decided to get into micros. Digico was the Great White Hope years and years ago but without any Government support nor the big American market which its rivals DEC and Data General had to grow roots in, it has always struggled from crisis to crisis.

That's history. Now, it has decided to launch a system starting for £1500, based on micro technology and running the micro standard operating system CP/M. Hooray!

Taking it for granted that the machine works (there is no excuse for a CP/M machine that doesn't these days, so long after the designs have all been developed and debugged) the real question that Digico has to answer is: how will the Prince micro be distributed?

The answer, encouragingly is 'a network of dealers.' Even more encouragingly, it is proposed that rental schemes will be available and that a seven years' maintenance guarantee will be introduced. The only cloud on the horizon is that the dealer network doesn't exist yet, and that Digico rather foolishly describes the Prince as 'bridging the gap between simple (and largely unuseable) hobby machines and full blown minicomputer systems.' The habit of thinking of minis as somehow 'better' than micros is one the minicomputer makers have always encouraged us in, but it bears little relation tc reality. If they were so much better, why don't they have Visicalc? Because of their wretched, restrictive and outdated multi-terminal operating software, that's why. Only in the speed of maintenance does the old mini offer anything; and if Digico get that right with the Prince, they'll make friends. Details on 04626 78172.



The cost of a computer, like that of a dog, takes no account of the amazing amount it costs to feed it. This is not just a filing cabinet with a box in it — it is a fire-proof media file cabinet. You put disks in and despite the temperature outside going up to 1700 deg F, it stays below 125 deg F inside the top drawer (they don't say for how long) for a mere £680, delivered to your office anywhere in the UK. Details 061-980 8341.

You plug your computer into the white circle just as if you had it plugged into the mains. When the mains power goes (a fuse fails, perhaps?) the 12V car battery in the Microguard takes over in two cycles, generating 240V at 50Hz. According to Microguard's makers, Capricorn Computer Systems, power can actually fail so briefly that only the computer will show the ill effects. Details (like why it costs £275) from them on Worcester (0905) 21541.

Vigilant PET

An interactive games/graphics package for PETs, called VIGIL, has been launched by Stateside software house Abacus. Vigil is an 'easy-to-learn graphics and games language that lets you quickly create interactive applications'. Its features include 60 commands, 80x50 plot positions on the 40-column PET and the ability to load/save applications on cassette. It costs $40 this side of the Pond, including p&p. More from Abacus Software, PO Box 7211, Grand Rapids, Mich 49510, USA.

New plan

If you almost liked the program Desktop/Plan but found that it has too many nasty habits, the Mark II version may please you. It supposedly keeps all the original features, but adds high resolution graphics, plus the ability to receive data from Visicalc and has a moving cursor to make controlling it simpler. It costs around $200 in the US, from Personal Software, for Apple II computers.

Apple hookup

The idea of Disk-Mate is simple enough: you plug one D-M into a whole lot of Apple's (up to four) and each one pretend that the D-M is a second disk, or printer, or graph plotter, and it organises things to that the sharing is done sweetly. At £385, it looks much cheaper than the far more ambitious Nestar network, and while it doesn't seem to allow one machine to talk to another like Nestar, it does offer a saving on expensive peripherals. Details from Mike Sterland on 01-626 8121.

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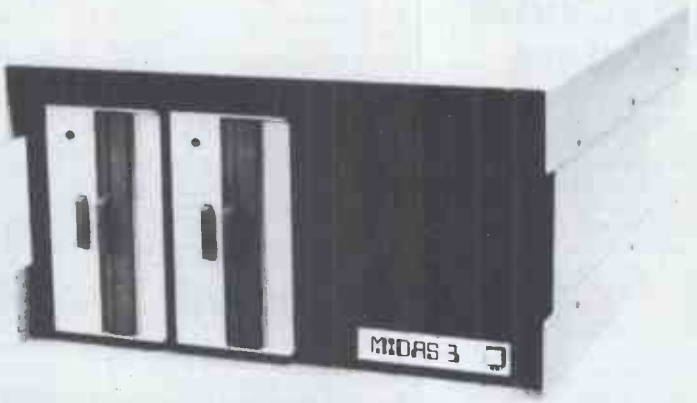

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COMMUNICATIONS

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.**

Club stand at PCW show

The organisers of the *PCW* show at the Cunard Hotel, London, 10-12 September, have allocated space for the use of computer clubs and ComputerTowns. The Amateur Computer Club has been appointed to oversee this area and I have been asked to organise it on their behalf.

We intend to use some of the space to run an exhibition for younger visitors but a number of small stands will be available for genuine amateur clubs and user groups. If you cannot attend then arrangements can be made to hand out leaflets about your club to interested enquirers and/or we will display a wall poster.

Any secretary interested in exhibiting or providing a poster, etc, should write to me as soon as possible giving name of club and reply address.

David Annal (ACC Exhibition Organiser), 142 Windermere Road, London SW16 5HE

Radix riddle

Here's a new topic for your columns! Did you know that children in secondary schools are still being taught to manipulate numbers to base 12 (duodecimal). Some cynics may regard this as progress, but I prefer to think that schools prepare children for real life.

The bit is an international standard of digital computing. The value of a series of bits can be expressed in any number base that is a power of two, for example binary is base 2, hexadecimal is base 16 and ASCII is base 128. Duodecimal is just not relevant.

Furthermore, the syllabus for duodecimal mathematics specifies that the extra symbols beyond the digits 0-9 must be the letters 'T' and 'E', soon to be replaced it seems by '@' and '*'!

Hexadecimal uses the digits 0-9 and the letters A-F for its 16 symbols, which by comparison is brilliantly simple since 'A' + 2 is 'C' and 'F'—1 is 'E' as one would expect.

Someone really ought to mention base 16 to the examining boards, who appear to be living in the 1970s with shillings and pence for money and feet and inches as the measure of a lost Empire.

Many of us in the micro business are hard pressed to find the time to even consider next month, let alone the future generation, but next time you meet a maths teacher, why not put a 'hex' on him/her!

Richard Ross-Langley, Mine of Information, St Albans

Transatlantic treatment

I write a word of warning to your readers, concerning the ordering of magazines directly from the USA, hoping to save a little money.

In April 1980, I sent a subscription to a very well known, and well written, American computing magazine, paying by Barclaycard. In June 1980, I was duly billed, and then I sat and waited for the normal 'allow 8 weeks for processing' to pass.

Having received no magazines for about five months, I wrote to the magazine's subscription department, asking for an explanation.

No explanation came, but a magazine did in December. However, I haven't had any since.

I have just now written another letter to both the subscription and the editorial offices of the magazine, hoping I might get a reply and a further 11 issues of the magazine.

The moral is not that we should not buy these magazines at all, but that we should go to a British distributor. I know I will certainly do that next time. After all, it is easier to phone a distributor in England to sort out a problem than to write to America and only hope for a reply.

Paul Blitz, Southampton

Adventure answer

I am writing in response to J Griffon's plea in your April issue. While I have not played 'Pyramid 2000', the situation described sounds almost identical to one in 'Adventure', the original game of this type. Here, it is merely necessary to release a small bird one is carrying. This then attacks the serpent and (for some unexplained reason) drives it off. May I suggest that Mr Griffon attempts something analogous to this — for example, releasing the bird god he mentions. I hope this will be of some use to him.

Trevor Mendham, Petts Wood

Thanks to all who wrote in with suggestions. We've decided not to print any more since it could spoil the fun for people still struggling — Ed.

Musical notes

The article 'Micro Music Making' (*PCW* March 1981) contained the assertion that a four-part music output loop could not be done in less than 118 microseconds on a 4MHz Z80. I have (under development) a music program which does the basic loop in less than 70 microseconds on this processor. It uses full 16 bit adds for updating the note-table position, and can be extended easily to more than four parts if desired, with only a proportional increase in time.

Ian Phillipps, Cambridge

Don Finlay replies: It was rash of me to state as fact what I had only guessed to be the case after a cursory glance at the long times taken to load the Z80. You are right that the 4MHz version can do this loop in less than 118 microseconds; I have had another look and devised a program which should do it in 91. So far I can't reach your figure of less than 70. Will you share your program with us?

Incidentally, you can improve enormously on these figures by using DMA. The Mountain Hardware music synthesiser, now available for the Apple computer, uses waveform table lookup methods on 16 tables simultaneously, achieving a total loop time of 32 microseconds for all 16. Sophisticated hardware is required, however, using two plug-in boards.

Alpha appeals

We read your article concerning the Onyx C8002 with great interest.

Although we wholly endorse your enthusiasm for 16-bit micros, or supermicros, as you call them, we feel that we must point out that the Onyx is by no means 'The first commercially available supermicro system' nor 'The first of the supermicros into the British computing area'.

The Alpha Micro, which uses the WD16 chip set, has been sold in the UK for in excess of two years, and its UK and European distributors, Alpha MicroSystems UK Limited, sold over 300 systems last year alone.

The Alpha also 'out benchmarks' the PDP11/45; can support over 1 Mb of memory; already uses hardware floating point as standard; can support three disk controllers on any one system.

In addition, up to eight Alpha Micros may now be linked in one local network, so sharing resources and competing in power with the superminis.

The Alpha operating system, AMOS, is also multi-user and has supported up to 73 terminals simultaneously in the USA. We ourselves have tested systems with over ten users on line. It also supports Pascal, Fortran and Cobol, and also Alpha Basic, a very high level implementation of Basic which is extremely popular with programmers worldwide. AMOS is free with each system installed, as are the Basic, Pascal and Lisp compilers and our Assembler Language.

Some 600 Alphas have now been sold worldwide, all using the 16-bit CPU and AMOS. You will therefore excuse our insistence that the Alpha Micro was in fact the first of the Supermicros to breach the commercial marketplace.

In the light of the above, I would be grateful therefore if you would publish, as soon as possible in your next issue, either my letter in full, or an editorial retraction.

W Leslie Button, Alpha Micro, London

Atom adding

Through the pages of your magazine I would like to seek some information on a problem I believe exists with the Acorn Atom home computer.

Myself and at least two other Atom owners I know of have had problems in adding the address buffers to the board as recommended in the Technical Manual. The problem arises when address buffer IC 3 is added, which causes the whole system to freeze and refuse to reset until the IC is removed. Acorn claims that it has not experienced the problem, and I therefore would appreciate it if anybody has this problem to contact either myself with a solution or Acorn with a complaint (or solution). My machine is an Issue 4 board and I would be interested to find out whether the problem

affects other issue.

I would just like to add that I am very satisfied with my machine as it stands and am only making this complaint public in an effort to find a solution.

Kevin Miller, 19 Skye Place, Seafar, Cumbernauld, Glasgow G67 1PF

Back to Basic

Judging by Peltu's use of Papert's book *Mindstorms* to criticise Basic, neither would recognise a logical argument even if they tripped over one (which seems unlikely because both have Something Important to say, and logical arguments slow the pace).

The Professor, so the adoring Peltu tells us, 'calls Basic a typical example of the QWERTY phenomenon'. It seems Basic has outlived its original justification — don't ask me why a new justification of Basic is not allowed: I'm not an MIT professor. Alas, then, Basic has 'lingered on' (just like the S-100 bus has lingered on, eh, Professor?).

Again, the Professor pities those who 'invented' complex arguments to justify quaint features in Basic, but he then proceeds to invent equally silly arguments based on the fact that Basic, Pascal, etc, are called 'languages', and we all know what a language is (don't we?), and how stupid it would be to restrict the English language to 50 words, blah, blah, blah. . .

An alert, conscientious reviewer should pounce on the Professor for saying 'Most teachers do not expect high performance from most students. . . ' Does 'most' mean 51 percent, 99 percent, or something in between? Does the Professor know? In what year did he count these teachers? Is he giving us the benefit of his research, or is he simply saying what the (USA) public wants to hear? Now that Malcolm Peltu has demonstrated his incompetence at contributing to an intelligent debate on Basic, may I encourage you, Sir, to start a genuinely serious and informed debate? This would involve participants making clear such essentials as:

Are they expressing opinions based solely on untried ideas, or are they also drawing on practical experience?

What aspects of Pascal, Basic, Algol, etc, are being discussed, and are they unique or intrinsic to the language? Is any criticism made aimed at the language or at a dialect (or particular implementation)?

What are the presuppositions which set the context of the debate? Is it assumed that there ought to be a single programming language for all microcomputer users, and, if so, why? If not, why not?

What languages are under discussion? Do we include novel features such as the vocabulary-making possible in Forth? Do we restrict discussion to existing languages or can new and improved languages and dialects be included?

Peter Head, London

Tracing trouble

As a TV service engineer, a great deal of my time is spent trying to trace and rectify intermitten faults, many of which are due to dry joints (perhaps inevitable with assembly line bath-soldering).

Thus, when constructing my UK101, I took the utmost care to avoid dry joints, solder bridges, etc, studying every joint with a jeweller's glass, having previously removed the flux with a toothbrush and cleaning solvent. Despite these and other precautions, I have been troubled with intermittent faults and I feel my experience may be of interest to other constructors.

The earliest problem was tape-loading. I, like many people, do not possess a small cassettes recorder with an earphone socket which apparently has a signal of the correct amplitude for feeding to a computer. I therefore used my stereo cassette deck simply unplugging the DIN lead from the amplifier and into a socket connected to the UK101, a five-pin DIN socket (180 degrees). Pins 4 and 1 are right and left channel input and are shorted together and fed to the interface input. Pins 5 and 3 are the same for output (for saving). Pin 2 is earth.

This is okay if tapes are recorded at a sufficiently high level for reliable playback and loading. Problems encountered were due to a faulty recorder — music sounded okay until I listened with headphones. Also some software tapes bought just wouldn't load.

The next problem was crashes to programs which had been debugged, and this was found to be a memory fault due to the COLD START routine giving the message '2302 bytes free' when it should have been 7423 bytes. A bit of juggling with hex and I deduced that Basic's memory test could not access any higher than 0BFF hex, which meant that 0C00 hex was probably where the fault lay. I calculated that this lived inside IC34, but swapping chips around made no difference (at first, anyway).

Next I blamed an intermittent missing RS3 signal and foolishly tried to trace it with an oscilloscope, forgetting that a conventional 'scope is no good at catching very short one-off pulses.

I suspected plated-through hole connections and in fact filled up with solder every such connection on the entire board — a practice I would not recommend. After this and some more chip-swapping the memory fault disappeared.

The final fault crashed programs, especially if the computer had recently been switched on and hadn't yet warmed up. When the program was listed, its tail end was often found to be corrupted with graphic characters, etc. At other times a program would stop with an error message when no error existed. Occasionally non-existent line numbers would be named. Most recently, after a crash and LIST command, the tail end of a program was corrupted by a list of Basic words.

On consulting a Basic memory map, I found that BAS1 contains both error messages and a table of Basic words. I removed the chip and found that the IC pins were black in colour. After cleaning the pins with a very small file, I found some others with the same black pins and one by one removed, cleaned and reinserted them. Since doing this I've had no more problems.

Finally, I would advise fitting the 5V regulator to a really big heatsink on the outside of the case. If a plastic case is used, the heatsink should only be attached to the rear of the base-tray to facilitate easy removal of the cover.

David Henniker, Edinburgh

Forth I

In reply to your comments in the Newsprint section under the heading of 'Forth sally' in the March issue of your magazine, I understand your frustration on being told that Forth can only be used on one machine. This is not true.

Forth is virtually machine-independent and can be implemented on machines using the 6502, 6800, 6809, Z80 or 8080 microprocessors for less than £15.

If anyone is interested in using Forth, then contact me the Hon Secretary at: Harry Dobson, The Hon Secretary, Forth Interest Group UK, c/o 38 Worsley Road, Frimley, Camberley, Surrey GU16 5AU, or ring Deepcut (STD 02516) 6254.

Our meetings are held on the first Thursday in every even month of the year at 7pm in room 408 at the Polytechnic of the South-bank, Borough Road, London.

The group exists to promote the Forth computer language and its dialects and is non-profit-making.

H Dobson, Camberley, Surrey

Forth II

I am writing in response to the item entitled 'Forth sally' in your Newsprint column in the March issue of *PCW*.

There are many sources of Forth in the USA, and a fairly complete list can be found in the August 1980 issue of *Byte*. It is admittedly less widely available in this country but I have conducted a very brief, and certainly incomplete, survey of implementations of Forth in the UK, the results of which are as follows:

1) A disk-based version is available now for the Apple from Personal Computers Ltd, Bishopsgate, EC2.

2) In the very near future, Acorn Computer Ltd will be releasing a cassette-based version for the 12k Acorn Atom, including an editor and graphics facilities.

3) A version for the Ohio Superboard should shortly be available from Mutek, probably as an 8k EPROM as a plug-in replacement for Basic.

4) A slightly non-standard, but very fast, version may soon be available, from Shop, for the UK101 and this, again, is likely to be in 8k of EPROM.

While on the subject of help and information, I should also mention that there is a course, on Wednesday afternoons, at Willesden College, in which the students are assisted to implement Forth on their own computer. Further details can be obtained from Bill Stoddart, Willesden College of Technology, Denzil Road, London NW10.

Richard de Grandis-Harrison (Chairman, Forth Interest Group UK), London

Cheap, Cheap!

I know people have moaned in the past about advertisers in *PCW* quoting somewhat misleading VAT-less prices but may I have a quick moan about some people's idea of 'cheap'? Whilst checking on various printer prices I found about half a dozen from £400-£1000 all being advertised as 'low cost', 'ultra cheap', 'absolute total unmitigated giveaway!!!' (well, nearly). But seriously, what on earth would these people call 'expensive' if £1000 is 'low cost'?

Maybe I'm an idiot but to me any printer over £400 is overpriced.

Phillip Watson, Bedford

We say it rather depends on what's being offered for the money. A daisy wheel or laser printer is clearly going to cost more than a good old dot matrix impact printer. Perhaps 'good value' would be a better description than 'cheap' — Ed.

NASBUS NEWS

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This Nasbus compatible EPROM board accepts up to 16, 2716 or 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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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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BITS & PC's PCG

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Newly developed Nasbus compatible board that can accommodate up to 64K of RAM including Page Mode facility. **Prices: £110 (16K), £130 (32K), £150 (48K), £170 (64K). Add VAT to all prices.**

All prices are correct at time of going to press and are effective 1st May 1981.

DISKPEN

The powerful text editor written for the Nascom is now available on a 5¼ inch floppy disk with a number of new features. **Price £43.25 + VAT.**

PORT PROBE

Allows monitoring of input and output of Nascom PIO. This board can generate interrupts and simulate handshake control. **Price (kit) £17.50 + VAT.**

HEX & CONTROL KEYPADS

Hexadecimal scratchpad keyboard kit for N1/2: **Price £34 + VAT.**
As above but including (on the same board) a control keypad kit to add N2 control keys to N1. **Price £40.50 + VAT.**

BASIC PROGRAMMER'S AID

Supplied on tape for N1/2 running Nas-Sys and Nascom ROM BASIC. Features include auto line number, full cross-reference listing, delete lines, find, compacting command, plus a comprehensive line re-numbering facility. **Price £13 + VAT.**

GEMINI EPROM-PROG.

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Tel: (0937) 63774.

BUSINESS & LEISURE MICROCOMPUTERS
16 The Square, Kenilworth, Warks.
Tel: (0926) 512127.

ELECTROVALUE LTD.
680 Burnage Lane, Burnage, Manchester M19 1NA.
Tel: (061) 432 4945.

28 St Judes, Englefield Green, Egham, Surrey TW20 0HB.
Tel: (0784) 33603. Tlx: 264475.

TARGET ELECTRONICS
16 Cherry Lane, Bristol BS1 3NG.
Tel: (0272) 421196.

INTERFACE COMPONENTS LTD.
Oakfield Corner, Sycamore Road, Amersham, Bucks.
Tel: (02403) 22307. Tlx: 837788.

HENRY'S RADIO
404 Edgware Road, London W2.
Tel: (01) 402 6822.
Tlx: 262284 (quote ref: 1400).

YANKEE DOODLES

Tom Williams reports on the American side of the microscene

How far removed from the throne are *you?* A new program currently running on Heath/Zenith H-89 and Heath H-8/H-19 computers under HDOS will allow you to enter and keep track of up to 1000 different ancestors. Roots89 may sound like it would be of limited interest (my initial impression) but on using it I found myself enthralled. This column is not normally used for product reviews and I don't plan to make it a habit but Roots89 deserves special attention for several reasons.

The first and most striking thing about the package is the documentation. The subject is geneology, a topic the ordinary user may not know very much about other than being vaguely aware that grandmother was doing a lot of rooting around in old family records. So the first half of the software manual is devoted to the subject of genealogy. It gives the reader a general introduction to the methods and tools of genealogical research and lists some of the main sources of information which the interested researcher can consult. It discusses the use of pedigree charts (family trees) and family group sheets, and then does something unheard of: it actually presents a *bibliography* of general works and sources, so that the reader can delve into the subject to any desired depth. Remember, the computer is a tool, not the end.

The program itself is very well-designed, and is almost entirely menu-driven. At times when only menu selections are to be made, the other keys are masked so that mistaken entries do not crash the system. At other times, entry of data from the keyboard is permitted. Menu selections are made via function keys on the terminal, so that will have to be considered when it is transported to other systems.

Roots89 consists of seven main modules: EDIT for entering data on ancestors and updating the file, LIST to list all or selected portions of the file. FAMILY will select a name and list all marriages and offspring of that person. The user can then proceed forward down the line, following the descendants and their marriages, etc. The TRACE function displays a family tree up to five generations deep on any individual in the file; it can also be printed. RELATIONSHIP will tell how any two names are related to each other, and ANNIVERSARY will list births, deaths and marriages for any selected date back through history.

There is a demonstration file included on the distribution disk for the user to practice with. It contains a list of fictional warring clansmen in Ninth Century Britain who suddenly discover through Roots89 that they are all related. Beyond its specific function, I believe the documentation for Roots89 goes very far toward setting a new standard for quality, clarity and comprehensiveness in personal computer software. It is cordial, explains both the subject being treated and the role of the computer in the larger picture, and provides examples that enable the user to use the program almost immediately.

Roots89 is available from Commsoft, 665 Maybell Ave, Palo Alto, CA 94306 and is priced at US $125.

There is a new wrinkle in low-cost printers. A novel little number made by Seikosha in Japan and marketed in the US by Axiom, of San Fernando, California, the GP-80M produces a 5x7 dot matrix print using only a single hammer mechanism. The hammer is rather cup-shaped and it strikes the paper through the ribbon. The paper, however, lies over a rotating splined platen. For each horizontal position, the hammer makes seven strikes/nostrikes, depending on the character being formed. The carriage is moving at a constant speed across the paper and timing allows seven hammer strikes per dot width. Thus, on close examination, characters may appear slightly skewed, and the printer does not produce lower case with true descenders.

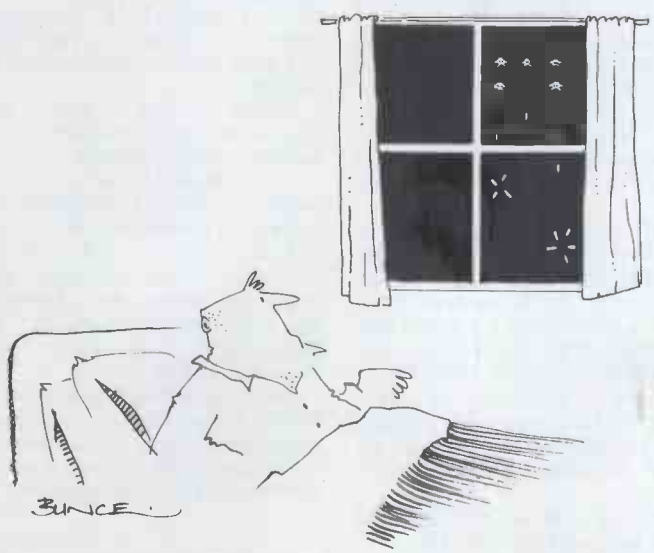
The cost advantages, on the other hand, are significant. The GP-80M sells in single quantities for $399, prints 80 columns wide and is also dot-addressable so that it can do dot graphics. Axiom's address is 1014 Griswold Avenue, San Fernando, CA 91340, USA.

Printers — and peripherals in general — continue to become more intelligent. It appears that there is a process underway in which ever more functions are migrating from computer software to peripheral firmware. In order for this to happen, those functions have got to become generally accepted as desirable, but when they do migrate to peripheral firmware, it means that that more drudgery has been offloaded from the host to allow it to do those really important computing jobs. The result is more throughput and greater computer power in small machines.

In printers, this takes the form of normal word processing functions like right justification, proportional spacing, tabbing and so on being performed by printer firmware instead of subroutines in the word processing software. Diablo, of Hayward, California, offers a firmware option that does proportional spacing, tabbing, and other functions. Qume has just introduced two new members of the Sprint family, the Sprint 7 and the Sprint 9. The Sprint 9 offers a whole package of firmware formatting options designed to greatly simplify word processing software design.

Another company, Howard Industries of Anaheim, California, has modified an Olivetti ET-221 intelligent typewriter to accept computer input. The Olivetti typewriter performs a great number of functions like bold print, right justification, tabbing, underscore and page formatting. The Howard interface makes the machine recognise commands that are embedded in the text stream as if they were formatting commands from the keyboard. This design has made it unnecessary to write a special word processing package for that peripheral. By simply imbedding the proper commands in the text file, the user can make the printer go through the nifty gyrations without a lot of software design.

The Diablo and the Qume firmware options work the same way, by recognising the embedded unique strings in the text file. This points up a very interesting economic sequence. It is usually more efficient to implement a function in software than in specially designed hardware. But once a function has become accepted and is desired by the user community, it is even more economical to move the function to firmware — either ROM or PROM — and to let it migrate to the peripheral concerned. This makes its execution automatic on a single unique command from the CPU and frees that little wonder to do the more abstract computing jobs.



NEWS

ComputerTown UK! is a nationwide network of voluntary computer literacy centres. All letters should be addressed to CTUK! c/o 14 Rathbone Place, London W1P 1DE

Philip Joy rang me this weekend to say that CTUK Romford is well and truly under way. Sessions run every other Saturday from 1 to 4 pm in the children's library. Philip runs five machines — three dedicated to problem solving and two to games. His approach to teaching the power of the computer is to get people to come along with simple problems which are then tackled by writing an appropriate program, either by themselves or with Philip's help. What an immediate way to get the message across! The games running on the other machines are to catch people's initial interest. When they tire of these, as they eventually do, then they usually want to learn more about what makes the computers tick. Philip is currently running one Apple and four Atoms and, so far, has averaged around 16 people per session. He, like me, firmly believes in a low profile approach to publicity so that things can grow naturally and within the capability of the organisers to cope. Philip restricts his advertising to posters in the library window and lets word of mouth do the rest.

Vernon Gifford rang again from Croydon to suggest a ComputerTown display at the *PCW* show in September. It would form part of the area being given to computer clubs. Will ComputerTown organisers who'd like to participate please write to me so I can get some idea of space needed? I don't envisage any charge for the stand but you will, of course, have to make your own travel and accommodation arrangements. It may be that we could take it in turns to man the stand, spending an hour or two on the stand and the rest of the day mooching around the show. Let me know what you think.

Andrew Holyer started ComputerTown Horsham on 28 March. We are waiting with bated breath for his report of the occasion. We'll bring a full report next month.

John Bone wrote again from ComputerTown North East with an assortment of news items. First of all he praised the efforts of the other people involved in CTNE, each of whom covers a different part of the region. For those needing a local contact, the names and phone numbers are: Gateshead: John Bone, 0632 770036; Newcastle Upon Tyne: Steven Christian and David Thompson, 0632 643417 and 679119 respectively; South Shields: Richard Powell, 0632 559167.

Anyone wishing to write to this particular 'Town should address their letters to John Bone, 2 Claremont Place, Gateshead, Tyne and Wear NE8 1TL. As a matter of courtesy I would suggest you enclose an SAE if you want a reply.

Other news from CTNE is that they think the idea of various CTUK organisers getting together is a good one and they suggest London as being a suitable location. Other 'Towns please comment. CTNE recently gave demonstrations at a local 'children's fair' in aid of the NSPCC. Six machines were shown (two TRS-80s, two Video Genies, a Nascom and a ZX80) and £5.00 was raised for the charity by getting people to pay to play games. Not Space Invaders, apparently! CTNE's fame is spreading — people are demanding ComputerTown evenings from as far as 40 miles away (Morpeth in Northumberland, to be precise). Come on readers — you can't leave all the work to John and his friends.

John has suggested we print a 'Best of the CTUSA Newsletters' or, better still, get CTUSA to send them direct to *bona fide* CTUK organisers. I visited CTUSA recently and put the suggestion to them; more news on that next month. John's request for free copies of 'The Last One' may be a little harder to arrange, but I'm working on it. And no, it wasn't an April Fool's joke — you'll see.

Anyone else in Dorchester interested in starting a ComputerTown? Chris Donaldson has written from 7 Higher Brockhampton, Dorchester, Dorset to ask would-be helpers to contact him. Once again, if you contact him by letter, an SAE ought to be included for his reply.

Jeremy Robinson writes from Radio Birmingham to say that he may be able to help in setting up ComputerTown groups in the West Midlands. He sounds very enthusiastic about the project and, with the radio station backing him, this could bode extremely well for ComputerTowns in the West Midlands. Contact Jeremy (incidentally, he's a programme organiser) at BBC Radio Birmingham, PO Box 206, Birmingham B5 75D.

Peter Kiff and Jon Finegold are a pair of teachers in Thanet who would very much like to set up a ComputerTown in their area. At the moment they have a 380Z, a ZX80 and an Atom and they honestly admit that their enthusiasm probably outstrips their knowledge, 'but we're catching up fast'. Anyone else in their area can contact these gents by writing to Peter at 52 Stone Road, Broadstairs, Kent CT10 1D2.

Worcester now, where Tony Cartmell of chartered accountants Butcher, Holtom & Co, is seriously considering starting a CTUK. Anyone in the area who'd like to join in the fun should contact Tony at 54 Foregate Street, Worcester WR1 1DX, telephone (0905) 29827.

T F Whyatt writes from Runcorn to say that the North West Computer Club is interested in forming a CTUK in its local area. Anyone wanting to help should write to 29 Summer Lane, Halton, Runcorn.

Judith Morris writes from the CEDAR (Computers in Education as a Resource) project. She is very excited about CTUK and has offered the project's help. It will take me a while to study the literature Judith has sent me but if any readers are already familiar with it perhaps they would care to write to me with their views. More news on this next month.

Graham Hawker is very interested in setting up a ComputerTown in the Twickenham/Richmond area. He's a real enthusiast with a house full of micros and a keen interest in adventure-type games. Write to him via CTUK, 14 Rathbone Place, London W1P 1DE.

Someone recently asked us about insuring microcomputers and, coincidentally, R J Dee of R J Dee Insurance Services wrote to say that he offers the sort of cover we need. He enclosed all sorts of information describing the cover offered for the various uses of machines: home, groups, schools, exhibitions and courses. I can't quote all the details here, so I suggest you write direct to Mr Dee at 14 York Place, Clifton, Bristol BS8 1AH, telephone (0272) 38117. Other insurance companies wishing to offer a similar service can write to CTUK! at 14 Rathbone Place, London W1P 1DE and we shall place your name on a register which we will send out to enquirers on receipt of an SAE.

Other interest in CTUK this month has come from Scotland, South Ealing and Carrollton, Georgia, USA.

Our thanks to all of you who are helping to make ComputerTown such a success. We wish you all luck and invite you to write in with your news and advice to others who may be about to tread the same path. Remember, the aim is to cover the country with ComputerTowns and we've got a few thousand still to go.

We look forward to hearing from you. Please remember to enclose an SAE if you'd like a reply. And please don't ring us at the *PCW* offices since CTUK is entirely a spare-time project.

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BENCH TEST

NEC PC-8001

The expected wave of micros from Japan is growing steadily. Andy Thompson tests the latest to hit our shores.

The NEC PC-8001 is one of the new generation of small business/personal computers now beginning to make their appearance in this expanding market. A complete range of accessories and peripherals are becoming available and should be marketed in the UK by the end of the year. The actual PC-8001 comprises a console unit containing up to 32k of user RAM, 32k ROM (including 24k of Microsoft Disk Basic-N), parallel output port including drivers for a Centronics-type printer, serial I/O port with software selection of any two standard baud rates between 9600 and 110 (the two available for this facility are selected internally by readily changeable links) and interfacing for the disk and cassette drives. The serial port is at TTL levels but a very small box is available to convert this to a full protocol RS232 facility. The console unit I have was purchased in Japan and therefore operates on 110 volts and also has an alternate character set implementing the Japanese Katakana characters with a console key selecting either of the two sets in a similar way to a shift lock. The power supply is a very neat module situated above the main circuit board at the rear of the unit. It is very well shielded and generates very little interference to the neighbouring TV or radio equipment. A considerable side benefit of this efficiency is the fact that the computer runs extremely cool — I had it operating on one occasion for about 36 hours and the unit was still only just warm to the touch.

Hardware

The manufacturer has adopted a non-integrated approach in that all the units are packaged separately. The actual console unit is very similar to my old and trusty Exidy Sorcerer although it is considerably smaller, measuring only 17x18x3in. The I/O connectors are grouped along the rear panel and, apart from the use of DIN plugs for the video and cassette connectors, seem thoroughly reliable. I must add that DIN plugs are a pet hate of mine for professional use but these have given no trouble in the six months or so of hard use that I have given the system.

The main expansion connector is an edge connector which would connect to the expansion box (PC-8011) to enable the addition of extra RAM, ROM or I/O cards, etc. Most of the cards that are available in Japan now are bank-selectable, making the expansion almost unlimited. Once the expansion is implemented, the machine can be readily used as an intelligent terminal via a modem and has in fact been used on-line, by me, to the Source timeshare network in the US.

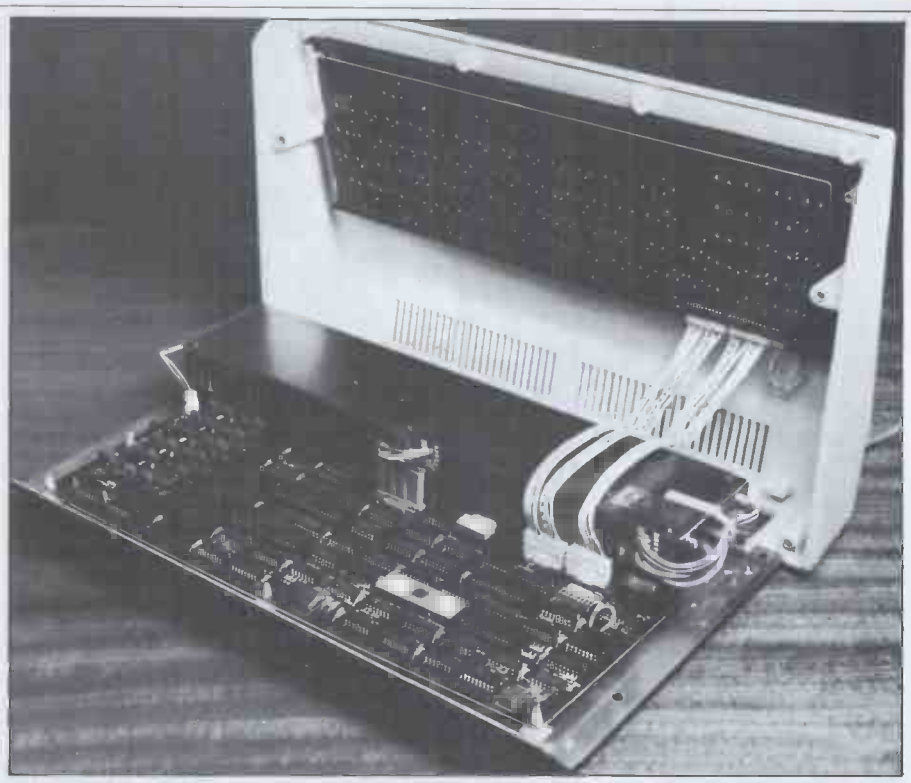
Next to the expansion interface is another similar edge connector to the disk drives. These are only available as dual 5in versions at present although there are plans to market a Winchester-type hard disk unit. Two versions of the drive unit are available: the PC-8032 connects to the console and the PC-8031 is daisy-chained to the 8032 to give a four-drive capacity. The manufacturer has opted for a relatively low density, single-sided system with a capacity of 286 kbytes per unit. This approach of going for the extra reliability, rather than extra storage, is certainly one that I approve of, having had a considerable amount of trouble with the quad density drives on my Exidy. My main complaint about the drives is that the track access time seems slow although it did not really cause any problems in use. The drive unit is very neat and, at a mere 5in high, can conveniently be placed beneath the console unit.

The next connector is for the colour

monitor. The NEC outputs red, green and blue non-composite video signals together with luminance and sync. These are all used to feed the NEC colour monitor. Two versions of this are available; one is high resolution with absolutely staggering quality even at the maximum screen density of 80 characters/line, while the other is a lower resolution monitor, mainly for use with graphics displays, although it functions perfectly at up to 48 characters/line. Both these are 12in screen size which I have found perfectly suited to normal use. In Japan an adaptor is available to interface the PC-8001 to a normal domestic TV set although obviously there is a loss of quality with this method. Whether or not a similar unit is made available for the 625 line PAL television system would obviously be a matter of demand. A monochrome composite video output is the next connector along; 1 V p-p with full sync is available here for feeding to any standard video monitor or via a suitable RF adaptor to a broadcast television set. Again, although connecting to a television seems an attractive option, this will simply not do justice to the very high quality display capability of this machine.

The remaining DIN connector is for the cassette interface. One cassette recorder is interfaced under full motor control. The format chosen is an extremely reliable FSK coding using frequencies of 2400/1200 Hz Kansas City running at 600 baud. This may seem a trifle slow but it has proved to be totally reliable in practice, allowing a very wide range of settings for the volume and tone controls. I have used this with a number of cassette recorders ranging from a domestic hi-fi machine to a very cheap (£15) portable machine. I have also been using one of the tiny mini-cassette recorders available cheaply from various mail-order firms and again have not even had one faulty read! A useful Basic function, CLOAD?, allows you to verify the tape just recorded by comparing it to the version still in memory. Having just mentioned the reliability of this system, however, I must say that I only used this the first few times until my confidence was unassailable.

The console cabinet is easily removable, allowing access to the baud rate selector jumpers. These are not soldered but use a clip system to allow software selection between any two of the standard baud rates up to 9600. The serial interface uses its own UART and thus does not affect the cassette output at all. A very useful command in Basic — TERM a,b,c,d — will turn the unit into a dumb terminal supporting full RS232 protocols. The four parameters are used to select ASCII/JIS (7/8 bit) words, baud rate, parity selection and auto cr after a line feed. With the addition of the expansion unit, intelligent terminal use is supported with both RS232 and IEE-488 outputs. The CPU is a version of the Z80A running at 4 MHz manufactured under licence by NEC, as are the memory chips and many of the other components. The internal layout is very neat and well thought out, basically on one main circuit board. 32k of RAM fills up the available space internally, although more can be added via the expansion box. ROM space is four sockets holding



32k, although only 24k is used by the Microsoft Basic-N, leaving one socket available for user expansion if required.

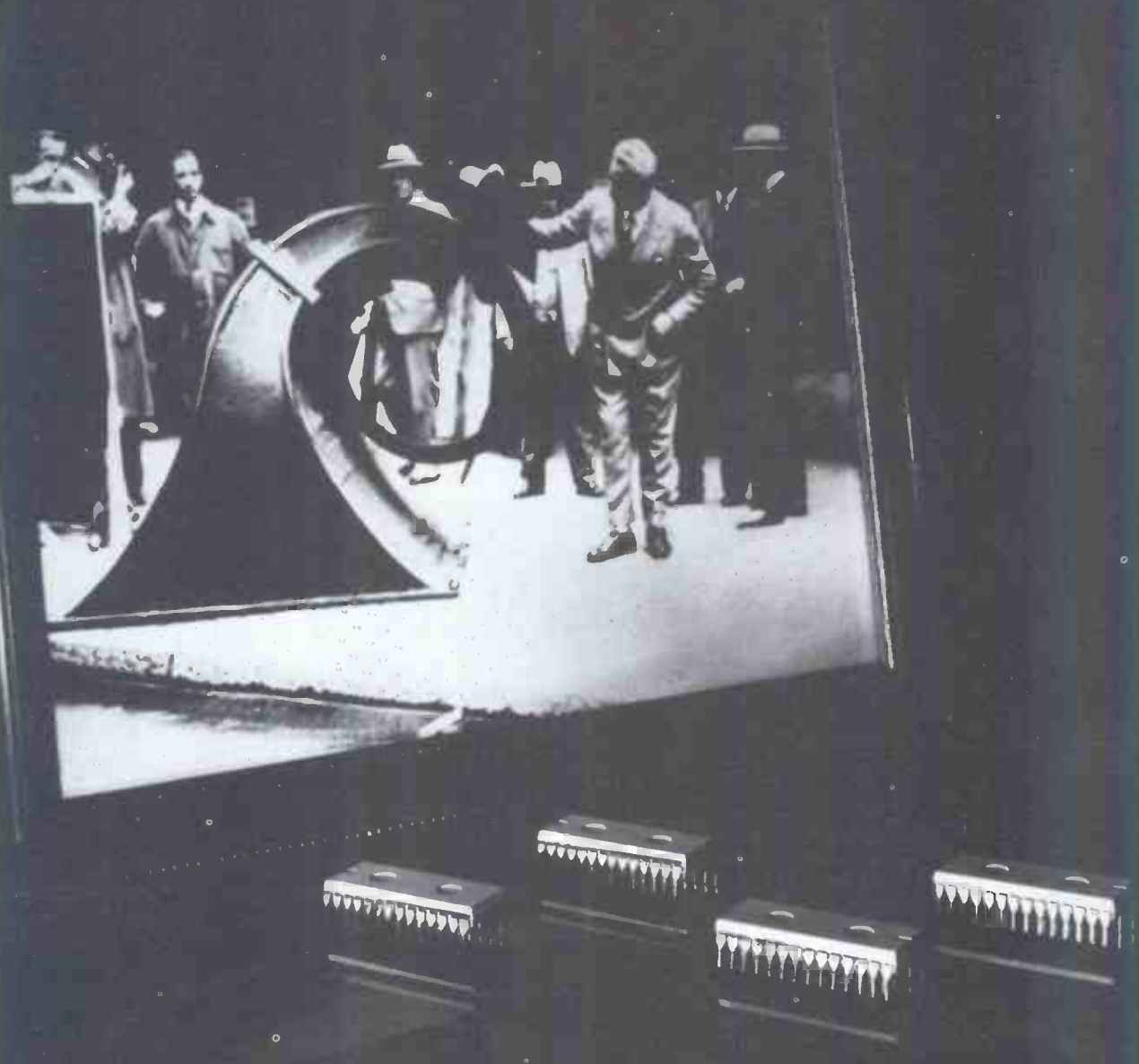
The screen display is one of the high points of the PC-8001. Basic commands enable you to specify the number of characters per line (80, 72, 40, 36) and lines per page (25 or 20). These are dynamically selectable and may be changed during a program run to give more emphasis to certain statements if required. The facility of 80 chars/line is useful when formatting output for a printer.

Graphics facilities on this unit are far in advance of any other machine I have seen. The colour definition and clarity are phenomenal with both graphics and characters able to be defined in a range of eight colours (or shades of grey on a monochrome monitor) or flashing, reverse, hidden, etc. Other Basic commands enable simple, one-command drawing of squares, rectangles, etc, using lines or characters and either infilled or open. The Basic command CONSOLE a,b,c,d sets the screen parameters: a is the top line of the scrolling area, b is the number of lines to scroll, c is the switch for the display on the lowest line of the current assignments of the ten function keys at the top of the keyboard and d is the colour/monochrome switch. The only fault that I could find with the keyboard is the lack of a locking shift key. However, since upper and lower care are equally acceptable to the interpreter this is no great problem. In fact only file names differentiate between upper and lower case and this has to be born in mind when referencing these files. All the keys have auto-repeat built in — if you hold down the key, after a brief pause the repeat function starts operating. The feel of the keyboard is superb and even a fast typist was unable to type faster than the keyboard could handle.

Software

As already mentioned, the supplied language is a version of Basic by Microsoft, called Basic-N. It is a comprehensive dialect which, apart from the normal range of commands and functions, supports several commands directly related to the NEC. As would be expected from a machine with such a powerful video output facility, the screen formatting is very comprehensive. For example, the CONSOLE

THE TALKIES COME TO TOWN



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NEC PC-8001

command enables the user to define a scrolling area on the screen leaving the rest untouched and to switch between colour and monochrome. The same command contains a switch to control the display on the last screen line of an abbreviated list of the functions allocated to the reserved keys. These are themselves pre-programmed using the KEYn, 'function' format. They can be dynamically allocated during the program run and can contain up to 15 characters including a carriage return. There are five of these keys situated above the keyboard and they operate in both shifted and unshifted mode giving a total of ten definable functions. Very good use is made of these in the word processor package kindly loaned together with the colour monitor by NEC(UK). This is loaded as a system disk and seems to use a dedicated operating system. It uses colour very effectively to differentiate between various fields and facilities and uses the pre-programmed function keys for all control input to the computer, thus virtually eliminating errors in this section. If and when it becomes available it is a very powerful wordprocessor package having a lot of very useful facilities.

Direct screen editing is supported, which makes possible correcting program lines without the necessity of re-typing the entire line. Various programs are supplied with the machine either on disk/tape or as listings in the apparently very comprehensive manuals. I say apparently only because I jumped the gun by purchasing the machine in Japan so all the books are written in Japanese! I have, however, seen the preliminary drafts of the English language versions and these are very well translated with none of the 'comic opera English' so often associated with these texts.

The ubiquitous CP/M is also now available for the PC-8001, so making available a massive range of software. The RAM expansion cards for the expansion box are bank-selectable so a good sized CP/M system can be readily configured. The internal ROM containing the Basic interpreter can be disabled thus freeing up another 32k of memory space for expansion RAM. This facility definitely grades the PC-8001 as a business machine rather than a home computer, even though the competitive price might seem to give the wrong impression. For it to succeed in this market it will need to be supported with plenty of software and NEC's UK staff seem very well aware of this need. One of the problems with reviewing a machine prior to the launch date in that market is the fact that so much is only promised; however, since so much is already available in Japan with more good software coming onto the market every month, the future looks very bright.

Benchmark timings

BM1	1.7
BM2	8.3
BM3	18.1
BM4	17.8
BM5	18.6
BM6	29.5
BM7	49.2
BM8	7.0

All timings in seconds

Documentation

This big problem with this section is that with the release of the PC-8001 series not due in the UK for a couple of months, the only finished documentation that I have is written in Japanese and that is not, I'm afraid, one of my strong subjects! However, since the

TECHNICAL SPECIFICATIONS

CPU:	PD780C-1 (Z80A), 4 MHz
RAM:	32k max internal (expandable externally)
ROM:	32k max internal (supplied with 24k Basic-N)
Disks:	Two units each double 5in, total capacity 574 kbytes
Cassette:	One unit under software motor control 600 baud.
Serial port:	One, RS232.
Parallel port:	One, output for system printer (Centronics type).
IEE488 port:	Available with expansion unit only.
Screen:	NEC Colour monitors 12in max 80x25 chars.
Keyboard:	58 key main, 20 key numeric + 5 function keys.
Software:	Basic-N, CP/M, Fortran, E-Basic, etc.

System VIP
* Vector 3 terminal with 6-slot S100 bus.
* Fast (4 MHz) CPU using the powerful Z80.
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PLUS
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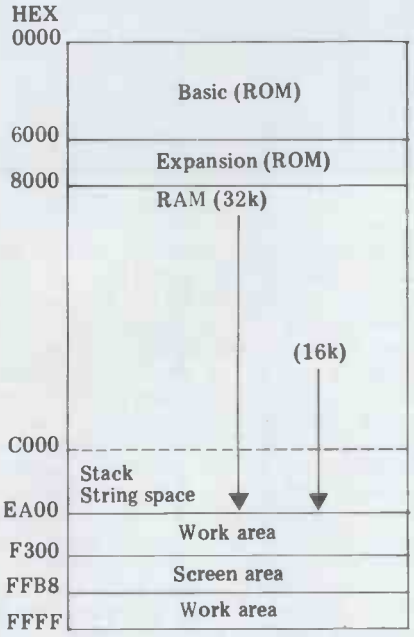
wording of Basic is in English characters and with the help of a Japanese colleague, it is possible to say that the manuals seem very comprehensive and well laid out. The indexing is very good which is particularly vital during the first few months of use. A separate booklet is issued for each component, ie, there is one for the PC-8001 console, one for the disk unit, one for Basic-N, one for the expansion box, etc. The Japanese booklets are well printed with spiral binders and are supplied with plenty of example programs. I do have a preliminary copy of the documentation in English on the Disk Units and on Basic-N and these are certainly of a very high standard, both in presentation and in the English translation.

Memory map



Expansion

Expansion of the basic computer is one of the good points of the PC-8001. Many interesting add-on units are now available in Japan and the intention is to market most of these over here as soon as demand warrants. Obviously joysticks and paddles for games purposes are available together with a good range of extended I/O devices.

NEC in Japan has been talking about a cheaper version of its daisy-wheel printers becoming available for this market but there is nothing positive yet. Obviously the NEC Spinwriter interfaces perfectly to give high quality print output.

Potential

One of the problems with reviewing this machine is that, while its facilities and quality obviously suit it for the business market, its price puts it clearly within the range of the home user. It is certainly in a different league from the majority of the so-called hobby machines and yet if the projected prices that I have quoted (courtesy of NEC (UK)) are to be relied upon it will make a very significant impact over here. I think the main recommendation to the potential business user must be to forget about the price and compare the quality and facilities; to the hobby user, forget the facilities and compare the price!

NEC PC-8001

Conclusion

This powerful little machine has facilities far in advance of its price grade and certainly if you compare it with any of the similar units such as Apple, Exidy, ABC, etc, it will stir up the market a lot. The mechanical construction is very good, the electronics are excellent and the machine offers superb value for money. About the only reservation I have about the PC-8001 is the non-availability at present of an interface to the S100 bus. However I am sure that before long one will be forthcoming; if not from NEC, then from another manufacturer, for competition in the far east is very hot.

Prices

PC-8001 Console inc 32k RAM and Basic-N	£450
PC-8031 Dual disk drive (inc connectors)	£675
PC-8042 Low resolution colour monitor	£250
PC-8043 High resolution colour monitor	£480
PC-8062 Converts RS232 port to correct levels	£40
PC-8021 Matrix printer (80 cols)	£375

BENCH TEST

DIGITAL RESEARCH'S MP/M

Adrian V Stokes continues our series of multi-user systems evaluations.

A previous Multi-User Benchtest described the Onyx C8002, a complete multi-user system, comprising both hardware and software. This review is merely of software and little attention is paid to the hardware on which it is run. The software is known as MP/M, standing for Multi-Programming Monitor Control Program. MP/M is a trademark of Digital Research of Pacific Grove, California and it is 'an upward compatible version of CP/M 2.0 with a number of added facilities'.

CP/M (Control Program for Microprocessors) is a fairly sophisticated operating system (similar, in many ways, to that available on various DEC mainframe and minicomputers) available on a wide range of micros. It is a single-user system.

MP/M is a multi-user operating system, based on CP/M and offering the facilities of CP/M with, in addition, facilities for supporting multiple users. In fact, MP/M can be operated in single-user mode (ie, configured for a single console) in which case it is almost identical to CP/M. Its power becomes apparent when a few of the additional facilities are listed: multi-terminal support; multi-programming at each terminal; inter-process communication and synchronisation; ability to use bank-switched memory and memory protection supported; scheduling programs to be run at a fixed date and time.

These facilities are similar to those available in many large timesharing systems. When one compares the available features on MP/M and a mainframe, then examines the different hardware on which each is run, it is clear that MP/M is a relatively sophisticated system.

Hardware

MP/M requires an 8080 or Z80 CPU, at least 32k of memory, one to 16 consoles, one to 16 disk drives (each of which may contain up to eight megabytes) and a clock, configured so that it interrupts the processor.

Of course, better performance is obtained with more hardware and MP/M would normally be run in a system with banked memory, a full interrupt system and multiple consoles.

The term 'banked memory' might need some explanation. An 8080 or Z80 can address a total of 64 kbytes. In many applications this amount of memory is inadequate and some artifice must be employed to increase the available memory. One such method is known as bank switching in which a number of banks of memory (each, usually, of 64 kbytes) are resident in the machine but only one is selected at any one time. Switching between banks is achieved by the CPU writing a single byte of data to an output port and is thus extremely fast.

The hardware on which we performed the tests described here consisted of an Industrial Micro Systems series 8000 machine (based on a Z80 CPU) with 192 kbytes of memory (bank-switched) and two 8in double-density, soft-sectored floppy disk drives, kindly loaned to us by Equinox Computer Systems. It consisted of a single rack system with the only controls visible being an illuminated power on switch and a reset toggle at the front. The back panel had spaces for six RS232 connectors and three parallel ports. In the original machine lent to us, only two RS232 connectors were provided but it was found to be extremely simple to modify this to the four required by adding one I/O board into the S100 bus and connecting the outputs to two of the blanked connectors.

Access to the bus edge connectors was very simple requiring the removal of four screws (unfortunately by means of Allen keys rather than an ordinary screwdriver), whereupon a plate could be lifted away giving immediate access to the boards. Access to the remainder of the machine was similarly very easy, again requiring the removal of a few screws. The machine appeared to be very robustly built (and fairly heavy) and the interior layout was well designed.

For the tests described below, we used standard VDUs operating at 9600 baud. In all the tests, the VDUs operated as 'glass teletypes' and no sophisticated facilities were used (or required).

Software

The software was provided on two disks. The first consisted of the MP/M system and the second was a CP/M system.

The former had the basic MP/M system together with a number of utilities, including, for example, one to generate a new version of the system (GENSTAT). In addition, we had access to a Basic interpreter and a Pascal compiler configured for CP/M (or MP/M, since all software written for CP/M can run under MP/M with few, if any, changes). Source code for many of the components of the operating system was supplied with detailed comments, enabling a user to modify the system to his own requirements without too much difficulty. At present, it is expected that MP/M will be supplied to companies which produce turnkey systems and so the end-user would not need to be bothered with modifying the system to any extent. Should he need to do so, it would be possible.

The MP/M supplied was the first verion of the software to be released and a second version is expected in the near future. It is likely that this will overcome many of the problems encountered in our tests.

Documentation

The documentation, as supplied with the system, consisted of three manuals. The first was Digital Research's 'MP/M User's Guide'; the other two were Industrial Micro Systems Inc's Implementation Guides for CP/M 2.2 and MP/M 1.1.

The latter two are merely short guides describing the implementation of CP/M and MP/M on the IMS system. They are concise and expect the reader to have a fairly good understanding of the hardware and the software but are clear and easy to follow. If someone wishes to reconfigure a CP/M or MP/M system, he should have sufficient background to understand the documents.

The MP/M User's Guide consists of three parts, bound into a single soft-cover volume. The first is a description of the features and facilities of the system, from a user's point of view. The second is a description of the actual MP/M system intended to give any user enough information to be able to write system processes which make use of the facilities of MP/M. The third section describes how to configure MP/M for a new computer system or how to generate a new MP/M system for the current computer.

Clearly, to a new user, the first section is the most important. It is also the shortest (16, 68 and 31 pages respectively for the three sections) and gives relatively little information. Since many of the commands are identical to those available under CP/M, the reader is referred to the CP/M manual for a

description of these commands in detail. This is extremely inconvenient since it means the user has to continually cross-reference between the two documents. The information contained in the MP/M guide is insufficient except for a list of the commands. For example, the RENAME FILE command is described as: 'The REN (rename) command allows the user to change the name of files on disk. If the destination filename exists, the operator is given the option of deleting the current destination file before renaming the source file.'

While understanding that there might be a case for not giving a full description in both manuals (a case with which I would disagree), at the very least enough detail should be given to enable the user to execute the commands (for example, the command format). This would take relatively little space but allow the manual to be used on its own, rather than having to use a second manual.

This is a fairly minor criticism compared with the fact that relatively little user information is given. For example, there is no information on how to access files from one user's area while logged in as another user, nor was there any explanation as to the meaning of being a particular user (and, in fact, the system would allow more than one real user to share the same user number, leading to some interesting problems of file access).

Also, the Functional Description of MP/M (which occupied a single page) was so highly condensed that it was very difficult to understand unless the reader had a fairly good knowledge of multi-tasking operating systems. For example, the description of queues is that: 'They can be used for the communication of messages between processes, to synchronise processes and for mutual exclusion.'

It also states facts with little explanation, such as: 'MP/M manages memory in pre-defined memory segments. Up to eight memory segments of 48k can be managed by MP/M. This management of memory is consistent with hardware environments where memory is banked and/or protected in fixed segments.' This explanation sounds reasonable until it is realised that most such banked memory systems operate using 64k memory banks and there is no explanation of MP/M's using the lower figure.

The second part of the manual, the interface guide, is very detailed and gives enough information to achieve its purpose — allowing the user to write system processes under MP/M. The only criticism is that, at the cost of making the manual rather thicker, the commands could perhaps have been described on separate pages but the current layout is clear.

Similarly, the third part of the manual achieves its purpose fairly well, although, once again, it is a very concise explanation. However, this doesn't matter nearly as much as in the User Guide part of the manual since anyone needing to alter MP/M is likely to have quite a good knowledge of operating systems. Even with this knowledge, some problems were encountered using the manual, which we describe later.

The various Appendices (11 in all) are helpful and include, for example, sample programs, heavily annotated. These are followed by a good index.

Overall, our reaction to the manual is mixed. First, it tries to do too many things, such as being a User Guide and a System Programmer's Guide. Second (and perhaps as a result of this), it is too concise in many places, particularly the User Guide.

System testing

The system testing took place in a number of phases. First, a single terminal was used and many of the facilities of the system tested. Second, multiple terminals were used and any changes noticed. Finally, the Benchtests were conducted with varying numbers of terminals.

With a single terminal, the system was found (as specified) to be very similar to CP/M although, on initialisation, status information about the system was printed at the console (specifically, the console attached to port 0) and this conveyed little information to the user, while taking up a significant amount of time. However, since this was printed out as the system was initialising and configuring itself, no useful purpose would be served by inhibiting this output (except, perhaps, to save confusing casual users).

The standard (CP/M) commands were tested and various points noted. Perhaps the first one is that there are no built-in commands such as are available in many operating systems and each command actually has the effect of loading the appropriate program (eg, the command 'ASM' loads the program ASM.COM) and then executing it. This is a very flexible method, enabling users to increase the command repertoire of the system merely by storing suitable command processors on the disk. But the great disadvantage of this method is that it takes a few seconds to load the appropriate processor; this in itself is not a great disadvantage since it is unlikely that many command processors could be resident in memory and so they would have to be loaded anyway. Where it is very inconvenient is if an illegal command is typed (for example, by misspelling a legal command) and the system has to search the disk for the appropriate command processor before discovering that it doesn't exist. A more sensible approach would be for the operating system to search the system disk on initialisation and make a list of all command processors resident on the disk, thus giving a list of legal commands which could be searched rapidly without needing to scan the entire disk each time a command is given. This would also overcome an additional problem, that a user can be 'logged in' to a particular disk — that is, when a disk drive is not specified in a filename (or a command), the logged-in disk is taken as the default. This means that, when logged into a disk other than the system disk, each command must be preceded by 'A', specifying that the command processor is to be found on the system disk (unless, of course, a suitable command processor is available on the logged-in disk). The suggestion made above could overcome this problem also.

When using the single-user commands, one or two peculiarities were noticed, particularly when aborting commands. In some cases the abort character (control-C) was trapped and the user prompted whether he really meant to abort; in other cases, the process was immediately aborted. Unfortunately, this appeared to be done on an arbitrary basis and did not seem to correlate with the possibility of restarting the command again. The most obvious example was that of printing the current date and time (TOD P) which continually changed (by the ingenious method of reprinting the line as often as possible, with a carriage return and not a line feed terminating the output). To break into this, it is necessary to type control-C but, after doing so, the user is prompted 'ABORT (YES/NO)' while, even if a mistake had been made, no harm would have been done, nor would there have been any difficulty in re-starting.

But the point of this review is the set of commands unique to MP/M, even those available in single-user mode. One of the most important of these is the ability to DETACH jobs; this can be done either from the program itself or from the terminal. A detached program

Table 1 MP/M commands

CONSOLE	Determine console from which command is entered
DSKRESET	Reset disk drives after changing disks
ERASE	Delete file(s) on disk
SYSGEN	Generate a new version of the system
TYPE	Type a file
USER	Print/change user code
DIR	Print disk directory
REN	Rename file
ED	Call text editor
PIP	Call 'Peripheral Interchange Program' (transfers data between disks and/or peripherals)
ASM	Call assembler
SUBMIT	Submit a command file to the batch queue
STAT	Print statistical information about file storage
DUMP	Print file in hexadecimal
LOAD	Call system loader
GENMOD	Produce a 'page relocatable' file
DDT	Call the 'dynamic debugging tool'
MPMSTAT	Print MP/M status
MPMLDR	Print system information (automatically printed on system load)
SPOOL	Spool ASCII files to the printer
STOPSPLR	Purge spool queue and stop spooler
TOD	Set/print date and time
SCHED	Schedule a program for execution at a specified time
ABORT	Abort a running program

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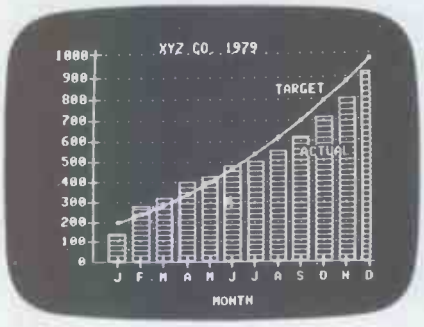

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can continue processing but is not connected to a console, although it can be re-attached to the console from which it was detached when required. Using this mechanism, one console can initiate a number of different processes which can then perform work in parallel with each other. To detach the current process, the user merely types control-D and to re-attach, the word ATTACH is typed, followed by the program name.

A second major change from CP/M to MP/M is to allow multiple user codes (obviously, in most circumstances, these will correspond with the real multiple users but they can be used even in a single-user mode). When the system is initialised, each attached terminal is assigned a user number automatically, corresponding to the console number. The system console is automatically User 0. This user number can be examined or changed by means of the USER command.

Corresponding to each user code is a set of files which are intended for access by that user alone (although it is possible and, in many circumstances, desirable for users to be able to access other users' files — this is not described in the User Guide). User code 0 is reserved for files which are common to all users. One major problem with this facility is that there is nothing to prevent a file stored under a particular user number having the same name as that of a common file. This can be quite useful (for example, a user might want to try a version of a command processor without destroying the standard version) but only if the order in which the various user areas are searched is unambiguously described (in most systems, the user's own area is searched first, followed by the common area). In the case of MP/M, this is not done; indeed, as the User Guide states: 'In the event that a file with the same name is present under user code 0 and another user code, the first file found in the directory will be accessed.' As the algorithm for storing files in the disk directory is not given, effectively either the user's own file or the system file will be accessed on a random basis.

After testing these commands, we decided to attempt to generate a new version of the system, as described in the manual, using the GENSTAT command. There is a reasonable amount of detail in the manual about the use of the command but there are many items which are not clearly explained, such as, 'If you wish to pre-allocate a memory segment a value of FF should be specified'. The concept of pre-allocation is not defined.

The parameters to be specified in the GENSYS program are quite complex and it is fairly easy for wrong values to be given, especially when specifying those for the bank-switched memory. To quote the manual, 'extreme care must be taken when making these entries as there is no error checking done by GENSYS regarding this function'. Not only is there no error checking but, as a result, it is possible to generate a system which cannot run. This is a poor feature of the system but one which should not provide an insuperable problem since the user should be able to test his (unusable) version, discover that it is so and try again. MP/M, however, has a nasty trap for the unsuspecting user — at the end of the system generation process, the system that has been generated is immediately written back to the disk, overwriting the (presumably runnable) system, with the user being given no chance to specify whether he wants this done or the chance to write the new system to a different disk. This behaviour should be compared to that of trying to exit from the time of day routine described above!

In our case, this feature did not prove an insuperable problem since it was possible to recover by bootstrapping the CP/M system and performing the MP/M system generation (using a better set of parameters) under CP/M. In other circumstances, it could prove to be highly dangerous.

Another small, unforeseen, trap with the system generation process also occurred. During system generation, the user is queried as to the number of consoles for which the system should be generated. This number is only used if it is less than that specified in the XIOS program; in our case, XIOS specified two whereas, at system generation, we required four and, despite the system appearing to accept the latter number, it then proceeded to generate a system for two consoles. In order to overcome this, it is necessary to edit and reassemble XIOS. This problem is described in the manual but is not likely to be noticed until the problem as been discovered.

Benchtests

After testing many of the commands, we proceeded to test the system in a true multi-user mode and to examine its behaviour under load, especially using the Benchtests described in our first article.

Perhaps the first noticeable feature was that, when a second user was performing useful work, the response to the other user was significantly worse and this was confirmed by the Benchtests which showed a very clear correlation between the number of users and response time. For example, using our first Benchtest, the time for two users was exactly double that for a single user and this behaviour was quite consistent.

The same behaviour was noticed when various other functions were being performed and all could be explained by the load on the system with one exception. This one was when Pascal was being used. If both users were running the same program, the time was exactly double that for a single user (exactly as expected, following the behaviour of the Basic benchtests). However, if one user was *not* running a program and the other was, the time was identical to that for both users running the program. A similar situation occurred when one user was running the Basic version of the Benchtest and the second user was running the Pascal version. A doubling of time was found but, when the Pascal program was stopped, the Basic program took just as long as when the Pascal program was running.

Thus we had the anomalous situation that, when two users were doing useful work, the response time was exactly the same as when one was doing useful work and the other doing nothing, provided that 'doing nothing' meant the Pascal system waiting for input. The solution to this anomaly was eventually supplied by Equinox Computer Systems, who suggested that the Pascal system was written in such a way that, when it appeared to be doing nothing, it was in fact checking the console status and that this took quite a large amount of CPU power. This was a problem well worth noting when designing systems to be used in multi-user mode.

Conclusions

MP/M is a highly sophisticated system and represents a considerable advance in software for microprocessors. However, the current release of the system has a number of deficiencies and does not seem to fulfil adequately the expectations generated by the literature, which implies a full-blown, all-singing-and-dancing multi-user system rivalling Tenex or TSO in its facilities. To expect such a system is highly optimistic and unlikely to be fulfilled for the forseeable future on systems of the power of the one we tested.

On the other hand, for current users of CP/M, MP/M may fulfil an important role by providing a multi-tasking (rather than multi-user) system so that, while the system is primarily servicing a single user, other, less important, functions can take place at lower priority (such as printing files) and these need not be stipulated in advance, as they are in various commercially available systems (such as ones for spooling output). With MP/M, the user can specify the extra tasks required.

Another role for MP/M is that of process control or some similar function where the load on the system is not particularly high (and certainly not as high as the 16 users postulated by MP/M).

The system as tested was fairly minimal and we hope, in the near future, to repeat this Benchtest using the next release of the system and a hard disk rather than floppies.

To summarise, MP/M represents a considerable advance over CP/M and may well be of considerable use in many applications, but should not (yet) be thought of as a system to rival those available on mainframes.

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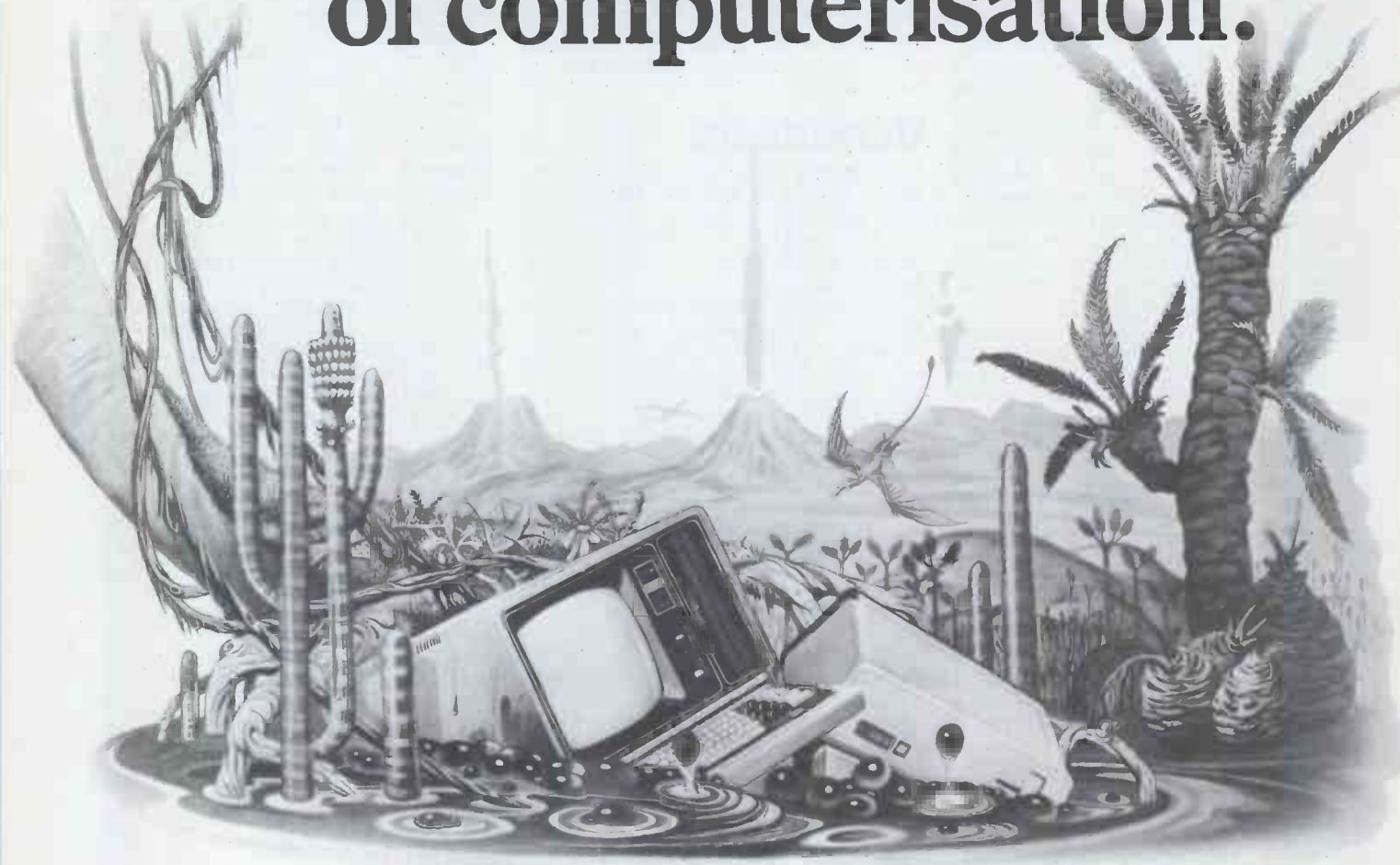

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INNOVATIVE TRS-80 SOFTWARE

FROM THE PROFESSIONALS

COMPAK

The title of this program is a composite word which may be interpreted in two ways, either as standing for COMplete PAcK of programmer's aids or as standing for one of the principal features of the program, namely the ability to compress Basic programs to a bare minimum. The suite is made up of four broad categories of utilities. In the aggregate they comprise a complete utility containing every foreseeable feature that a Basic programmer could require. It is written by Nigel Dibben in his usual efficient way and some indication of the complexity and completeness of the program is shown by the fact that even Dibben has been working on it for some number of months!

Up until now, very useful utilities have been sold by us separately, and, of course, we will continue to do so, but for some time it has become obvious that there is a market for a utility program that does everything. Whilst the author was working on this concept, we asked him to include a program which would compress Basic programs over and above the usual simple removal of spaces and REM statements. Actually the original idea for the compression of programs came from software which has been written for the Model II and which is featured in our catalogue under the name SKRUNCH and COMPRESS. The resulting program is, as we have said, a complete programmer's aid for the serious Basic programmer.

The complete program occupies 7 or 8K of RAM. Although this is no problem to the disk user, it may well be to the 16K tape user. In order to get over this difficulty (and incidentally to save money for users who have some of the utilities already) the program is available in two parts in addition to being available in the whole. The two parts are deliberately sold at the same price and at a price such that the sum of them is equal to the composite. Thus the customer does not lose from buying his program in two sections. The program is split so that COMPAK1 contains the compression and general purpose sections. COMPAK2 contains the debug, edit and general purpose sections. COMPAK contains all of the foregoing. All are compatible with both Level II Basic and Disk Basic and can be supplied either on tape or disk. The disk version contains all three programs.

Space does not allow us to describe COMPAK at any length. It is, of course, fully described in our catalogue, but briefly, split into its various sections, the features are as follows:—

COMPRESSION: Removes all redundant characters or blanks including non-used GOTO statements after THEN, redundant colons, redundant quotation marks, etc. After all redundant characters have been removed the program may be packed so that all lines that can be syntactically joined together will be. Further packing may also be carried out, the effect of which is to make the program almost unreadable but still workable.

DEBUG: Over 12 DEBUGing features are included which enable the program to be traced through step by step or line by line. Breakpoints may be inserted and the contents of variables may be displayed all the time. When an error is found the Edit mode may be entered immediately and automatically. Essentially, the DEBUG feature permits the programmer to find even the most hidden of bugs.

EDITING: Includes a complete user definable shorthand for shifted keys. Occurances of strings and variables may be found and counted. They may also be found and a wait executed so that the user may enter Edit or whatever. The find feature may be extended so that it will automatically find the occurrence and replace it with another user defined statement or string. Lines may be joined together with the automatic insertion of a colon. Lines may be checked for incorrect referencing and marked accordingly. Lines may be copied one to the other. Programs may be appended one to the other; in other words, a block is inserted after the current program so that another may be fed in and then the both joined together. An unusual feature is the ability to decode PACKED strings which contain machine language or graphics code.

GENERAL PURPOSE: A complete renumbering function together with the ability to change the renumbering increment in mid-program. A status report displays the space used by all relevant parts of the program such as arrays and variables plus of course the program itself. A Rescue feature is included so that "lost" Basic programs may be recovered. A lower case switch may be initiated so that lower case characters are printed out rather than the shorthand previously described.

We would emphasise that the above is only a synopsis of the features of this extensive program. We are not aware of any incompatibilities with the current Video Genies.

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LDOS

First there were the TRSDOS's, 2.0, 2.1, 2.2 and 2.3. Then came Newdos+, essentially a patched version of the TRSDOS's but with a number of very useful commands and utilities added. Then VTOS 3.0 and VTOS 4.0. These constituted a departure from the earlier DOS's and featured Device Independence so that devices such as the keyboard, printer, VDU and disk drives could interact directly together. Then came Newdos80 which is a rewrite of Newdos+, adding new utilities and new Basic commands, its main features being the abillty to mix different capacity drives on the same cable and the ability to use variable length records. Now from LOBO International comes LDOS, the fifth generation disk operating system for the TRS-80 microcomputer. It combines most of the advantages of the preceding disk operating systems and unlike some of them, is accompanied by a complete and readable set of documentation, which includes a Technical Section containing relevant addresses.

It is impossible to describe all of the features of LDOS in an advertisement. For instance it includes no less than 35 library commands as follows:—

APPEND	COPY	DEVICE	DIR	DO	FILTER	KILL
LIB	LINK	LIST	LOAD	MEMORY	RENAME	RESET
ROUTE	RUN	SET	SPOOL	ATRIB	AUTO	BOOT
BUILD	CLOCK	CREATE	DATE	DEBUG	DUMP	FREE
PROT	PURGE	SYSTEM	TIME	TRACE	VERIFY	XFER

All of the useful abbreviations in Newdos are included and the System Commands in Basic (CMD) now number eleven. A program called LBASIC/FIX is included, with which the normal TRSDOS Disk Basic may be patched to include a number of new commands and features. A Job Control Language is included and in fact is one of the most powerful features of LDOS. It allows the user to compile a sequence of commands or key strokes for later execution as a chain, with or without user intervention. There are too many new features to list them herein, but examples are: The ability to provide an audible signal, output through the cassette port. To flash or blink a one line message on the video display. A WAIT feature is included so that the machine can be put into a "sleep" state until such time as the system clock matches the time specified. And so on!

Hard disks in addition to single/double density, single/double sided, 8" and 5¼" floppies are supported although they may, of course, require hardware modifications. Utilities included in the package are:

BACKUP	COMMAND FILE	FORMAT	LCOMM
PATCH	RS232	KEY STROKE/MULTIPLIER	PRINTER FILTER

A Basic Renumber facility is included, as is a Basic Cross Reference function. Both are similar to the ones in Newdos+ and Newdos80. Most of the utilities are library commands which were existent in the previous DOS's, have been improved with the addition of new functions or facilities.

The prime development team of LDOS consisted of no less than 8 first rank programmers and they had the support and advice of six other well known programmers. They have done an excellent job to bring to the user what must be the best disk operating system so far produced for a microcomputer, which is destined to become the Standard DOS.

LDOS is totally upward compatible with TRSDOS, that is to say LDOS will be able to copy files and programs from TRSDOS disks onto LDOS formatted disks. As they are competitive disk operating systems, it is not suprising that the manual states that disks created under Newdos are not guaranteed to be compatible with LDOS, but we have not experienced any difficulty. We have done some work on investigating the compatibility of LDOS and the Video Genie and at the time of going to press we have found no incompatibilities. LDOS appears to run on the Video Genie without any problems at all. LDOS is compatible with either the Tandy or Electric Pencil lowercase modifications and Scripsit. LDOS is available for the Model I and Model III. A Model II version will be available shortly.

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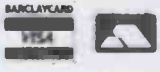

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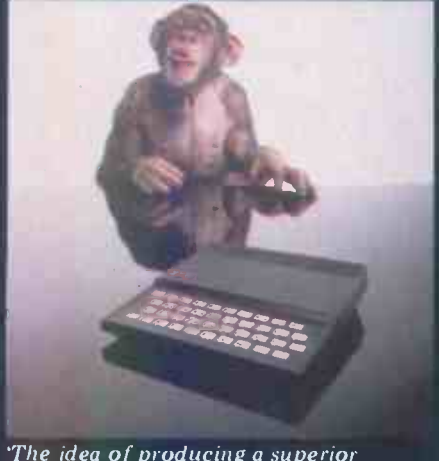

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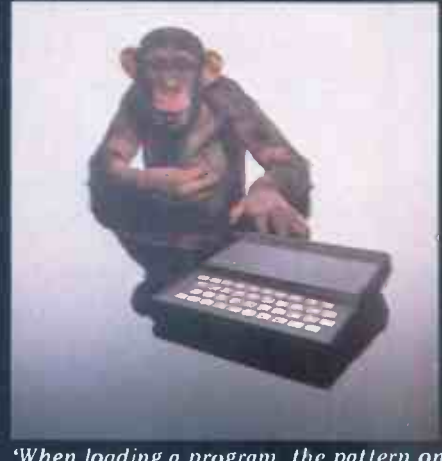

'When loading a program, the pattern on the screen shows you when data is being recognised.'

BENCH TEST

SINCLAIR ZX81

Right from the start, I had better explain that the ZX81 costs £50 in kit form and £70 ready-built and, as such, represents absolutely amazing value for money. Whatever shortcomings are highlighted in this Benchtest must be weighed against this fact.

Like the ZX80, its predecessor, the ZX81 will be available by mail-order and, by the time you read this, deliveries should be coming through. Clive Sinclair tells me that he plans to up production to 10,000 units per month starting in April and that he'll be producing 10,000 ZX80s to satisfy overseas demand, so, providing that 10,000 or fewer of you order the new machine per month, delivery should be swift.

Sinclair has been a bit cheeky in his advertisements. Under a column entitled 'New, improved features', he proceeds to mention three things that were included in the ZX80 when it was launched over a year ago!

For the benefit of those unfamiliar with the ZX80, it was the first ready-built computer to break the psychological £100 price barrier. It was well-made but looked slightly cheap in its lightweight plastic case and with its shiny keyplate. The 'keys' were printed on a plastic membrane with a metallised back; when each 'key' was pressed, the metallic back came in contact with PCB tracks, shorting them to complete the appropriate circuit. The system plugged into the domestic television to give an extremely clear display, and program storage could be made onto the home cassette recorder. The ZX80 came with 1k of user memory (RAM) and a 4k operating system/Basic language chip.

The main limitations of the ZX80 were the fact that it could not handle floating point numbers or cassette files. Also, when first launched, memory expansion came a bit expensive but this changed when the 16k plug-in RAM became available. The ZX80 certainly represented a great step forward and offered excellent value for money for people wanting to learn about computing.

So what in the ZX81 is new, compared with the ZX80? First, an extra 4k of ROM is provided, which allows 30-odd additional functions to be incorporated. This will also drive the printer (expected in the summer). I couldn't test this, but I have seen it working. It is an electrosensitive printer requiring aluminised paper, the surface of which is burnt off by an electrical discharge to reveal the black paper underneath. Don't study the photos too closely, because they show a model, not the real thing. The ZX81 costs an

Just as we get used to more computing power for the same money, along comes Clive Sinclair offering much more for much less! David Tebbutt reports.

amazing £30 less than the ZX80, thanks to some neat design consolidation in a Ferranti chip custom-built to Sinclair's requirements. The total number of chips in the basic system is four, against the ZX80's 21. The ZX81 and its peripheral products are all cased in sturdy black ABS plastic. And very nice it looks, too.

Hardware

Although physically smaller than the ZX80, the new machine weighs in at 13oz, about 2oz heavier than its predecessor. The system needs a UHF television, a cassette recorder and a power supply to make it usable.

On my colour television the screen is a pleasant green and all characters are displayed in black. The machine offers no colour facilities and my guess is that you shouldn't hold your breath waiting for them. I suspect that a projection system based on three of Uncle Clive's miniature TV tubes might appear one day but, then again, I also suspect that he'd introduce another computer to take advantage of this. The display is 24 lines of 32 characters of which two lines are reserved for system messages and commands. Low resolution graphics are provided to give 64 by 44 plotting points. As with the ZX80, the display is very clear and rock-steady.

I'm pleased to see that the new power supply has its own flying lead for the attachment of a normal mains plug. (The ZX80 was awkwardly designed with an integral plug which often needed an additional socket or extension lead.) This power supply must give 600 mA at 9V but, since the ZX81 draws close to this, the standard power supplies actually give 700 mA and I would recommend that readers using their own supplies go for the higher rating, too.

Once again, the keyboard is formed by an underprinted plastic membrane which is everything-proof (water, chemicals, Coca-Cola, cigarette ash, monkeys, editors, etc). The keyboard layout is different from the ZX80's so, if you're upgrading, prepare to make a few mistakes at first. At the same time it is an improvement, since each keyword is frequently placed at or near its initial letter. (All you have to do now is learn the qwerty layout!)

Here are a few ideas for Uncle Clive: a plug-in battery pack, a plug-in single-line LCD display and a remote (infra-red or ultrasonic) facility so that you can sit in your armchair beaming the display information at an aerial adaptor on the television.

Compared with the ZX80, the ZX81 looks very smart indeed — one could almost say tasteful. It has a nice shape and texture and the keyboard is made of a non-reflective material, a definite improvement.

The plug-in 16k RAM pack fits to the edge of the PCB where it protrudes from the rear of the casing. The cursor takes a while to appear at switch-on, because the system is checking to see how much memory is present in order to set certain system variables. If you're a machine code freak you can reset the RAMTOP variables in order to give you somewhere safe to tuck your precious program.

Five screws hold the ZX81 together; three of them are hidden under the pads on which the machine stands (footpads? — surely not). You know what I mean — those non-skid things. There's a substantial heat sink for the regulator under the rear of the keyboard — it's a good place to warm your hands on a chilly morning. The PCB is held into the casing by two screws. The keyboard is separate from the main PCB and is connected to it by a couple of flat printed cables. The main PCB is well designed and neatly made. Assembly of the ZX81 is done very professionally by the Timex Corporation in Scotland (the same people that are making Sinclair's latest miniature television).

The basic ZX81 contains four chips — ROM, 3.5 MHz Z80A CPU, 1k memory and the Ferranti custom-made chip — plus a limited assortment of bits and pieces. It's very, very simple — I think even I could build it. A few spare positions on the board give the manu-

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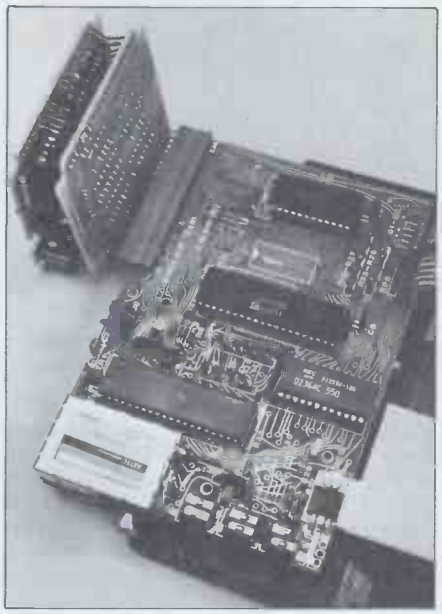

facturer a certain amount of flexibility to tweak the machine to the requirements of different television systems and to be prepared in case a memory chip famine occurs. The Ferranti chip handles all the I/O and control signals between the various elements of the machine. Nosing around inside, I notice that it has a very cosmopolitan flavour, with memory from Malaysia, the CPU and ROM from Japan, a UHF modulator from the Philippines, a regulator from El Salvador and the custom chip from Britain. The edge connector is not gold-plated (what do you expect for £70?); it's just the PCB printing taken out to the edge. The 16k RAM pack contains two boards connected at the edge. One board contains eight 4116s which are driven by the other board's assortment of seven chips which handle the memory addressing and refreshing.

Software

The ZX81 syntax-checking is excellent because, unlike the ZX80's, instead of operating on each character as it's entered, the system waits until NEWLINE is hit. Finding your way around the keyboard at first is a real hoot — some of the keys have five functions. As before, the single stroke keyboard entry is a joy to use and the automatic spacing inserted by the system makes program listings clearly legible. For example, if you tried to enter 10FORN=1TO10, it would appear as 10 FOR N=1 TO 10. Pretty neat, huh?

Editing is very simple. You position the cursor on the line to be modified, hit the EDIT key and then make your corrections. Additional characters and functions are automatically inserted at the cursor position within the line while RUBOUT deletes the character or function to the cursor's left. A touch on the NEWLINE key confirms the changes.

The machine can be used as a calculator but shouldn't be bought for that purpose since the precision is less than one would expect of such a device. It is, however, far better than the integer-only ZX80, offering $+/-10^{+/-38}$. If numbers get out of hand it presents results in standard scientific notation. For those who can't readily visualise this level of accuracy, it means numbers up to 4,294,967,295 can be represented with complete accuracy. That's $2^{32}-1$. The smallest positive number is about 4×10^{-39}. Five bytes are needed to store a number, which goes a long way to explaining why the Benchmark timings are slower than with the ZX80, which only required two.

An enormous number of functions have been crammed onto this rather small keyboard. This has been achieved by using two special keys: graphics, which allows the user to key all the graphic characters as well as the normal characters as white on black; and function, which allows the user access to (surprise, surprise!) special functions. A normal mode of operation also exists. In addition to all this, the keyboard has a bog-standard shift key, thus increasing the range of options for each key still further.

The character set is a one-off — it's not ASCII or anything I recognise. I think we'd be safe if we called it Clive code. The TV display isn't exactly memory-mapped — it tends to move around and change its size depending on what's going on. It is, however, possible to find the start of the screen area and then to access the screen by PEEKing and POKEing the screen locations in the buffer.

Basic

All but one of the ZX80's Basic functions, plus a substantial number of additions, have been incorporated into the 8k ROM which drives the ZX81. The following commands and statements are provided over and above the old ZX80 repertoire: ASN, ACS, ATN, COS, EXP, INKEY$, PI, SGN, SIN, SQR, INT, LEN, LN, TAN, VAL, <=, >=, <>, COPY, DIM A$, FAST, FOR. . . TO. . . STEP, LLIST, LLIST n, LPRINT, PAUSE, PLOT, PRINT AT, PRINT TAB, SCROLL, SLOW, UNPLOT. The missing function is TL$, which was used to return a string minus its first character. This ROM plus an appropriate keypad overlay is available to existing ZX80 users who wish to upgrade their machine. They should note, however, that even with the new ROM they will continue to get the screen flicker which, I'm sure, they've grown to know and love by now.

The machine can be operated in two modes — SLOW (sometimes called 'compute and display'), and FAST. FAST mode offers the world famous screen flicker every time you hit a key, while SLOW mode keeps the screen refreshed at all times, resulting in a nicer display, moving graphics and a lot of irritating delays: see the Benchmarks for comparisons. If you need to see the screen continuously then SLOW mode is a boon. If you don't, say if you were doing lots of calculations, then it's better to use the FAST mode. The two can be called from within a program, thus offering the best of both worlds. The SCROLL feature removes the top line from the screen and moves each line up, leaving a blank bottom line. Without SCROLL, the display freezes when the bottom line is reached. A PAUSE instruction is provided which suspends a program's operation for a user-defined period or until a key is depressed. The screen is visible when in PAUSE mode, regardless of whether the program is running FAST or SLOW. In SLOW mode the screen flickers slightly when the PAUSE takes effect but in FAST mode it has to come on altogether. This means that you'll have to be careful not to have your PAUSEs too close together, unless you actually enjoy watching the screen going absolutely bananas. The INKEY$ function is welcome since it can be tested to see if a key is being depressed and, if so, which key it is. This feature is great for fast-moving games since you need only hit the key you're interested in — there's no need to hit NEWLINE.

There are no DATA or READ instructions but this can be circumvented by saving a program with all its associated variables and then using a GOTO to kick the program off when it's reloaded. (RUN automatically clears any variables.) Pressing CONT, not

surprisingly, allows you to continue the program. PLOT and UNPLOT functions (0,0 is in the bottom left-hand corner) are provided, giving a graphics capability of 44 by 64 points. Each point, or pixel (picture element), is a quarter the size of a normal character. Hardly high resolution but better than a poke in the eye with a sharp stick!

The cassette needs either 35mm sockets or an appropriate adaptor. SAVE is offered but no VERIFY, so saving a long program can be a bit worrying. I suggest you first save a few short programs, just to make sure the controls are set properly. When loading a program, the pattern on the screen shows you when data is being recognised. The theory of cassette adjustment is that you play a data tape, gradually turning the volume up until the pattern appears. Then you turn it up a little more and it should be ready for use.

The printer, when it arrives, will allow you to LPRINT and LLIST data and programs respectively. Even better, it will allow you to dump the screen contents to the printer using the COPY command either within the program or as an immediate instruction. Such a screen copy takes about 12 seconds to produce.

The only function to disappear is the TL$ command mentioned earlier. The same thing can be accomplished using the LEN and TO instructions. All trigonometric stuff is in radians and PI is provided to help you unravel the results. SGN = signum which can possess one of three values: −1, 0 and +1. At one stage the new ROM (for the ZX80 and, subsequently, for the ZX81) was expected to offer DRAW, UNDRAW, DATA, READ and RESTORE features. Instead I think the idea of adding printing facilities became more important. After all, these features can be realised using the existing range of commands.

A character string of any length may be used as a numeric variable name, providing it starts with a letter. String variable names are restricted to A$ to Z$. String and numeric arrays may be any number of dimensions — the limit is dictated by the amount of free memory available. String arrays are character arrays really, with the last entry in a DIM statement being the number of characters per array element. With a full 16k RAM and a small program (it fitted on the screen) I set up a string array 100 x 6 x 25 characters long. I used this since each element would be about the size of a name and address record, allowing extra information like telephone number and birthday, for example. Substrings are handled using the TO function. LET A$=B$ (3 TO 5) would make A$ a three character string comprising the third to fifth characters of string B$. This open up possibilities for giant strings and the use of string slicing to extract variable length fields.

Documentation

A programming book is provided with the system: *ZX81 Basic Programming* by Steven Vickers. The cover is a very odd photo (montage?) of what appears to be a couple of model delta-wing jets on top of a solitary skyscraper at night. Two red windows peer at you from the upper floors. It must be full of deep meaning which totally escapes me. Sinclair Research specially commissioned it. Can any psychologist readers tell us what it's all about, please?

The book is written for the novice, and it does a pretty reasonable job. It is infinitely better than the book given out with the ZX80. What a pity, then, that just as the reader is about to key something in for the first time, he encounters the most off-putting (and unnecessary) paragraph in the whole book: 'A message like this, telling the computer to do something straight away, is a command; this particular one is a PRINT command, but also a PRINT statement. Calling it a PRINT statement just specifies its form without referring to how the computer is going to use it. Thus every command takes the form of a statement, but so do some other things — program lines do, as we shall see in Chapter 8.'

The style of the book isn't really to my taste although Steven reveals a lot about himself with his talk of dead tax collectors and expressions like 'Lor', love a duck'. *Eye* fans will be delighted with his reference to *Talbot?* on page 38 (I find the question-mark rather becoming, don't you?). Oddly, error codes are referred to as report codes. Perhaps the idea of associating errors with the machine was just too abhorrent, even if they do happen and even if they are usually the user's fault. Ho hum — more psychologist fodder. There are the usual typographical errors which didn't get cleared up but I couldn't find too many. The only other thing in the manual which actually troubled me was the reference to pounds, shillings and pence in one programming example. My kids (aged ten, eight and six months) didn't know what it was all about and, let's face it, a lot of these machines are going to be bought by, and for, kids.

Potential use

Who would use this machine? Kids will love it (so will Dads) and, at this price, I can't think of a better way of introducing them to the subject. Most courses on computers and especially on Basic programming cost more than the ZX81. In my view you can buy a ZX81, have a lot of fun, learn a bit about computers and Basic programming and decide whether you like it or not. If you don't like it or if you decide to move on to bigger and better things, you can always sell the machine (or give it to ComputerTown). The 16k RAM pack is a must for anyone doing anything remotely serious. The printer, when it arrives, will give you the chance to keep a record of all that interesting stuff you've got locked in the machine. The floating point arithmetic certainly makes the ZX81 a far more useful machine than the ZX80 and I suspect that many people will give it serious consideration as a result. You must bear in mind the sort of limitations imposed by the ZX81's inability to handle files. You can save a program with all its variables on tape, which gives you 16k for both programs and data. In my earlier example, I managed to get 100 records of 150 characters each into memory with a short program of 20 lines or so. There's no reason why you shouldn't record the program again with another 100 records, which would overcome this particular limitation. The only problem you'd be left with, then, is the fact that other programs cannot access the same data. I think that if you're really worrying about this sort of thing then maybe you require a more substantial system.

Expansion possibilities for the ZX81 are limited at the moment to the printer and the 16k RAM pack. I asked Clive Sinclair if there was any chance of

GOTO page 154.

Technical Specification

CPU:	NEC Z80A, 3.5 MHz
Memory:	1k RAM expandable to 16k
Keyboard:	Plastic membrane under-surface printed
Screen:	Domestic UHF television
Cassette:	Domestic audio recorder
Firmware:	8k ROM containing Basic and operating system

Binary Operations

\+ − * / ** = > < <= >= <>

Statements (all except INPUT may be used as commands)

CLEAR	CLS	CONT	COPY	DIM	FAST	FOR..TO..(STEP)	GOSUB
GOTO	IF..THEN		INPUT	LET	LIST	LLIST	LOAD	LPRINT
NEW	NEXT		PAUSE	PLOT	POKE	PRINT	(TAB)	(AT)
RAND	REM	RETURN		RUN	SAVE	SCROLL		SLOW
STOP	UNPLOT							

Functions

ABS	ACS	AND	ASN	ATN	CHR$	CODE	COS	EXP	INKEY$
INT	LEN	LN	NOT	OR	PEEK	PI	RND	SGN	SIN
SQR	STR$	TAN	USR	VAL					

Benchmark Timings (in seconds)

	Slow	Fast	ZX80
BM1	17.7	4.5	1.5
BM2	27.2	6.9	4.7
BM3	65.3	16.4	9.2
BM4	63.0	15.8	9.0
BM5	74.2	18.6	12.7
BM6	199.3	49.7	25.9
BM7	275.6	68.5	39.2
BM8	91.6	22.9	couldn't be done

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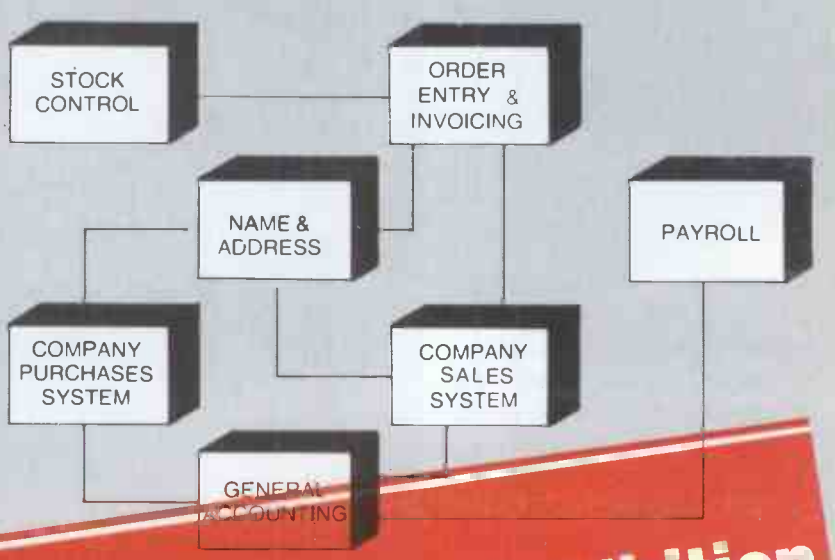

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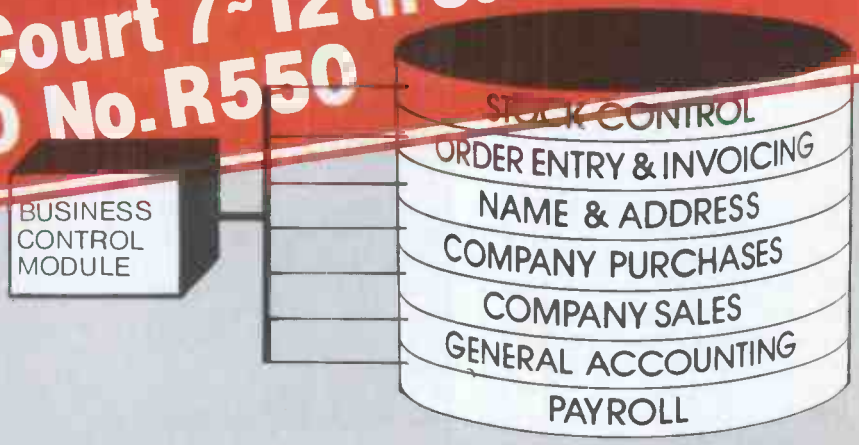

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FAIRE FUN

This year's West Coast Computer Faire, held in San Francisco, was a roaring success with 450 stands, 160 conference speakers and almost 32,000 visitors. Last year was considered successful with just 20,000 attendees. Jim Warren, the man responsible for the show, and his staff must be congratulated for this remarkable achievement. David Tebbutt reports from the Faire.

Last year about 20,000 people turned up for the Faire so Jim Warren decided that 30,000 tickets should more than cover this year's requirements. Can you imagine the scene on Sunday morning when he realised that a few thousand more tickets would be needed? Faire staff were going absolutely bananas with their John Bull ticket printing outfits, just trying to keep pace with the demand.

Sunday just wasn't Jim's day. Every year he organises an exhibitors' breakfast in one of the local hotels. It is an opportunity for the exhibitors to get together for a cosy chat. Last year was bad enough when around 130 people turned up. This year a ballroom was needed to accommodate the 515 who arrived!!!

Some sights

The show was not without its fair share of odd sights. The first to catch my eye was the Dynavit exerciser bike which enables you to watch yourself having a heart attack on a display panel of LEDs. It's made by Nordic Fitness Products, 4170 Gross Road, Capitola CA95010. Sinclair treated us to a flying duck-like display of ZX80s. Come to think of it, ZX80s are probably lighter than the flying ducks on grandma's wall. Then there was the dragon playing music on the Alpha Syntauri stand and the Adventure Island set up by Adventure International. IBM looked out of place with its very low-key 5120 display, and Don Lancaster looked distinctly unhappy sitting beneath a sign inviting all and sundry to 'meet Don Lancaster' — which no one was. Finally, on the memorable sights front, there was Britain's very own Chris Cary, who'd somehow managed to recreate Comp Shop's tatty decor on his MicroAce stand.

Software

Lots of software products were on display but, short of employing an army and giving each member two or three packages to hit, there is no way that we can be even remotely comprehensive. Accordingly, I'll mention a few which caught my attention.

Now it is a little-known fact (unknown even) that I have been spending my spare time writing a program which simulates the operation of the human brain. That is to say, it mimics the knowledge networks with the indisputable advantages of total recall and swift association of related ideas. Imagine my joy when I learnt that someone else has already trodden the same path and come up with a product which does just this and much more. The disk-based product is called Grow and it can be run on the North Star Horizon and the Apple and it is primarily aimed at the CAI markets. To quote from the blurb, 'Grow is an extensible system for authoring creative CAI programs, adventure games, and dynamic knowledge networks. In Grow, knowledge is represented textually by nodes which may be edited and executed like programs.' Anyone familiar with Tony Buzan's work will instantly recognise the potential for this system. Mike Gurr is the UK dealer for this product and he can be found at 140 High Street, Tenterden, Kent TN30 6HT, tel (05806) 4278.

Another little-known fact is that I somehow allowed myself to be persuaded to give a talk at the Faire. The subject was The Last One and I'm pleased to report that the talk went well and that I'd wisely dragged David James across the Atlantic to answer the questions. Without him that part may not have gone so well. A lot of interest was generated in his system, so much that he had to spend almost 35 hours demonstrating it between Friday lunchtime and Sunday night. That'll teach him to get on the cover of *PCW*. (If you don't know what I'm talking about, read the February issue.)

A neat range of packages is offered by the Micro Applications Group. Under the generic terms Prism and Magsam, the company offers some interesting application development software. Database management and list management facilities are at the heart of these systems, and together they can satisfy a very high proportion of a user's data processing needs. I set up a database of estate agent's information and was then able to access this information by any field and to produce a variety of reports from the derived information. I liked it. It seems like a good way for an inexperienced user to get off the ground. Further information is available from 7300 Caldus Avenue, Van Nuys, CA 91406, tel (213) 881 8076.

Friends Software is a bunch of ex-IBM people who have created a very good file management system which includes a report writer and file re-

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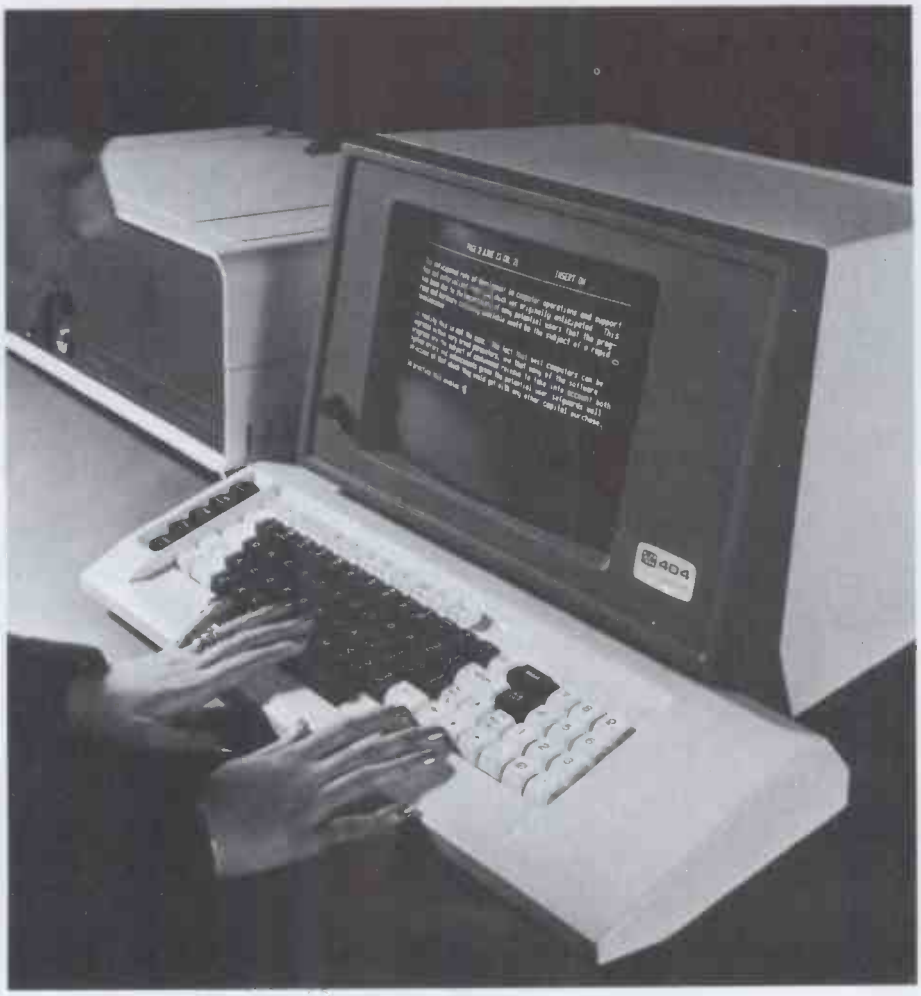

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organisation facility. Access/80 is a micro version of a system which has started its life on IBM and Univac mainframes back in 1963. It runs under CP/M and requires at least 56k memory. It looks good. Contact Friends Software at Tioga Building, Suite 440, 2020 Milvia Street, PO Box 527, Berkeley, CA 94701, tel (415) 540 7282.

Books and magazines

The first news is that *PCW* had a stand at the show and did a roaring trade under the eagle eye of Angelo Zgorelec (*PCW*'s founder), aided and abetted by Ted and Timbo. Ted will soon become famous for his cartoons in *PCW* and Tim is one of the mainstays of the *PCW* show. We attracted the punters with uncharacteristically modest signs which proclaimed '*PCW* brings computing to California'!!!

Dilithium Press had its usual excellent selection of books (Brainfood). My favourite title this year is *Nailing Jelly to a Tree*. The book is about implementing software on a micro and the title is derived from the fact that at times it is such a nebulous business that it can be like *Nailing*. . .

InfoWorld can be expected to join forces with Japan's *ASCII* magazine. This could make Pat McGovern's publications a real force to be reckoned with — in the UK he already owns *ComputerWorld UK*.

Hayden has been publishing micro books for some while now. Recently it started pushing out microcomputer software — *Sargon* for the Apple among other things. Now it has bought ailing magazine *Personal Computing*, which can only be good for the magazine.

Another phenomenon which the US marketplace can support is that of specialist magazines. There are already a number of publications available for the Apple and the 6502 has its specialist magazine *Compute*. Now the same publisher, Robert Lock, is publishing a VIC magazine. It's called *Home and Educational Computing* and details may be obtained from PO Box 5406, Greensboro, NC 27403, USA. For TMS9900 fans, a *99'er* magazine is also being published six times a year, starting in mid-April. Subscriptions cost $25 or $40, depending on whether you want surface or air mail. Contact Emerald Valley Publishing Company, PO Box 5537, Eugene, Oregon 97405, USA, tel (503) 485 8796.

Scott Adam's Adventure Island.

Dragon music on the Alpha Syntauri stand.

The Dynavit exerciser bike. Did I say bike?

Apple

Everyone knows that Apple is one of the world's most popular machines, and it is with this in mind that a number of manufacturers are coming out with Apple compatible products. Three products which are worthy of mention are a music synthesiser, an ink-jet colour printer, and a video disk system controlled by the Apple.

Passport Designs have created a nice Apple music synthesiser called the Soundchaser. A supplied edit system allows you to define four contours — two envelopes and two low-frequency oscillators. Alternatively, you can choose from a standard series of predefined contours. Along with the Alpha Syntauri we have arranged to review this instrument shortly. Further information can be obtained from Passport Designs, Box 478, La Honda, CA 94020, tel (415) 747 0614 — ask for David Kusek.

The three-colour ink-jet printer is available from the Omnico Computer Corporation. Any colour graphics which may be displayed on the screen may be printed with this interesting device. Maximum print size is 13in wide by unlimited length, and DOS 3.3 compatible software allows screen dumps, normal and expanded line printing, overlaying, etc. Further details may be obtained from 3300 Buckeye Road, Atlanta, Georgia 30341, USA, tel (404) 455 8460.

The Videodisk hooked up to the Apple is called the DiscoVision. Each plastic disk holds almost 30 billion bits of information held on up to 54,000 tracks. Each track represents one picture frame with two-channel sound and computer control information included. The disks revolve at 1800rpm and tracks can be pulled off in sequence or according to programmed requirements. Educators should be looking very seriously at this sort of thing. DiscoVision may be contacted at 3300 Hyland Avenue, PO Box 6600, Costa Mesa, CA 92626, tel (714) 957 3000.

Communications

The Source is going strong since its takeover by *Reader's Digest*. One of the French terminals was lurking around on the stand so the rumours of massive deals must be true, though quite how

FAIRE FUN

massive the deals are no one would say. One of the brochures had 'May The Source be with you' plastered across it. Groan!!

A neat little terminal is available from Cybertek. It can send or receive data either via its inbuilt modem or via an acoustic coupler. Without the acoustic coupler, the terminal is actually pocket-sized. The ideal use would be for the person who needs access to plenty of information but who finds it impossible to carry it all around. Or perhaps the information changes so quickly that it is out of date almost as soon as he leaves the door with the latest listing. If the data is back home on a computer, then Cybertek's Pocket Terminal allows him to dial up the mother machine and make appropriate enquiries and updates. Transmission speed is selectable up to 300 baud. For further information write to PO Box 7500, Menlo Park, CA 94025, tel (408) 263 4379.

Accessories

Anchor Pad is a neat little device for those of you who are worried about burglars pinching your pride and joy. (Your computer, that is.) It saves all that messing around with superglue, too. Anchor Pad comprises a number of very sticky pads which you fix to your desk, worktop or whatever and onto which you mount a base plate. You then bolt another plate to the underside of your computer. Lugs on this interleave with lugs on the bottom plate. Having interleaved, you then slide strong steel rods through the entire assembly and, finally, secure the rods from access by fixing locks on their ends. Rivets through the sticky pads ensure that they cannot be separated from the work surface by a thin wire. For further information, contact: Anchor Pad International Inc, 9046 Lindblade Street, Culver City, CA 90230, tel (213) 559 7111.

The Dynatyper allows you to convert any electric typewriter into a printer for your micro. It is capable of thrashing your typewriter far faster than it was ever designed to be thrashed — 50 cps, in fact. You'll be pleased to hear that the accompanying software allows you to slow things down a little so that your machine doesn't fall to bits. Dynatyper doesn't affect the normal functioning of your typewriter and it is available for the Apple, the TRS-80, the GPIB and RS232 interfaces. It costs a shade under $500 and for further information contact Rochester Data Inc, 3000 Winton Road South, Rochester, NY 14623, tel (716) 244 7804.

Machines

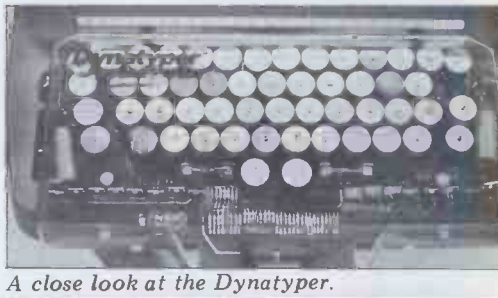
The Japanese computer club was once again in evidence, showing off some very nice machines. The most impressive is already available in the USA — it is called the BMC if 800. It features an eight-colour smooth scrolling screen with a choice of character modes — either 40 or 80 columns and 20 or 25 rows. Five-inch dual-sided double-density disks and a built-in printer complete the package. Light pen and ROM-pack options are also available. Fantastic! I suspect that this is, in fact, an Oki computer. Addresses for further information are BMC Elektronik, Capim Center, RoBmarkt 15,6000 Frankfurt/Main and BMC International Tanimachi 5-27, Higashi-ku, Osaka, Japan. The other new machine on this stand was the Hitachi MB 6890 but unfortunately its own colour display was so overshadowed by the BMC machine that the latter stole all my attention.

One of the nicest looking new machines on display was from Archives Incorporated. It is a 64k, S100, Z80, CP/M machine with twin 5in drives. A 5 Mbyte Winchester disk is an available option and 10 MByte (five fixed/five removable) is also available. The screen is 25 x 80 or 240 x 100 with features such as inverse, video blink, and underline in any of eight intensities. A function keypad, a numeric keypad and 23 user-definable keys complete this very nice machine. More information can be obtained from Archives Inc, 404 West 35th Street, Davenport, IA 52806, tel (319) 386 7400.

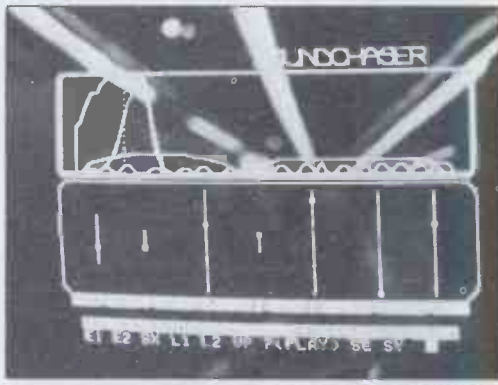
Another interesting machine is the Expander. It is interesting because it was designed by Lee Felsenstein, the creator of the Sol. The system features the ubiquitous S100 bus, a Z80 processor, the ability to drive a 24 x 80 display, and low resolution colour graphics' Cassettes can be driven at 500 or 1500 baud and the slower speed makes this machine compatible with the TRS-80 format. The system will sell for less than $2000 and it's no good looking for disks because there aren't any — yet. For further information contact Micro-Expander at 6835 W Higgins Avenue, Chicago, IL 60656.

And now for the one you've been waiting for: Adam Osborne's modestly named Osborne 1. It, too, was designed by Lee Felsenstein and it's not at all a bad piece of kit with its twin 5in floppies, CP/M, 64k and built-in TV screen. Wordstar, Mailmerge, SuperCalc (a hotted-up VisiCalc), CBasic and MBasic are all supplied as part of the basic package. Adam is planning to launch this system on the UK market for less than £1000. Apart from the small screen, the package looks good, very good. It is possible to plug in to an external monitor if you want to avoid eyestrain. Adam says that this machine is portable — he's even put a carrying handle on the rear as if to emphasise the point. Alan Wood of Digitus tells me that the Osborne 1 is portable 'but only if you enjoy getting a pain in your back!'. The machine will run for three to five hours from an optional battery pack.

An attentive audience for The Last One.



A close look at the Dynatyper.



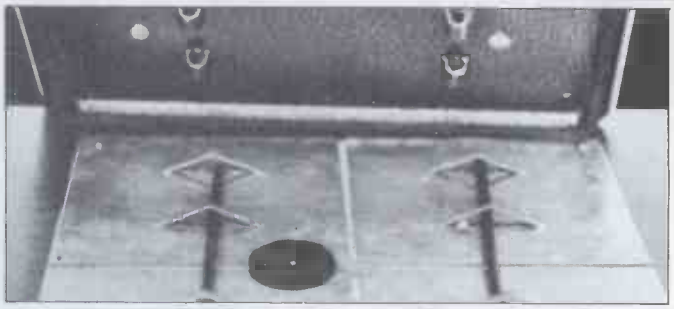
The Soundchaser and, above, a typical display.

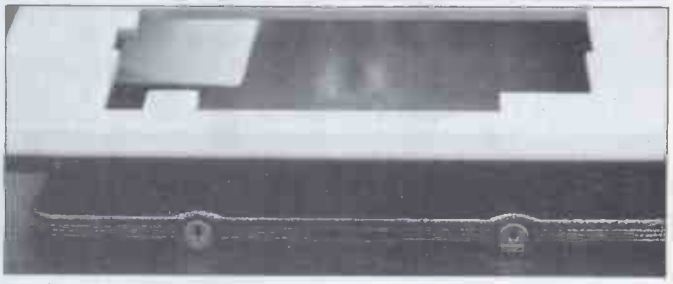
I wasn't going to mention Commodore's VIC but I just have to say that the joystick controller being used was taken from an Atari!

Organisations

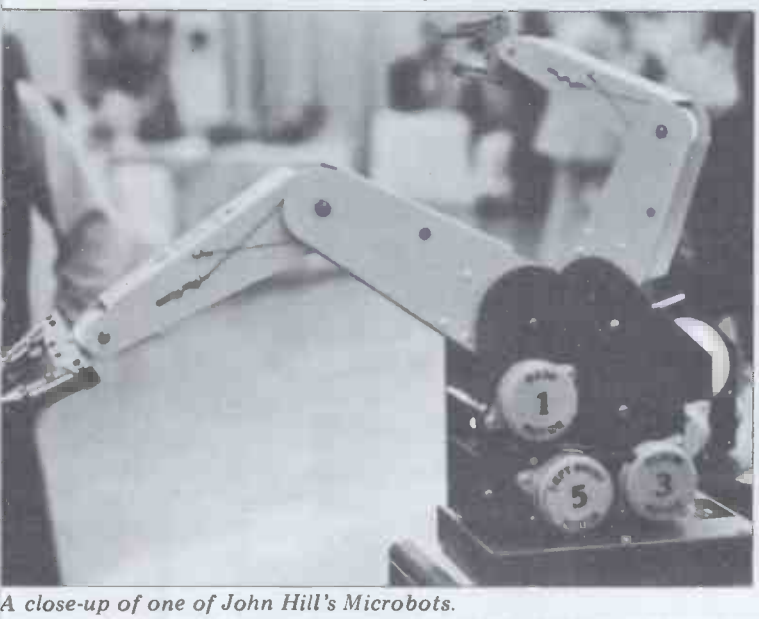
You've heard of activity holidays for kids, haven't you? Inevitably there is now a computer camp for boys and girls aged ten to 18. It really looks like fun. Apart from computing, kids can learn to ride horses, go swimming or hiking and play tennis. As well as learning to program in Basic (or Fortran, Pascal, Cobol, etc) and playing computer games, films are shown and guest lecturers give a wider view of computer applications and how they work. I quote Computer Camp's stated goals: 'To have the participants experience joy and satisfaction in learning a skill that will be of tremendous value to them their entire lives; to teach the Basic programming language; to expand

BM's modest stand. Spot the editor's leg.

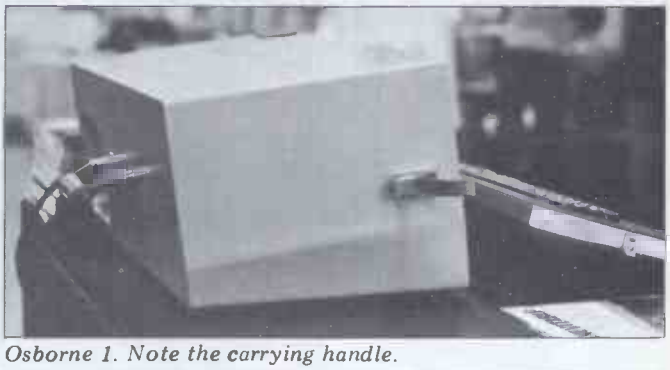




A picture paints a thousand words. The Anchor pad security system.



A close-up of one of John Hill's Microbots.



Osborne 1. Note the carrying handle.

surroundings, both environmentally and socially; to create a supportive atmosphere to facilitate emotional growth.' Computer Camp is at lovely Zaca Lake, about 40 miles north of Santa Barbara in California. The fortnight costs $795 per head plus the cost of getting there. It looks like fun — is anyone in the UK doing the same sort of thing? If you are, write and let us know. Computer Camp's address is 1235 Coast Village Road, Suite G, Santa Barbara, California 93108, tel (805) 965 7777.

I intended to spend some time with a group called Women in Information Processing. This is an organisation dedicated to help women pursue careers in this industry by keeping them up-to-date with relevant news, establishing an effective network of contacts, both with women in the organisation and through seminars organised by local WIP forums (or should it be 'fora'?). Anyone interested should write to Janice Millar, WIP, 1000 Connecticut Avenue, Suite 9, Washington, DC 20036. If you get anything going in the UK, perhaps you'd like to get in touch with *PCW* and we'll broadcast the fact.

Anyone involved with Computer-Town will know that it was launched in the UK as a result of my visit to the Faire last year. There I met one Bob Albrecht, who fired me up (is that why he's called 'The Dragon'?) to the whole idea. This year, he's come up with an idea which might just work, too. If we could get computers donated by interested parties, we could lend them to capable children on condition that, while they have the machine on loan, they must teach all the kids in the street. The scheme will be called ComputerKid and we're going to try it out using the kids we already know through ComputerTown. Dealers, importers and manufacturers: what machines will the kids be pestering their parents for this Christmas? - It's up to you.

Write to ComputerKid, 14 Rathbone Place, London W1P 1DE. Would-be ComputerKids please don't write until we have something concrete to offer.

White elephant

Finally, there was the White Elephant Award. Each year, Adam Osborne takes it upon himself to announce the most significant achievements in the microcomputer business during the previous year. This year he gave three honourable mentions and just one award. Adam has an undoubted talent for recognising a good product long before anyone else realises what's going on. In previous years he has picked a number of winners, including Visicalc and CP/M. This year, the single award went to Motorola for the 68000. To my great glee, he mentioned David James (who invented The Last One) as being one of the people who had 'given us the most in the past year'. Why glee? Because *PCW* was first with that particular story.

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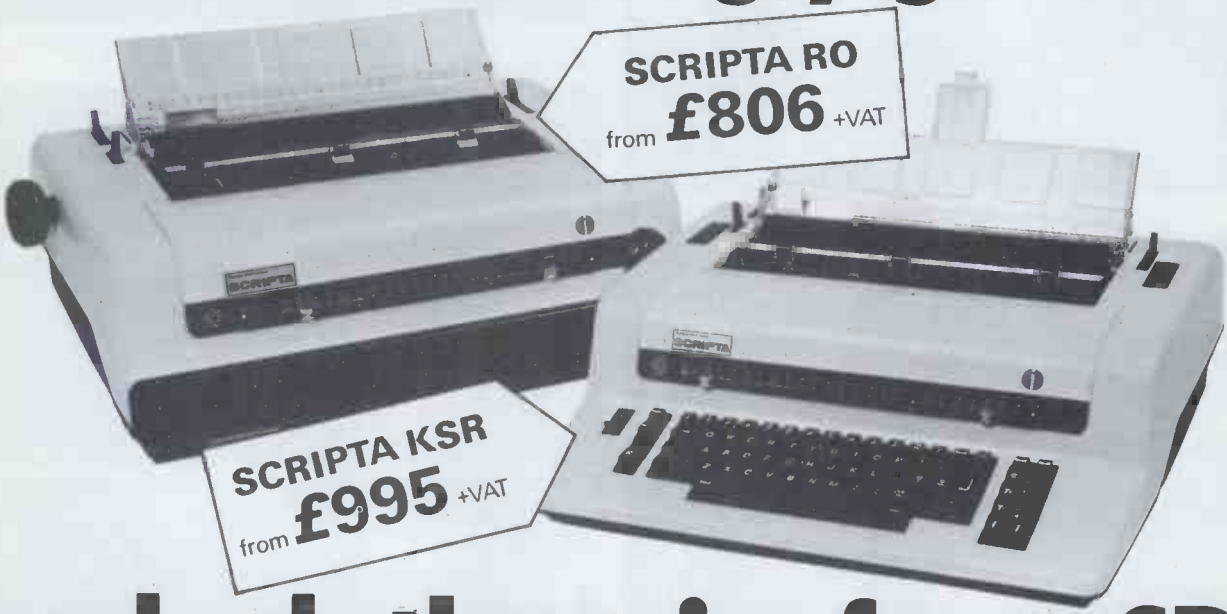

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COMPUTER GAMES

BRIDGE

By David Levy

Last month we looked at one of the most popular card games, Contract Bridge, and we examined some of the problems involved in writing a bidding program. This month we shall consider the even more difficult task of writing a program that can play a bridge hand, both from the declarer's seat and from the seat of one of the defending players. Let us begin by looking at the nature of the problem.

Contract Bridge differs from most of the games that we have discussed in one respect that is not immediately obvious. (The fact that it is not a perfect information game is quite another matter.) In a game such as chess, it is not important to win in any specific number of moves — the important thing is to achieve the desired result and it is more pleasant to win in 25 moves than to win in 100. A program can play a good game of chess if it can avoid tactical oversights and play reasonably sensible strategic moves. Its overall performance will not be optimal, but that does not matter — it is the result that counts.

In bridge, and similar card games that have a trick-taking stage, there are only a limited number of 'moves' (ie, tricks) in the game. A hand of bridge lasts for 13 tricks, never more and never less, and so it is essential to achieve the desired result within those 13 tricks. For this reason, a bridge playing program must aim to determine a hopefully optimal strategy in order to maximise its chance of success. Even if bridge were a full information game, the number of 'moves' would make an exhaustive tree search prohibitive. There are 13 cards that can be led to trick one, 12 cards which can be led to trick two, and so there are 13(!) ways of selecting the card to be led to each trick. This number must be multiplied by the number of cards that may legally be played by the second, third and fourth players who play to a trick, and the result is a number so enormous as to make exhaustive search unfeasible.

A subset of this problem was solved by Berelekamp many years ago. He wrote a program to play 'double-dummy' bridge hands in No-Trumps. Double-dummy means that everyone can see all of the cards in all of the hands, so declarer is playing a full information game, and need make no estimate or guess of where particular cards lie in the defending hands. By reducing the problem still further, so that only No-Trump contracts were attempted, it was possible to write a

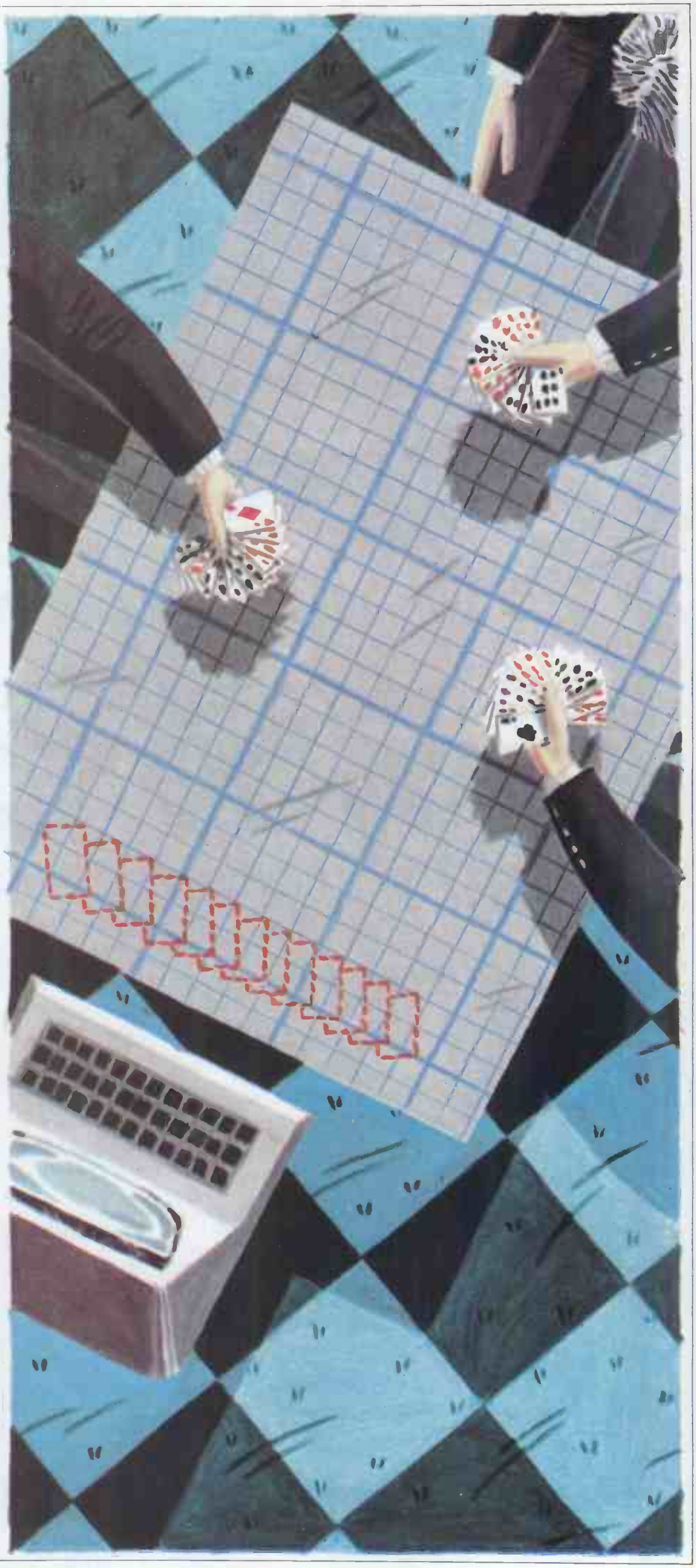

Illustration by Alan Adler

program that performed satisfactorily. The approach adopted by Berelekamp was to create a hypothesis for playing the contract from declarer's hand, then to try to refute this hypothesis and to create an improved hypothesis.

This approach is really an intelligently directed exhaustive search. The intelligence, or bridge knowledge, is used to guide the search and hopefully any contract which can be made *will* be made before the program runs out of time. The serious reader will find it useful to read the original paper on this particular program.

In the real world of bridge, where the situation of the defenders' cards is not known exactly, programming becomes far more difficult. An expert bridge player will often be able to make an intelligent guess, after the bidding, as to how the suits are distributed between the defending hands, and he may also know or be able to guess the exact location of certain key cards, particularly the missing aces. He does this by gleaning information from the bidding, and those of you who studied last month's article will have realised that some of the information passed during the bidding can actually be used during the play of cards.

Very little has been done in the way of programming the play of the cards at bridge. There are two commercially available bridge computers, neither of which plays at the same level as the best chess programs, and there are a few other programs around which readers may have come across in the micro literature. One of America's leading computer bridge experts, Thomas Throop, has done much to popularise the subject in North America. He has a regular column in *Personal Computing* in which he describes how various hands were played by his own program, which runs on a mainframe, and on George Duisman's program, which is available for Apples and other personal computers. So far Throop has not discussed how his program works, so there is no available literature on the detailed programming of bridge play. But hopefully this situation will improve as more people become interested in computer bridge. In Britain, Dr Alan Stanier wrote his PhD thesis on the subject of bidding a bridge hand and then planning the play from declarer's seat, and much of my own understanding of the problem stems from my reading of his thesis. The ideas expressed in the present article represent a simplified distillation of Stanier's ideas and one or two of my own.

Stanier correctly emphasised the importance of having the playing program learn from the bidding. Perhaps the most obvious application is in trying to decide which way to play a *finesse*. Consider, for example, the following situation:

Spades: A J 5

Spades: ? Spades: ?

Spades: K 10 3

South is declarer and wishes to try to make three spade tricks. No spades have yet been played, so the defenders have seven spades between them, including the Queen. There are two ways of trying for three spade tricks, both involving a finesse. South can guess that the missing Queen is in West's hand, in which case South plays the King of spades, discarding the 5 from dummy, then the 3 — and if West does not play the Queen then dummy's card is the Jack. If South guesses that East has the Queen, the play is different: the 3 is played from South, dummy plays the Ace and leads back the 5 — if East does not play the Queen on dummy's 5 then South plays the 10, otherwise he plays the King, taking the Queen and winning the third trick with the 10.

If the defenders have bid, declarer might be able to make some deduction from the bidding which helps him decide which way to take the finesse. If West has bid spades, then it is a reasonable assumption that he holds the Queen. If East is the only defender who bids, and late in the hand he has already played cards with sufficient point values to justify his bid, it is not unreasonable to guess that West holds the missing Queen. Deductions similar to these are not difficult to program, and the reader can use his own knowledge of bridge (and what he can find in books) to suggest various deductive routines which might help the play of a hand.

How to decide on a strategy

The most difficult problem for a human bridge player will often come at the very start of a hand, before he decides which of dummy's cards to play on trick one. At that stage he must plan his strategy, and an incorrect strategy can result in the wrong card being played as early as trick one. We shall now examine a simple strategy which could be programmed on a micro.

When the bidding is over and the defender leads a card to trick one, declarer should count the number of sure tricks that can be seen. It is possible that the contract can be made simply by playing 'winners' until the required number of tricks has been taken. Such hands are not really interesting, as they require no particular skill or thought, apart from ensuring that the cards are played in the correct order so that the program does not get itself blocked (when it is forced to play from, say, dummy's hand when it really wants to play from its own).

If it is not possible for the program to make a contract merely by playing off top winners, it must try to create extra tricks in some way. Various techniques exist in bridge, whist and similar games for creating these extra tricks; some of them are simple, such as the finesse that we examined earlier, others are more complicated, such as squeeze plays — playing out so many winning cards that the defenders are unable to keep all their important cards. Our simple strategy will be to explore three different methods of creating extra tricks: the finesse, establishing extra tricks in long suits, and cross-ruffing. If one or more of these techniques appears likely to be successful, and the program 'thinks' that it has found a method of creating a winning plan, then it should follow this plan unless and until it is forced to re-think, ie, until the plan goes wrong. If the defending players deviate from the plan at any point, the program must reassess how declarer should play the hand, and this reassessment will usually result in a new plan. The flow chart for this strategy is given in Figure 1.

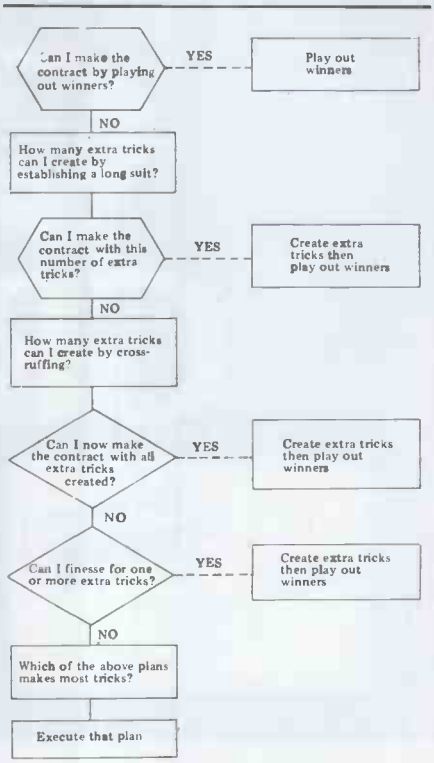

Fig 1 Simple declarer strategy — flow chart

As I mentioned earlier, this strategy is rather simple, and will not provide a challenging game for strong bridge players. It should, however, allow the reader to write a program that plays an entertaining game for players below club strength. You will note that if the program is unable to generate a plan that either guarantees the required number of tricks, or at least gives some chance of making the desired number of tricks, then it will cut its losses and employ whichever plan results in the smallest number of penalty points.

Executing the strategy

Once the most promising plan has been found, the program must decide in which order it is going to play the cards. Here the normal heuristics of bridge (and other trick-taking games) apply. The two most important principles to follow are:

a) When you are following a plan that involves giving away the lead at some stage, eg, playing a finesse or establishing a long suit by conceding one or more tricks, you must ensure that you have not weakened yourself in another suit to the extent that you can lose tricks unnecessarily. One common error made by beginners is leading out all their winners in a suit, thereby leaving themselves with one or more losers in that suit. Then, when a finesse fails or a trick is conceded while establishing a long suit, the vulnerable suit is attacked by the defenders and one or more trick is lost. The way to avoid this happening is to establish the long suit before playing off top tricks in other suits, unless you are aiming for a squeeze play (which is too sophisticated for our strategy).

b) Always ensure that the player on the

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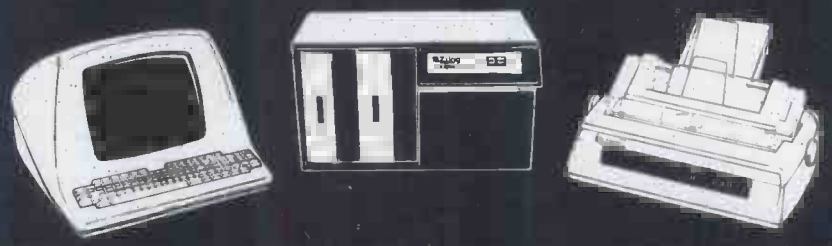

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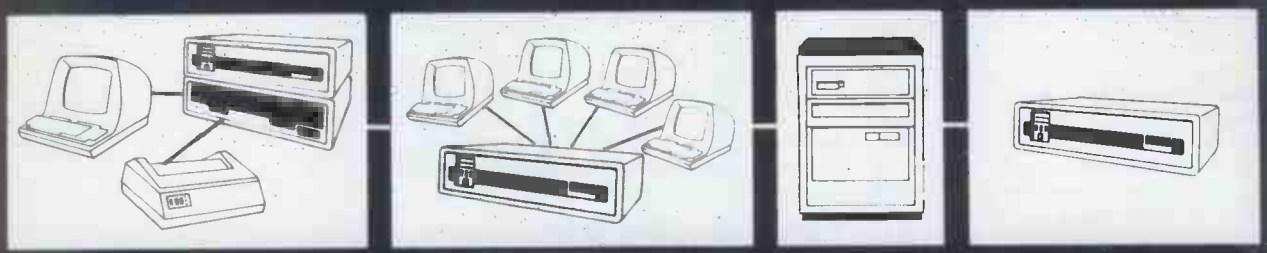

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lead is the player whom you want to be on the lead, and not his partner. A simple example of how things can go wrong is seen in the following situation:

Spades: 6 5 3
Hearts: A Q
Diamonds: —
Clubs: —

Spades: —
Hearts: K J
Diamonds: 4 3 2
Clubs: —

Let us assume that South has the lead, and that North's spades are the last three spades (and therefore they will all win), while South's diamonds are not the last three diamonds (and will therefore be losers). The contract is being played in No-Trumps. South leads the J of hearts, North plays the A, then North plays the Q of hearts and suddenly notices what he has done wrong. South must now take this trick with the K and then he is forced to lead a diamond, losing the last three tricks instead of winning with the remaining spades. Of course, there are various ways that the cards could be played in a different order, so that North-South would make all five tricks, but this example shows you how a careless mistake can cost several tricks and turn a good contract into a bad one.

End play situations

When a number of tricks have been played, the number of cards remaining in each of the players' hands becomes small enough to allow for some sort of exhaustive search of the game tree. How many tricks must be played before this type of situation arises will depend largely on two factors: the certainty with which the program is able to place all the remaining cards in the correct players' hands, and the speed of execution of the exhaustive search routine.

In the previous article, when we discussed the way that a hand might be bid, we saw how it is possible to put upper and lower bounds on the number of cards in each suit that is held by each of the players. These bounds can often be made more constrained during the bidding and once play begins they are constrained still further, as the exposure of dummy's cards provides more information. Finally, as one player shows out (ie, shows that he has no more of) a particular suit, the exact number of cards in that suit remaining in a player's hand can be determined.

Sooner or later, the program will be able to estimate the exact number of cards of each suit in each of the two unseen hands. Furthermore, from information gained during the bidding and the play, it may be able to arrive at an intelligent guess as to the location of some specific, high-value cards. It is then in a position to play what will have become a full-information game or, to be more precise, an almost full-information game (since it is likely that the exact location of one or two cards will remain unknown). When this stage is reached, the program can construct a two-person game tree of how the remaining cards might be played, and by searching this tree it can find the optimal way to play the last few tricks. This technique applies when the program is playing from either the declarer's seat, or from one of the defenders' seats.

During the play of the cards, the program should ask itself, as it is about to decide on its play to each trick, whether or not is has sufficient information to enable it to perform such a tree search. For this purpose, we should divide cards into 'important' and 'unimportant' cards. Loosely speaking, an important card may be defined as one which, if its location is guessed incorrectly, will affect the result of the succeeding tree search. All other cards are 'unimportant'. Simple examples of both types of card are easy to find. If the defenders each have two remaining clubs and declarer has two clubs, both of which are higher than all of the defenders' clubs, then it is quite immaterial which way round the defenders' clubs are distributed, since declarer is bound to take both of the last two club tricks. But in the case of a missing Queen, which must be caught by a finesse carried out in the correct direction, a wrong guess as to the location of the card will result in the finesse going wrong, and at least one trick being lost which should not have been lost. So the missing Queen will be an 'important' one.

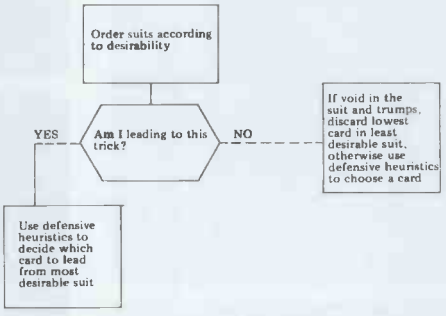

Fig 2 Defensive flow-chart

As a general rule, I would suggest that the program should not try an exhaustive tree search until the number of 'important' cards remaining is no more than one.

Having written your tree search routine, you will have an opportunity to try it out after different numbers of tricks have been played. This will enable you to time the execution of the routine where there are 3, 4, 5 . . . tricks remaining to be played. You can then decide what sort of time delay is acceptable to you, and set the 'end-play parameter' so that the exhaustive search does not begin until such time that the computer's delay in calculating its optimal play is acceptable. Remember — the computer can determine the optimal end-play strategy for defending players as well as for declarer, and since you will be playing one of the hands and the computer will be playing the two unseen hands, you must allow for a delay by both of the other players. Unfortunately, there can be a substantial difference between the times needed to search trees with the same numbers of cards (or tricks). This is because one tree-search might be performed in a near optimal ordering (ie, the search heuristics provide a good ordering of the 'moves') while another tree-search might be highly non-optimal in its ordering. Another reason for a large disparity in the search times is that even with the same number of *tricks* to be played, there can be vastly differing numbers of nodes on the search tree because of the way that the suits are distributed. If all the suits are evenly distributed among the players, the branching factor at each node will be small. If the suits are unevenly distributed, the branching factor at some nodes will be small and at others it will be large. The combinatorial effects of these differences might result in two trees having the same number of tricks but widely differing numbers of terminal nodes.

How to play the defence

Bridge books are full of useful defensive heuristics which can be used by your program, particularly at the very start of a hand when it is necessary to decide what to lead to trick one. Perhaps the best known such 'rule' is: when defending against a No-Trump contract, lead the fourth highest card of your longest suit. This type of lead tells your partner something about your longest suit and he can then decide how to play that suit. Another simple heuristic is that if you only have two cards in a particular suit, and declarer is playing a trump contract in another suit, you normally play the higher of your two cards first, then the lower of the two, so that if your partner gets the lead he can play another card in that suit and you will be able to trump (if you have any trumps) because by then you will be void in that suit.

Defensive heuristics can be employed to update the information that the program is keeping about the number of cards of each suit in each hand, and in certain cases it might also be possible to update information about specific cards. For example, if your partner leads the 8 of spades against a No-Trump and you can see the Ace, Jack and 9 of spades (in your own hand and dummy's hand), then if partner's lead was the fourth highest spade in his hand he must hold the King, Queen and 10.

The simplest strategy to program for defensive play is one which orders the suits in their 'desirability' from the defenders' point of view. A defending player should be able to decide which suit or suits will not be profitable for him to lead, and he can then rank the other suits so that when faced with a choice of what to lead at the start of a trick he can lead a card from the suit at the top of the desirability list. Reasons for putting a suit high on the desirability list are varied: a player may wish to lead a card merely to transfer the lead to his partner's hand; or he may wish to lead a card in his weakest suit so as not to give away any tricks by a bad lead; or he may have one or more winners in a suit and may wish to take them. The order of desirability will usually change quite often during the course of a hand, as more information is revealed about the distribution of the suits and the locations of certain cards. But the concept is not a difficult one to program.

Having ordered the suits in this manner, the program decides which card in the suit should be played on the basis of the various defensive heuristics that you have programmed. For this you will

GOTO page 151

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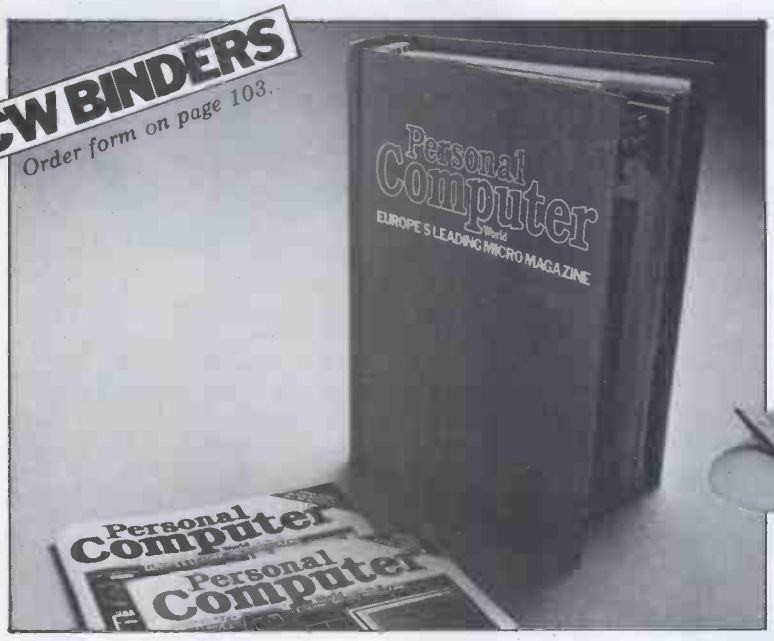

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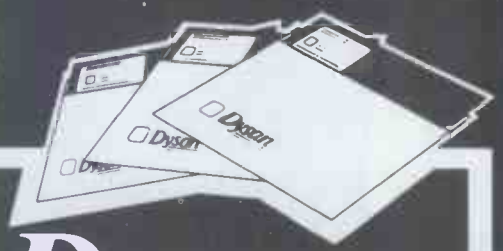

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PART 10: TESTING A SYSTEM

Lyn Antill offers some sound advice on a vital aspect of systems development.

It goes without saying that testing is a vital part of programming, but it's not really all that easy to do. Even the sort of program that can be fitted into a micro is so complex that it would take years to run through every possible combination of instructions. And, of course, if you found a mistake and needed to change something, then you would have to start all over again, to ensure that the change hadn't affected any of the things you had already tested. And all this would only get you to the point where the program did what the programmer thought it was supposed to, without any guarantee that this was what was needed.

Program testing is now moving towards the state of testing in the much more organised engineering industry. First, the components are tested; then the machine itself. This rigorous testing continues long after the product has been put into service, which is all rather time-consuming and expensive. However, this must be set against the cost of installing a system which fails. What do you stand to lose if the program pays out too much money, or doesn't bill your customers enough, or wipes out all your records for the last week's business?

Writing testable programs

The necessity of testing programs is the primary justification for a 'structured' approach to programming. Programs need to be built out of testable components — a routine to input and check a date, a routine to calculate VAT, to throw a new page and repeat the headings, etc. Each of these routines is testable in its own right and once it has been shown to work, it can safely be called from any point within the program. It is necessary to test that each routine has been called in the right place, that the right information has been fed into the routine and that the right use has been made of the information that came out.

This is not the place for a lesson on structured programming because that is the programmer's responsibility. But it will influence the user's approach to testing if he knows that the programs have been written in this way. If you are satisfied that the component routines (procedures) are operating successfully, then you have only to test the way in which they have been put together into complete programs. A procedure may be something that is repeated frequently, but it could just as well be a small job that is only done once.

Testing a program against the specification

Documentation — a description of how the program works and what it does — is a vital, though universally despised, aspect of programming. It involves hard work and little fun, unlike writing programs. However, a senior programmer told me that it was only when she came to document the program that she was really able to ensure that it did what the analyst had said it would.

Documentation is particularly important for microcomputer programs because, with no professional systems analyst working on the specification, there is even more room for misunderstanding about the requirements between user and programmer. It is very tempting for the user to think that he has paid a programmer to get on with the job of writing programs, but it is the user who is going to use them, so he must make sure that they are doing what he wanted. Getting someone to write a program is not the same as getting the garage to work on your car. The garage mechanic can test your car after he has worked on it because he already knows what you are looking for. The programmer doesn't have this knowledge about how you are going to use the program.

So, the first stage of testing is to try the program out on simple data to see whether it appears to be doing the right sorts of things (just as you would do if you had bought a program package). It will take more than just a cursory glance to see whether or not you like the program; you will have to set aside some time for you, the programmer, and any other people likely to come into contact with the program, to get together and go through it bit by bit.

If the program has been written in a structured way it should be possible for you to see bits of it as they are written. This is ideal because problems can be spotted immediately and something done about them before they get built into the system.

Testing the program against operator errors

During the life of a commercial program a lot of stupid mistakes are likely to be made by the people operating it. If the program is not proof against these then there is a likelihood of errors being introduced to your data, or even of it all being corrupted or lost.

These careless mistakes fall into several categories. Firstly there are the ones where you just hit the wrong key — either a typing error or a misunderstanding of what was supposed to go in next. Every program should check that you haven't entered a letter or a punctuation mark where there should have been a number, or chosen an option that wasn't on the menu, or entered a value that was outside the permitted range, and so on.

Another common sort of error is the procedural one where you do things in the wrong order — entering the parts of a transaction in a different sequence, trying to take totals before reaching the end, trying to delete the day's work before backup copies have been taken and so on. Again this is the sort of testing you will be doing by accident when you are getting to know how to operate the program. If you get to know the program by messing around with it, rather than by scrupulously following the manual, then you are likely to test out many of these safety features. Extend this testing by doing things which you know are stupid, just to see what happens.

Can errors be corrected?

This is one of the worst areas for the programmer. It is difficult enough to get the program to deal with all the things it has to, without having to bother about undoing the user's silly mistakes. So you may well find that you have quite a problem getting those mistakes back out of your data, or that you can make an even worse mess of it when you try. But users *do* make mistakes and so the program has to allow for this.

It's quite hard to imagine yourself making mistakes, but a quick look at your own office now will show just how inevitable these mistakes will be — transactions with wrong account numbers or amounts that have to be changed afterwards, items being entered twice, or left out so that you have to go back and insert them. Problems like this are usually much easier to deal with on a manual system, but computers are much less flexible, so everything has to be done by the book.

For this reason, you have to go out of your way to think of all the errors which might occur in real life and then try to see whether you can get out of

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them with a computer.

Here are some of the things you might want to look for:

— if you've realised immediately that the last item was wrong, can you get it out straight away? This is always happening — you write something down, look at it, or think about it subconsciously, and it's obviously wrong, so you rub it out, or reach for your Tipp-Ex. Most mistakes are noticed at this stage and you should be able to wipe them out, otherwise they get embedded into the system and it's much more difficult to make corrections later;

— you may have entered a complete transaction that should not have been included, so it should be possible to delete it. Of course, there have to be checks to make sure that no-one is wiping out transactions willy-nilly, or making fraudulent deletions of valid data. Perhaps there will still have to be a batch total that must agree, or a list of changes to the input transactions so that they can be checked afterwards;

— changes may have to be made afterwards if it is discovered that data which was thought correct at the time actually contained errors. This is particularly tricky if the incorrect data has been used as the basis of further transactions. The history of an account, or whatever, is always apparent on an old-fashioned ledger card — you can see if changes have been made and, if necessary, can insist that any changes be initialled, but to do the same thing on a computer requires different procedures. On a large database there are lengthy logs of all the transactions that have been entered, which terminals and programs have looked at or changed different records and so on. This is not possible on a micro, but something has got to be done to make sure that your data is accurate and that changes have been made properly and with due authorisation.

Unfortunately, there are no easy answers to such problems, because no two users have the same procedures into which the micro must fit. This means that you may be unable to rely on your programmer to achieve this reliability. While he should certainly have some good ideas, anything he builds into the program will have to fit into your general operations.

Security and back-up

Essentially, then, you have to be satisfied that nothing that the program does, or nothing that your operators do by accident, will wreck your data. Does the program query ever attempt to erase data, to ensure that you didn't hit the wrong key? Does it insist that you make a security copy of your data before you finish a run? Does it print out an audit trail? Does it check that all inputs are reasonable and within the permitted range for items of the type, so that, for example, you're not paying the tea lady £1000 a week? *(And why not? — Over-egalitarian sub-ed.)*

Even if your programmer has made good provision for taking security copies of your data, how easy is it for you, if today's data has been ruined, to take a copy of yesterday's data and bring it back up to data? If you have to key in all the transactions again it will take you the whole day. If there is a lot of data it might well be possible to take a copy of all the valid transactions on disk and read them back through a separate input routine. This means that you will have a bit of time to wait for the program to run, but at least you'll save all that keying time. (This is the method used on mainframes where the keying time would be astronomical; of course they have more disk drives than a micro, but it is sometimes possible to fit more than one logical file on one disk, provided the files are not too big.)

Does the program crash?

A fair amount of micro software is still rather Heath Robinson in nature and somewhat unpredictable. The editor I use for preparing this text crashed three times in a row yesterday when I was doing a simple, perfectly legitimate typing correction with a file that was not apparently too big. It may or may not be obvious to the programmer that I was trying to do something the machine will not allow but as I didn't know how the program works, I couldn't possibly tell. Fortunately, I had already taken a disk copy of that page otherwise I would have lost all the work I'd done. Programs shouldn't crash, but it is virtually impossible for the programmer who knows how the program works to understand the feelings of the user who doesn't. It takes some deliberate 'dumbness' on the part of the user to test out the robustness of a program.

Program bugs?

I have so far been working on the assumption that the programmer has been doing a reasonably professional job. However, there is still an assumption among programmers that a certain number of bugs in any program are inevitable. Thus, though you should expect from the programmer something which is not apparently full of holes, programmers *are* human and there may well be careless programming mistakes. To a certain extent this will be because anyone buying micro programs wants them done on the cheap, either by hiring a youngster, or by getting someone to write them quickly. If you want something totally reliable you will have to pay more for the extra thought and testing it will take. This is not usually necessary, provided you realise that you will have to check up on what the programmer is doing, and spend time on picking up his mistakes.

The best test of anything is to give it to someone else, because after you have looked at a thing a few times, you get used to it the way it is. Your programmer should be able to give you a reliable product, but it's still in your interest to make sure. . .

Test data

If you are going to test a data-processing program, or any sort of input processing program, then you must have some input to test it with. You can test for silly bugs and obvious weaknesses with data you make up as you go along, but if you are going to test a program really thoroughly then you have to have well-thought-out data, both to see how it works under ordinary conditions and to see how it stands up to problems and critical situations.

The programmer will not normally have access to this sort of data and rely on you to provide it. This is often done by running selected portions of yesterday's work, after you've finished using it and before it gets filed. This is more accurate than trying to make up realistic data and should give you the best possible feel for whether the system is actually doing what you want. It'll be a bit of a hassle getting the program changed at this stage — you don't like it, so don't go asking for piffling changes, because they'll cause more trouble than you think. It's easy to think you want a change just because the new system is a bit different from what you're used to. But if you *do* see a real problem, 'speak now or forever hold your peace'.

This stage of testing also gives you a good chance to see how the program fits into your daily routine, and to see whether any changes are needed to your normal way of doing things: you're not only testing the program but the whole system, of which the program and the computer are just a part.

Another standard way of testing a program is to use bebugged data, that is, data into which mistakes have been intentionally incorporated. Ordinary data doesn't contain that many mistakes, so you could go through several months of operation without certain combinations of errors normally being encountered. If you want really good security and strength from your program, this testing will require careful consideration. And it is preferable that you, rather than your programmer, carry out this testing, because the person who wrote the program will know what mistakes not to make, simply because he knows how the program works.

One area of operation which regularly causes problems is the time when your files get too large. Unpredicatable things can happen when the program tries to write a record to a disk which is already full. It is quite likely that the operating system will take over from the program and you'll have lost touch with your files. It is usually possible to recover from this situation, but often such recovery is dependent on your hitting the right sequence of commands. It is very difficult in practice to do this testing. You might well choose instead to have a regular look at the amount of free space on your disks and split the data between two disks as soon as it gets anywhere near to the limit. If you are trying to produce a foolproof program to be used by a lot of different people then you will just have to make up, and key in, enough records to fill the disk. You could try modifying the input procedure so that it keeps inventing random records and writing these instead. This is undoubtedly the quickest way of testing the file-full procedure, even though it involves tinkering around with the code.

Conclusion

Testing is as important a part of installing a computer system as any other stage. Of course, there shouldn't be any

GOTO page 153.

"GREETINGS OLGA... BORIS CALLING..."

If you've got past the Space Invaders stage and you're wondering what to do next with your micro, why not hook it up to a radio receiver and 'listen' in to radio teletype messages? George Sasson (G3JZK) describes how he did this with his RML 380Z.

As a radio amateur, I am often asked by others aspiring to a transmitting licence to help them learn Morse code. The principal requirement is for slow Morse practice tapes, at speeds as low as four words per minute (wpm). It is very difficult, as well as boring, to send Morse accurately at such slow speeds, so here is an obvious application for the computer. The 380Z includes an 8-microsecond clock signal used for timing. By counting cycles of this clock, delay times of any length can be generated, so software was written enabling Morse characters to be generated from the keyboard and sent to one of the cassette-control relays. These routines were added to Basic, USR call arguments in the range 32 to 90 being used to send the corresponding ASCII characters. Thus, to send the string A$, one calls the subroutine:

```
FOR I=1 TO LEN(A$)
A=USR(ASC(MID$(A$,I,1)))
NEXT I
RETURN
```

This system worked very successfully and a large number of cassettes of slow Morse were produced. With suitable Basic programs, it was possible to key in enough text for half an hour of slow Morse in a few minutes, then leave the machine to get on with it. The only hardware modification needed was to connect the transmitter key socket to the cassette control relay and to arrange a recorder to record the transmitter sidetone signal.

Having progressed so far, I naturally began to think in terms of computer reception of signals. Many years ago, I had once been the proud possessor of an old ex-Post Office Creed teleprinter. This device produced hard copy in the form of printing on strips of gummed paper tape 3/8in wide, intended to be torn up, licked and stuck onto telegram forms. With this, I had been able to receive propaganda broadcasts, mostly from Peking and Tirana (Albania). However, further supplies of the tape were unobtainable and when my remaining stocks became damp and gummed up into a solid mass, I rather lost interest. The only solution was to saw up toilet rolls into 3/8in slices, but this proved impractical. With the computer, though, such difficulties would not arise; if the printer runs out of paper, there is always the VDU. Leaving aside Morse reception for the moment, I felt that a radio-teletype (RTTY) reception project would be worthwhile.

RTTY signals are transmitted using frequency-shift keying (fsk). A carrier signal is sent which alternates between two frequencies, known as the mark and space frequencies. The spacing between them varies from 850 Hz down to less than 100 Hz. If this signal is received as single-sideband, two audio frequencies of corresponding spacing are obtained at the receiver output. The resulting signal would be very similar to the Research Machines cassette system, which uses two frequencies of 1200 and 2400 Hz for mark and space signals.

Various possibilities were considered for interface circuits, and I finally settled on the use of a 4046 phase-locked loop (PLL) working from the receiver headphones socket. Direct counting of the incoming frequency was not practical, bearing in mind the much noisier environment of the radio spectrum as compared to cassette systems. A circuit was designed and constructed using the 4046 which, in the absence of an incoming signal, oscillates at about 1500 Hz about the middle of the receiver passband. When signals are fed to it, it locks onto the strongest signal in the range 800-2500 Hz. To obtain this wide range, a short time constant (about 1 msec) must be used in the feedback network from the phase discriminator to the voltage-controlled oscillator. This feedback voltage is approximately proportional to the frequency of oscillation and it is fed to a voltage comparator together with a voltage from a preset potentiometer. The comparator output is a remarkably glitch-free digital signal, which can be fed to one of the computer input ports.

RTTY signals are transmitted using the Baudot code. In the idling condition, a mark signal is transmitted (see Figure 1). A character is initiated by the transmission of one unit at space frequency; this is known as the start pulse. This is then followed by five code pulses, which may be either mark or space, of one unit length. After the last code pulse, the signal returns to mark for at least 1½ time units; this is the stop pulse. The reason for the extra half unit is to allow the receiving machine a chance to catch up if, by chance, it is running a little slow. After the stop pulse, the start pulse of the next character may be sent.

As there are only five code pulses, the code only allows of 2^5 or 32 combinations, which is not really enough. Therefore, two code combinations are dedicated to figures-shift and letters-shift. The other combinations then have two possible values, according to which of figures-shift and letters-shift was last transmitted. This raises the number of useful characters to 60. A large number of versions of this code are currently in use for various languages and alphabets. Various speeds are also in use, the most common being 50 baud (start and code pulses 20 ms, stop pulse 30 ms). This gives a transmission speed of about seven characters/second. Amateurs use a 45.45 baud rate, which is the old American standard.

A decoding algorithm for this code is simple enough to devise; the following was adopted:

1. Wait until signal goes to space. This is beginning to start pulse.
2. Wait for half a time unit. This should be middle of start pulse.
3. Time a series of five time units, sampling the incoming signal at the end of each. These times should be the middles of the code pulses. Shift a 0 or a 1 depending on state into the temporary character storage location.
4. After last code pulse, wait a further 1½ time units. This brings us to half a unit before the end of the stop pulse.

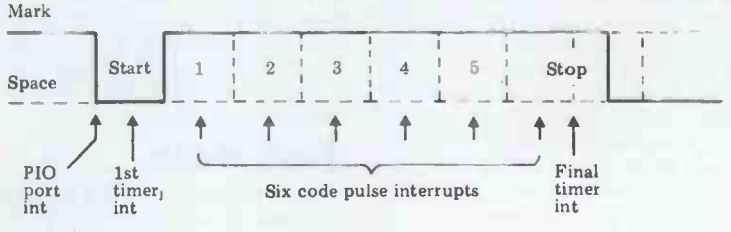


Fig 1 Baudot code signal timing diagram, showing interrupt times. Most commonly-used pulse length is 20 ms for start and code pulses, 30 ms for stop pulse (50 baud)

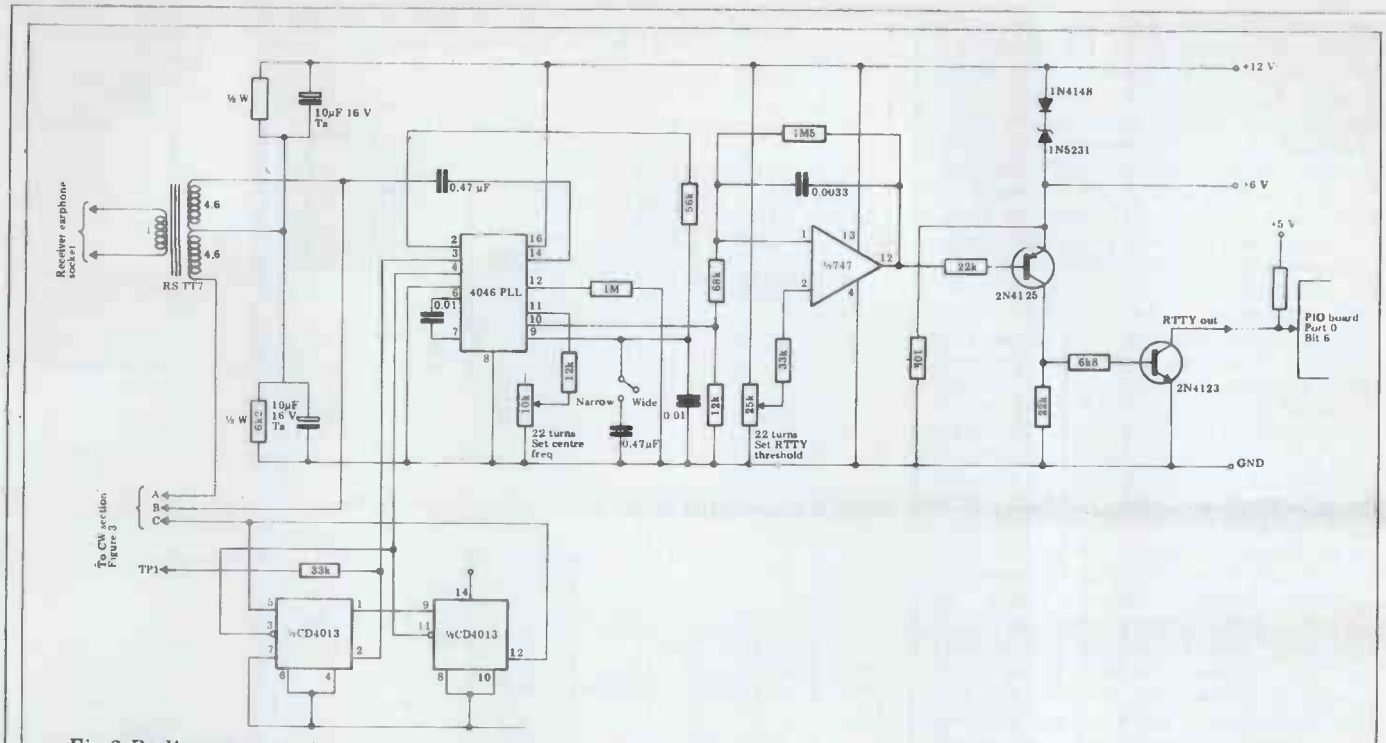


Fig 2 Radio-computer interface

5. Get ASCII equivalent to Baudot code in temporary character stores from look-up table; clear tcs; output ASCII to VDU or printer.
6. Go to step 1.

This system worked well enough but it had the disadvantage that the CPU was almost totally occupied in timing the incoming signals. The only time available for processing the incoming data was the odd half time unit (10 ms) at the end of the stop pulse. Because of this limitation, any sophisticated manipulation of the incoming data — such as compiling a file of stock exchange prices as transmitted by Reuters news agency — was out of the question. One could do little more than simply print out the text. Ideally, the system should be interrupt-driven, ASCII codes of incoming characters being pushed onto a stack as they come in, whence they could be retrieved by the Basic program at its leisure.

To this end, a PIO interface board was obtained from Research Machines. This contains three MK 3881 parallel input/output chips, each of which has two I/O ports and a MK 3882 counter-timer chip with four programmable counters. One of the I/O ports is connected to a D/A converter, which in turn drives a voltage-controlled oscillator with sine-shaping. This can be used for transmitting RTTY signals if required and also Morse (eliminating the need for the key connection to the cassette-control relay). If a number less than 20 is output to this port, the oscillator stops; values of 21 to 255 give tones ranging up to about 5 kHz, enabling limited music programs to be written. Another I/O port is used (two bits only) for high/low frequency and signal present/absent inputs from the receiver interface unit.

Three of the counter/timer units of the MK 3882 are connected in series from the eight microsecond clock signal available in the machine. Each may be programmed to divide by a ratio of up to 256, permitting a wide range of timing functions. The fourth counter channel is connected to a 4 Hz signal, derived by division down by six decades from the 4 MHz clock. This channel can be programmed to divide by 240, giving an interrupt once a minute. The interrupt routine increments a real-time clock, minutes, hours, days and hundreds of days being stored in certain memory locations. The time can be read to a precision of 1/4 sec by INPutting the state of the fourth counter channel.

With this useful addition to the machine, a fully interrupt-driven RTTY receiving routine can now be implemented as follows:

1. When the input frequency goes to 'space' (beginning to start pulse), the PIO port generates an interrupt which:
1.1 Deglitches itself
1.2 Clears temporary character store
1.3 Enables timer interrupts, setting timer to time half a pulse unit.
1.4 Disables its own interrupts
1.5 Returns from interrupt
2. After half a pulse unit, the first timer interrupt occurs which:
2.1 Sets timer to time periods of one pulse unit.
2.2 Sets code pulse counter to time six pulse periods
2.3 Returns from interrupt
3. Thereafter, six further timer interrupts occur at the middles of code pulses 1 to 5 and of the stop pulse, which:
3.1 Sample incoming signal frequency; shift 0 or 1 into temporary character store. (Bit obtained during stop pulse is later discarded).
3.2 Decrement code pulse counter; if not zero, then return from interrupt.
3.3 If it is zero, then:
3.4 Decode Baudot character in tcs, push ASCII onto stack (256 bytes).
3.5 Set timer to time a further half pulse unit, and execuite final interrupt routine.
3.6 Return from interrupt.
4. The final interrupt routine is executed one pulse unit into the stop pulse, half a unit before the end of the character. It does the following:
4.1 Disable timer interrupts
4.2 Enable PIO port interrupts, ready for next start pulse
4.3 Return from interrupt.

The final waiting period of half a pulse unit before enabling for the next character is most important. This brings the total duration of the decoding cycle to seven units, while the incoming signal duration is 7½. Thus the receiving system free-runs only slightly faster than the incoming signals, so that in conditions of interference it is less likely to lose synchronism. When a signal is first tuned in, it takes a few characters to pull into sync but this is no great disadvantage. As a refinement, the program could continuously monitor the duration of the incoming characters, and adjust this final waiting period accordingly but this has not yet been implemented. See the 'Programs' section for an assembler listing of the currently used program.

For each character received, nine interrupts are generated, taking only a few microseconds to execute. What is the machine doing for the rest of the time? Mostly, it is looping around, waiting for a character to appear on the stack:

```
120 A=USR(2):IF A=0 THEN 120
```

A zero value for A indicates that the stack is empty. However, there is no reason why sophisticated Basic programs for manipulating the incoming data should not be written. This would not be possible without the use of interrupts.

The sheer speed of these routines can be demonstrated with an interrupt-driven Morse encoding routine. With this, I can program the machine to calculate and print the square roots of all integers up to 100, while simultaneously transmitting: 'Now is the time for all good men to come to the aid of the party' at about 40 wpm. The simultaneous Morse transmission makes no perceptible difference to execution time as measured with a stop-watch.

Having been to all this trouble, one may well ask the question: what signals

can one receive with the system? Firstly, of course, there are amateurs, for whom RTTY activity is centred around 14090 kHz in the 20-meter band, though locally some signals may be found on 80 and 2 meters. Amateurs use very narrow frequency-shifts, calling for fine tuning and a stable receiver. There is a lot of interference, so that a tunable audio filter (such as those marketed by Datong Electronics) is advisable between receiver and interface unit. Secondly, there are the international news agencies; these signals are likely to be of most interest to the non-radio amateur. These are to be found scattered all over the short-wave band, anywhere between about 5 and 22 MHz. Most of them are of East European or Third World origin and there is a certain monotony about their material. The most noteworthy of these is Tirana, to be found in English on 10435 kHz at 1500 GMT most days. Of the western agencies, Agence France Presse is usually a good signal at night on 5837 and 8022 kHz in English and during the day Reuter's Beirut transmitter comes in quite well on 18334 kHz. The frequencies, however, are subject to frequent change, and one must spend a lot of time tuning around to locate them. Some stations occasionally transmit details of their frequencies and schedules, and these are most useful.

Another class of transmission to be found all over the short waves is what I call the 'numbers machines'. These churn out apparently interminable sequences of five-figure groups; evidently it is meteorological data. These are boring but they are reliable — and useful as test signals. A number of radio telegram links are still operating, despite cables and satellites, and these are to be found around 10 to 13 MHz, sending personal and commercial telegrams.

The Soviet Navy also relies heavily on telegrams, to judge by the amount of traffic. These transmitters are to be found in the marine bands, around 8350 and 12500 kHz. They use narrow shift, and a version of the Baudot code which comes out as an approximate transliteration of Russian. However, they use the null character (all code pulses=space) for letters shift, so unless the program is modified for this it prints out all numbers. The traffic consists mostly of greetings telegrams: 'Greetings, dear mother, on the occasion of International Womens' Day, and best wishes for success at work: signed Ivan.' However, there are occasional excitements like warnings of rocket firings in the Barents Sea, or icebergs off the coast of Newfoundland.

The Soviet news agency TASS is to be found on a large number of frequencies, transmitting in a variety of languages. For Russian, they use a quite different version of the Baudot code. Breaking this proved an interesting exercise, as I had little to go on other than that TASS was BFXX. However, a lucky guess that FATFRVXBFR was AFGANISTAN, and all else fell into place. A separate look-up table for this code has been added, and a single-character transliteration of the Russian letters devised.

TASS and other agencies also transmit a great deal of material in Arabic. This code uses no carriage returns but double line feeds. I would be glad to collaborate with anyone who knows the language in breaking it.

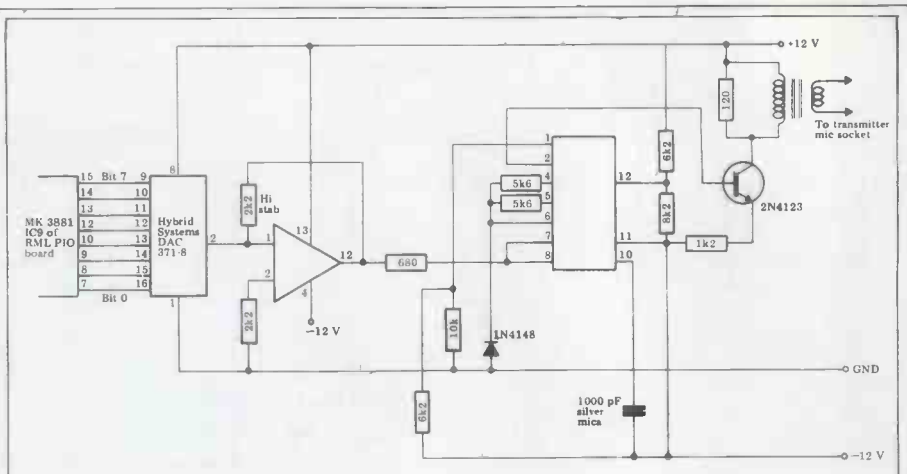


Fig 3 Transmitter section

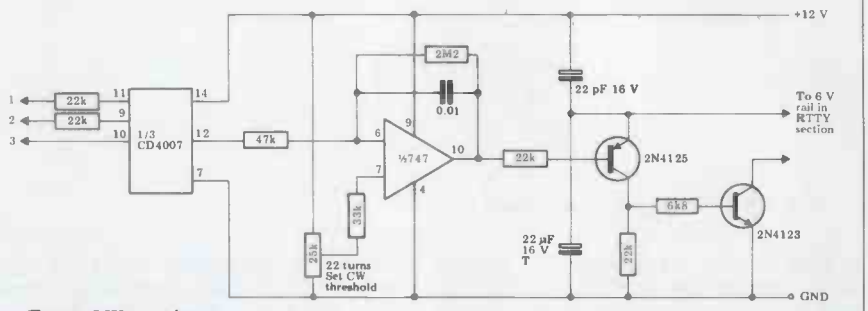


Fig 3 CW section

```
TK MARsAL ROKOSSOWSKIJ NWR/NMF 364 34 25/2 2300.
WRU4IT' T/S SERIa N-25
NOWOROSSIJSK PROFTEHOBRAZOWANIa 12 KW 9 sILOWOJ MARINE
WASIL'EWNE,
MARINA POZDRAWLau TEBa PRAZDNIKOM MEzDUNARODNYM DNEM zENOIN
8 MARTA zELAu TEBE KREPKOGO ZDOROW'a SHAST'a USPEHOW zIZNI
DOMA BUDU KONCE MARTA  CELUu
WASa-
```

Sample Russian telegram (Soviet Navy code). Translation: 'From (ship) Marshal Rokossovski No 364 34 25 Feb 2300. To: Marina Vasilevna Shilovaya, Flat 9, Professional-technical education St. 12, Novorossisk. Marina I greet you on the holiday of the international day of women 8th March. I wish you good health, happiness and success in life. Will be home at end of March. Best wishes. Vasha.'

On the short waves, there are also many signals which sould rather like Baudot code but which in fact are not. If tuned in, they print garbage. On analysis, these prove to look just like binary noise; an apparently random sequence of mark and space pulses, with no regularly-occurring start and stop pulses. Common pulse lengths used are 10, 13.33, 16.67 and 20 ms. Some have been found sending a repeating 56-bit sequence; trying to break these would be an interesting exercise. With practice, these signals can be distinguished by ear, as they lack the regular rhythm of the Baudot code.

Tuning in the RTTY signals presents no great difficulty, unless a very narrow shift is being used. So long as the mark and space frequencies are either side of the preset threshold (around 1500 Hz), good copy should be obtained. However, the choice as to whether mark or space is the higher frequency is apparently arbitrary; one must try tuning it both as upper or as lower sideband, and make a note of which is in use for future reference. Most commercial and news agency transmitters use the wide 850 Hz shift; this is wide enough for my receiver (Yaesu Musen FRG-7) to be left on a station all day without drifting far enough to lose copy.

Having achieved satisfactory RTTY reception, the next move is obviously towards Morse reception and ultimately, perhaps, full automation of the amateur station. Whether this could ever be achieved satisfactorily or not, and if so, whether or not it would be legal, are open questions; nevertheless, it will be an extremely interesting exercise in programming!

RTTY

The unit is constructed on a piece of Veroboard cut to fit into a spare slot in the 380Z case. It is connected to the PIO board with a multiway connector which carries the computer +12 V, +5 V and −12 V supplies to the interface unit, and the current output of the digital-to-analogue converter mounted on the PIO board. Single-bit signals for carrier on/off (port 0 bit 7) and frequency high/low (port 0 bit 6) are returned to the PIO board.

Two scrambled cables carry audio signals to and from the radio equipment via a DIN socket at the rear of the computer cabinet. Signals are at the levels normally encountered at a receiver headphone socket and as

supplied by a low-impedance dynamic microphone.

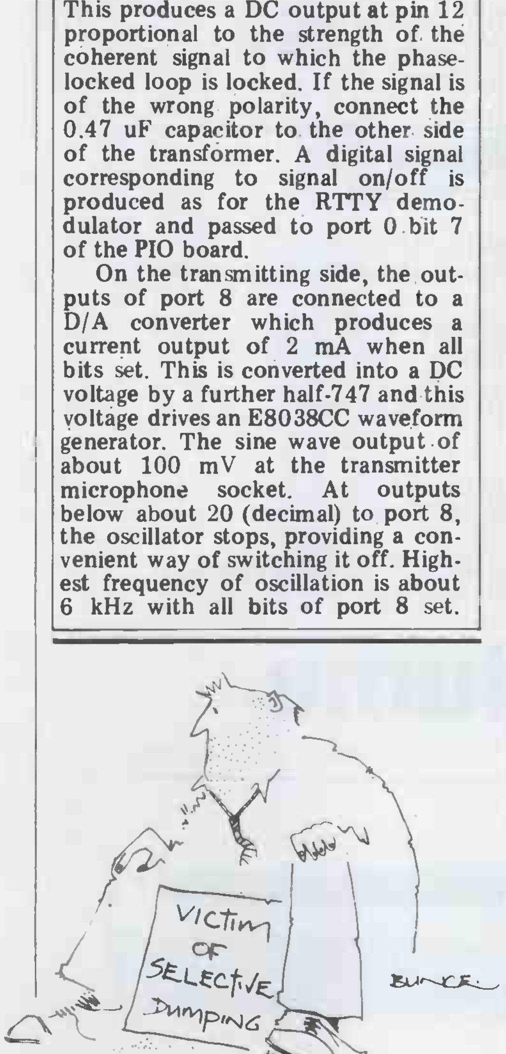
To avoid earth loops, audio transformer coupling is used. However, RF interference is reduced if the radio earth is connected to the computer case at the DIN socket.

The RTTY section consists principally of a CD4046 phase-locked loop IC, which tracks the strongest coherent signal at its input in the range 800-2500 Hz. The VCO control signal, derived from the phase comparator output, is also compared with a preset DC level by a half-747 op amp working as a high-gain comparator. This gives an-off signal, which is converted to TTL levels by a discrete-component level translator. Output is via open collector; a pull-up resistor of about 33k may be connected from it to the 5 V rail.

The 4046 in fact oscillates at twice the signal frequency, an arrangement of two D-type flip-flops being used to halve its frequency and provide in-phase and quadrature outputs. When using phase comparator 1, the 4046 locks into a 90-degree phase relationship with the incoming signal, so a quadrature oscillator signal is also necessary for CW demodulation.

In the CW section, this quadrature signal is compared with the incoming signal in a balanced demodulator using one section of a CD4007 IC. This produces a DC output at pin 12 proportional to the strength of the coherent signal to which the phase-locked loop is locked. If the signal is of the wrong polarity, connect the 0.47 uF capacitor to the other side of the transformer. A digital signal corresponding to signal on/off is produced as for the RTTY demodulator and passed to port 0 bit 7 of the PIO board.

On the transmitting side, the outputs of port 8 are connected to a D/A converter which produces a current output of 2 mA when all bits set. This is converted into a DC voltage by a further half-747 and this voltage drives an E8038CC waveform generator. The sine wave output of about 100 mV at the transmitter microphone socket. At outputs below about 20 (decimal) to port 8, the oscillator stops, providing a convenient way of switching it off. Highest frequency of oscillation is about 6 kHz with all bits of port 8 set.




```
0000               ;   VERSION .001
0000               ;   **********************************
0000               ;   *                                *
0000               ;   *             RBFTY1             *
0000               ;   *                                *
0000               ;   **********************************
0000               ;
0000               ;   ROUTINES TO BE ADDED TO RESEARCH MACHINES
0000               ;   BASIC VERSION 5.0 FOR RADIO TELETYPE
0000               ;   RECEPTION. NEEDS PIO BOARD WITH SIGNAL
0000               ;   0=SPACE, 1=MARK TO BIT 6 OF PORT 0 (CONTROL
0000               ;   PORT 2).
0000               ;   CTC CHAN 12 IS CONNECTED TO AN 8 MICROSEC
0000               ;   CLOCK, CHAN 13 TO O/P OF CHAN 12.
0000               ;
0000               ;   BASIC ENDS AT ADDR 6C5DH. ROUTINES START
0000               ;   AT 6C60H.
0000               ;
6C60                   ORG 6C60H         ;INTERRUPT VECTOR TABLE
6C60 6A6C              DEFW DUMINT       ;CH 12-NO INTS
6C62 036D              DEFW PLSINT       ;CH 13-PULSE INTERRUPT ROUTINE
6C64 6A6C              DEFW DUMINT       ;CH 14-NO INTS
6C66 6A6C              DEFW DUMINT       ;CH 15-NO INTS
6C68 C56C              DEFW START        ;CH 0 -START INTERRUPT ROUTINE
6C6A               ;                     ;OTHER PIO CHANS NOT USED.
6C6A               ;-----------------------------------
6C6A FB                DUMINT: EI
6C6B ED4D                      RETI      ;DUMMY INT ROUTINE
6C6D               ;-----------------------------------
6C6D                   USR:              ;*USR ROUTINE ENTRY*
6C6D CD2744            CALL 4427H        ;USR ARGUMENT INTO DE
6C70 7B                LD A,E            ;LS BYTE INTO A
6C71 00                NOP
6C72 00                NOP               ;SPACE FOR FURTHER CALL
6C73 00                NOP
6C74 E607              AND 7H            ;ALLOW 8 CALLS
6C76 21836C            LD HL,JPTBL       ;ADDR OF BOTT OF USR JUMPTABLE
6C79 87                ADD A             ;DOUBLE USR ARG
6C7A 0600              LD B,0
6C7C 4F                LD C,A            ;BC=TABLE OFFSET
6C7D 09                ADD HL,BC
6C7E 7E                LD A,(HL)
6C7F 23                INC HL
6C80 66                LD H,(HL)
6C81 6F                LD L,A            ;HL NOW HAS ADDR OF ROUTINE
6C82 E9                JP (HL)           ;JUMP TO IT!
6C83               ;-----------------------------------
6C83                   JPTBL:            ;USR JUMPTABLE
6C83 566F              DEFW DISINT       ;USR(0)-DISABLE INTS
6C85 936C              DEFW DUMRET       ;USR(1)-NOT ASSIGNED
6C87 776D              DEFW GETCHA       ;USR(2)-GET ASCII FROM STACK
6C89                                     ;& RETURN TO BASIC
6C89 936C              DEFW DUMRET       ;USR(3)-NOT ASSIGNED
6C8B 936C              DEFW DUMRET       ;USR(4)-NOT ASSIGNED
6C8D 946C              DEFW INRTTY       ;USR(5)-INITIATE RTTY RECEIVE
6C8F 546D              DEFW CLRSTK       ;USR(6)-CLEAR RX STACK
6C91 936C              DEFW DUMRET       ;USR(7)-NOT ASSIGNED
6C93               ;-----------------------------------
6C93 C9                DUMRET: RET       ;DUMMY USR CALL
6C94               ;-----------------------------------
6C94                   INRTTY:           ;INITIALISE RTTY ROUTINE
6C94 ED5E              IM2               ;SET INT MODE 2
6C96 3E6C              LD A,6CH          ;MS BYTE OF INT VECTOR TABLE
6C98 ED47              LD I,A            ;TO INT REGISTER
6C9A 3E60              LD A,60H          ;LS BYTE TO CTC INT REGISTER
6C9C D30C              OUT (12),A        ;AUTOMATICALLY DOES 13,14,15
6C9E 3E68              LD A,68H          ;LS BYTE TO PIO CHAN 2
6CA0 D302              OUT (2),A         ;WHICH IS CTRL CHAN FOR CHAN 0
6CA2 21BC6C            LD HL,TABLE1      ;ADDR OF CONTROL WORD TABLE
6CA5 0E0C              LD C,12
6CA7 0606              LD B,6
6CA9 EDA3          JP1: OUTI
6CAB EDA3              OUTI
6CAD 0C                INC C
6CAE 10F9              DJNZ,JP1          ;OUTS 2 BYTES EACH TO 12 AND 13
6CB0 0E02              LD C,2
6CB2 0605              LD B,5
6CB4 EDB3              OTIR              ;OUTS 5 BYTES TO CHAN 2
6CB6 CD546D            CALL CLRSTK       ;CLEAR RX STACK
6CB9 FB                EI
6CBA ED4D              RETI              ;380Z PIO BOARD NEEDS DUMMY RETI
6CBC               ;-----------------------------------
6CBC               TABLE1:               ;TABLE OF CONTROL WORDS
6CBC 7F197F64          DEFB 127,25,127,100
6CC0                                     ;CH 12 DIVIDES BY 25 TO GIVE O/P
6CC0                                     ;AT 5 KHZ. CH 13 DIVIDES BY 100
6CC0                                     ;WHICH IS 5000/BAUD RATE. CHANGE
6CC0                                     ;THIS VALUE WITH POKE FOR OTHER
6CC0                                     ;BAUD RATES.
6CC0 FFFF57BF83
                       DEFB 0FFH,0FFH,57H,0BFH,083H
6CC5                                     ;CTRL BYTES FOR CHAN 0/2
6CC5                                     ;SEE HANDBOOK FOR EXPLANATION.
6CC5               ;-----------------------------------
6CC5               START:                ;INT ROUTINE EXECUTED WHEN
6CC5                                     ;START PULSE BEGINS.
6CC5 C5                PUSH BC
6CC6 D5                PUSH DE
6CC7 E5                PUSH HL
6CC8 F5                PUSH AF
6CC9 0610              LD B,16           ;THIS ROUTINE WAITS FOR 16
6CCB F702          JPG: EMT 02H          ;KEYBOARD CHECKS AND ONLY
6CCD DB00              IN A,(0)          ;CONTINUES IF FREQ IS SPACE
6CCF 17                RLA               ;AFTER ALL OF THEM. IF NOT,
6CD0 17                RLA               ;IT DOES A RETI AND AWAITS
6CD1 00                NOP               ;ANOTHER START INTERRUPT.
6CD2 CB15              RL L
6CD4 CB14              RL H
6CD6 10F3              DJNZ,JPG
6CD8 AF                XOR A
6CD9 B4                OR H
6CDA B5                OR L
6CDB 201C              JR NZ,JP2
6CDD 00                NOP
```

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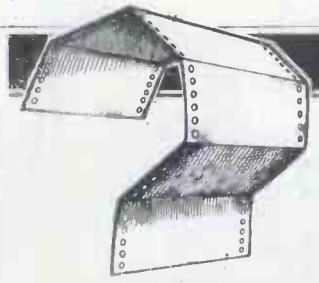

COMPUTER ANSWERS

Send your queries to: Sheridan Williams at 35 St Julian's Road, St. Albans, Herts.

Sound advice

I am new to computing but not to electronics. Would you answer the following questions:
1. How do the 'sound boxes' work on computers like the PET, TRS-80, etc?
2. How are they interfaced?
3. Could I build one for the Compukit 101?
4. Where could I get a circuit diagram?
5. Failing item 4, could I adapt a PET/TRS-80 box to fit my Compukit?
W J Mawdsley, Wigan

There is a wide range of ways to produce sound on a microcomputer. About the simplest, from a hardware point of view, is to use machine code routines to send alternate ones and zeros to an output line of a user port. A simple transistor amplifier can then be attached to the line to produce an audio output of predetermined frequency. One disadvantage with this method is that it wastes CPU time, requiring attention from the CPU for the full duration of sound output.

Soundboxes for the PET use a similar serial approach but avoid this latter problem by using the shift register facility on the 6522 user port. This allows audio output to continue at the chosen frequency without the active support of the CPU, since the audio is generated by the shift register and not by the CPU itself. Again, the external hardware is very simple — a transistor amplifier is connected to the CB2 line of the user port, which, in turn, drives the loudspeaker. Software for this type of soundbox is pretty straightforward. The port is first of all initialised for shift register output on CB2 and appropriate data is then placed in the shift register and its associated timing registers to produce the required output.

If you are after a more sophisticated soundbox, the type based on a device known as a 'Programmable Sound Generator' may be worth considering. One of the most readily available PSG chips is the General Instrument AY-3-8910. This is a 40-pin device containing three tone synthesisers, a white noise generator of variable colour, three mixer channels whose output levels may be individually controlled, and an envelope shaper that may be applied to any of the three channels. All functions are software controllable from Basic or machine code, and the variety of sounds that may be produced with this chip is quite astonishing. The AY-3-8910 retails at around £10.

The problem with adding a soundbox to the UK101 is that this machine does not have an integral user port. Several companies are advertising add-on sound units for the UK101, however, and if you want to build your own, see the October 1980 *PCW*, which contains an article on interfacing the AY-3-8910 to the '101.
David Harper

More problems

I wonder if Mr Hutchinson would be interested in the enclosed problems. Perhaps you would tell me what is the next step up from the ZX80? I am frustrated by the lack of moving graphics, graph plotting facilities, floating point/scientific functions. I would like to be able to calculate and plot differential equations and the ability to handle large multi-dimensional arrays would be useful.
G J Suggett, Chichester

Many thanks for the problems — I have tried them myself, and they can provide a bit of fun.
1. Take any odd number X, multiply by 3 and add 1 (ie, form 3X+1). Now divide this by 2 as many times as are necessary to reach another odd number. Repeat the process. All numbers so far tested eventually reach 1 after enough repeats. It has not been demonstrated that all numbers must reach 1, so can you find one that doesn't?
2. Take an n-digit number X. Let MAX be the largest number that can be formed from the digits of X, and MIN the smallest. Define a new X to be MAX-MIN. Repeat this process. For four-digit numbers, for instance, all numbers eventually reach 6174; for other values of 'n', cycles can be found; what numbers are reached for values of n greater than 7?
3. Consider a number X. Let Y be the number X with its digits in reverse order. If X=Y (X is a palindrome) then stop, otherwise form the new Y as X+Y. Most numbers reach a palindrome and hence stop. But X=196 goes on at least 50 times; does it ever stop?

To answer Mr Suggett's question of 'what comes after the ZX80?' is easy — the ZX81. But seriously, you have hit the snag; the ZX80/81 represent exceptionally good value for money but anyone with a slight flair for computing will outgrow them in a few weeks. Nevertheless, there is a good second-hand market for them even if you do lose a fair bit of money. Next step up depends on how much interest and money you really have. Having told everyone to wait for the 'Newbrain' I now realise that there is little point waiting for ever. I attended a meeting where the BBC outlined the plans for its new series of microcomputer programming courses in late 81/early 82. The BBC micro (which will be built by Acorn) seems from the spec to be a system with potential. Here is a brief spec: Available Autumn 1981 at approx £230; 2 MHz 6502 CPU; 16k RAM; 32k ROM (the ROM includes 16k Basic); 16k operating system including machine, cassette, disk and network operating systems; eight display modes: Teletext, 80 x 25 character mode, 320 x 256 high-res mode with up to eight colours; Microsoft Basic, cassette, TV and video interfaces and a travel keyboard.

There will be an enhanced version at around £330 which has, in addition, memory extended to 32k RAM, A-D interface, Centronics printer interface, RS232, 'Tube' and Bus connectors.

This all seems to be good value for money and unless the same happens to this as the Newbrain, then it should be worth waiting for. If you cannot wait, then visit a few dealers and try the Video Genie, or the Acorn Atom.
SW

Growing an Acorn

I would like to know some information about extending the memory of my Acorn Atom. I recently bought four RAM chips from Acorn which should extend the memory by 2k. The chips are marked thus: 043B MM 2114N-L and cost £10.22 per 1K. I have seen other 2114s advertised costing £2.25 each (£4.50 per 1K). Would these be suitable and, if so, what conditions should they meet (450 ns or 200 ns etc)? Why are Acorn's chips so expensive?
Richard Hallam, Grimsby

There are two main conditions that 2114 RAM chips for your Acorn should meet. They should be of the low power variety (sometimes coded 2114-L or LP), so as not to overwork the Atom's power supply as you expand further; and they should have a fast enough response time. Since the Atom operates with a 1MHz clock rate, like many 6502-based machines, it will work happily with memory chips having a 450 ns response time and does not require the more expensive 200 or 300 ns types.

The price of memory chips such as the 2114 and 4116 is dropping almost daily and it is now possible to buy 2114s at around the £2 mark. These will work perfectly well on the Atom and will reduce the cost of further expanding your machine to less than one-third of the price you quote.
David Harper

Genie mods

I am pondering whether to buy a Video Genie, TRS-80, or a Nascom 2, so could you answer these questions:
1. Can the Genie/TRS-80 be modified in hardware or software to produce a 64 x 32 line VDU; if so, how?
2. Is it possible to speed up the Genie/TRS-80 to 4 MHz?
3. Can the Genie be given MZ-80K type graphics instead of lower case?
R Moore, Richmond

1: Two options of character format are available on the VDU, either 64ch x 16 lines or 32ch x 16 lines. To obtain either format the MODESEL (mode select) line must be set to either a 1 or 0 depending on which option is required. In software terms this requires an OUT instruction to address FF with data bit 3 set to '0' for 32 x 16. POKE can be used on Level II to operate this function, but on Level I it is necessary to have the T-BUG software package to select this mode. The video system is limited to 1024 RAM mapped locations and would therefore require a major alteration to the system to achieve a larger number of characters.
2: Any Z80/Z80A-based system is capable of supporting up to 256 I/O peripherals. This is achieved by using an address taken from the lower order eight address bits, together with the IN/OUT instructions from the Z80 instruction set. The appropriate signals are as follows:

Hardware:	$\overline{IORQ}$	$\overline{RD}$
	$\overline{IORQ}$	$\overline{WE}$
Address:	A0 → A7	

COMPUTER ANSWERS

Data: D0 → D7

In addition, it is, of course, possible to memory-map additional peripherals as is done with the VDU but this would be at the expense of the 64k addressing capability of the processor.

3: Any Z80-based system working at 2 MHz can, in theory, be speeded up to 4 MHz. To do this it is necessary to change to the Z80A processor; it is pin-compatible so you just change one for the other. The processor clock frequency must be increased correspondingly but, as in most systems, the processor clock is derived from a higher frequency, it is now merely a case of selecting the appropriate divider output. Access times can be a problem if you speed up the data clocking rate above that quoted for the memory chips in use. This is because once a memory location has been addressed, there is a delay before the data in that location is available for reading correctly.

Terry Bourne

Micros and radio

I am a technical author and also a radio amateur, considering the purchase of a personal computer for word processing and scientific calculations. It could also have practical uses related to amateur radio. One application would be to convert radio-teleprinter signals to text for display on the VDU and copying on the printer. A dedicated micro-based instrument, the TONO Theta 7000E, is available at £640... more than many general purpose micros!

Do you know of a program that would perform these functions on a micro?

P J Horwood, Dartford

A program is available to run on either the Tandy TRS-80 Model I, Level II (16k minimum), or on the Video Genie. This is 'Morse Code Communicator', available from A J Harding (Molimerx) at under £18 on tape, or about £21 on disk. Another useful program for radio amateurs is 'Ham Radio', available from Microcomputer Applications, of 11 Riverside Court, Reading at £6.50. This covers more general aspects.

I understand that a hardware solution to the Morse decoding problem is available in the USA from Megatronics for under £100 but I do not have an address for them. It is possible that other radio amateurs might be able to help with this, as I understand the firm is well-known. See also the article on decoding RTTY elsewhere in this issue.

P L McIlmoyle

Wrong!

In an earlier issue (Dec 80) you published a reply to an enquiry regarding high resolution plotting on the UK101, which I found disappointing as it did not work! The trouble is that the answer assumed that the UK101 had characters that it does not possess! Could I have your comments please?

M Croft, Leeds

I must apologise to readers for disappointment caused by my over-enthusiasm. On reading the manual for the UK101 and learning that it had no fewer than 255 different graphics characters I just assumed that these must include the set of 64 needed for high resolution plotting. In fact, I still find it hard to credit that this is not the case, despite my subsequent confirmation of this sad fact. It might well be worthwhile for a future version to be so equipped. In the meantime, Comp Shop has kindly pointed out that you can get quite reasonable graphics by making use of the characters from ASC(128) to ASC(135), which respectively produce the eight individual horizontal lines making up a pixel.

Another solution would be to get the new Programmable Character Generator for the UK101 and Superboard from Premier Publications of Croydon. However this costs £81 in kit form!

P L McIlmoyle

Starting small

Could you please advise on the choice of a microcomputer system meeting the following needs:

1. Should start in an inexpensive basic form but capable of expansion, even up to printer and floppy, should I later decide to go for these.
2. The computer would be for 'personal' use with a bias to scientific and technical use. Business programs would be rare and of low priority.
3. I would be happy to build from a kit and would prefer a modular construction in the interests of flexibility.

D B Lillics, Edinburgh

Before plunging into hardware we should do our systems analysis. If you want a computer mainly for scientific and technical use, you will need an appropriate language. The most popular for such work is Fortran, but a good (at least 8k and preferably 12k) Basic will also serve. If you want to use one of the newer languages, then APL could well be your choice. The latter two are also widely used for business programs and Basic, of course, for personal computing.

If you want a choice of languages, then you need a machine that is not limited to one language in ROM. Adding your other requirements narrows the field a great deal and leaves effectively the Microtan and the Transam Tuscan. The latter is designed around the S100 bus and is intended to use CP/M as a disk operating system. If you do move to disks, this will let you choose from a wide selection of commercially available languages, including Fortran, extended Basics and APL. Both systems allow you to build up from a basic system to one which is quite sophisticated.

P L McIlmoyle

AIM info

Has *PCW* reviewed the AIM 65? If not, can you give me a reference to a review in another journal?

My interest is in learning about microprocessors, I/O devices and control techniques. I have no particular interest in running programs in Basic.

L A Gilbert, London

If *PCW* has reviewed the AIM 65, my data retrieval system is letting me down! However the following references should help: *Practical Computing*, 2, 7, July 1979, p 38, *Computing Today*, 1, 10, Dec 1979, p 20.

The AIM 65 has long seemed to me to be a much neglected machine and its price is by no means unreasonable, bearing in mind that this single-board includes a printer! While it was originally intended for use with machine code, a Basic interpreter has been available for a while for those who want it. Perhaps it will gain in popularity now that the 'Cubit' conversion card has been introduced by Control Universal Ltd. For £75 this adds to the AIM 65 an extra 4k of RAM, an extra VIA, a 4k EPROM socket for development work and an interface to all Acorn Eurocards, thus paving the way to a very considerable potential expansion.

P L McIlmoyle

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by Kevin O'Connell

German blitz

Mr Arndt Rottenbacher of Berlin staged an interesting little tournament which was reported in the March issue of *Rochade*. He played a four-round tournament, among five chess machines, at 'blitz' (five seconds per move) chess (see Table 1). The machines were played on the following settings: 1. Level 1; 2. Five seconds per move; 3. Level 1; 4. Level 1; 5. Level A1; 6. Level 0.

The conference 'Advances in Computer Chess 3' was held at Imperial College, London in April. The proceedings will again be published by Edinburgh University Press and I will give the details in this column a little nearer publication date.

The second World Microcomputer Chess Championship will probably be held in Hamburg near the end of the year. I will announce full details as soon as they become available.

Botvinnik

Dr Mikhail Botvinnik was World Chess Champion 1948-1957, 1958-1960 and 1961-1963 and has been involved in computer chess since 1958. Pergamon Press has just published his *Selected Games 1967-1970* (£5.80 in paperback, £12.00 in hardback). A careful study of the 40 well-annotated games would improve anyone's understanding of chess. However, the main interest to anyone involved in computer chess must be the final chapter of the book, 'The Tale of a Small Tree', in which Botvinnik outlines his thinking on computer chess and describes the historical evolution of his program 'Pioneer'.

ICCA

The International Computer Chess Association is the governing body for computer chess. You can join and get the Association's newsletter for $10.00 per year. A set of reprints of all previous Newsletters is available for $5.00. Write to Dr Ken Thompson, Bell Telephone Labs, Room 2C423, Murray Hill, NJ 07974, USA.

I am currently compiling a list of available chess programs for personal computers. If you know of anything (other than Microchess and Sargon) that is available, please drop me a line stating the name of the program, the machine it runs on, machine requirements, author of program, publisher of program and, if known, the price and where it can be obtained. I will then share that information with all readers of this column.

	1	2	3	4	5	6	
1 Sargon 2.5	xxxx	=111	1=1=	1111	01=1	1111	17
2 Chess Champion Mk III	000=0	xxxx	1110	0=-=1	1110	1=01	11
3 Intelligent Chess	0=0=	0100	xxxx	=11=	1110	1010	10
4 Sensory Voice Challenger	0000	=01=	0=-=0	xxxx	=-=11	0111	9
5 Mephisto	=010	0100	0100	00=-	xxxx	0110	6½
6 Sargon 2.5	0000	100=	0101	0010	0110	xxxx	6½

Table 1

The 2nd European Microcomputer Chess Championship

The Second European Microcomputer Chess Championship will be held as part of the Fourth *Personal Computer World* Show at the Cunard Hotel, Hammersmith, London, 10-12 September. The organising committee consists of David Levy, myself and the editor of *PCW*. It is hoped that Dr Michael Clarke and Peter Morrish will again be tournament arbiter and tournament director respectively. Here are the tournament rules:

1) The Championship is open to chess programs running on a single microprocessor. All entrants must provide their own microprocessor hardware, which must compete from the tournament hall.

2) If it is necessary to limit the number of entries, the decision as to which entrants shall be accepted will be made by the organising committee on the basis of games played by the program.

3) Programs which are, or are about to be, marketed as chess machines or as software for personal computers will be allowed to enter, but they will have to pay an entry fee of £200 per program. Cheques should be made payable to 'Sportscene Publishers (*PCW*) Ltd'. Such entries will only be accepted if made by a copyright owner (manufacturer, programmer, etc) of the program. In the case of an experimental program from an established manufacturer or software house, this may only be entered if the manufacturer or software house also enters at least one of its already commercially available programs and on condition that the experimental program plays under the name of '. . . . (manufacturer's name) Experimental'.

4) The closing date for entries shall be 15 August 1981, although entries may be accepted after that date at the discretion of the organising committee. Confirmation of acceptance or rejection of entries shall be made known by 25 August 1981.

5) The Championship will be run as a five-round Swiss system tournament unless the organisers decide that the number of entries requires a different number of rounds. Any alteration to the number of rounds will be notified to entrants before the first round.

6) Unless otherwise specified, rules of play are identical to those of regular 'human' tournaments. If a point is in question, the tournament director has the authority to make the final decision.

7) Games are played at the rate of 30 moves per player per hour.

8) The tournament director has the right to adjudicate a game after four hours of total elapsed time or 60 moves have been played, whichever is the later.

9) If an entrant encounters technical difficulties (machine failure, program failure) during the course of a game, the tournament director may allow the clock to be stopped for up to 30 minutes. The total time that an entrant's clock may be stopped during a game is 30 minutes and there shall be a limit of three occasions in which each entrant may take a time-out during each game.

10) There shall be no manual adjustment of program parameters during the game. Before play begins, the operator shall do all initial setting-up of the computer. At this time the operator may freely specify any operational parameters, such as rate of play, suggested openings, value of a draw, etc. After play begins, the role of the operator is passive. As such, the operator is not allowed to alter any parameter settings during play that might alter the course of the game. The arbiter must give permission for non-routine communication by the operator. During play, the operator is to communicate the moves of the opponent to the computer, to make the computer's moves on the board and to press the clock, unless any or all of these actions are rendered unnecessary by the computer's ability to perform them.

11) In the event that a program makes the offer of a draw, that offer shall be communicated to its opponent (if there is a way to do so). No human connected with a program may intervene by offering a draw, accepting a draw, or in any other way.

12) Any program making an illegal move shall lose the game, unless the illegal move is due to program failure or machine failure, in which case such failure may be rectified in accordance with rule 9. Should a program make an illegal move (whether the same or different) three times in succession, it shall lose the game.

13) At the end of each game each entrant is required to hand in a game score to the tournament director. Entrants must keep the score of each game as the game progresses.

14) In the event of a tie for first place the sponsors have the right to insist on a play-off competition. If the tie involves more than two entries, a tie-break system may be employed.

15) The outright winner of the tournament, whether a commercial or non-commercial entry, shall receive the *Personal Computer World* trophy for the European Microcomputer Chess Champion.

16) Details of the prizes will be announced no later than the confirmation date of 25 August.

17) All queries regarding the competition shall be addressed to: Second European Microcomputer Chess Championship, *Personal Computer World*, 14 Rathbone Place, London W1P 1DE.

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 .

1st Prize
DAI PERSONAL COMPUTER

2nd Prize £100
3rd Prize £50

Articles of around 2500 words are invited, 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, Adrian V Stokes, Chairman of the IYDP Technology Working Group and Judith Hann, presenter of Tomorrow's World and science writer.

Please send your entry to IYDP Competition, 14 Rathbone Place, London W1P 1DE, enclosing a suitable SAE if you would like it returned.

Personal Computer World

19 81
International Year of Disabled People

Data Applications Ltd has kindly donated the first prize of a 48K personal computer worth £595. Plugging into the domestic TV, it provides sound, colour and high-resolution graphics.
Sharp Electronics (UK) Ltd has kindly donated the third prize of £50.

The IYDP has requested an extension of the deadline for the competition to 31 July 1981. This is to help students fit their efforts around the academic curriculum.

THE GREAT COVER-UP!

Not since the days of Watergate has there been a public scandal of such far-reaching implications.

It has recently come to the attention of the *PCW* Secret Police that certain regular readers have been storing their valuable back issues 'au naturelle'.

We consider this practise to be singularly lacking in dignity, and would therefore appeal to you in the name of common decency to please ensure that your magazines are properly dressed at all times.

This may be achieved by the simple expedient of purchasing one or more of our sturdy yet colourful *PCW* binders.

So why not join in the great cover-up and preserve your precious *PCW*'s in their original pristine perfection.

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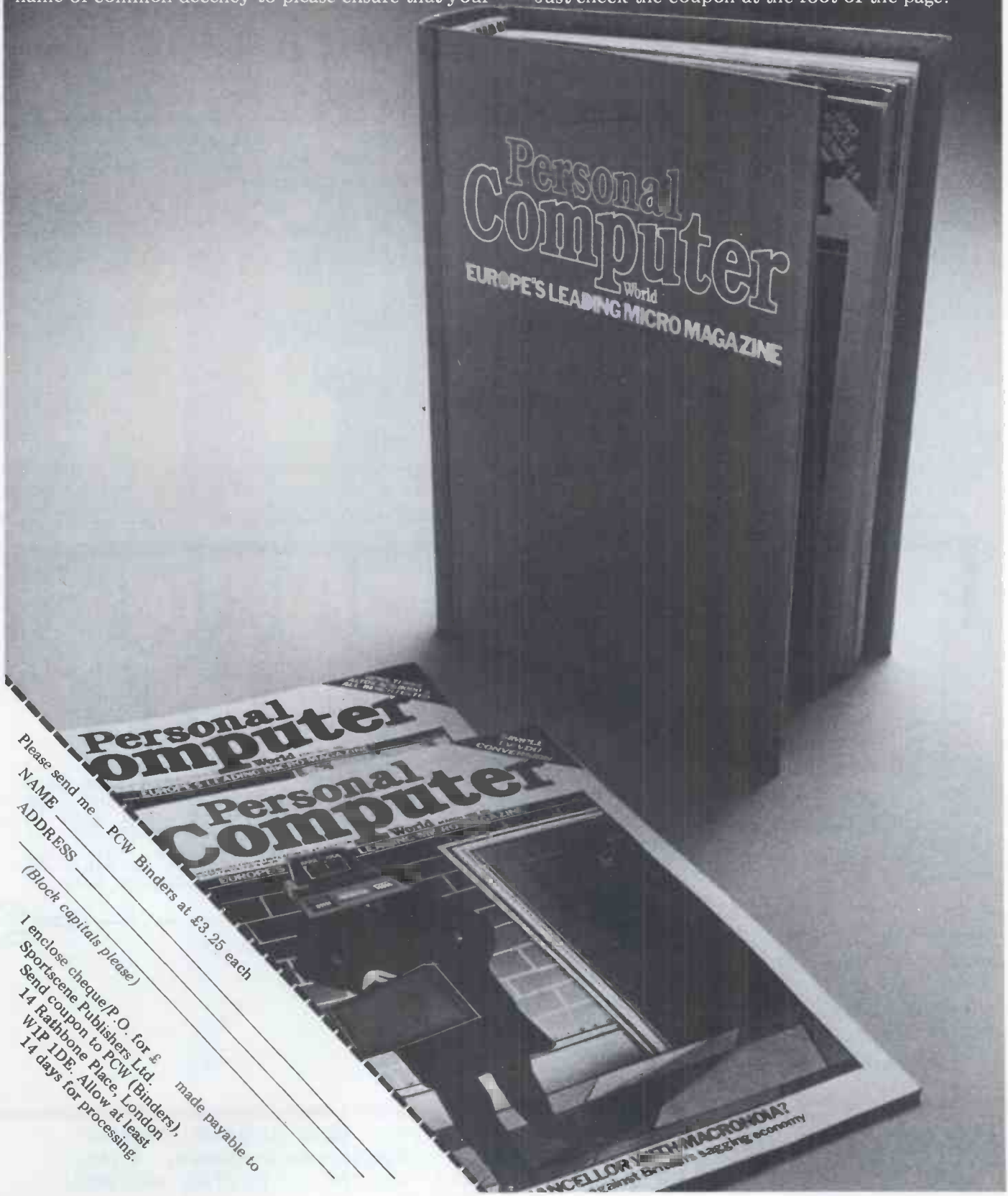

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Increase your PET'S Basic by one third!

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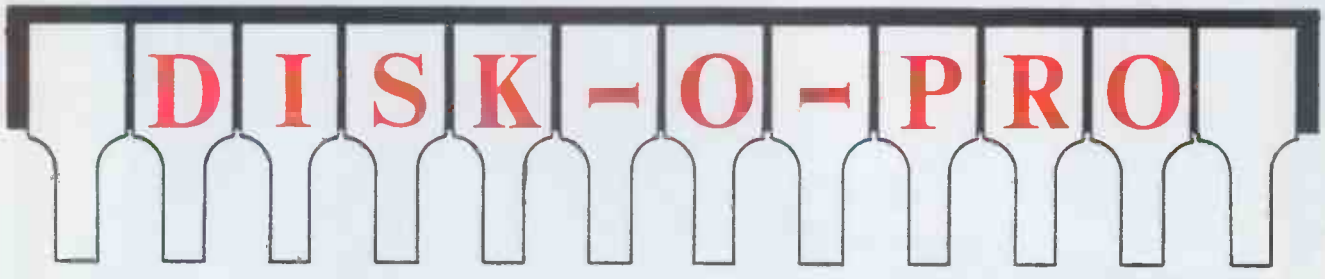
BASIC FOUR USERS - COMPARE:	COMMAND-O 4KB ROM	TOOLKIT 2KB ROM
AUTO	Yes	Yes
DUMP	Yes	Yes
DELETE	Yes	Yes
HELP	Yes	Yes
FIND	Yes*	Yes
RENUMBER	Yes*	Yes
TRACE, STEP	Yes*	Yes
OFF, KILL/BYE	Yes	Yes
MOVE (8032)	Yes	No
SEND (IEEE/DISK)	Yes	No
INITIALIZE (DISK)	Yes	No
EXECUTE (DISK)	Yes	No
MERGE, MERGE#	Yes	No
PRINT USING	Yes	No
BEEP (CB2)	Yes	No
SCROLL, OUT	Yes	No
SET SOFTKEY	Yes	No
'EAT' KEY	Yes	No
REPEAT KEY (4032)	Yes	No
CTRL KEYS (8032)	Yes	No

* IMPROVED

BASIC TWO USERS - COMPARE:	DISK-O-PRO 4KB ROM	BASIC 4 UPGRADE
DIRECTORY, CATALOG	Yes	Yes
DLOAD, DSAVE	Yes	Yes
DOPEN, DCLOSE	Yes	Yes
SCRATCH, RENAME	Yes	Yes
COPY, BACKUP	Yes	Yes
RECORD, APPEND	Yes	Yes
CONCAT, COLLECT	Yes	Yes
HEADER	Yes	Yes
DS, DS$, AUTO-LOAD	Yes	Yes
SEND (IEEE/DISK)	Yes	No
INITIALIZE (DISK)	Yes	No
EXECUTE (DISK)	Yes	No
MERGE, MERGE#	Yes	No
PRINT USING	Yes	No
BEEP (CB2)	Yes	No
SCROLL, OUT	Yes	No
SET SOFTKEY	Yes	No
'EAT' KEY	Yes	No
REPEAT KEY	Yes	No
KILL	Yes	No
KEEP SAME TOOLKIT	YES	NO



COMMAND-O (£50.00 + Vat) for Basic 4 CBM/PETS 4008-16-32 (40-col) & 8016-32 (80-col)
DISK-O-PRO (£50.00 + Vat) is for Basic 2 PET Models 2001-08-16-32 and 3008-3016-3032
COMMAND-O and DISK-O-PRO are both 4KB masked Roms, not Eprom or disk-based, and come with 80-page manuals by Greg Yob and Jim Berkey. Users of Visicalc or other Roms in the UD12 (80-col.) or UD3 (40-col.) expansion Rom slots will require SPACEMAKER II, either 2 or 4 Rom models, at £21.95 or £29.95 + Vat. DEALER and OVERSEAS enquiries to: Calco Software, Lakeside House, Kingston Hill, Surrey, KT2 7QT, Tel: 01-546-7256
Overseas P & P: please add £3.00 airmail (Europe), or £5.00 airmail (outside Europe)

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PLEASE DEBIT MY ACCESS/BARCLAYCARD NO:

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PCW6

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NAME .....

ADDRESS .....

.....

.....

TEL .....

Calco Software

To: Calco Software, FREEPOST, Kingston-upon-Thames, Surrey, KT2 7BR. (NO STAMP REQUIRED)

WORD PROCESSOR BENCH TEST

WORDPRO 4 PLUS

Continuing his series of WP Benchtests, Peter Rodwell examines one of the packages available for the CBM 8000 series.

It was always a little difficult to take the original Commodore PET totally seriously. Name apart, it had several drawbacks as a business machine, even after it was given a proper keyboard: in particular, its 40-column screen width was limiting, especially for word processing, the application in which we're interested here.

Commodore, too, realised that a 'serious' PET was needed and produced the 8000 series, with a larger screen holding 80 characters per line; this, among other features, made the 'SuperPET' more suited to business use.

Software houses have responded by producing an ever-growing range of applications packages for the 8000 series, including several word processing packages.

This review is of the Wordpro 4 Plus package, produced by Pro-Micro Software Ltd and marketed by Professional Software. The package was tested on an 8032 computer with the 2040 twin minifloppy disk drive unit and a Diablo 630 daisywheel printer.

Wordpro 4 Plus comes on a disk (formatted for 2040, 3040, 4040 and 8050 drives), a ROM which fits into one of the spare sockets inside the SuperPET, a set of stickers to denote the control keys and a manual. Installing the ROM is easy — the manual even has a diagram of the ROM sockets to ensure that it's put in the right one — and it can stay in place while the machine is being used for other applications.

Editing

Wordpro 4 Plus is an all-in-one package, which means you can edit text and print it without having to first save it to disk and run a formatting program. This is convenient, but it eats up memory space, as we'll see in a moment.

With the ROM installed, you load the program from Basic and run it by typing RUN. The loading was not always foolproof and occasionally I had to abort it and jiggle the disk around in the drive before starting again; the manual warns you about this.

You're then asked a series of questions to set up various system parameters, such as the size of text buffer required and the type of printer being used (see photo); WP4+ has built-in drivers for any CBM printer, the NEC Spinwriter, Diablo 630, Qume Sprint 5, TEC 1500 and any other suitable printer which can be interfaced to the SuperPET. With the questions answered, you're into the program proper, which, initially, gives a blank screen with a status line across the top; this tells you what control mode you're in, prompts you when you're doing things like saving to disk, and shows the current cursor position as line and column numbers.

There's no need to hit return at the end of each line as you type unless you want to force a return — at the end of a paragraph, for instance; return is shown as a small arrow symbol on the screen. But WP4+ does not have auto word wrap-around, in which, if you're halfway through a word when you reach the end of the line, the whole of the word is automatically transferred to the start of the next line. The result (of not having wrap-around) is that the text is just that little bit more difficult to read as words are split randomly at the end of lines.

Control functions are activated by pressing the RVS key followed by the key corresponding to the desired command — using the stick-on labels makes this quite easy.

Cursor movement is by the SuperPET's normal cursor keys. If you're not familiar with a Commodore keyboard, this is a little inconvenient at first; there are only two cursor keys and upwards and right-to-left movements are obtained by shifting the keys. Nearly all the keys have an auto repeat action which functions if the key is held down for more than a second or so. The cursor can be homed to the top left-hand corner of the current page or text file but the only way to get to the bottom of text is by scrolling right through it with the cursor down key. A 'go to line n' command is available, useful if you have a standard text requiring minor alterations at a known line before printing. It's also possible to insert comments which won't appear in the printed text.

Tabs are set by positioning the cursor on the line and pressing a control key; tab positions are shown as small squares below the rule under the status line and tabbing is then carried out using the machine's tab key.

Insertion and deletion operate on words, sentences and lines, and are straightforward to use. Erasing works on all the text, specific lines or on all text following the current cursor position.

Blocks of text can be moved by first specifying which lines you're interested

in — a very easy process — and then positioning the cursor at the required destination. Pressing a transfer control key then moves the lines and deletes them from their original position. This function only works on entire *screen* lines, however, not on complete sentences.

Commands are available to find occurrences of strings and to search and replace strings; the latter is quite good fun as the replacing happens on the screen before your very eyes, although this must slow down the process considerably.

Wordpro 4 Plus gives the user two text buffers, one called main and the other called extra. Together they can handle a total of 139 lines, of which a maximum of 116 can be allocated to the main, working buffer. This limits the size of any piece of text to 9280 characters (1325 words or just under three single-spaced A4 pages).

The extra text buffer can be as large as 69 lines (5520 characters) and is designed for reading in material from a separate file for incorporation into the text in the main buffer. An easy-to-use variable function enables you to set up a standard letter in the main buffer, load a file of names and addresses into the extra buffer and automatically produce customised letters. The facility is by no means as powerful as that of Magic Wand, reviewed last month, and the maximum size limit of the extra buffer prevents you from holding a big mailing list, but for low to medium volume work it's a foolproof and simple system. Similar operations can be performed using paragraphs of text held in the extra buffer.

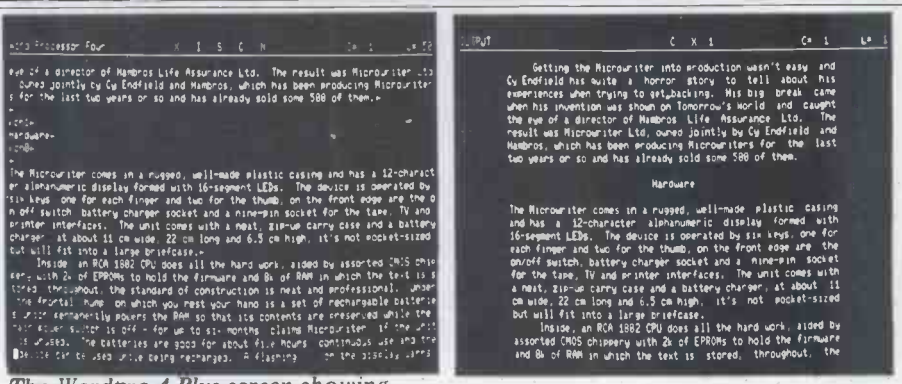
At first sight the 116 lines main text buffer limit may appear to be a severe handicap. However, it is possible to handle lengthy texts by splitting them into separate files.

Having entered your set of text files, you can then print them using a global printing command, by means of which the system will automatically start to print the next file as soon as it reaches the end of the first. Search and replace can also function globally, which is *extremely* useful.

Because of the 116 lines limit, it was not possible to carry out the full range of WP Benchmarks; in fact, only the two search and replace and the printer tests could be made, using the global facility, with the stopwatch stopped when the system paused to read in the next file from disk.

The final function which deserves special mention is the numeric tabbing facility provided by WP4+. This enables you to enter columns of figures and line up the decimal points — it works to two decimal places and is designed mainly for accounting. Further, the system will automatically add up or subtract the columns.

Disk handling is very straightforward, both for reading and writing (called recalling and memorising in the manual). It is possible to view the directories directly from WP4+, although doing so destroys whatever's in the text buffer at the time, which can be unfortunate if you wanted to see if there was enough space on a disk to save the text you'd just typed in! Various disk utilities are built into WP4+ including formatting blank disks, disk validation (which removes 'bad' areas of the disk from use, as the manual puts it), duplicating an entire disk, copying files either singly or in a linked group using a global command, and renaming and scratching files.



The Wordpro 4 Plus screen showing (left) text as typed and (right) as formatted.

The stick-on labels help considerably.

Total disk capacity with the 2040 drives is 170 kbytes, which works out at about 54 single-spaced A4 pages, split across several files, of course.

In summary, the editing side of WP4+ has been well designed around the SuperPET's facilities, is easy to learn and use and provides some useful capabilities for the general business user.

Formatting

Wordpro 4 Plus gives a good range of formatting capabilities, achieved by embedding commands in the text. The commands are denoted by a ✓ mark on the screen and several commands can be placed on one line, separated by a colon, although a few must be placed at the end of a command line.

WP4+ checks the command syntax during output; if it encounters an error it stops printing with the cursor positioned on the error and a 'syntax error' message is displayed on the status line.

You are given control over both margins, overall page length, number of lines per page, and line spacing (single, double or triple). Text can be justified or printed with either the left or right margin aligned and the other left ragged and there's also provision for 'outdenting' lines. Lines can also be centred between margins. There's a command to insert n blank lines in the text to leave room for a diagram and you can specify a line at which printing is to start on a page, both of which eliminate the need to insert multiple returns in the text, which would waste lines in the text buffer. You can force a page feed, either immediately or if fewer than a specified number of lines remain on the page. Ghost hyphenation is also catered for.

To match its built-in printing drivers, WP4+ provides a good range of printer control commands, catering for bolding, underlining, superscripting and subscripting. You can specify horizontal pitch and vertical lines per inch and you can define certain keys to produce codes matching special characters on some daisywheels. There's a pause command (to which you can add your own prompt which will appear on the screen) to stop printing should you need to change a daisywheel, for example.

Headings and footings can be specified, each occupying a single line at the top or bottom of the page. These lines are split into three 'fields', two aligned with the margins and one centred between them.

WP4+ allows you to preview the formatted text by outputting it to the screen instead of to the printer; this is a very useful way to ensure you've got it exactly right without wasting paper on draft copies. If you spot a mistake you can stop the output; this automatically puts you back into the editing

mode so that you can correct the error.

Printing can be done a page at a time, to allow you to insert sheets into the printer, or it can be continuous; it's possible to print from any page and, as I mentioned earlier, there's a global command which will allow you to print a series of linked files automatically. It's also possible to send the formatted output to disk and then spool print the text — this allows you to carry on editing another document while the first is being printed.

Like the editing, then, WP4+'s formatting is straightforward; there are a few frills but not enough to make the system complicated to learn.

Learning and documentation

Wordpro 4 Plus provides a useful range of functions without being complex. It's easy to use and learning is not difficult, although it would be made easier with better documentation.

The manual is a loose-leaf affair in a smart ring binder — the initial impression is good but this is ruined once the would-be learner opens it and gets stuck in. The manual covers all aspects of using WP4+, certainly, but in a loosely structured and not particularly logical way. The layout is poor, taking little advantage of the formatting which WP4+ offers to make such documents clearer. Take, as an example, the page on making a back-up copy of the system master disk; firstly, this doesn't appear until you're well into the manual and have already started to learn the system — it should be one of the first things explained; second, it's only when you get half way down the page that you discover that the instructions which you've been trying to execute apply only to the 8050 drives — users with other devices are suddenly told to turn to a page near the back of the book for their instructions. This is silly because the general tone of the manual is aimed at the complete novice — earlier, several pages are devoted to switching the equipment on and off, for example.

The general (but inconsistent) format is a series of lessons, some of which are followed by exercises; unfortunately the exercises sometimes follow exactly the previous lesson, giving an impression of repetition which becomes slightly tedious.

There are other small anomalies, such as the use of the symbol '@' when referring to the control symbol, which is confusing as there's an @ key on the machine which is used for search and replace.

To be fair, though, the actual explanations of the system's facilities are clear and comprehensible and, with patience, a novice should be able to use WP4+ without trouble once he/she's waded through the manual.

Users

Looking at our four user categories, then, who's going to find WP4+ useful?

On the whole, I wouldn't recommend it to the author/journalist, mainly because of its small text buffer and the consequent need to split text into a large number of fairly small files. As I fall into this category myself, I know how useful it is to be able to look back at what you wrote 70 pages earlier without having to save the current text on disk, load a different text file, look at it and then reload the part you're working on.

The report-writer would find this less of a limitation, as reports are far more structured than a piece of creative writing or a newspaper article. For anything other than the smallest of reports, he'd also have to split his work into a number of files but I think this wouldn't be too much trouble. The numeric tabbing feature would make financial report writing a cinch and the good formatting capabilities, coupled with a daisywheel printer, make WP4+ a useful tool for this user.

Quite how useful the package would be to a manager depends in this case on what he manages. A departmental manager in a big company, with limited personal WP needs and a secretary to do the complicated stuff, might find it very handy for memos but might be deterred by the modular hardware — trailing wires don't go well with the executive image. But a small businessman, again with limited WP requirements, would find WP4+ useful as an addition to other packages (stock control, etc) needed to run his business and now available for the SuperPET.

If the office requirement is for high volume word processing only, with no need for the SuperPET's other capabilities, then I wouldn't recommend Wordpro; although the secretary would feel quite at home with the hardware/software combination reviewed here, its limitations would, I feel, make it unsuitable for large mailing shots of customised letters, for example, or for producing long texts.

Hardware

We Benchtested the 8000 series in September last year so I'll confine my comments to its suitability for word processing. Certainly the 80-column screen is pleasant to use; it displays 23 lines of text, as the status line and its rule take the two at the top, but this is not a problem. The SuperPET displays green letters on a black background and these are very legible; there's a brightness control at the back of the machine and the characters have true descenders. The keyboard has a nice solid feel and is of proper typewriter pitch and layout.

The 2040 disk drives are quiet and quick. I experienced occasional difficulties when loading the WP4+ program itself but these never occurred when loading text files.

The Diablo 630 printer was borrowed along with the rest of the hardware from Professional Software and thus came with no documentation. It's very large and very heavy and vibrates considerably when printing, although noise levels aren't too high — you could carry on a phone conversation in the same room provided you were a couple of metres away from it.

The Diablo's print quality, using a plastic daisywheel and a nylon ribbon, weren't very impressive, but I'd expect this to improve considerably with a metal wheel and a carbon ribbon. It's quite quick, as the test shows, but although it can print bidirectionally, it would only do so for the final line of each paragraph — all other lines were printed left-to-right with a carriage return performed at the line end. Frankly I haven't the slightest idea why this was so.

Summary

Wordpro 4 Plus is a useful system which most users should find easy to learn and use, despite the documentation, which could certainly be a lot better. Its facilities bias it firmly towards the small business user who could use the SuperPET for other applications as well, rather than towards someone who only wants to do word processing and who has a lot of that to do. The limitation of 116 lines of text would make it rather unsuitable for the author/journalist but this should be much less of a problem for the report writer.

The SuperPET is very handy for word processing, having a good-sized screen and a nice keyboard. Some users may not like the separate disk drive.

The Diablo 630 is a big, robust, heavy-duty daisywheel printer capable of a useful range of functions and eminently suitable for all general business uses where quality rather than absolute speed is required.

BENCHTEST

Benchmark	Base time
1	n/a
2	n/a
3	n/a
4	n/a
5	108.4
6	109.1

Note: Because WP4+ cannot store the entire test text within its buffer, Benchmarks 1-4 could not be tested.

Printer test: Diablo 630

Time taken to print out 3000-word test text: 9min 51sec (30 char/sec, 304.5 wpm).

Prices (excluding VAT)

Wordpro 4 Plus	£395.00
CBM 8032 computer	Prices
CBM 2040 disk drives	vary
Diablo 630 printer	

Normal typeface
Bold & underlined

Sub$_{s}$cript and super^{S}cript

Fig 1 Diablo 630 typefaces.

PUZZLES

Alan Sutcliffe continues his series.

An arrangement of a set of tiles is shown in Figure 1. Some of the sides of the tiles have lines to them from their centres; some do not. The tiles cannot be turned over or rotated. With these conditions, this is the complete set of 16 tiles, which are shown in numerical order in Figure 2.

In an arrangement, every side with a line to it must be matched by another edge with a line; no such line may be left dangling. Last month I discussed such arrangements of these tiles and I gave a program that listed all possible arrangements in a matrix of 4x4 cells, as shown in Figure 3.

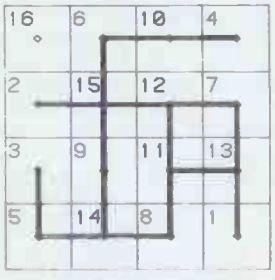


Fig 1 An allowed arrangement of the tiles.

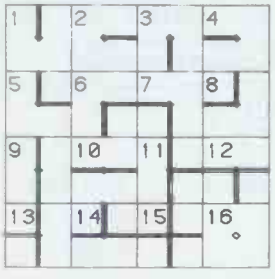


Fig 2 The set of numbered tiles, each on the cell of the same number. Not an allowed arrangement.

Cases that differed only by rotation or reflection were said to be ruled out. Rotations were excluded by keeping the X-tile 15 fixed in one position, in cell 6. Reflections are more difficult to deal with. With the X-tile on cell 6 the only line of symmetry is the diagonal through the centre of this tile and through the centre of the matrix of cells, as also shown in Figure 3. Consider now the blank tile 16. If this is in one of the cells 3, 4, 8 or 12 above the line of symmetry, then clearly there is for each solution a mirror image with the blank tile in cell 9, 13, 14 or 15 respectively. Notice that the blank tile cannot be placed in cell 2 or cell 7 next to the X-tile, nor in the mirror cells 5 and 10. Thus symmetrical cases are easily excluded by not placing the blank tile on cells 9, 13, 14 and 15. The program given last month deals properly with the cases where the blank tile is on cells 3, 4, 8 and 12, provided that the correct data for the starting position is given in each case.

This leaves the cases where the blank tile is on one of the cells 1, 11 or 16 which are on the axis of symmetry. Now two types of solution are possible First those which are self-symmetrical; that is, they are their own reflection in the axis of symmetry. Such solutions must obviously be counted just once each. Solutions of the second type are asymmetrical and occur in pairs, each the mirror image of the other. Since such reflections are not to be counted separately, only one case from each pair should be counted.

This is a typical problem in enumerating geometrical and other arrangements. Most of the rest of this article is devoted to discussing ways of dealing with it.

The program given last month works by taking cells in numerical order, given that the X-tile and the blank tiles have already been placed and for each cell tries tiles in turn until one is found to fit. The same procedure is then followed for the next cell. When no (further) tile will fit on a cell, attention is stepped back to the preceding one and here the existing tile is removed and the next one in order for this cell is tried. . . and so on. When a tile is placed on cell 16 a solution has been found. When an attempt is made to remove the (last) tile from the cell 1, the search is then complete.

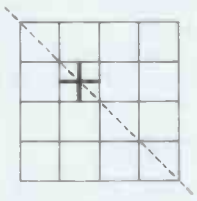


Fig 3 The matrix of cells showing the X-tile and the axis of symmetry.

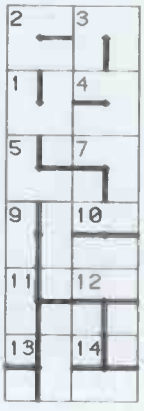


Fig 4 Pairs of tiles symmetrical about the diagonal axis.

To make the discussion specific, suppose the blank tile is on cell 1 and the X-tile is on cell 6. A start can be made in distinguishing symmetrical and unsymmetrical cases by considering cells 2 and 5. If the tiles on these two cells are symmetrical, accept the case. If they are not symmetrical, accept the case only if the tile on 5 has a smaller number than the one on 2, otherwise skip to the next tile for this cell.

The easiest way to test whether two tiles form a symmetrical pair is to set up a table at the start of the program. Remember that the symmetry we are interested in is about a diagonal axis from top left to bottom right. Figure 4 shows these pairs of symmetrical tiles. The four tiles which are not shown, 6, 8, 15 and 16, are self-symmetrical about this axis.

This test entails applying the following logic each time a tile is to be tested for a cell: if this is cell 5 and the tile is not symmetrical with the one on cell 2 and the tile has a larger number than the one on cell 2, then ignore this tile and select the next one; else carry on testing this tile to fit in the cell.

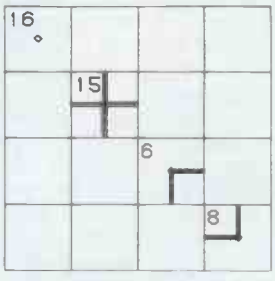


Fig 5 The first position of tiles along diagonal.

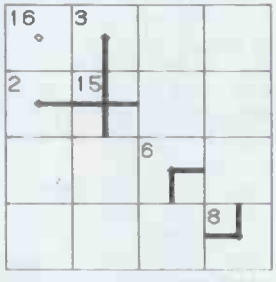


Fig 5(i) First position — partial arrangement.

Now, in the particular circumstances with the blank tile on cell 1, this logic will rule just one of each pair of symmetrical solutions. In general, however, it is necessary to carry on, when a partial arrangement is symmetrical, to test further cells to see if symmetry is maintained.

As tiles are added and removed, a table of markers is needed to record whether an arrangment so far is symmetrical. Only the following changes to the state of symmetry are possible: adding a tile to one of cells 5, 9, 10, 13, 14 or 15 (call these the S cells) may change a symmetrical arrangement into an unsymmetrical one; removing a tile from one of the S cells may change an unsymmetrical arrangement into a symmetrical one.

Adding and removing tiles from the other cells and skipping over the blank and X tiles cannot alter the state of symmetry or otherwise of an arrange-

ment. One marker is needed for each of the six S tiles. If there is no tile on the cell, the marker will be clear. If there is a tile on it, the marker will be set to either Symmetrical or Unsymmetrical. It is convenient, also, to have a current symmetry marker which has the same value as the marker for the highest numbered S cell with a tile on it, and is set to Symmetrical at the start of the program whenever none of the S cells has a tile on it.

The following logic is needed to preclude just one of each pair of mirror-image solutions from being counted. Whenever a tile is about to be tested in a cell: if the current marker is set Symmetrical and this is an S cell and the tile to be fitted is not symmetrical with the one already on its mirror-image cell (2, 3, 4, 7, 8 or 12) and the tile to be fitted has a larger number than the one on the mirror-image cell, then ignore this tile and select the next one; else continue testing this tile to fit in the cell.

After each tile has been fitted the following logic is necessary: If the first three conditions above held (S cell, symmetrical so far, unsymmetrical tile) but the tile had a larger number than the one on its mirror-image cell, then change the current marker to Unsymmetrical.

In all cases, set the marker for this cell equal to the current marker. That is

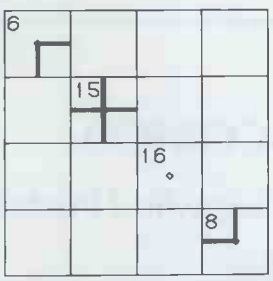


Fig 6 The second position of tiles along the diagonal.

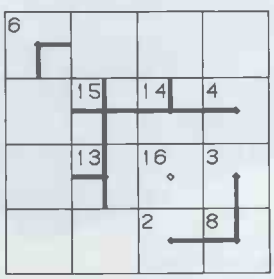


Fig 6(i) Second position — second partial arrangement.

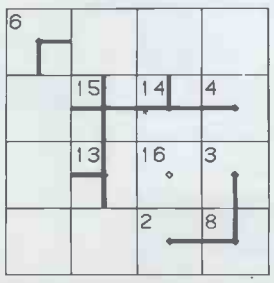


Fig 6(ii) Second position — first partial arrangement.

the logic for adding a tile. There remains the complementary process when a tile is to be removed: if this is an S cell then clear the marker for this cell and set the current symmetry marker to the value of the next lower numbered S cell, or to Symmetrical if this is cell 5 and there is no lower numbered S cell.

That is a lot of logic and a lot of program to rule out a set of cases which, while they are quite numerous, are easy to pick out by eye. That is why I decided not to incorporate it into my original program but to look around for another way of tackling the problem. What I found does not apply generally to problems of this kind but only to the particular circumstances of fitting these tiles into the 4x4 matrix. Theorem: there is only one symmetrical solution. Proof: symmetry is only possible about the diagonal axis already discussed. Tiles 6, 8, 15 and 16 are each symmetrical about such an axis and have no other mirror images. Therefore, in a symmetrical solution, all these four tiles must lie on the diagonal, in cells 1, 6, 11 and

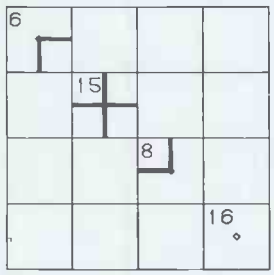


Fig 7. The third position of tiles along the diagonal.

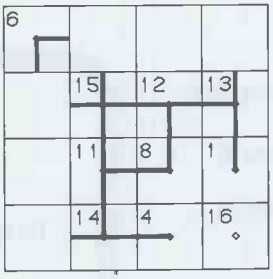


Fig 7(i) Third position — first partial arrangement.

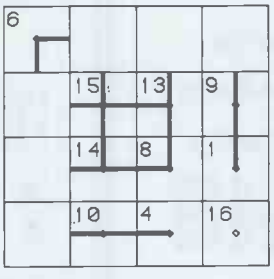


Fig 7(ii) Third position — second partial arrangement leading to a symmetrical solution.

16. The X-tile is already fixed in cell 6 to rule out rotations. There are only three possible ways of fitting in the other three tiles, since tile 6 cannot be put in cell 16 and tile 8 cannot be put in cell 1. The three arrangements are shown in Figures 5, 6 and 7.

The proof now procedes by taking each of these in turn and showing that only in one case is a symmetrical solution possible:

(a) Cells 2 and 5 can only contain tiles 3 and 2 respectively, as shown in Figure 5(i). No other pair of symmetrical pieces will fit. There is now no cell in which tile 12 will fit, so no solution is possible;

(b) Cells 12 and 15 may contain tiles 2 and 3 as in Figure 6(i). Tiles 13 and 14 must then go in cells 10 and 7. Only tile 4 will now fit in cell 8, and no tile remains that will fit in cell 4. Again no solution is possible. The only other possibility for cells 12 and 15 is tiles 9 and 10, as in Figure 6(ii). There are now two possibilities for tiles 13 and 14: either in cells 8 and 14 or in cells 10 and 7. In either case, however, it can quickly be shown that the remaining tiles cannot be fitted in;

(c) In the third main case, cells 12 and 15 must contain pieces 1 and 4. Cells 8 and 14 may then contain tiles 13 and 14, as in Figure 7(i). Then cells 7 and 10 must have tiles 12 and 11, but that leaves no possible placement for the rest of the tiles.

Alternatively, cells 8 and 14 may contain tiles 9 and 10 as in Figure 7(ii). Tiles 13 and 14 can now only fit into cells 7 and 10. It quickly follows that there is just one solution for the remaining pieces: shown in Figure 8.

That concludes the proof, but how does this help? It means that we do not have to worry about distinguishing symmetrical and unsymmetrical solutions. With the one exception just demonstrated, all the solutions with the blank tile on the diameter occur in pairs differing only by reflection. In each pair the tile on cell 2 must be lower in number than the tile on cell 5 in one

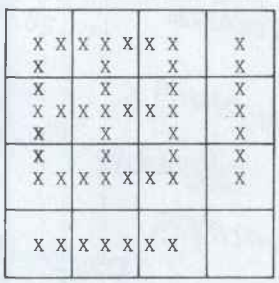


Fig 8 The only symmetrical solution in a 4x4 matrix, shown in character form.

case and larger in the other case. In our one self-symmetrical solution the tile on cell 2 (tile 12) is larger in number than the one on cell 5 (tile 11). Thus if we ensure that only cases where the tile on cell 2 is greater than the one on cell 5 are selected, we will get just one of each pair of symmetrical solutions plus all the self-symmetrical ones (there is only one).

All that is needed to achieve this is the following bit of logic each time a tile is to be placed on a cell in those major cases when the blank tile is on the diagonal (in cells 1, 11 or 16): if this is cell 5 and the tile to be fitted is greater than the one on cell 2 then treat this as though all the tiles had been tried on this cell (any remaining ones will have an even higher number) and so step back to the preceding cell (4) and try the next tile there, if any; else carry on as normal.

This requires two lines of code in the program given last month:

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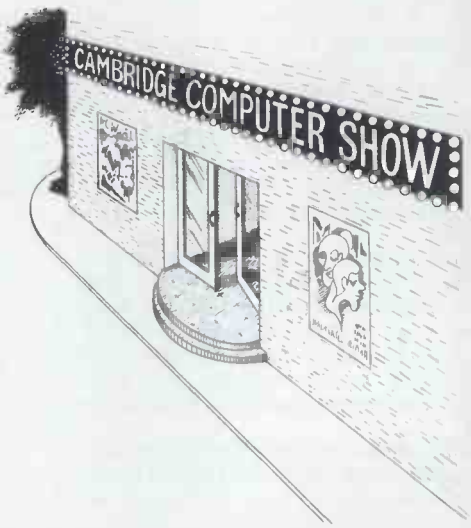

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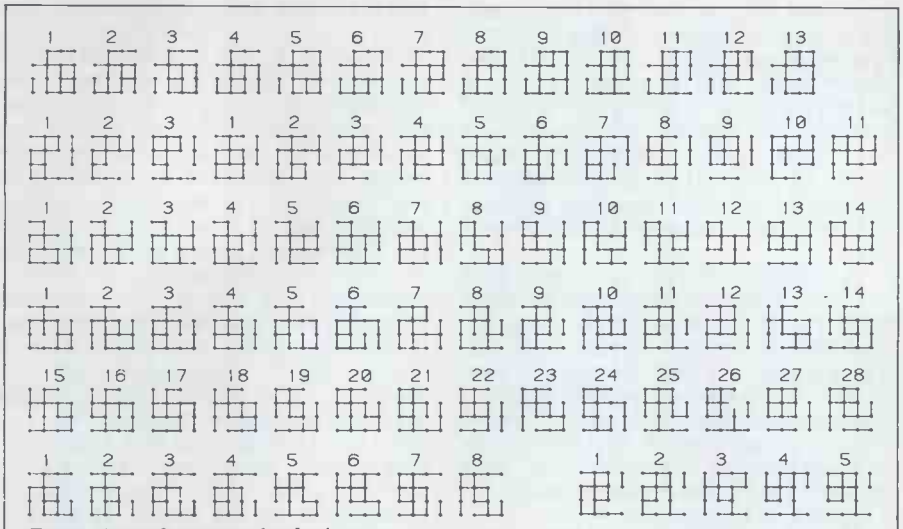

Fig 9. Complete set of solutions.

604 IF Q>D(2) THEN 430

Notice that the symmetry markers and the table of symmetrical pairs of tiles are not needed. The complete output for the revised program is shown in Figure 9. Notice that some solutions in more than one piece appear in different forms: for example, solution 9 in the second row appears again as solution 27 in the fifth row.

I cannot recall ever having taken so much thought and narrative to justify two lines of code. The converse is more usually the case. For example 'plot out the solutions in rows across the page' entails a page of uninteresting code, too dull to give here. You will have to write your own routine to display the results in a form suitable for your own system. Even if you have only character output the results can still be shown graphically. Each tile can be represented by a 3x3 array of characters, so that every solution fits into 10x10 characters. This is illustrated in Figure 8, which only shows the matrix of cells for reference.

But why all this? you may ask. It may seem that the detailed discussion above of how to identify symmetrical cases was not necessary, given that another way was found of dealing with the problem. But I wanted to illustrate first how a seemingly straightforward problem may need a lot of thought to program.

Secondly, I wanted to show how it can be worthwhile, when faced with such a problem, to search for alternative solutions and not simply to go all out for the first method that presents itself. In any attempt to enumerate geometrical arrangements, it is worth trying to see what theorems and rules can be found to short cut the hard slog of counting cases. The trick is to balance the effort between discovering the theory, developing an algorithm that benefits from it and one which can reasonably be programmed and also one that does not use excessive computer time.

The moral is, in a word, *think*. Still the world's best slogan, courtesy of IBM.

A third reason for giving the detailed discussion is its relevance to the general problem that remains — enumerating all the arrangements of the tiles when the matrix of cells is not limited in size.

Assume that the blank tile is not to be used, since placing it anywhere round an arrangement of the other tiles is trivial. Assume also that I have shown that no such arrangement can span more than seven cells from side to side or from top to bottom. Thus, if the X tile is placed in the centre cell of a matrix of 11x11 cells, then no arrangement can go off the edge of the matrix.

Arrangements are to be built up not by traversing the cells in order but by starting with one tile and than adding others that match the remaining free lines. Start with the X tile, which has four free lines, N, S, E and W. Rotations

PATTERNS

can be excluded by ensuring that of the four tiles immediately adjoining the X tile, the one at S, say, always has a smaller value than the other three.

Reflections are more difficult. All that can be said is that any axis of symmetry must pass through the centre of the X tile, and may be diagonal or orthogonal, as shown in Figure 10. A separate set of tests will be needed to exclude reflections in each of the four axes. A system of markers and a table of mirror-image pairs of tiles will be necessary for each axis.

The task is not simple and I will be glad to hear from anyone who develops a program for it, or who can contribute further to the theory.

Another interesting problem that is tricky to program but trivially easy by eye is to identify solutions that fall into more than one piece, like that in Figure 8. The following method can be used: start with any tile. Make a list of its lines to other tiles. For each item on the list of lines remove this line from the list, identify the adjoining tile, add its other lines, if any, to the list. Repeat this step until the list is empty. If all 15 tiles have been reached, then the arrangement is all in one piece. Otherwise, it is not.

Here is another small result to add to the ones given last month about the number of pieces an arrangement falls into, and the number of closed areas formed by the pattern of lines. I showed that every solution in one piece has two closed areas, and one further area is added for each separate piece in the solution. No solution can be in more than three pieces, with four closed areas. My last result is that where a solution is in more than one piece all the enclosed areas must be in the same piece.

A solution in two parts has three enclosed areas. At least two of them must be in the same piece. There are nine tiles which can be the corners of a closed area. At least six of them must be used to make two rectangles with a common side. That only leaves three to form a closed area in the other piece and that cannot be done. The same argument holds even more strongly for a solution in three pieces.

On 17 January 1716, just a few months before his death, the great German philosopher and mathematician Leibniz wrote to a colleage about Solitaire, which pleased him much, he said. Years ealier, by the way, he had developed Pascal's calculating machine to do multiplication, division and the extraction of roots,and had also studied and developed the methods of binary arithmetic: two important contributions to the pre-history of computers. Leibniz was the rival of Newton in developing the calculus and he laid the foundations of combinatorial analysis. His lifelong dream was of a way to reduce all exact reasoning to a symbolic technique: realised, only partly, 150 years later in George Boole's *Laws of Thought*. In his letter he described how he played Solitaire backwards, starting with one piece on the board and then adding further ones by jumping an existing piece over an empty cell. This method of reverse play should always be tried in looking at the theory of any game or puzzle. Finally Leibniz wrote to his friend: 'But why all this? you may ask. I reply: To perfect the Art of Invention. For we must have the means of constructing everything which is found by the exercise of reason.'

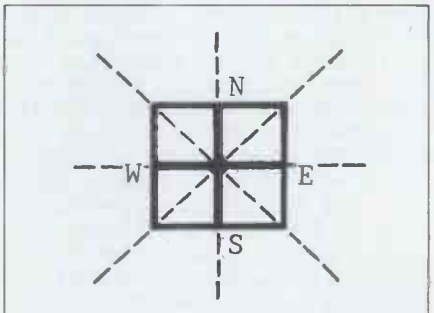

Fig 10. Axes of symmetry for the complete solution.

There is no better justification of personal computing. How Leibniz would have delighted to have his own small computer!

Next month, something about noughts and crosses, a game that I thought had given up its last secret long ago. But just how many different games of noughts and crosses there are, not counting reflections and rotations, of course. And something about a computer made from matchboxes and art students.

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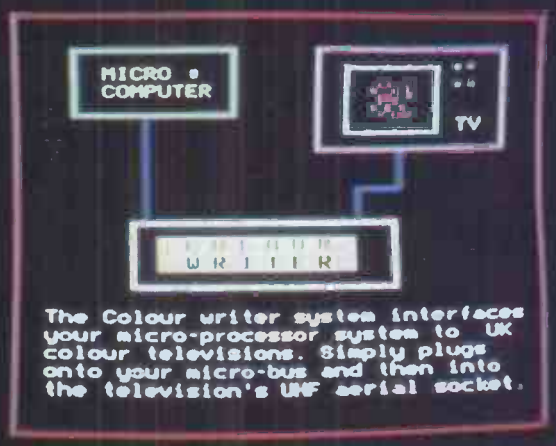

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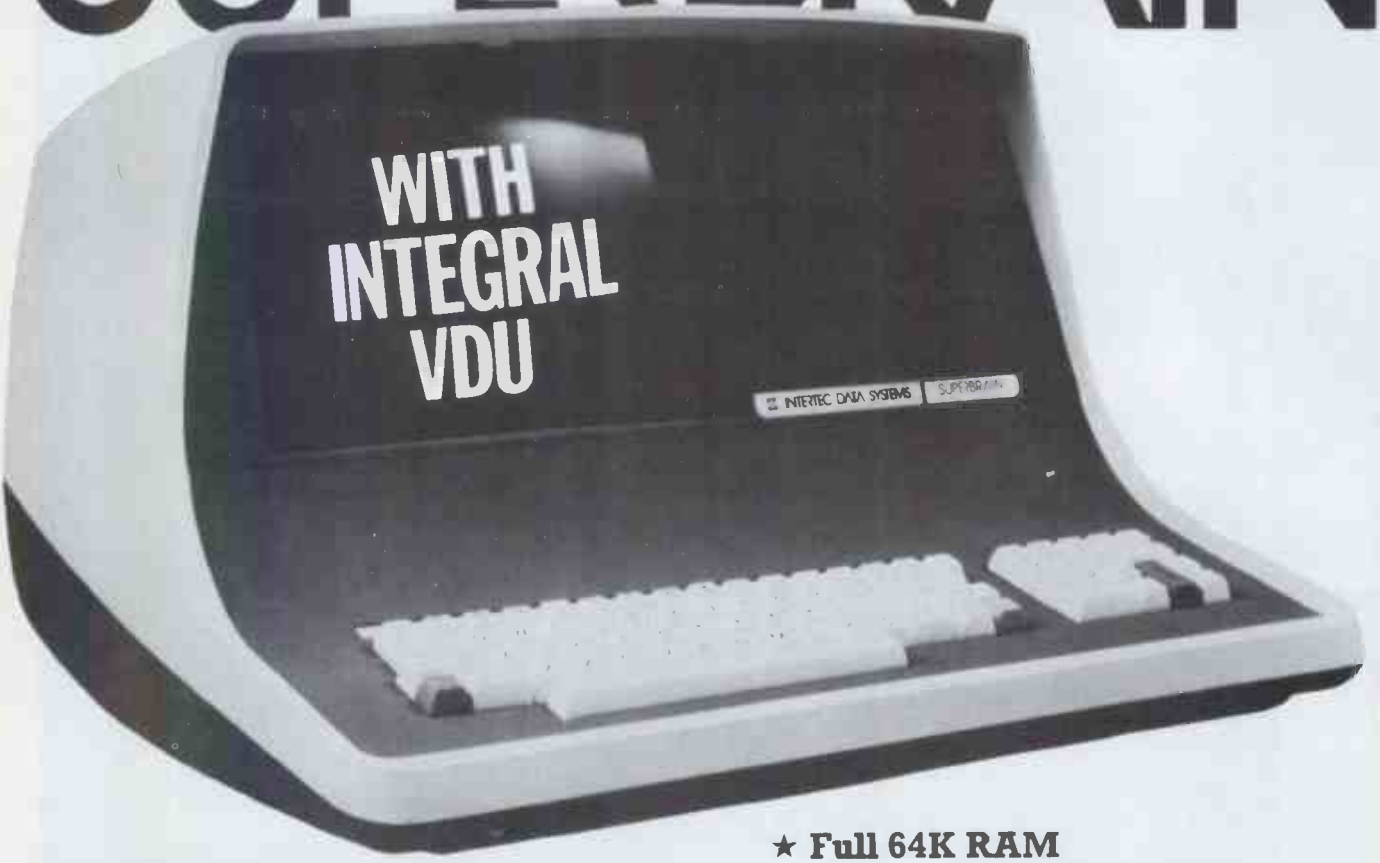

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YOUNG COMPUTER WORLD

Compiled by Derrick Daines

I was talking to the editor the other day (yes, we *are* on speaking terms!), when he used the phrase 'data validation techniques'. I prefer my own term 'mugtraps' — and said so. It so precisely describes what they are — traps for mugs who press the wrong key either accidentally or deliberately. It seems that some of you prefer the term, too, so I think I'll stick with it.

Apparently Commodore has its own method of dealing with mugs. When the user presses the RETURN key without first typing a character, the system crashes! This is a bit harsh and indeed violates the programming law that I mentioned in my last article — that, in the case of wrong input, the program should decline gracefully, not dramatically.

Neil Stoker of Gateshead has been thinking about this problem and has come up with the following little routine that he uses in all his PET programs:

```
1000 LET XT=548:REM — FOR 3000
   SERIES USE XT=167
1010 LET X$="":LET X1$="":POKE
   XT,0:PRINT " ? ";
1020 GET X1$:IF X1$="" THEN
   1020
1030 IF ASC(X1$)=13 THEN POKE
   XT,1:PRINT " ":RETURN
1040 LET X$=X$+X1$:PRINT X1$:
   GOTO 1020
```

As I have said before, I will welcome any little mugtraps that you have devised and to show my interest, I'll give book tokens for all those published on this page, so roll them in!

User|mag

As I mentioned last month, several magazines have dropped on my desk recently and I want to mention three of them. First is *Microscope*, edited by John Lane of Newman College, Genners Lane, Bartley Green, Birmingham B32 3NT. This mag consists of 16 sheets duplicated on both sides to a fine standard, the whole stapled inside an attractive card cover. The target is all those interested in primary computing and has, I think, hit just about the right note. There are articles on classroom uses, reactions and programming hints as well as some very good cartoons. A software library is listed and an example is given of a useful teaching program for the petappletandy type of machine. Perhaps what impresses me most about the whole thing is the air of confidence and above all, determination, that it exudes.

Next is a small offering from Central Program Exchange, based at the Dept of Computing and Math Science, The Polytechnic, Wolverhampton WV1 1LY. This is not so much a magazine as a newsletter offering and seeking aid and programs. Membership is £10 a year, for which you get free programs from their catalogue. Secondary and further education are well represented and they are now anxious to spread into primary computing too.

Lastly is a small mag distributed free by Computer Workshop for the much-neglected 6800 user. Drop a line to CW if you are interested; the idea is to build up a library of programs and also to develop an English magazine (free) on the lines of the *68 Journal*.

With so much going on (and there have been other little mags too), one ought perhaps to be happy about it, but I must confess to a small 'canker-worm of worry'. How much work is being unnecessarily duplicated up and down the land? How many of these worthy efforts are doomed to extinction? I wish I knew and, more importantly, I wish that one could do something about it, for we need as much dissemination of information as we can get.

One thing I am confident about is that the very life-blood of these magazines is the software — that is, program listings and access to libraries of more programs. Now anybody can knock together a few simple programs dealing with arithmetic drill, tables, counting, capital cities and so on, and if your local college mag continues to publish little else, interest in the mag dies. It follows that all such mags must look after their software authors. Get this right, and the rest will follow.

Of course, I must declare an interest here. As a prolific writer of programs myself, I may be biased. However, as more and more teachers become adept, there will be a natural and entirely human tendency to look for some return on the hundreds (thousands?) of hours required to attain that skill. I confess that I look sideways at budding magazine/library organisers that offer me the 'privilege' of membership at a fee, expecting me to submit my best programs and offering in return programs that are simple, uninteresting or of no use to me.

It therefore seems logical to me that many program libraries will remain simple, uninteresting or of little use unless and until the rights of program authors are looked into — and that means legally and nationally, as well as at the local level.

As I have said many times before, there are a lot of pirates in this business. Only last week I learned of a head who recently sold a £1000 worth of software to LEA and in the package were two or three unique programs of my own! Out of the goodness of my heart — and to help a fellow teacher — I had given him listings of educational programs. Once bitten. . .

Programs recieved

Battleship (PET) by Neill Jones (15) of Bristol. U-Boats (PET) by John S Smith (14) of Brentwood. Zombies, Maze & Survive (ZX80) by Michael Lloyd of Dublin. Picture Draw (TRS-80) by Robin Gardner (14) of Bedford. Toolkit (Nascom 2) by Richard Espley of Liverpool. Maze Driver (PET) by Jonathan Pugh (12) of Shaftesbury. Snakes & Ladders by Alexander Turner (11) of Windermere. Hot-Cold (ZX80) by A R Jones (15) of Loughborough. Multiple-Choice Driver Program by Larry Carasco (17) of Dollis Hill, London. Random Number Generator (TRS-80) by Andrew Bell (15) of Flackwell Heath. Alien Attack (CBM 8032) by Ian Fenton (15) of Shipley. Jump (TRS-80) by Mark Ripley (14) of St. Annes-on-Sea. Squash Practice (Sharp MZ 80K) by Anthony Windibank (13) of Formby, Merseyside. Space Invaders (ZX80) by C R Green (16) of South Croydon. Hitchiker's Guide by Sion Griffiths, Rhyl.

I think that's a record for any one month! For my money, Hitchiker's Guide was the most interesting. It derives ultimately from the Dungeons & Dragons type of game, and as a fan of the radio show, I found the addition of a neurotic robot to the D&D situation very fetching. But we'll see what the editor thinks.

Acorn Atom Rotate by Stuart Johnson

```
  5 DIM VV(9),NN(9)
  7 G=0;T=0
 10 FOR S=1 TO 9;NN(S)=S;N.
 20 FOR S=1 TO 9
 50 Y=A.R.%9
 55 IF Y=0 GO. 50
 60 A=NN(S);B=NN(Y)
 65 NN(S)=B;NN(Y)=A:N.
 68 T=T+1
 69 P.S12,"ROTATE — A JUNKSOFT CREATION",T'
 70 FOR P=1 TO 9;P.P":—",NN(P)';N.
 75 IF G=9 GO. 130
 80 IN."ROTATE POINT "R
 90 FOR J=1 TO R;VV(J)=NN(J);N.
 95 FOR J=1 TO R;D=R—J+1;NN(J)=VV(D);N.
100 G=0;FOR S=1 TO 9
105 IF NN(S)=S;G=G+1;N.
120 GO. 68
130 P.T"TRIES" ';IN. "WELL DONE. . . AGAIN "Y
135 IF Y=1 GO. 7
150 END
```

BUDGET TAPE

Tom Palmer describes how you can link up a cassette system with the bare minimum of hardware.

The scheme to be described began as an exercise in using software to replace hardware — I merely wanted some practice in writing programs. Later, it turned out that the scheme could compete with commercial methods. It should be of particular interest to readers who have a Microtan 65 (which has no cassette interface). While they are saving their pennies to buy Tanex (which will provide them with an interface) they could use the software method described below.

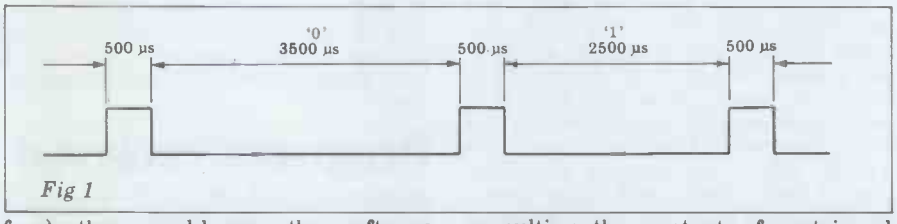


Fig 1

Commercial interfaces usually have counters and pulse-generators. A CPU can be programmed to act as a counter or pulse-generator. The essence of the present method is that, when sending a byte from RAM to tape, the bits are sent serially. If the bit is a '0', there is a gap of 3500 µs between pulses of 500 µs, whereas if the bit is a '1' there is a gap of 2500 µs. See Figure 1.

Since we will be referring to two types of program, it will be helpful to introduce suitable terms. There is the program which was initially stored in RAM at area A. We want to store it on tape so that we can later load it into RAM at area A when we want to re-run it. This is referred to as the 'tape program'. There is another program which we must write into a scratch-pad area of RAM so that the micro can control the loading of the tape program into area A. We call this the 'operating program'. (There is also an operating program for the recording process.) Hardware requires no software to tell it how to behave but a method which uses minimum hardware can be expected to require more software in the operating program than the conventional methods.

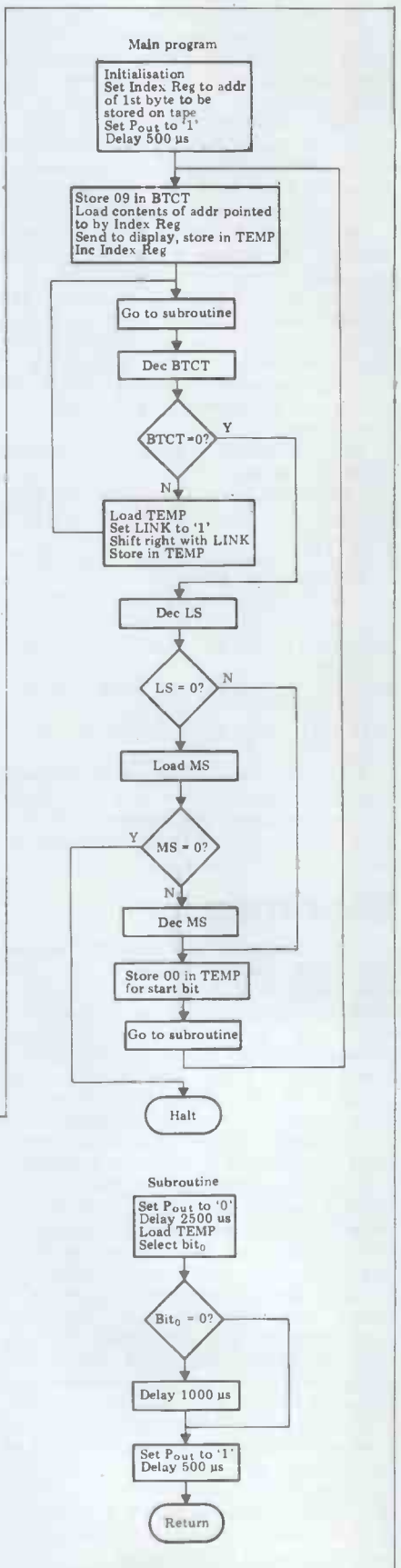
That is the snag associated with the software method. However, by writing a program of 115 bytes (for SC/MP), we can copy a much longer program from tape to RAM. If you have suitable facilities, you could, of course, store the operating program in a PROM.

If you have no PROM-burning facilities, as compensation for writing the operating program in RAM each time you want to load a tape program, the present method offers more confidence that, if the operating program reaches its appointed end, the tape program has been loaded correctly. Each byte copied from tape to RAM begins with a start bit ('0') and ends with a stop bit ('1'). When a tape program is being loaded into RAM, the operating program is expecting start and stop bits at certain periods. If it finds that, when a start bit is expected, a '1' has been received, or, when a stop bit is expected, a '0' has been received, it stops. If it reaches the end of the tape program, it is known that all the start and stop bits have been correctly interpreted. If it stops before the end of the tape program, the address of the last byte correctly loaded into RAM is available at a certain register in the MPU. By consulting the content of certain addresses, we can deduce the nature of the fault.

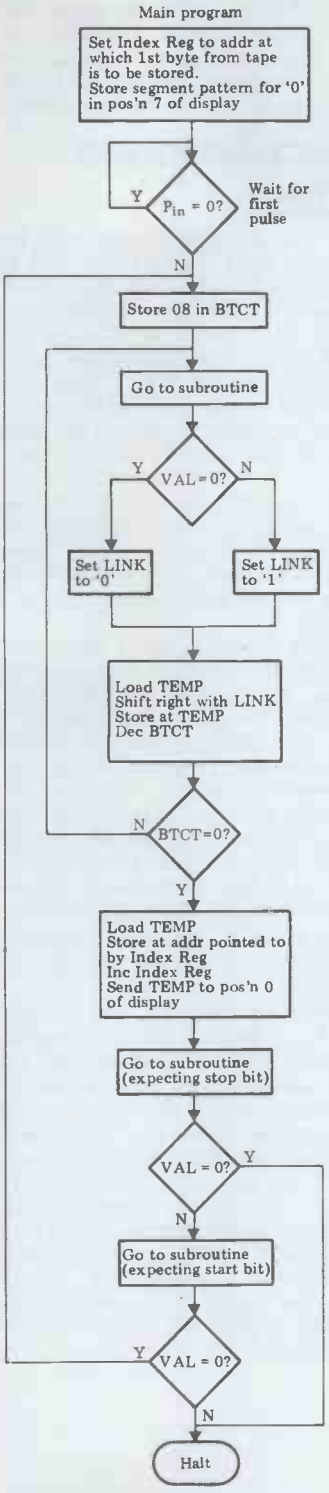
If you are a pessimist and take the view that, though '0s' and '1s' have been correctly interpreted when they were start or stop bits, they may have been misunderstood in the bytes themselves, you can change 32 bytes (in SC/MP) in the operating program for copying from tape to RAM. The modified program is called the 'comparison program'. After the tape program has been loaded into RAM, you can playback a second time; the comparison program will detect any discrepancy between bits stored in RAM and bits coming in from the tape.

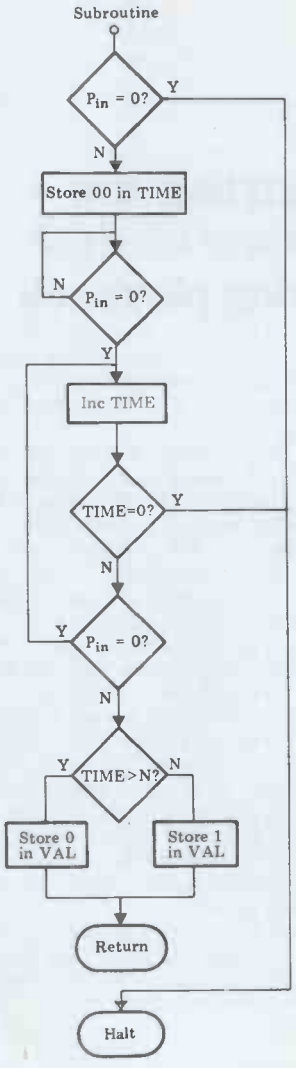
Thus the present method offers more confidence that a program has been loaded correctly (when the end of the tape program has been reached) and offers more flexibility than the usual methods. It is possible to deduce the nature of errors and the address of the byte at which they occurred.

It is disconcerting to playback with a blank display: there is no assurance that everything is under control. A feature of this present method (and of others) is that, when a program is being loaded



Program 1 Sending from RAM to tape. The program requires four addresses in RAM to hold the variables. It must be told the number of bytes to be copied from RAM to tape. Suppose this number is 0178 (hex); the most significant byte, '01' is stored at an address labelled MS while the least significant byte, '78', is stored at an address LS. An address, labelled BTCT, is required to hold the bit counter — this is initially set to 09 to allow for the eight bits and the stop bit. An address is also required for the byte being copied on tape; this is labelled TEMP. The contents of this address are shifted right with LINK when LINK has been set to '1'. This ensures that bit$_0$ (used in the subroutine) will be '1' when BTCT has been decremented to 1; thus the subroutine provides a stop bit. During recording, the least significant bit of the byte being copied is the first to be stored on tape.





Program 2 Loading from tape to RAM. This program (including the subroutine) requires addresses for four variables. Address BTCT is used as a bit counter. TEMP is used to build the byte which will be stored in RAM. The subroutine counts the number of times a loop can be executed while P_{IN} is '0'; the count is held in TIME. If a '0' is coming in from tape, P_{IN} is '0' for 3500 us; if a '1' is coming in, it is '0' for 2500 us. The average is 3000 us; the loop takes 57 us and 3000/57= 52.6 — say 53. This is in decimal — in hex it's 35. In the subroutine flowchart, in the box 'TIME>N?', N is taken as 35H. Because of the difference between 2500 and 3500, N is not critical. If TIME does not reach N before P_{IN} goes high, the program stores '1' at address VAL, otherwise it stores '0'. In the main program, VAL determines whether LINK is set to '1' or '0' before a shift right with LINK operation takes place on TEMP.

into RAM, we should see a rapidly-changing character in the display. While we are waiting for the recorder to bring the first bit of the first byte to the playback head, we see a '0' at a different position of the display. Similar remarks apply to the recording process, except that we see only a rapidly-changing character, never an unchanging '0'.

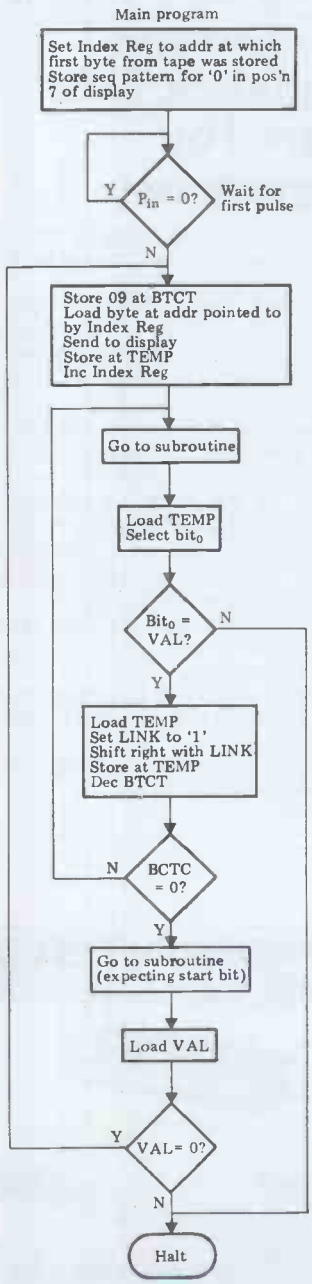
Before a recording is made of a program stored in RAM, the microphone is used to make an announcement of the name of the program and of the area in RAM at which it was stored. It concludes with a statement such as 'Period of silence: 15 seconds'. We stop the recorder, remove the microphone lead, plug a lead from the computer into the microphone jack, start the recorder (in the recording mode) with the microphone control set to a certain level (to be discussed later) and wait 15 seconds before pressing the micro's 'GO' key. Of course, the operating program for copying from RAM to tape must be stored in RAM before we press 'GO'.

This period of silence is useful when we are going to load the tape program into RAM. Several programs may be stored on one tape. We find the announcement of the program we wish to load, stop the recorder, plug the lead from the MPU into the extension speaker jack, set the volume control to a suitable level (to be discussed later) and start the recorder (in the playback mode). After five seconds or so, when any transients arising from the starting process have died way, we can press the 'GO' key and see the steady '0' in the display until the first bit of the first byte is brought to the playback head, when the rapidly-changing character appears.

(At one stage in developing the operating program, I used a header — a string of '1s'; the MPU waited for the first start bit before starting to load the tape program. This made the operating program longer than was necessary; a period of silence is just as effective.)

Sending a program from RAM to tape

The hardware is given in Figure 2; the software in Program 1. A pin of the CPU in an Input/Output port is pro-



Program 3 Comparing a program loaded from tape into RAM with the tape program. The subroutine and hardware are the same as in Program 2.

grammed as an output. (In SC/MP it could be Flag 0, on the MPU chip.) We refer to it as P_{out}. The only purpose of the hardware is to attenuate the voltage at P_{out}. Perhaps we could dispense with the hardware completely but adjusting the microphone control might be more critical.

Loading into RAM from tape

The hardware is given in Figure 2; the software is Program 2. In Figure 2, a pin of an Input/Output port of the MPU is programmed as an input; we refer to it as P_{in}. (In SC/MP, we could use the Sense B input on the chip itself.)

The diode, D_1, is required because, although pulses going into the recorder are positive-going, pulses coming out of the recorder (which has an amplifier with capacitor-coupled stages) go positive and negative. We want to protect the CPU or Input/Output chip against negative-going pulses.

Diagnostic help offered by program two

There are four conditions in which the operating program is brought to a halt.

In the subroutine:

(i) We left the subroutine for the previous byte when a positive-going pulse was just starting. If all is well, we should be testing the state of P_{in} before the pulse has finished. If P_{in} is '0', we have spent too long in the main program before going to the subroutine. Either something is wrong with the operating program or we need to increase the duration of the positive-going pulse.

(ii) If the gap between positive-going pulses is unduly long, TIME will be incremented through the sequence. . . FD, FE, FF to 00. Either the tape program has come to an end, or a positive-going pulse has been lost.

(iii) If a '0' occurs in the main program when we expect a STOP bit, the program ends.

(iv) If a '1' occurs in the main program when we expect a START bit, the program ends.

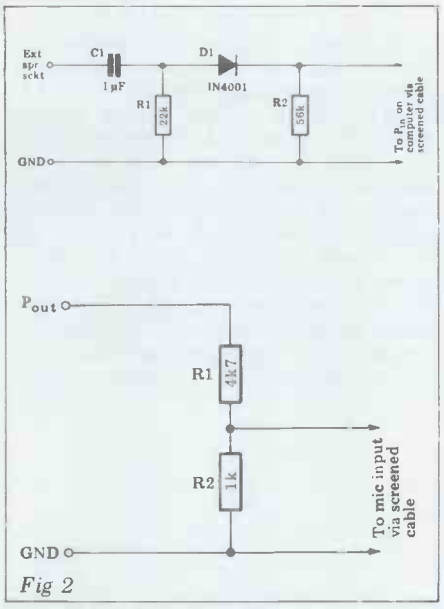


Fig 2

Adjusting the volume control during playback

This is a problem with most interfaces. Too low a setting means that the positive-going pulses will not be detected; too high a setting leads to distortion.

In my method, I have the volume control at maximum. There is then no ambiguity. The only snag is that, if I leave the control at maximum when I am searching for the verbal announcement of the program I wish to play back, the volume is uncomfortably high. The remedy is simple.

Working with the volume control at maximum during playback means that the microphone control during recording must not be set too high. In my recorder (a Philips 3302) I find that the control can be set at 4 or 5 for recordings that are satisfactory for playback at maximum volume. Since the lead from the MPU, when plugged in the extension speaker socket, cuts off the internal speaker, there is no overpowering noise.

Since a recording is only made once, whereas a tape program may be played back many times, it is worthwhile spending some time experimenting with the microphone control to find the best setting. For a given recorder, with a given brand of cassette, we can expect the microphone control to require the same setting with all programs recorded.

Miscellaneous notes

(.) It was said earlier that each byte is preceded by a START bit and terminated by a STOP bit. It was found that the operating program for loading from tape to RAM could be shortened if the first byte had no START bit. (But the first byte sent to tape — and received from tape — begins with a 500 us pulse). So the operating programs are arranged to omit the START bit of the first byte.

(ii) In the Mk 14, it was necessary to store on tape a long program in two sections. There was the first tape program, extending from 0A80 to 0BFF; and a second tape program from 0F12 to 0F85.

In my first attempt, I was successful with the first section, but not with the second. I originally thought that my operating program for loading from tape was wrong. But the diagnostics offered by the Program 2 suggested that the second section was not stored correctly on tape. It was then realised that, after storing the first section, I should have pressed the RESET key. When this had been done, the second section could be stored correctly.

The point is that, after recording the first section, P_{out} was left in the '1' condition.

When we recorded the second section, P_{out} was set (by the program) to '1'. Since it was '1' already, this had no effect on the capacitor-coupled amplifier which feeds the recording head. The moral is: when you have made one recording, set P_{out} to '0' (by pressing RESET, or otherwise) before making a second. Or, more generally, before making a recording, press RESET.

Although this is an elementary point (with hindsight) it may have taken me some time to correct the mistake, without the diagnostics offered by Program 2.

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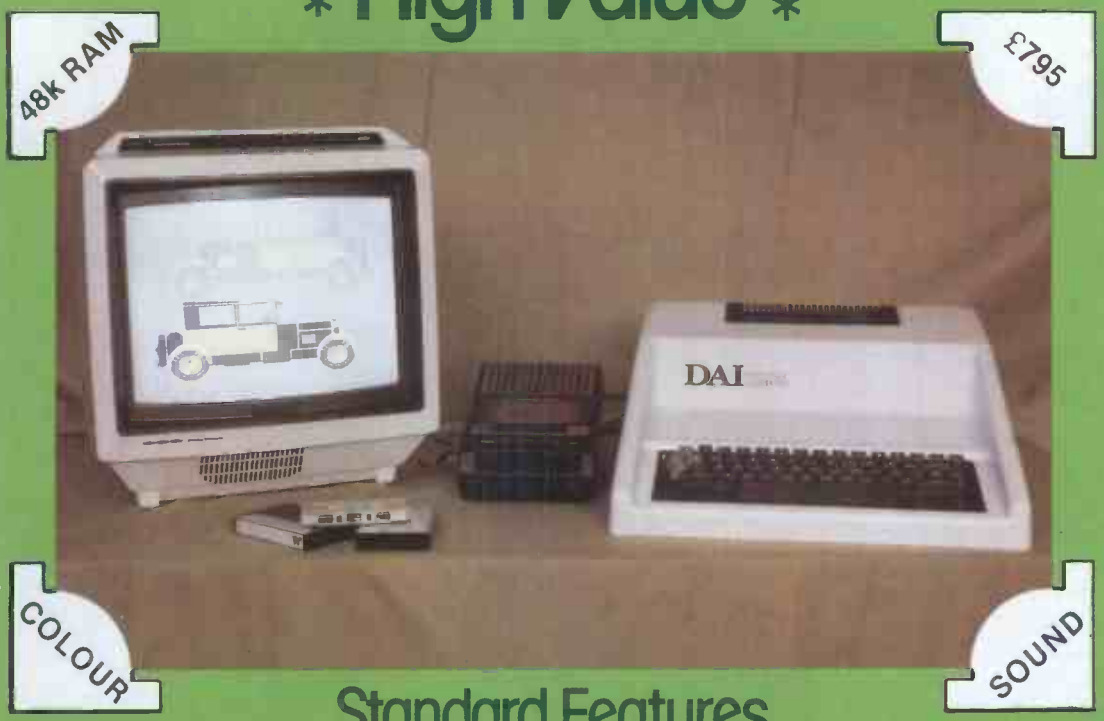

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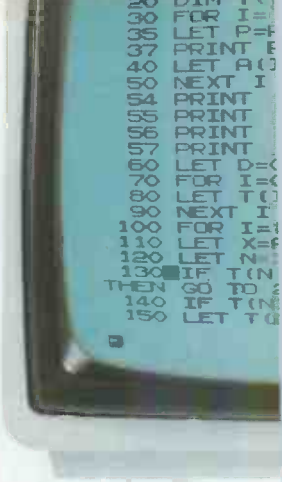

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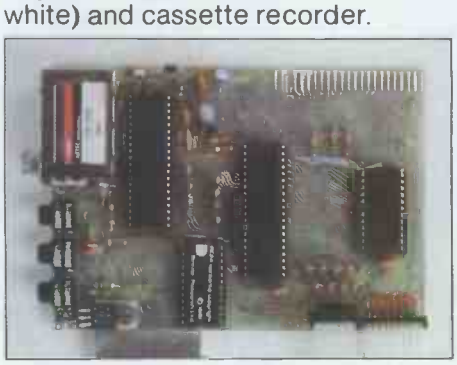

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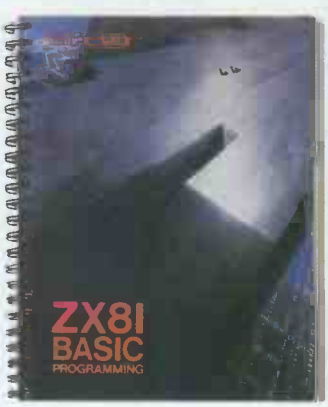

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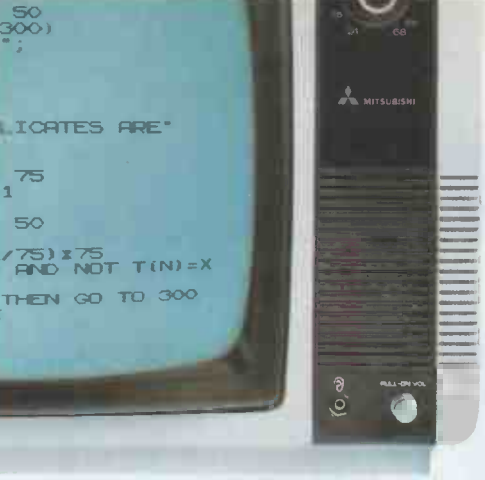

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BOOKFARE

Malcolm Peltu gets his teeth into some new books.

Os-d'oeuvre

This month's 'Bookfare' is a four course meal. The main course is a double helping of Human Factors, followed by tempting silicon pud with social impact custard and rounded off with some ripe and tasty legal cheese.

For a starter we have a neat little hors d'oeuvre prepared by the publishing kitchen of the National Computing Centre (NCC). *Operating Systems for Microcomputers* by John Lane is the first of a new series, 'Computing in the 80s', which aims to provide concise, up-to-date briefings on the latest computing developments.

Although Lane's book is a bit expensive for what it is (£3.50 for 77 well-spaced pages), it sets a good benchmark for the series. Lane succinctly describes the objectives and nature of an operating system (OS) and provides a valuable primer to anyone using micros for personal, business or industrial applications. Do not expect detailed reference material or evaluation checklists; the purpose, as Lane explains, is to 'establish an awareness of current practice and trends.' And this is what he does clearly and with no frills. The descriptions are primarily concerned with run-time OS environments and only brief mention is made of program development and testing capabilities.

Three main types of OS are discussed – single-user Disk OS (DOS) and multi-tasking (MTOS) for general purpose microcomputers and real-time executives for dedicated systems. A short (one-page) insight into the requirements of multi-micro OS needs is also provided. For each type of OS, Lane starts with a general description of the purpose of such systems, followed by an overview of the facilities that should be provided and, finally, a couple of summarised product specifications to illustrate what is on the market.

The ubiquitous CP/M and Zilog's RIO are the DOS examples chosen; MVT Famos and Data General MP/OS (Micron) exemplify MTOS products; and TI's Timber and the Intel RMX/80 are used to illustrate the real-timers. The juxtaposition of general theory with practical examples is a useful way of explaining the nature of different systems without either being too general or too specialised.

In the Appendices, there are paragraph-length summaries of 17 other operating systems. Although these are rather short, they do provide a rough guideline to the variety of capabilities available.

The book achieves its aims but I feel that, for the price, it should have provided some evaluation guidelines and more idea of why one OS may be better or worse than another.

For mainframe dinosaurs like me, I liked the way Lane places micro OS capabilities into the broader OS spectrum. It would be useful if the NCC uses its 'Computing in the 80s' series both to bring together past and present developments and to assist all computer users to sharpen their critical faculties when selecting systems. Lane's book describes the outline sketch. I hope future publications in the series provide some more detail and colour.

Hail homo termino -videns

'We are in the midst of a rapid evolution of the species *Homo Termino-Videns* (the VDU-viewing man). This has alerted trade unions all over the world, which in turn have alerted the safety and health authorities.' O Ostberg of the University of Lulea in Sweden thus summarises the driving force that has suddenly made ergonomics one of the trendy catch phrases of the computer business.

What began as fears that operators could damage their eyesight by prolonged use of VDUs has blossomed into a fuller examination of the ways in which human factors, organisational structures, job design and environment and equipment specifications can determine system effectiveness.

Ostberg is one of over 50 contributors to *Ergonomic Aspects of Visual Display Terminals*, which, along with the National Computing Centre's *Designing Systems for People*, form this month's 'Bookfare' main course. Ergonomics officially means the 'study of efficiency of persons in their working environment' according to the *Concise Oxford Dictionary*. In practice, it has come to signify a human-centred approach to equipment and systems design. This is contrasted with the traditional approach in which the objectives of a computerised applications were set primarily in terms of business and corporate organisational aims and implemented by technical computing staff who were frequently remote from the users of the system.

Illustration by Ian Wright

Like architects who live in comfortable luxury houses and design tower blocks unfit for human habitation, computer specialists have frequently redesigned and degraded other people's jobs from the security of their own highly paid and interesting DP palaces. This led to rumblings from all levels of users. For many managers, the personal computer came like manna from heaven, showing that it was possible to get things done more effectively and quickly than the computer boffins could deliver. For operational staff who were often intimidated by poorly designed systems, fears about VDUs and health became a focal point for

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their worry and frustration.

In retrospect, it is shocking and alarming how little emphasis was given to the human factor in systems design. Lip service was paid to the notion of gathering user opinions during systems analysis but nobody in the design process had the responsibility or the expertise to handle aspects of behavioural sciences and ergonomic design which are of central importance to the whole exercise.

As the two books under review demonstrate, detailed research into human factors in computer design has so far primarily been focused on physical equipment and workplace layout specifications and physical human side effects. It is only just beginning to touch on such topics as job design, psychological perceptions and optimum criteria for designing the interaction of people and computers.

There are still some influential people who unfortunately regard any talk of human factors as 'Luddite'. For example, John Butcher MP, one of the most vociferous MPs on the subject of computing, recently made the extraordinary statement that 'If the unions push such views as "Jill mustn't sit in front of a screen for more than an hour at a time," we may not get the benefit of products which could give us increased efficiency.' Yet most ergonomic research has confirmed that *unless* VDU operators get regular breaks, their efficiency suffers through fatigue and eyestrain.

Etienne Grandjean of the Swiss Federal Institute of Technology, one of the editors of the *Ergonomic Aspects of Visual Display Terminals* (together with E. Vigliani) states: 'There is no doubt that eye troubles are more frequent with VDU operators than other clerical groups.'

This book contains a great deal of interesting research evidence into the health effects of VDUs. There is also a wealth of advice on how most of the physical problems can be overcome. Eyestrain, headaches, back and neck pains, sleeplessness, etc, can all be caused by thoughtless implementation.

One of the few British contributors, D Doran of British Airways, explains that much of the discomfort experienced by VDU operators is unnecessary and he rightly places the onus on the VDU manufacturer to meet required standards — and on users insisting on these standards. For example, the keyboard and screen should be separate; the screen angle adjustable; brightness and contrast control should be separate; character flicker should be eliminated; displays with phosphors which generate blue or red characters (other than in full colour displays) should be avoided; chairs should be adjustable; and so on.

The book is composed of the edited proceedings of a 1980 International Workshop in Milan on VDU ergonomics and is essentially a collection of research papers. Although it is of prime interest to researchers, I would recommend that any person involved in managing, designing or implementing computer systems should try to get hold of a copy to see how much is known about physical ergonomics — and how little about other aspects of human factor engineering.

The NCC book *Designing Systems for People* is far more accessible and contains some excellent checklists, primarily concerning the physical aspects of VDUs and workplace design. As such, it is an extremely useful design aid but I was disappointed that it did not go into more detail on some of the broader psychological and social issues, like job design, evaluation of database enquiry languages, etc.

What is provided is a very useful attempt at combining the disciplines of of applied ergonomics and systems analysis by bringing together authors from the Human Sciences and Advanced Technology (HUSAT) research group at Loughborough University and NCC consultants. It is written in some ways like a structured specification, with each section beginning with a skeleton checklist which is then fleshed out.

As a skeletal outline, it encompasses a comprehensive range of systems design activities and gives at least a reminder that certain tasks should be performed. Some sections, such as that on user documentation and procedures to handle faults and breakdowns, are too generalised and skimpy to be much more than a mind-jogger. The physical ergonomics sections, however, go into full detail about temperature, humidity, desk height, display clarity and just about everything down to footrest adjustability. There is also an interesting section on dialogue design for interactive operation; what manufacturers glibly call 'user friendly' communications.

Although there is more than just a superficial examination of alternative techniques, such as menu and form filling, there is insufficient depth in the discussion of the most appropriate method for particular applications. The authors comment that: 'a simple paradigm for selecting a dialogue style has not yet been derived.' Consequently, they add, 'the choice of a dialogue style must depend on the trial and error matching of task and user characteristics with the characteristics of the dialogue styles.' But they do provide some useful insights into how to approach dialogue design in a structured manner.

What the two books highlight is the need for human factor specialists/ergonomists/behavioural scientists/call-them-what-you-will to become part of the systems design process from the earliest possible stage, both in creating systems for manufacturers and applying them in user organisations.

In an introduction to the NCC book, Brian Shackel, head of HUSAT, and David Coan of the NCC summarise the requirement: 'Many computer systems must in future be designed for "non-expert" users. More emphasis must now be placed on the man-machine interface and on all aspects of communicating between systems and people. Otherwise inadequate facilities are provided: computers are used inefficiently and the users may well become bored, tired and error-prone. The ergonomic aspects of terminal selection and use must become part of the systems designer's portfolio of expertise.' However, they point out that, 'Computer system designers will not become ergonomists or human scientists' simply by reading the book, but that computer scientists need to have available the relevant experience and advice from such human scientists.

In a few years' time such an obvious point will doubtless appear anachronistic. But these two books — and others on the same subject that I have reviewed in recent months — mark a significant turning point in the involvement of people in the computer equation. They also illustrate why, in last month's 'Bookfare', I attacked the propagators of the myth that computing is easy just because Basic programming is easy. Even the simplest personal computer game is concerned with the interaction of people and machines. Neither of the two are simple.

It will take much sensitive, complex and careful design, implementation and experimentation in ensuring that Homo Termino-Videns sits tall and walks proudly and healthily.

Mature chips

The speed with which the 'micro revolution' hit Britain has exposed the inadequate response of the publishing industry to change. First newspapers, then magazines and, finally, books tried to grapple with a technology that few writers understood and with implications so vast that they could not be encapsulated in journalistic cliches without gross distortion. The first wave of articles, TV programmes and books were often hastily thrown together to jump on the bandwagon. Then a second more thoughtful wave began to appear, often clothed in garish publishing blurb. One of the best and most thoughtful of these books was published earlier this year, *The Silicon Chip Book* by *New Scientist* journalist Peter Marsh. In his description of basic microelectronics and computing technology, Marsh provides a readable tutorial, from the electron upwards.

Unfortunately, other parts relating to the information technology industry and specific facts and figures have, by their very nature, become dated. It is a pity that the publishers did not get the book out at least six months earlier before similar ground was covered by about half a dozen other popular paperbacks; though the delay in production has permitted the book to mature. Following some of the more hurried efforts of other writers, Marsh lingers and savours aspects of the technology, while attempting to demystify all jargon.

My main criticism is one I have levelled at other similar books. The real starting point should be a description and discussion of information technology; of information management, storage, transmission and processing. That is the real technology in which the micro plays a crucial but not overwhelming role. Marsh, however, does

place micros the context of their computer ancestors and covers a wide range of applications.

When he dons his pundit cap in looking to the future, Marsh neatly deals with the problem of deciding between Rosy Scenario or her down-at-heel twin brothers, Doom and Gloom. He outlines four possible scenarios and gives each economic, 'happiness', prosperity and likelihood ratings. The 'patched-up-go-for-growth' society, more or less a continuation of our current 'fudge and mudge', as David Owen might say, is rated as follows: 'Economic outlook: exceedingly gloomy. Overall state of happiness: fair. Prosperity level: very reasonable for some, low for the great majority (with prospects getting lower). Likelihood of taking place: high.' For 'the robot society', in which there is a no-holds rush into automation, his forecast is: 'Economic outlook: good. Overall state of happiness: patchy. Prosperity level: reasonable. Likelihood: quite possible.'

The two low probability scenarios are Britain ditching past industries and creating a new society by going flat out for new industries; and a low growth ecological society.

The *Silicon Chip Book* should really be read in association with Marsh's equally comprehensive and thoughtful articles in *New Scientist*, particularly a series he has recently written on the Japanese industry and factory automation.

The speed of developments means that some form of quicker publishing cycle than a book is needed when words become increasingly perishable commodities. However, there is enough good, non-time dependent material in the *Silicon Chip Book* to make it a useful buy for students and all others wanting a technological background to help place today's news in perspective.

Copyright

Finally, a brief mention of another topical subject, copyright. The computing press is filled regularly with stories of arrests, claims and judges' rulings. Much of this publicity has focused on the question of whether software can be copyrighted or patented. Electronic information technology raises a much wider range of challengers to existing copyright notions, such as the position of material 'published' on a service like Prestel, or stored and accessed in online library information services.

Copyright — Intellectual Property in the Information Age by Edward W Ploman and L Clark Hamilton offers an international perspective in extending the copyright debate. Ploman is a lawyer, former director of international relations for the Swedish Broadcasting Corporation and currently executive director of the International Institute of Communications. Hamilton is assistant director for systems development at the Library of Congress, Washington.

The first two-thirds is a broad historical and international analysis of the origins of copyright, international agreements and particular national systems. It then examines how these general rules, mainly developed in a pre-computer age, have to grapple with new techniques. Ploman and Hamilton offer few solutions but perform a valuable service in pointing out the international significance of these issues. The Third World already fears the dominance held over communications media by the developed countries, particularly in the West, and have sought to control such communications, mainly the news media. As various electronic techniques merge into an integrated information technology that encompasses tradition capabilities such as news dissemination, TV, publishing, etc, the international battle to regulate and control communications becomes more complex and potentially more explosive.

Unfortunately, their descriptions of some proposed policies for the 'information age' lapse into the unnecessarily sterile jargon of the 'international relations' strategists. Inevitably, the book is also out-of-date in terms of recent developments, such as the US Computer Software Copyright Act, which was passed at the end of last year.

The book, however, provides much useful background and reference material to this increasingly important subject.

This month's 'Bookfeast' had the following menu.

Hors-d'ouvre

Operating Systems for microcomputers by John Lane (National Computing Centre, £3.50).

Main course

Designing Systems for People by Leela Damodaran, Alison Simpson and Paul Wilson (National Computing Centre, £12.50)

Ergonomic Aspects of Visual Display Terminals eds Etienne Grandjean and E Vigliani (Taylor & Francis, £18.00).

Dessert

The Silicon Chip Book by Peter Marsh (Abacus, £2.50)

To follow

Copyright by Edward W Ploman and L Clark Hamilton (Routledge & Kegan Paul, £12.50)

TECHNICAL REVIEW

by Chris Sadler

The question of Basic, its many dialects and its unrivalled position as the major microcomputer language (especially for beginners), has come to the fore again recently, particularly in the light of the BBC's announcement of plans to commission its own machine (from Acorn Computers) and to run at least one television series around it. Although there are many people who believe that there are languages better suited than Basic, both for learning to program and for programming proper, it is particularly interesting to receive a batch of the more recently published Basic textbooks for review, especially because it will be through such books that this new group of mass-media users will actually learn to program.

Although a large number of Basic primers are already on the market, it seems to me to be a particularly hard task to write a good one. In the first place, the author has so many things to cover at once — describe the features of the language, teach the principles of programming and introduce those aspects of the computer system (particular Basic dialect, keyboard usage, system operation) necessary for the reader to 'drive' the machine. The first of these is fairly straightforward since Basic has a limited and reasonably unobscure syntax. However, it is important to be careful of the order in which the different instructions are introduced, since some might involve much distracting explanation about the underlying mechanisms before the reader is really prepared for it. Wayne Amesbury in *Structured Basic and Beyond* cites the READ. . . DATA sequence as an example of the sort of instruction which should be left until (in this instance) the keyword INPUT has been mastered and is completely familiar. By contrast, the very first program (page 12) which L R Carter and E Huzan suggest in *Computer Programming in Basic* consists of a READ. . . DATA pair followed by a PRINT statement, which goes to show how easy it can be to start off on the wrong foot.

In the third and final book selected for this review *(Programming in Basic for Personal Computers)*, David Heiserman makes the point that if learning syntax was all that there was to learning Basic, then anyone could teach themselves by means of a manufacturer's user manual; but it is programming itself, or 'problem-solving' as it is known in its more generalised form, that is difficult to learn and indeed teach. Because of the level of abstraction required and the need for some careful planning and thought before any coding is done, there is a discipline associated with programming which is independent of Basic or any other language. As a Pascal devotee, I cannot avoid declaring an interest and observing that there may be languages in which this discipline is more naturally and effectively manifested than in Basic but, nevertheless, in any programming book, I would look for some commitment on the part of the author to some programming ethos.

Structured Basic and Beyond, for instance, goes for the full structured programming approach. Each programming example is first expressed in an Algol-like pseudocode (ie, in terms of structures like repeat-until, if-then-else, etc) and this is then translated into Basic to produce a running program. I thought that the difficulties of the translation process were rather underemphasised — Basic doesn't easily support the structured constructs and the reader might have some trouble matching up an if-then-else with an uncommented fragment of Basic filled with GOTOs. Flowcharts are only used to lend emphasis to the structured constructs where these are first introduced. To my mind, this is the right approach to learning programming,

GOTO page 149.

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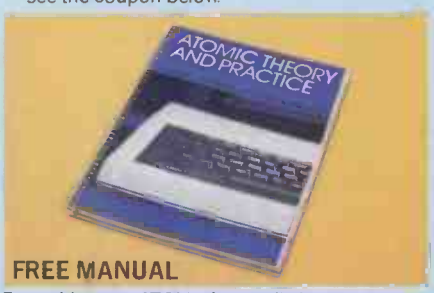

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If you'd like to contribute your routines (for any of the popular processors), send them to:
Sub Set, PCW, 14 Rathbone Place, London W1P 1DE.

Our first look at the 6502 processor is with a variation, sent in by P Nowasad of Laren, Holland, on the 'Find Out Where I'm At' theme. The routine of our first Datasheet, FIND, is used to determine the start address of a block of memory dynamically but, unlike FOWIA, it does not return you to the address it has picked up (because it has pulled it from the stack) but to the next address to be pulled from the stack of the code that called it.

In this example

```
0000            JSR     BLOCK
0003            JSR     WRITE
                .
                .
                .
0060 BLOCK:     JSR     FIND
0063            .BYTE   7
0064            .ASCII  "MESSAGE"
```

the return from FIND is to the address 0003 but with the address 0063 in the Y,X registers, ie, the high order byte in Y and the low order byte in X. In this case WRITE is a routine for printing strings on an Apple II which, not having an Apple II, I pass on untested and without the routine FDED which outputs a character:

```
WRITE:  STX  1E      ; low addr byte
        STY  1F      ; high addr byte
        LDY  #0
        LDA  @1E,Y   ; string length
        TAX
LOOP:   INY          ; move along
        LDA @1E,Y    ; string
        JSR  FDED    ; output chr
        DEX          ; no of chrs left
        BNE  LOOP
        RTS
```

To make FIND strictly equivalent to FOWIA and return to the address it picked up, instructions PHA, TXA and PHA need to be inserted between TAY and INX.

The 6502 processor puts the high order return address byte to the stack first followed by the low order byte and the address it stacks is one less than that of the instruction following the jump to subroutine.

Fowia

I have had complaints about the the inordinate length of April's Z80 FOWIA — and after I was so pleased with it too! Dave Barrow and Richard Steedman all gave this code to cuts its length by a third:

```
POP     HL
JP      (HL)
```

M6809

Struck by the awkwardness of the M6800 instruction set, as shown in March's HEXMV, Ian Phillips of Cambridge shows how the same job is done in M6809 code when, on input, the source address is in X, the destination address in Y and the byte count in B:

```
CVHX:   STB   ,-S    ; B to sys stak   E7  E2
        CLRB         ; 0 to checksum   5F
CV1:    ADDB  ,X     ; add in chksum   EB  84
        LDA   ,X+    ; load & add 1    A6  80
        BSR   CVBT   ; convert byte    8D  08
        DEC   ,S     ; count down      6A  E4
        BNE   CV1    ;                 26  F6
        LEAS  1,S    ; count from ss   32  61
        TFR   B,A    ; get checksum    1F  98
CVBT:   PSHS  A      ; save 2nd nibl   34  02
        LSRA         ; shift           44
        LSRA         ; first           44
        LSRA         ; nibble          44
        LSRA         ;                 44
        BSR   CVNB   ; cnvt 1st nibl   8D  02
        PULS  A      ; get 2nd         35  02
CVNB:   ANDA  #$F    ; nibble          84  0F
        ADDA  #$90   ; conversion      8B  90
        DAA          ; of nibble       19
        ADCA  #$40   ; to HEX          89  40
        DAA          ; done            19
        STA   ,Y+    ; store & add 1   A7  A0
        RTS          ;                 39
```

ZX80 arithmetic

The following Datasheets, SNEG4, SMUL4, DADB4, SDIV4 and SBAD4, come from Dave Barrow of Hemsworth who sent a set of five signed 32-bit routines. Who is going to give us the best M6800 and 6502 code to match?

Datasheet

```
;= FIND — Get memory block address
;/ CLASS: 1
;/ TIME CRITICAL? No
;/ DESCRIPTION: Gives in the Y,X registers the address of a block
                of memory placed immediately after the jump to
                FIND.
;/ ACTION:  ↑A
;/          X←A
;/          ↑A
;/          Y←A
;/          YX←YX+1
;/ SUBr DEPENDENCE: None
;/ INTERFACES: None
;/ INPUT: None
;/ OUTPUT: Y contains the high order and X the low order byte of
;/         the address immediately following the jump to FIND.
;/         The stack pointer has been incremented by two to cause
;/         a return not to FIND's return address but to the return
;/         address of a routine that jumped to FIND.
;/ REGs USED: A, X, Y and "P"
;/ STACK USE: minus 2
;/ LENGTH: 9
;/ PROCESSOR: 6502
FIND: PLA       ; pull return address          68
```

```
                TAX     ; ; low byte            AA
                PLA     ;                       68
                TAY     ; high byte             A8
                INX     ; adjust to first       E8
                BNE L1  ; byte of block         D0  01
                INY     ;                       C8
          L1:   RTS     ; pop to original call  60
```

Datasheet

```
;= SADB4 — Convert ASCII Decimal String to 4 Byte Signed Integer
;/ CLASS: 1
;/ TIME CRITICAL?: No
;/ DESCRIPTION: Converts RAM located ASCII decimal string beginning
;/              with "+", "—" or first digit to signed 32-bit integer,
;/              giving error information in flags.
;/ ACTION:      Get sign if any.
;/              Clear 32-bit accumulator.
;/              Get (next) digit and convert to binary
;/              multiply accumulator by ten and add digit
;/              repeat until non-numerical character found.
;/              Negate if sign was "—".
;/ SUBr DEPENDENCE: SNEG4 (negate 4 bytes on stack)
;/ INTERFACES: None
;/ INPUT:  HL points at first byte of string in RAM.
;/ OUTPUT: No error: Z reset, HL points at terminating character
;/                   signed binary equivalent in BC,DE
;/                   Cy copies sign.
;/         Error: Z set, HL returned unaltered
;/                DE points at terminator or overflow digit
;/                Cy set: no valid digit before terminator
;/                Cy reset; overflow — number too large.
;/ REGs USED: BC DE HL Flags
;/ STACK USE: 12 (including CALL and use SNEG4).
;/ LENGTH:    81
;/ TIME STATES: 9109 max. (excluding infinite string of leading zeros).
;/ PROCESSOR: Z80
;
SADB4:  PUSH  AF        ; save A                    F5
        EX    DE,HL     ; make DE pointer to RAM and EB
        LD    A,(DE)    ; get first character in A. 1A
        SUB   2DH       ; subtract ASCII "—" and    D6  2D
        PUSH  AF        ; save Z flag.              F5
        PUSH  DE        ; save initial point.       D5
        LD    HL,+0     ; clear 32-bit accumulator  21  00  00
        PUSH  HL        ; in HL,(SP).               E5
        LD    B,+1      ; initialise default.       06  01
        JR    Z,LOOP0   ; skip if character was "—". 28  04
        ADD   A,+2      ; test for ASCII "+".       C6  02
        JR    NZ,SKINC  ; skip increment if not sign. 20  01
LOOP0:  INC   DE        ; address next character and 13
SKINC:  LD    A,(DE)    ; get in A.                 1A
        ADD   A,C6H     ; convert to binary but end if C6  C6
        JR    C,ENDLP   ; greater than 9            38  21
        SUB   F6H       ; or less                   D6  F6
        JR    C,ENDLP   ; than 0.                   38  1D
        LD    B,+2      ; word count for multiplying 06  02
LOOP1:  EX    (SP),HL   ; (SP) first time, HL second time. E3
        PUSH  BC        ; save word count           C5
```

```
;/OUTPUT:      No error: Z reset, Quotient in BC,DE, Remainder in IX,IY
;/                       CY copies Quotient sign.
;/             Error: Z set, IX,IY,BC,DE returned unaltered
;/                    CY set: 80 00 00 00 was input
;/                    CY reset: Division by 0.
;/REGs USED: BC DE IX IY Flags
;/STACK USE: 18 (including CALL and use SNEG4).
;/LENGTH:    121
;/TIME STATES: 13015 max.
;/PROCESSOR:Z80
;
SDIV4:  PUSH  IX        ;get dividend sign in H     DD E5
        EX    (SP),HL   ;and save HL.               E3
        PUSH  BC        ;save                       C5
        PUSH  DE        ;divisor.                   D5
        LD    L,A       ;save A.                    6F
        LD    A,H       ;XOR dividend with divisor to give 7C
        XOR   B         ;quotient sign in Sign flag. A8
        LD    A,H       ;move dividend sign = remainder sign 7C
        RLA             ;into Cy flag.              17
        LD    A,L       ;restore A and              7D
        PUSH  AF        ;save A and flags.          F5
        PUSH  BC        ;complement                 C5
        PUSH  DE        ;divisor                    D5
        CALL  SNEG4     ;to get                     CD  XX  XX
        CALL  C,SNEG4   ;absolute value             DC  XX  XX
        POP   DE        ;or                         D1
        POP   BC        ;error flags.               C1
        JR    Z,ERR4    ;jump if divisor = 0        28  58
        JR    C,ERR4    ;or 80 00 00 00.            38  56
        PUSH  IX        ;get                        DD E5
        PUSH  IY        ;absolute                   FD E5
        ADD   HL,HL     ;value                      29
        CALL  C,SNEG4   ;of                         DC  XX  XX
        POP   IY        ;dividend                   FD E1
        POP   IX        ;or                         DD E1
        JR    C,ERR4    ;error if 80 00 00 00.      38  48
        POP   HL        ;get AF in HL               E1
        POP   AF        ;remove stacked divisor and F1
        EX    (SP),HL   ;save AF.                   E3
        LD    HL,+0     ;clear 32-bit accumulator   21  00  00
        PUSH  HL        ;in (SP),HL.                E5
        LD    A,+32     ;bit count.                 3E  20
LOOP4:  ADD   IY,IY     ;shift left                 FD 29
        EX    (SP),IX   ;dividend into              DD E3
        EX    (SP),HL   ;accumulator                E3
        ADC   HL,HL     ;by one bit.                ED 6A
        EX    (SP),HL   ;                           E3
        EX    (SP),IX   ;                           DD E3
        ADC   HL,HL     ;                           ED 6A
        EX    (SP),HL   ;                           E3
        ADC   HL,HL     ;                           ED 6A
        EX    (SP),HL   ;                           E3
        SBC   HL,DE     ;subtract divisor from accumulator ED 52
        EX    (SP),HL   ;and set result bit in quotient E3
        SBC   HL,BC     ;which shifts into IX,IY    ED 42
        EX    (SP),HL   ;as the dividend shifts out. E3
        INC   IY        ;                           FD 23
```

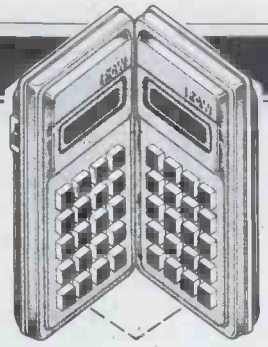
```
        PUSH  DE          ; and RAM point.                          D5
        LD    C,A         ; new digit 1st, carry 2nd time.          4F
        LD    B,+9        ; addition count for multiply by 10.      06 09
        LD    D,H         ; copy value to be added 9 times          54
        LD    E,L         ; for " *10 ".                            5D
        XOR   A           ; clear A.                                AF
LOOP2:  ADD   HL,DE       ; HL     HL * 10 by addition              19
        ADC   A,0         ; getting carry in A.                     CE 00
        DJNZ  LOOP2       ;                                         10 FB
        ADD   HL,BC       ; add new digit // carry from L.S.word    09
        ADC   A,B         ; getting carry in A.                     88
        POP   DE          ; restore RAM point                       D1
        POP   BC          ; and word count.                         C1
        DJNZ  LOOP1       ;                                         10 EC
        JR    NZ,0VFW1    ; overflow if carry into A from HL,(SP).  20 04
        BIT   7,H         ; test for carry into bit 32              CB 7C
        JR    Z,LOOP0     ; and do again if clear.                  28 DA
OVFW1:  INC   B           ; prepare for Z set                       04
ENDL P: DEC   B           ; Z set if error, reset if okay.          05
        POP   BC          ; (SP) into BC.                           C1
        JR    Z,END1      ; skip if error                           28 0A
        POP   AF          ; else remove initial point from stack.   F1
        EX    (SP),HL     ; M.S. word to stack, sign in L.          E3
        PUSH  BC          ; number now on stack for negation        C5
        XOR   A           ; (clear A and Cy for okay message.)      AF
        BIT   6,L         ; if sign was "—".                        CB 75
        CALL  NZ,SNEG4    ;                                         C4 XX XX
        DEC   A           ; reset Z flag.                           3D
END1:   POP   HL          ; signed binary equivalent in BC,HL       E1
        POP   BC          ; or initial point in HL if error, in     C1
        JR    Z,ERR1      ; which case skip.                        28 01
        EX    DE,HL       ; terminator point in HL, number in BCDE  EB
ERR1:   EX    (SP),HL     ; restore                                 E3
        LD    A,H         ; A with output flags.                    7C
        POP   HL          ;                                         E1
        RET               ;                                         C9
```

Datasheet

```
;= SDIV4 — Four Byte Signed Integer Division
;/CLASS: 1
;/TIME CRITICAL?: No
;/DESCRIPTION: Divides one signed 32-bit integer by another in the
;/             range 80 00 00 01 to 7F FF FF FF. Returns signed
;/             Quotient and Remainder or error information in flags.
;/ACTION:      Compute Quotient and Remainder signs.
;/             Make values absolute.
;/             Clear 32-bit accumulator.
;/                Shift left dividend into Cy
;/                shift left accumulator from Cy
;/                subtract divisor from accumulator, set result bit
;/                if accumulator negative add back divisor and
;/                                                   reset result bit
;/                repeat 32 times.
;/             Negate Quotient, Remainder is signs demand.
;/SUBr DEPENDENCE: SNEG4 (negate 4 bytes on stack)
;/INTERFACES: None
;/INPUT:       IX,IY / BC,DE
```

```
        JR    NC,DECA4    ;skip if accumulator positive     30 07
        ADD   HL,DE       ;else add back                    19
        EX    (SP),HL     ;divisor                          E3
        ADC   HL,BC       ;and                              ED 4A
        EX    (SP),HL     ;reset                            E3
        DEC   IY          ;result bit.                      FD 2B
DECA4:  DEC   A           ;repeat                           3D
        JR    NZ,LOOP4    ;32 times.                        20 DC
        POP   BC          ;(SP)into BC                      C1
        EX    (SP),HL     ;AF into HL                       E3
        EX    (SP),IX     ;HL into IX and IX to stack       DD E3
        PUSH  IY          ;quotient now on stack.           FD E5
        PUSH  BC          ;put remainder on                 C5
        PUSH  IX          ;stack and move                   DD E5
        SRA   L           ;remainder sign into Cy.          CB 20
        CALL  C,SNEG4     ;negate if necessary.             DC XX XX
        POP   IY          ;signed remainder                 FD E1
        POP   IX          ;into IX,IY.                      DD E1
        SLA   L           ;move quotient sign into Cy       CB 25
        CALL  C,SNEG4     ;and negate if necessary.         DC XX XX
        LD    D,+0        ;prepare for Z reset.             16 00
        JR    END4        ;                                 18 03
ERR4:   LD    D,+1        ;prepare for Z set.               16 01
        POP   HL          ;AF into HL                       E1
END4:   LD    A,H         ;restore A.                       7C
        DEC   D           ;okay or error in Z flag.         15
        POP   DE          ;divisor or signed quotient       D1
        POP   BC          ;into BC,DE.                      C1
        POP   HL          ;restore HL.                      E1
        RET               ;                                 C9
```

```
DATASHEET
;= SBAD4 — Convert 4 Byte Signed Integer to ASCII Decimal String
;/CLASS: 1
;/TIME CRITICAL?: No
;/DESCRIPTION: Converts a signed 32-bit integer to an ASCII decimal
;/             string, beginning "—" if negative, giving error
;/             information in flags.
;/ACTION:      Make value absolute.
;/             If negative put "—" in RAM.
;/                Divide number by ten
;/                convert remainder to ASCII and push on stack
;/                repeat until number is 0.
;                 Pop digit off stack and load into RAM
;/                increment RAM pointer
;/                repeat until all digits off stack.
;/             Load terminator (ASCII SPACE) into RAM.
;/SUBr DEPENDENCE: SNEG4 (negate 4 bytes on stack)
;/INTERFACES: None
;/INPUT:       BC,DE contains 32-bit number. HL points to RAM.
;/OUTPUT:      No error: Z reset, ASCII equivalent is in RAM
;/                          DE points at 1st character
;/                          HL points at terminator
;/                          CY copies sign.
;/             Error: Z set, Cy set, 80 00 00 00 was input
;/                    values returned unaltered.
;/REGs USED: BC DE HL Flags
;/STACK USE: 10 min. 24 max. (including CALL and use SNEG4).
```



CALCULATOR CORNER

Compiled by Dick Pountain

YET MORE ON THE CASIO QUIRKS...

Since I last wrote on the subject (*PCW* Jan '81) I have received sufficient material from readers to make up a sizeable book. Sorting through this material to see what is new and putting together partial discoveries from different authors has been quite taxing, and I shall present the results as tersely as possible. This, then, is the current state of Quirkology...

i) Generating the characters

It was in a state of late night debilitation that I unwisely wrote that the 10L registers represented a 'Pyrrhic victory'. As many of you smartasses leapt to point out, a trade-off of program space for memory space can be made, the alpha characters being generated as required. The trade-off is quite cheap, given a suitable routine; the smallest I have received is Jonny Østensen's elegant 16 steps:

P1 Min F 19 INV X ⩾ F
GOTO 0 M—F 5
INV X ⩾ F M—F 14 M+F
MR.F M—F LBL0.

By storing a 'blank' in M.F (by hand) this will generate the indirect address for memories 0-19 and 20-29 in MF. This gives 30 memories for a loss of only 2 and 16 program steps (more if you want automatic input and output routines, of course).

Two quick points: the ^{0} as originally generated is, in fact, $^0 \times 10^{100}$. A genuine ^{0} may be produced by 'blank' ÷ 0.1 or by 60 ÷ '—'. Secondly, if the old ^{0} ($\times 10^{100}$) is treated as follows:

$^0 + 1 = \div 10 = \times =$

the result is a harmless-looking 1. However, this character (actually 1×10^{300}) behaves exactly like i, the square root of —1! It squares to negative numbers and will add to 'imaginary' numbers but not to real ones. (Thanks to Roland Neville for that one.)

ii) Concatenation of the alpha characters

It is possible to concatenate the alpha characters with each other (and with numeric characters) to make words, but by a rather complex and indirect method. I owe much of this material to W Foster of Tolworth and to J Østensen.

First, we must discuss arithmetic with the alpha characters. The alpha characters are each associated with a decimal value between 10 and 15 like the A to F in hexadecimal representation. The characters can be added to themselves or to ordinary numbers under the following rules:

a) Ordinary numbers must be treated as strings of digits 0-9 and represented so; eg, 935 = [09][03][05];
b) Alpha characters are similarly represented; eg, PC = [11][12];
c) Addition (or subtraction) now proceeds by adding equivalent places: eg,

935 + PC ≡ [09][03][05] +
[11][12]
[09][14][17];

d) Whenever a place sum in brackets exceeds 9, take a 10 out and carry as a 1 to the next place (on the left):

[09][14][17] ≡ [01][00][05][07]

So that 935 + PC is displayed as 1057;
e) If *after* all the carries any place sum exceeds 15, then subtract 16 from it. Any result which still exceeds 9 will be displayed as the equivalent alpha character, otherwise as a numeric one:
For example, P + 9 =
[11] +
[09]
[20] ≡ [01][10] ≡ 1^0,
or blank + blank =
[15] +
[15]
[30] ≡ [01][20] ≡ [01][04] ≡ 14.

The rationale for this odd arithmetic can be guessed at. It is a distorted hexadecimal arithmetic, the anomaly being that tens are carried instead of 16s. This is presumably because the Casio uses BCD arithmetic (binary coded decimal) rather than binary floating point and has a tens carry 'wired in'.
f) I have not so far fully cracked the rules for subtraction. Alphas behave as above if subtracted from other alphas, but when subtracted from numerics the carry fails in some circumstances which causes, eg, P to behave as 95 rather than 11. Multiplication proceeds by a set of rules so complex that it would require a whole column to itself, and division is so far a mystery to me.
g) When alpha characters 'collapse' into decimal values, as they do under many arithmetic operations, they follow the above rules:
PPP collapses to 1221 as PPP ≡
[11][11][11] ≡ [01][02][02][01]

We may now proceed to the trick for producing alpha strings. When 10-digit numbers are divided by alpha characters, mixed alpha-numeric displays are produced, —E being the most useful divisor in this respect. W Foster discovered the magic expression 7444444444 ÷ (—E) which produced a display of nine blanks (with a minus sign). This display, which can be stored, has the property of encoding other 10-digit numbers into alpha strings, according to a consistent and unaltering code. Let us from now on write β as the symbol for 'blank'. The magic display is thus —βββββββββ. When a 10-digit number is *added* to this, an alpha string results according to the following code or mapping:

0 → ^{0}, 1 → P, 2 → C, 3 → E, 4 → —, 5 → β, 6 → 0, 7 → 1, 8 → 2, 9 → 3.

As you can see, all the alphas are available, but only 0 1 2 and 3 from the numerics. Two further points: the first digit of the 'code' number is always 1, and the result must be INTed to remove a P which is always produced. The resulting string has only nine digits, the initial 1 being wasted as a 'guard' digit.

As an illustration:

— β β β β β β β β β +
1 3 1 7 2 5 1 3 3 1 INV INT
= E P I C P E E P

Other equally meaningful epigrams may be composed at will, though Hungarians and Italians may be able to make more useful words with this limited alphabet. Incidentally, this process violates the adding rules given above. The β in the magic number behaves as [10] and there are no carries.

At this point, I should say that it is possible to produce certain strings directly by division of 10-digit numbers, bypassing the 'magic number'. However, the translation code is not consistent and varies with position; in addition, no one divisor will produce the full character set.

The story does not stop here, however. The full range of numeric digits can be incorporated into strings, by going to another stage of indirectness.

Produce, by the above route, a string with 0 in every position where you require a numeric:
eg, 1222666222 + [magic number] =
CCCOOOCCC.
Now *subtract* 1,000,000,000 from this string which 'inverts' it to —EEE999EE—. Now *add* to it 1000 abc 000, where a,b,c are arbitrary digits from 0 to 9. The result 'reinverts' the string and inserts a,b,c into the 'window' of zeroes, thus CCC a,b,c CCC. This works wherever the zeroes are placed in the original string, but if they are in a leading position they will be supressed, ie, 000 CCC CCC appears as CCC CCC. The process still works, however, to produce abc CCC CCC.
To recap, the full process is shown in Table 1.
Construct 'code' number 1133156666
Add magic number and INT —βββββββββ
Produces string with 'window' zeroes
PEEP 0000
Subtract 1000000000 to give 'inverted' string — —CC—P0000 *
Add 1000006357 PEEP 6357

By storing the inversion (*), any other 4-digit number abcd could be inserted into the window by adding 100000abcd to the inversion. This process allows us to use 5 and 8 as additional 'alpha' characters, incidentally. Obviously, all this fiddling may be

GOTO page 150

NEWCOMERS-START HERE

This is our unique quick-reference guide, reprinted every month to help our 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 16 in which the letters A to F represent the values ten 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 halfway 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, circuitry 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 ten 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

DIRECT ACCESS

The most important change this month follows the announcement of the Sinclair ZX81. This will eventually replace the ZX80 and is cheaper, easier to assemble and more powerful! All this is made possible by the introduction of a new master chip, designed by Sinclair, which replaces 18 chips from the ZX80. The ZX81 also incorporates a new 8k Basic ROM. Two small business systems appear for the first time this month: the Oscar, which has particularly good word-processing capabilities; and the System 20, a fully expandable system enjoying the support of Extel's extensive field engineering network. In the SBC section, note a powerful new board available from Maclin Zand, based on the MC6809. Finally, I should mention that the Bigboard is no longer available in kit form and it will now cost you £450 fully assembled. Send updates for 'In Store' to me, Dick Olney, *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: 97 44896	16-40k RAM; Z80A; C; 12", 16 x 40 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 (320k) £895; dual 8" F/D (2 Mb). BT 1/80. (I)
ACT System 800 (£3950)	ACT: 021-455 9898 (50)	48k RAM; dual 5¼" F/D (800k); 12", 30 x 64 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 (1 Mb); 2 x RS232 ports; 1 P/P.	CP/M; *Basic; CBasic; Cobol; Pascal; Fortran.*	Expandable to 4-user system with 58 Mb 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.	OS; Basic; *Pascal; Fortran.*	280 x 192 high resolution graphics; Integer Basic in 6k ROM; Option: single 5¼" F/D (116k) £349.
Atari 400 (£395-16k)	Ingersoll: 01-226 1200 (TBA)	8-16k RAM; 6502; C int; cartridge slot; 12 x 20 TV int; RS232C port; touchpad k/b; Opt: C £55.	OS (10k ROM); Basic (8k ROM).	High resolution colour graphics. 4-channel sound. Four games controller/light pen sockets.. BT 10/80. (I/B).
Atari 800 (£695-16k)	As above.	8-48k RAM; 6502; C int; 4 x cartridge slots; 12 x 20 TV int; RS232C port. Opt: single 5¼" F/D (90k) £525; 16k RAM £145.	As above.	As above. Software & RAM on cartridge modules. Up to 4 disk drives. BT 10/80. (I/B).
Athena 8285 (£5694)	Butel-Comco Ltd: 0703 39890 (TBA)	64k RAM; 8085A; dual 5¼" F/D (644k); 12" 25 x 80 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 (2 Mb); 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 (1.2 Mb); 12" 24 x 80 VDU; 180 cps printer.	Basic; *Fortran; Cobol.*	Upgradable to multiuser system with 34 Mb H/D. Full range of business packages included software dealers TBA. (S)
BASF 7120 (£5155)	BASF: 01-388 4200 (TBA)	64k RAM; Z80A; 3 x 5¼" F/D (480k); 12", 24 x 80 VDU; RS232 port; P/P.	DOS; *Ex Basic; Cobol U.*	H/D available soon. Also 7110 with dual F/D £4275. Disk controller has own Z80A. BT 9/80. (I)
Billings BC-12 FD: (£3995)	Mitech: 04862 23131 (TBA)	64k RAM; Z80A; dual 5¼" F/D (640k); 12", 24 x 80 b&w (or b&g) VDU.	DOS; Basic; *Fortran; Cobol; A.*	With dual 8" F/D (2 Mb) £5995. Additional dual 8" F/D £3000. (S).
C/09 (£3975)	SWTP Ltd: 01-491 7507 7507 (16)	56k RAM; 6809; dual 8" F/D (2 Mb); 8", 16 x 80 VDU; 1 S/P.	TSC FLEX; *Basic; Pascal; A; Dis A; T/E; U.*	VDU is intelligent. Option: 15 Mb H/D £3575; with dual 5¼" F/D (350k) instead of 8", £3000. (H)
Canon BX-1 (£3850)	Canon Business Machines (UK) Ltd: 01-680 7700.	64k RAM; 6800; Single 5¼" F/D (65k); 12", 25 x 80 VDU; 5 x V24 ports.	DOS; Ex Basic; A.	Also supplied with integral thermal printer instead of VDU. (S&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 (1.15 Mb) 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 (0.5 Mb); 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 (1.15 Mb); 2-16 S/P.	OS65U; Basic; *CP/M; Fortran; Cobol.*	Expandable to multi-user (8) system. Options: C3B & C3C H/D units. 74 Mb for about £8500. (S&H).

List of Abbreviations

A	Assembler	G/C	Graphics card	M/A	Macro assembler	S	Software
BT	Bench Tested	H	Hardware	N/A	Not available	S/P	Serial port
C	Cassette	H/D	Hard disk	N/P	Numeric pad	T/E	Text editor
E	Extensive	I	Introductory	O/S	Operating system	TBA	To be announced
F/D	Floppy disk	Int	Interface	P/P	Parallel port	U	Utility

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)
Clenlo Conqueror System B (£1950)	Clenlo Computing Systems Ltd: 01-670 4020 (TBA)	64k RAM; Z80; dual 8" F/D (1 Mb); 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); 10 Mb H/D; 3 S/P; 2 P/P.	CP/M; CBasic-2; Pearl 11: *U.*	With 26 Mb and no F/D £5950.
Compucolor II (£995)	Dyad Developments: 08446 729 (TBA)	8-32k RAM; 8080; 13" 32 x 64 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 7860 (17)	48-60k RAM; Z80; dual 5¼" F/D (630k); 9". 16 x 80 VDU; 40 col printer; RS232 port, P/P.	Basic: A; *Fortran; Pascal;* U.	IEEE-488 Controller and S100 int. Many applications packages avail. (E)
Compucorp 655/ 665/675 (from £5895)	As above	60k RAM; Z80; Up to 4 x 5¼" F/D (160k-2.4 Mb); 9", 20 x 80 or 12" 20 x 80 or 20" 60 x 80 VDU; 40-col printer; RS232 port.	As above	Prices incl installation and training. Opt: 10-20 Mb H/D
Computermart 2000 DS (£1500)	Computermart: 0603 615089	32-256k RAM. 8085; dual 8" F/D (1-2 Mb); S/P; P/P.	CP/M; *Cis Cobol; Basic; Fortran*	Expandable to multi-user, multi-tasking, multi-processor 96 Mb H/D system (around £15000).
Cromemco System 2, System 3, System Z2H. (£2100/ £3730/£5430)	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 (1.2 Mb) on Sys 3; 10 Mb 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); 11-22 Mb H/D. BT 10/79 (E).
DAI (£595-48k)	Data Applications (UK): 0285 2588 (TBA)	12-48k RAM; 8080; C int; 24 x 60 VDU int; RS232 port; over 20 industrial ints.	Basic (ROM); U.	Colour graphics up to 255 x 335; 3 notes & noise generator; PAL O/P to TV; Paddle int; H maths option. (I). ET 10/80
Diablo 3000 (£8950) (TBA)	Business Computers Ltd: 01-207 3344	32k RAM; 8085; dual 8" F/D (1.3 Mb); 12", 24 x 80 b&w VDU; 45 cps 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 (1.14 Mb); 4 x RS232 ports; EIA port.	CP/M; Basic-E; CBasic; *Cobol; Fortran; Pascal.*	14 or 28 Mb 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); 11 Mb H/D; 4 x 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 4 Mb F/D and 20 Mb H/D. (H).
Durango F-85 (£7500)	Comp Ancillaries: 0784 36455 (12)	64k RAM; 8085; dual 5¼" F/D (1 Mb); 9", 16 x 64 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 (1 Mb); 12-24 Mb H/D. (S).
Dynabyte 5200-5900 (£2300)	Metrotech 0895-57780 (15)	64k RAM; Z80; S100 bus; 2 ser ports; 1 par port; any com of 5¼" F/D (630k), dual 8" F/D (1Mb),9/27/45 Mb H/D, 32/64/96 Mb Cart Module Disk.	CP/M; MP/M; CP/Net, CBasic, MBasic Cobol, Fortran, Pascal, PL/1-80	All systems expandable to multi-user and networking; CP/M inc in base price for F/D systems, MP/M for H/D systems.
Dynabyte 5200-5900 £2300	Metrotech 0895-57780 (15)	64k RAM; Z80; S100 bus; 2 ser ports; 1 par port; any com of 5¼" F/D (1.2 Mb) 9/27/45 Mb H/D, 32/64/96 Mb Cart Module Disk.	CP/Net, CBasic, MBasic Cobol, Fortran, Pascal, PL/1-80.	All systems expandable to multi-user and networking; CP/M inc in base price for F/D systems, MP/M for H/D systems.
Equinox 200 (£7500)	Equinox: 01-739 2387 (N/A)	64-512k RAM; Z80; 10 Mb-1200 Mb H/D; 6 x S/P; 1 P/P.	CP/M; CBasic; *Cobol; Fortran.*	Multi-user MVT/FAMOS available in place of CP/M. 16-bit version (Equinox 300) £10,000. (S&H).
Euroc (£7995)	Euroc: 01-729 4555 (TBA)	34k RAM; 8080A; dual 8" F/D (1 Mb); 15" 25 x 80 b&w VDU; 132 vol 140 cps printer.	CP/M; CBasic; A; U.	Financial software available. Supply of stationery included.
Executive Mini-computer (£378)	Binatone Int: 01-903 5211 (N/A)	16k RAM: Z80; 500 bps C; 32 x 64 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 798147 (27)	16-48k RAM; Z80; RS232 port; 1 P/P; S100 connector; 30 x 64 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 (316k) £600.
Gemini 801 (£1075)	Gemini: 02403 22307 (7).	64k RAM; Z80A; Single 5¼" F/D (315k); 25 x 80 VDU int; RS232 port. P/P.	CP/M *Basic; Cobol; Fortran; Pascal; A; T/E.*	Up to two integral & two external F/D. Graphics. With no F/D and C int. £750. (S)
Haywood 3000 (£2022)	Haywood: 65 28301. (TBA)	48k RAM; Z80A; dual 5¼" F/D (800k); RS232 port; P/P. Opt: 15" 28 x 80 VDU £799.	CP/M; *Basic; Cobol; Fortran; Pascal; W/P.*	Also system 7000 with 48-65k RAM and 8" F/D /2.5 Mb) £2999. (S)
HP 85 (£1830)	Hewlett Packard Ltd: 0734 784774 (16)	16-32k RAM; C.P.U.; 5", 16 x 32 VDU; C (200k): 64 cps printer; 4 P/P. Options: dual 5¼" F/D (540k) £1408; dual 8" F/D (2.4 Mb) £3744.	Basic (ROM)	Full dot matrix graphics. Complete range of interfaces, peripherals and application packages avail. 16k RAM £222. (S).
IMS 5000 (£1500)	Equinox: 01-739 2387 (20)	16-56k RAM; Z80; dual 5¼" F/D (320k); 2x S/P; 1 P/P;	CP/M; C/Basic; *Cobol, Fortran.*	3 drives option: (S&H).
IMS 8000 (£2500)	As above	64-256k RAM; Z80; dual 8" F/D (1 Mb); 2 x S/P; 1 P/P	CP/M; CBasic; *Cobol; Fortran; MicroCobol.*	Multi-user MVT/FAMOS available in place of CP/M. (S&H).

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ITT 2020 (£867)	ITT: 0268 3040 (15)	16-48k RAM; 6502	Monitor; A; ExBasic; Dis A.	360 x 192 high res graphics. Ex-Basic in 6k ROM; Options: single 5¼" F/D (116k), £425; 16k RAM, £110; RS232 port, £96; 32k system, £931: 48k system. £995. (B).
Ithaca DPS1 (£3995)	Ithaca: 01-341 2447 (10).	64k RAM; Z80; dual 8" F/D 1 Mb); 2 x RS232 ports; 4 x P/P. Opt: H/D.	CP/M; *Basic; Cobol; Fortran; Pascal; A; U.*	Z8000 16-bit processor board avail. IEEE/S100 (8 or 16 bit) compatible. (E).
LX-500 (£3500)	Logabax Ltd: 01-965 0061 (13)	32k RAM; Z80; dual 5¼" F/D (180k); 12" 25 x 80 b&w VDU; 100 cps printer.	DOS; Basic; A.	Other printers available. (S).
LSI M-One (£4200)	LSI Computers: 04862 23411 (20)	8-16k RAM; 8080; dual 8" F/D (1.2 Mb); 12", 24 x 80 b&w VDU	FMOS; A	Choice of standard business packages included in price. (S).
LSI M-Two (£7900)	As above	64-128k RAM; 8085A; dual 8" F/D (1.2 Mb); 12", 24 x 80 VDU; 60 cps printer	Elsie; *CP/M; Basic; Cobol Fortran; Pascal; A; U*	Max 8 VDUs and 4 printers. Many applications packages available. Option: 10 Mb H/D £2600. (S)
Macro 1 & 2 (£3750 or £280 pm).	Micro APL Ltd. 01-834 2687 (TBA)	64k RAM; Z80; dual 8" F/D (1 Mb); 4 x RS232 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", 20 x 80 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).
Micro Trainer 1 (£650)	Hewart; 0625 22030 (N/A)	16-32k RAM; 6800/6809; 10" 16 x 24 VDU; 2 x C int; Opt: dual 5¼" F/D (160k) £595; 8k RAM £17.	Basic; A; *Pascal; PL/M; W/P*	SS50-based system. Graphics avail. Int card with real time clock £17. (I)
Mikro 1000 (£3950)	Airamco: 0294 57755 (TBA)	64k RAM; Z80; dual 8" F/D (1 Mb); 12" 24 x 80 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 (1.2 Mb); 3 S/P; RS232 port	Stardos; CP/M; Basic; *Cobol; Fortran*	(E)
Microtan 65 (£69)	Tangerine: 0353 3633 (6)	1k RAM; 6502; T Mint; Exp up to 277k RAM.	1k TANBUG monitor; 2k A, disassembler, cassette firm ware; *10k Microsoft Ex Basic.*	Options: bulk I/O modules, hi-def colour graphics, DOS, system racking, ASCII keyboard. (S&H)
Millbank Sys 10 (£2995)	Millbank: 01-788 1083 (6).	65k RAM; Z80; dual 5¼" F/D (700k; 12", 24 x 80 VDU; 2 x RS232 ports; RS449 port; P/P.	CP/M; *Basic; Cobol; Fortran; Pascal; PL1; W/P*	One high level lang. included. 12-month warranty. Mainframe comm. package. H/D avail. soon. (S&H)
MS5001 (£8250)	BMG Ltd: 0793 37813 (N/A)	64k RAM; 8085; dual 8" F/D (1 Mb); 12", 80 x 24 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" 16 x 64 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", 14 x 64 VDU; 1 S/P; 1 P/P.	FDOS: Basic; A; U.	As above. Multi-user O/S avail. Options: 10 Mb H/D.
MSI System 12 (£8000)	As above	56-184k RAM; 6800; 10 Mb H/D; 9", 16 x 24 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; 2 x C 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", 24 x 80 VDU; 150 cps printer; 2 S/P; 1 P/P.	DOS; Basic; CP/M; *Cobol; Fortran; Pascal.*	With 32k and single F/D £1495. Options: 18 Mb H/D.
Onyx C8000 £6850)	Onyx Dist Ltd: 0734 664345 (TBA)	64k RAM; Z80; 12 Mb Cartridge; 10 Mb H/D; RS232 port; P/P	CP/M; *Basic; Cobol; Fortran; Pascal; W/P*	C8001 with 128k RAM £8220. Multi-user version avail. using Oasis. (E) BT 3/81
Oscar (£2495)	IDS Ltd: 0908 313997 (30)	64k RAM; Z80; dual 5 ÷ F/D (800k); 12", 25 x 80 VDU; RS232 port; 1 P/P	CP/M; *Basic; Pascal; Fortran; Cobol; W/P; A*	Also avail. with dual 5¼" F/D (1.6 Mb) £2905 and dual 8" F/D (2 Mb) £3380. Advanced video board. (S + H).
Panasonic JD 800U, JD840U (£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 (2 Mb); 12", 24 x 80 green VDU; 3 x RS232 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; 2 x RS232 ports: 2 P/P.	Pascal.	CPU instruction set is P-code; no interpreter needed. Available with dual 8" F/D (2 Mb) £3900.
Paxa 640 (£3400)	Westrex Ltd: 01-405 4261 (TBA)	64k RAM; Z80A; dual 8" F/D (512k); 10", 24 x 80 VDU; RS232 port; P/P.	CP/M; *Basic; Cobol; Fortran; Pascal; A; W/P; U*	Maintenance contracts avail. 10 Mb H/D avail. soon. (S)

List of Abbreviations

A	Assembler	G/C	Graphics card	M/A	Macro assembler	S	Software
BT	Bench Tested	H	Hardware	N/A	Not available	S/P	Serial port
C	Cassette	H/D	Hard disk	N/P	Numeric pad	T/E	Text editor
E	Extensive	I	Introductory	O/S	Operating system	TBA	To be announced
F/D	Floppy disk	Int	Interface	P/P	Parallel port	U	Utility

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)
Periflex 630/64 (from £1995)	Sintrom: 0734 85464 (5)	64k RAM; Z80; dual 5¼" F/D (630k); 2 x RS232 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) £464, dual 8¼" F/D (1 Mb) £1025. BT 6/80 (S&H)
Periflex 1024/64 (from £2750)	As above	64k RAM; Z80; dual 8" F/D (1.2 Mb); 2 x RS232 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" 25 x 40 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). BT 12/80. £895. (I).
Powerhouse 2 (£1125)	Powerhouse Micros: 0422 48422 (TBA)	32-64k RAM; Z80A; 5" 29 x96 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", 29 x 96 VDU; RS232 port; external bus.	As above.	VDU as above. With 1.2 Mb F/D £3500. ExBasic & FDOS in 14k EPOMs £300. (H)
Raannd SP1 (£5500).	Raand: 0506 33372 (TBA)	64k RAM; MCP 1600; dual 8" F/D (2 Mb); 12", 24 x 80 VDU; RS232 port; P/P.	Pascal	Based on Microengine (with integrated P-code). BT 12/80. (S)
Rair Black Box (£2250)	Rair; 01-836 4663 (N/A)	32-64k RAM; 8085; dual 5¼" F/D (260k); 2 x RS232 ports.	CP/M; Basic; Cobol; Fortran; M/A	16k RAM expansion £250 10 Mb H/D £2500.
Research Machines 380Z (£1123)	Research Machines: 0865 49791 (N/A)	16-56k RAM; Z80A; 2 x C; RS232 port.	ExBasic; A; T/E; U; *CP/M; Fortran; Cobol; Algol; Cesil.*	Limited graphics. Many possible systems. With 48k RAM & dual 8" FD (1 Mb) £3394.
S/09 (£5350)	SWTP Ltd: 01-491 7507 (16)	128k RAM; 6809; dual 8" F/D (2 Mb); 8", 21 x 92 VDU 2 x S/P; 1 P/P	TSC FLEX; *Basic; Pascal; A; Dis A; TIE; U.*	VDU is intelligent. Expands to Option: 15 Mb H/D £3575. 60 Mb H/D multi-user system. Maintenance contracts. (S&H).
Saracen (£1925)	Bytronix 0252 726814 (TBA)	32-64k RAM; Z80; dual 5¼" F/D (800k); 2 x RS232 ports.	CP/M; *Basic; Cobol; Fortran; Pascal; A.*	Applications packages & maint. contracts avail. With dual 8" F/D (2 Mb) and 64k RAM, £2676. (E)
SBS 8000 (£1449)	Manhattan Skyline Ltd: 08012 3442; C Itoh 01-353 6090 (TBA)	64k RAM; Z80A; 12", 16 x 64 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 (2 Mb) £1400. BT 11/80. (S)
SEED System 1 (£2000)	Strumech: 05433 4321 (4)	32-64k RAM; 6800; dual 5¼" F/D (160k); 9", 16 x 24 VDU; RS232 port.	DOS; Basic U; *Fortran; A; Pilot; Strubal; T/E*	Several F/D options. With 64k RAM & dual 8" F/D (1.2 Mb) about £3000. (E).
Sharp MZ-80K (£480) (22)	Sharp Electronics (UK) Ltd: 061-205 2333 (22)	6-34k RAM; Z80; C; 10" 24 x 40 VDU; Option: dual 5¼" F/D (289k) £780.	Basic (14k ROM); A.	Graphics; loudspeaker. 18k RAM version £529; 22k £549; 34k £599. BT 10/79 (B).
Sharp PC3200 (£2995)	As above	64k RAM; Z80A; dual 5¼" F/D (500k); C int; 12", 25 x 80 VDU; 70 1pm printer.	DOS; U; Basic.	CP/M may be avail. next year. Various expansion cards avail. (I&B)
Sinclair ZX81 (£50-kit, £70-built - prices inc VAT).	Sinclair: 0276 66104	1-16k RAM; Z80A; C int; TV int; full K/B; 44-pin expansion port	Basic (8k ROM).	Advanced 4-chip design. Printer avail soon.
Smoke Signal Chieftan (£1807)	Systems Implementation Ltd: 06924 5666 (TBA)	32-64k RAM; 6800/6809; dual 5¼" F/D (160k); 12", 24 x 80 VDU; RS232 port.	DOS; *68/FLEX; Basic; Fortran; Cobol; U.*	With dual 8" F/D (2 Mb) £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 (1.02 Mb) with BS200.	DOS; Basic	All solitaire systems are compatible; graphics on 11 x 13 dot matrix. (S)
Sord M100 ACE (£2259)	Midas Computer Services Ltd: 0903 814523 Exleigh Bus. Mach. 0736-66577.(10)	48k RAM; Z80; 8k ROM dual 5¼" F/D (246k): 24 x 64 green VDU; RS232 port: S100 bus; N/P	O/S; Basic; *A; Fortran; Pascal.*	Up to 4 drives possible. Colour graphics avail. (I)
Sord M223 Mk II-VI (£3489)	As above	64k RAM; Z80; 8k ROM; dual 5" F/D (700k); 12", 24 x 80 green VDU; RS232 ports; S100 bus; N/P	*O/S;* Ex Basic; *CBasic; Multi-User Basic; Fortran; Pascal; Cobol.*	Expandable to 4 Mb F/D. 32 Mb, H/D, 5 screens, 2 printers. M243 with 192k RAM & dual 8" F/D £6871.
Sord M100 (£795)	Midas Computer Services Ltd: 0903 814523 Exleigh Bus. Mach. 0736-66577. (8)	48k RAM; Z80; 8k ROM 12" 24 x 64 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", 24 x 80 green VDU; RS232 ports; S100 bus; N/P	*O/S;* Ex Basic; *CBasic; Multi-User Basic; Fortran; Pascal; Cobol.*	Expandable to 4 Mb F/D. 32 Mb, 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", 24 x 80 VDU; 2 x RS232 ports; Option: single 8" F/D (1 Mb) £1090: 20 Mb 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: 01-485 5574 (TBA)	64k RAM; 2 x Z80; dual 5¼" F/D (320k); 12" 25 x 80 VDU; S100 bus; RS232 port.	CP/M; A; *Basic; Cobol; Fortran; APL; Pascal.*	Limited graphics, Mainframe int avail. Full range of application packages avail. Opt: dual 5¼" F/D (320k); dual 8" F/D (2.4 Mb); 8.120 Mb H/D. BT 8/80. (S&H).

List of Abbreviations

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E	Extensive	I	Introductory	O/S	Operating system	TBA	To be announced
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IN STORE

DIRECT ACCESS

Machine (Price from)	Main Distributor/s (No. of Dealers)	Hardware	Software	Miscellaneous (Documentation)
System 10 (£2995)	Millbank 01-788 1083 (TBA)	64k RAM; Z80; dual 5¼" F/D (700k); 12", 24 x 80 VDU; 2 x RS232 port; P/P	CP/M; *Basic; Fortran; Pascal; Cobol; PL/1; W/P.*	12 month warranty. Maint contracts. Applications packages avail. Choice of high level language in price. (E)
System 20 (£3971)	Extel: 01-739 2041 (TBA)	64-512k RAM; Z80A; dual 8" F/D (1 Mb); 12", 24 x 80 VDU; 3 x V24 ports; 1 P/P	CP/M;E Basic; *M Basic; Pascal; Cobol; Fortran*	Maintenance contracts avail (132 field service engineers). Expands to multi-user system. Options: 13.7 Mb H/D £5799: 27.4 Mb H/D £6674. (S)
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 774844 (N/A)	64k RAM; 8080A; single 8" F/D (250k); 12", 25 x 80 VDU; 7 x 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).
Tandberg TG 8450 (£2200)	As above	64k RAM; 8085; single 5¼" F/D (77k); C int; 12", 24 x 80 VDU; RS232 port; P/P	TDOS; *Basic; Cobol; Fortran; Pascal.*	TDOS is CP/M compatible. Opt: single 5¼" F/D (77k) £250 (up to four); dual 8" F/D(2 Mb) £1800. (S&H)
Tandy TRS-80 Level I (£335)	Tandy: 021 556 6101 (200)	4-16k RAM; Z80; C; 12", 16 x 64 VDU	Basic (4k ROM); A.	Expandable to Level II. Many extras available. (I).
Tandy TRS-80 Level II (£408)	As above	4-48k RAM; Z80; C; 12" 16 x 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 £227), up to 4. BT 6/80 (I).
Tandy TRS-80 Model 2 (£1999)	As above	32-64k RAM; Z80A; single 8" F/D (500k); 12", 24 x 80 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 (Microsystems) Ltd: 0734 664343 (8)	64k RAM; Z80; dual 8" F/D (1 Mb); 12", 24 x 80 VDU; 2 S/P; 3 P/P. Options: dual 8" F/D (1 Mb) £1149; with 2 Mb £1455.	CP/M; *Basic; Fortran; CBasic; Fortran; Algol; Pascal.*	TM Z80 enhanced model in integral workstation £5595 (with 4 Mb F/D). DPS 64/2 with 2 Mb F/D £3494. (S&H).
TI 99/4 (£750)	TI: 0234 67466 (TBA)	16k RAM; 26k ROM; 9900; 24 x 32 VDU; 2 x 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).
UDS 3000 (£2300)	Kemitron: 0244 2187. (TBA)	64k RAM; Z80A; dual 8" F/D (500k); 2 x RS232 ports. Opt: with dual 8" F/D (2 Mb) £2500.	CP/M; *Basic; Cobol; Fortran; Pascal.*	Full range of industrial support cards. Multi-user with H/D avail. soon. (E)
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 (2.4 Mb); 3 S/P; 2 P/P.	As above	High-res graphics. Also System 3030 with 32 Mb H/D and single 5¼" F/D £7500. (E)
VIP (£2125)	As above	64k RAM; 3k ROM; Z80A; single 5¼" F/D (315k); 12", 24 x 80 VDU; RS232 port; 3 x P/P	CP/M; *Basic; Fortran; Cobol; Pascal; A.*	Up to 3 additional F/D drives. Options: dual 8" F/D (2 Mb) £1063, 32 Mb H/D (TBA). (H&S). BT 2/81
Video Genie EG3003 (£330)	Lowe Electronics: 0629 2817 (N/A)	16k RAM; Z80; 500bps C; 32 x 64 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; 808A (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; 2 x 8080; dual 5¼" F/D (256k); 15", 25 x 80 VDU; RS232 port.	O/S; A; U; *Basic;* Cis Cobol.	User programmable character set. Option: dual 8" F/D (1 Mb). (S).
Zenith WH-11A (£2673)	Heath Ltd: 0452 29451 & 01-636 7349 (N/A)	LSI 11; 16-32k RAM; 25 x 80 VDU; S/P; P/P.	*O/S; Basic; Fortran;* A: U.	PDP 11-compat. Option: 2 x 8" F/D (1 Mb). £1717 (S&H).
Zenith Z89 £1570-£1710	As above	16-48k RAM; Z80; single 5¼" F/D (102k); 12" 24 x 80 b&g vdu; RS232.	*Basic; A; HDOS;* CP/M; *MBasic; CBasic; Fortran.*	3 x 5¼" F/D possible. Options: dual 8" F/D (1 Mb) £1717, 20 Mb 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: 10 Mb 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 40 Mb H/D. (S&H).
Z-Plus (from £4000)	Rostronics Ltd: 01-870 4805(16).	64k RAM; Z80A; dual 8" F/D (0.5/1 Mb); 12", 24 x 80 VDU; 4 S/P; 1 P/P	CP/M: MP/M; A; U; *Basic; Cobol; Fortran; Pascal; APL; PL/1; Algol.*	Complete with furniture. Various business packages avail. Option; 20 Mb H/D £4000. BT 12/79 (S&H).

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E	Extensive	I	Introductory	O/S	Operating system	TBA	To be announced
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DIRECT ACCESS

SINGLE BOARDS

Machine (Price from)	Main Distributor/s (No. of Dealers)	Hardware	Software	Miscellaneous (Documentation)
Acorn System 1 (£65)	Acorn: 0223 312772 (10)	41/8k 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. Cn be expanded to disk-based system. (S&H)
ADS MC6809 (£250	Maclin-Zand: 01-837 1165(N/A)	2k RAM; 4-16, ROM; MC6809; RS232 port; 2 P/P; S100; 256 x memory mapped I/O ports.	ads MON (in 2716), *OS-9 Basic 09*	Has multi-user, multi tasking capabilities using 0S-9. (E).
Aim 65C (£285)	Pelco: 0273 722155(7)	1-4k RAM: 6502; 4-20k; ROM; Full K/B 2 x C; 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).
Bigboard. (£450)	Maclin-Zand 01-837 1165 (N/A)	64k RAM; Z80; F/D controller; 24 x 80 VDU controller	2k monitor; *CP/M; Basic; Fortran; Cobol; Pasal; A.*	Many options. Will support up to four 8" F/D drives. BT 3/81. (E)
Biproc (£119)	B L Micros: 0494 443073. (TBA)	1k RAM; Z80; TV int; RS232 port. Opt: 4k RAM £8; K/B £30.	2k Monitor; A.	With 9980 instead of Z80 £155 as well as Z80 £180. Kit. (H)
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 program 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).
Hewart 6800S (£299)	Hewart: 0625 22030 (N/A)	16k RAM; 6800; full K/B VDU int; 2 x C 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)
Microaxis 1 (£250)	Micro Design 0296 86866 (N/A)	1k RAM; 1-8k PROM; 6809; 8 channel A-D system; 12 optically isolated I/O lines.	1k monitor	Designed for industrial control. Can be expanded to F/D system. (H)
MPC 09 (£750)	As above	17k RAM; 48k PROM; 6089; RS232 port; 50 I/O lines; 4 timers; 1 W audio amplifier.	1k monitor; *Multi-tasking 0S.*	As above.
Microtan 65 (£69)	Tangerine: 0353 3633 (6)	1k RAM; 6502; 16 x 32 TV int; Options; 64 x 6 1 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; *B Basic; Tiny Basic; A; T/E; U.*	Kit. Built version £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; 2 x 6522 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; 16 x 64 VDU *or* TV int; C int; 1 S/P.	1½k monitor; 2½k Basic.	64-chair graphics. Disk int running CP/M about £200. (S&H).
Tuscan (£195)	As above	8k RAM; 8k ROM; Z80A; 5 x S100 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. BT 1.81. (S&H)
UK101 (£179)	Comp Shop: 01-441 2922 (4)	4k RAM; 6502; full K/B; 16 x 48 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).

TRANSACTION FILE

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For sale

Nascom 1. . . with Nas-sys 1, PSU, recently purchased, fact built with full doc, £160 ono. Tel Brian Reece, Hornchurch 73488.

Colour board. . . for UK101 or Nascom 1, 8 colours & 8-col background, full doc & demo drive, £30. Nick Hardy, 33 Manor Drive, Leeds, W Yorks LS6 1DD.

PET 2001. . . 8k with int cass, only 4 months old, little used, vgc, £335 ono. Tel: Reading (0734) 599103.

PET 2001-8k. . . small keyboard, sound box, lots of s/ware, £350. Epson TX80 printer, as new, PET int & cable (most retail prices don't include these), £350. Tel: 01-886 7354.

ZX80. . . 3 months old, working, leads, manual, PSU, much s/ware, 2 books (over 90 progs), many progs on tape, membership of ZX80 club, worth over £100, sell £75. Tel: 096273 2723 eves.

TRS-80. . . pocket computer, cass int, manual, good cond, hardly used, orig cost £137, sell £105 ono. Tel Glenn Cassim, 01-572 1818 eves, 01-560 3160 ext 4316 day.

PET 8k. . . int cass, progs worth over £400 inc Invaders, Microchess, etc. Unit modified to inc UHF mod displaying text on TV, monitor on/off switch, reset & interrupt switches, inc 'PET Revealed' & prog info, £470. Tel: 04218 2159 after 6.

Antiques dept. . . PDP8S with huge 8k memory, 3 power packs, punch encoders (2), rack mounting, cooling fans, 114 tape progs, exchange for Apple, PET or sim, value about £350. Tel: Preston 731664 or 862217.

Casio fx502p. . . & FA1 cass int, orig instructions, cassette, overlays, prog library, leather case, £75 ono. Tel: Medway (0634) 367799.

T159. . . perfect cond, inc maths/utilities & stats module, £90 the lot. Tel Fahidy, Reigate 44046.

TRANSACTION FILE

SHARP MZ-80k. . . 1 month old, begineer's manual & books, several progs inc Space Invaders, dustcover, orig box, accept £400. Tel 01-992 8254 eves.

VDU. . . RS232, full keyboard, exchange for UK101, Ohio Superboard, Vid Genie, Tuscan or Nascom 2, etc. 8 4116 RAMs for sale, £15. Tel Jack, 01-567 1092 after 7.

TRS-80 I. . . 48k, 2 drives, Tandy Centronics Line Printer 1, 16 disks, books, progs etc, I got a Model II so must sell, £1500 ono (list £2144). Tel: 01-993 2111.

MZ-80K. . . unwanted s/ware: 10 pin bowling, labyrinth, lunar lander, Eliza, the lot for £15, will separate. Tel: Edinburgh 031-667 4205 eves.

ZX80. . . as new, free delivery & demo (reasonable distance), £75 ono. Tel: Slough 43484.

Exidy Sorcerer. . . WP Pac, £90; development Pac, £60, as new with doc. Tel: 01-979 4370.

DCL 3000. . . paper tape terminal & pedestal, standard switch options inc half/full duplex, 110/300 baud, remote control of reader punch, tech ref manual inc, offers please. Tel: 01-723 6305.

Nascom 2. . . 32k RAM, 32k Basic, Zeap, Nas-dis, debug, music box, VDU, cass, TX-80B printer, doc, tapes, offers around £1000, will separate. Tel Wakefield (0924) 496337 or 496127.

ZX80. . . factory built, as new, with PSU, leads, manual, extra 1k memory, expansion module, 1 month old, bargain at £95 inc p&p. Tel Chris, 0924 492225 eves.

PET 16k. . . new ROM, large keybrd, 1 yr old, cass deck, manual, cover, progs & computer mags, £550 ono. Tel Edinburgh, 031-552 2189.

PET 2001 8k. . . small keybrd, 3 months old, orig packing, inc games progs, free delivery Berkshire/W London, £540 ono. Tel Bracknell 27701 after 7.

PET 32k. . . green screen, cass deck, dust cover, new, boxed, £600. Tel Earlswood 2371.

ZX80. . . Sinc checked, leads, PSU, manual, Magic book, many progs, £70. Tel 0474 812704 after 5.

Microtan 65. . . prof assembled, tested, with keypad, power-on reset, full Microtan & Tanex manuals, 4 mnths old, cost £90, sell £75 ono. P Blakeman, Ellesmere College, Ellesmere, Shropshire.

77/68 CPU. . . less Sws & LEDs, £25. Mon 1 inc 1k RAM, UART, bootstrap ROM, £30. 32x21L02 250 ns, £25. IBM VDU & keybrd & control station, £100. Manuals for all. Tel: Keith Raynes, Reppham (060 526) 8181 eve.

Nascom 1. . . with buffer board, PSU, 16k memory extension, UK1111 mod, Vero cases (if req), cost new (kits) £400, offers. Tel Martin Isba, 061-941 4156 eve & w/ends.

TI59+PC100C. . . & 2 S/ware modules, TI packette, many progs by me, over 50 mag cards, exc cond, full doc, sell around £220, or swap for HP with money adj as nec. Tel Chobham (09905) 7805 eves.

PET 32k. . . with cass, manual & some games, £550 ono. Tel: 01-866 2532 eves & w/ends.

PET 8k. . . small keybrd, int cass, manuals, books on Basic, Microchess, Othello, many games, could deliver reasonable dist of W London, £350 ono. Tel L Fletcher, 01-748 7881 (office), 01-995 9047 (home).

ZX80 16k. . . large new keybrd/numeric pad, new PSU, large Maplin case, interupt sw, much s/ware inc draughts & active display, all leads & manuals etc, any reasonable offer accepted. Tel Chelmsford 56632 after 6.

Heath H14. . . serial printer, RS232, used with TRS-80, £200 ono. Tel Lavington, Wilts (038081) 3734.

Sharp MZ-80k. . . 48k RAM, as new, hardly used, £475 ono. Sharp assembler, £35 ono. Monitor listing, £10 ono. Memory: 18x4116, £2 ea; 16x4027, £1 ea. Tel: Bolton (0204) 592146.

ZX80. . . as new, Sinc built, with leads & manual, £70 inc p&p + insurance. Tel Southend-on-Sea (0702) 337466.

ZX80. . . Sinc built, 4 months old, 1k, old 4k ROM, with PSU, manual, leads, cass playsers, 1 blank cass, 3 books, 106 inc post. R Erding, 271 Meadow Head, Sheffield S8 7UN, Yorks.

ZX80. . . with manual, PSU, etc. Will demo if buyer collects, £70. Tel Medway (0634) 573531 eves & w/ends.

16k S100. . . memory board with bank select (suit Alpha Micro), new cond, £110 ono. Tel Barney, 0925 54117.

Nascom 1. . . in card frame as supplied by Nascom, with buffer board, memory exp board, 3 A PSU, Nas-sys 3, Zeap, Nas-dis, Naspen, £300. Tel 01-828 3887.

Sharp PC1211. . . with manuals, cass int, £90. Michael Ross, Crossmead Hall, Exeter.

Grandstand/Fairchild. . . prog TV game, good cond, inc demo & 11 other carts inc baseball, hangman, bowling, maze, spitfire, drag strip, desert fox, robot war, oxo, etc, hundreds of variations. Cost £200, accept £100. Tel Sunderland (0783) 212416.

Microtan 65. . . Tangerine built, manual, keypad, graphics, as new, £70 ono. Tel Cambridge (0223) 811000 eves.

Acorn Atom. . . 8k RAM, 8k ROM, fp chip fitted, Basic & assembler, PSU & manuals, 192 x 256 graphics resolution, s/ware cassettes, prof built & cased, £210 ono. Tel Brighton 561670 after 6.

Casio fx502p. . . with FA1 cass int, as new, boxed, all manuals, games progs, £75 ono. Tel Steve, 01-450 3449 eves.

PET 8k. . . old ROM, cal keybrd, £350. Tel 01-863 1681.

PET 16k. . . new ROM, large keybrd, Toolkit, Picchip, ext cass, soundbox, decrash sw, PET Revealed, many more PET books, hundres of progs on tape, no offers under £850. Tel: Mike 01-440 0724, 4.30-9.

Compukit. . . light pen for use with Hyspec I/O port, with s/ware & instructions, £11. 5 Centronics 36 way sckts, as new, removed from new printers, £4 ea. UK101 draughts prog (8k), £2. 2x8T28 buffers for Compukit exp, £3 pr. Tel Esher 66453.

Sorcerer 32k. . . £580 or exch for PET 16/32k, would consider other 6502-based micro. Tel 0253 725979.

Books. . . Zaks 'Programming the 6502'; '6502 Applications Book'; 'Microprocessor Interfacing Techniques', as new, £4 ea. Tel Evesham 852410.

HP41C. . . prog calc, printer, card reader, 4 mem modules, finance app pack, maths pack, manuals, cards, spare paper rolls, £550 ono. Tel Paul Meio, 058 476 670 after 6.

PET 8k. . . int cass, games progs, £350 ono. Tel Mr Emery, 05438 2232 (home) or 0902 21382 (work).

PET 2001 8k. . . with games, assembler, manual, adaptor, little used, £350 ono. Tel: 01-997 3971.

TRS-80 Line Printer 2. . . few months old, new cond, try reasonable offer. Tel 01-399 9022.

ASR 390. . . Teletype, 110 baud, keybrd, printer, paper tape punch/reader, in constant use until Jan, £100. Tel 0202 26147, eves.

Acorn Atom. . . 7k RAM, assembler, Basic, fp maths ROM, R6522 timer/VIA, I/O sckt, all leads/manuals, regulated 3 A 5 V PSU, hi-fi stereo Dolby cass, works fine with Atom, complete system £225 or Atom £195, cassette £35. Tel 0603 52885, Mondays 7—8.30.

Intergrand S100. . . cabinet with mains filter, fan, 30 A @ 5 V, 15 A @ ± 12 V PSU, card frame, motherboard (50% slotted), cut for 2 5" drives, as new, £240. Jade S100 PSIO card, 1 par 2 ser + tape ints, kit, £55. Tel 0705 551655 after 6.

UK101. . . 8k RAM, case, £190 for quick sale. Nascom Veroframe with 3 A PSU, £30. Mr M Lancaster, 4 Hanover Place, London Rd, Bath, Avon.

Sharp MZ-80K. . . 48k RAM, Basic, assembler, m/c tapes, games, manuals, £300 buyer collects. Tel: 061-665 1524 after 5.

PET 8k. . . old ROM, good cond, £345. Tel Gt Eccleston (Blackpool area) 70008.

EDTSAM & TBUG. . . ed/assembler & debug monitor for TRS-80 1½, orig cass, manuals, folder, 1 month old, as new, save £15 on new price, £20 ono for both. Tel Leamington Spa (0926) 32874 eves.

IBM 2740. . . I/O term, golfball printer, with desk, acoustic & dust cover, recond by IBM, full Selectric facilities in local mode, fault log since new, set parts & repair manuals, perfect working order, best sensible offer secures, must go, delivery poss. Tel Maidstone (0622) 674764.

Apple II+. . . 48k, disk drive, lots of s/ware inc Apple Invaders, tranquility base, the correspondent, 4 Adventures, £1000. Tel: 01-670 5909.

Rowtron. . . home ent centre, exc cond, inc 5 carts (sportsworld, combat, maze, blackjack, motor racing), many other carts available, £110. Tel Halifax (0422) 248107.

Volumes 2 & 3. . . of PCW & Practical Comp'ing (will split). Board war games (S+T) mainly WW2. ZX80, factory built. Offers. Tel 0344 27660.

ZX80. . . Sinc built, with progs & pckt book, unwanted Xmas gift, £80 ono. Tel Bookham 58271.

ZX80. . . with 16k memory, £120. Atari vid game & Space Invader cart, £100. Tel High Wycombe 444177 eves.

Books. . . Basic Handbook by David Lien, £8; Alorithm Writers Guide, £2; Programming for Microprocessors by A Colin, £3 or the 3 for £12. B Smith, 128 High St, Herne Bay, Kent, tel 5355 eves.

Philips G7000. . . prog videopac computer, full guarantee, manuals, adaptor, leads, joysticks, videopacs 1,3,8,11,14,20 cost £200, sell £155 ono. Tel Southfleet 2819 after 6.

Teletype ASR33. . . with paper punch/reader, good cond, seen working online, £175 ono. Tel Stafford 53058.

ZX80. . . fact built, as new, orig box, with user manual, PSU, leads, extra book or 30 progs, £65 inc p&p. Write: M Sparks, Flat 1, 13 St Ursula Grove, Southsea, Hants.

UK101. . . 8k, cased, new monitor, mainly LS ICs, spare set ICs (not RAMs), £250. Tel Biggin Hill 74713.

PET 8k. . . old ROM, Transcom printer & cable, Toolkit, 6 maths progs, 1 utility prog, well kept, all for £500. Tel Meyer, Hitchin (0462) 51275.

ZX80. . . fact built, PSU, extra 1k RAM, unused due to lack of time, £90. Sinclair SC/MP, as new, £25. Both for £110. Tel Wargrave (073522) 3981.

PET 2001 16k. . . large keybrd, green screen, new ROMs, cass deck, as new cond, 2 books (PET Revealed, Hands on Basic with a PET) & game tape, £550 ono. Tel Fulmer 2343.

Epson MX80. . . printer, latest model, unwated gift (already got one), unopened in maker's carton, specimen printout avail, £395 cash, collect. Tel 01-959 6516.

PET 16k. . . new ROM, large keybrd, ext cass, some progs, books & manuals, 5 months old, quick sale, cash crisis, £425. Tel Mick, 01-733 3682 after 5.30.

Nascom 2. . . with 16k RAM, PSU, graphics ROM, 8k Basic in ROM, 2400/1200/300 baud cassette, assembler, adventure, other s/ware, built & tested, £400. Tel Keresley, Coventry 2919.

T159 + PC100C. . . stat & maths modules, manuals, exc cond, £220. Tel Upper Warlingham 5737 eves.

Video Genie. . . 16k RAM, int cass, TRS-80 compact, perfect cond, 1 week's use, studies force sale, bargain £270 no offers. Write: 2 Manor Rd, Oxley, Wolverhampton, tel (0902) 783674.

Apple. . . parallel printer card + data book, brand new & unused £60 ono. Tel Earlswood 3267.

Westrex. . . teletype KSR, good cond, stand, works with Nascom etc, £200 ono. 4116 RAM, £21/8 inc. R Green, 60 Lattice Av, Ipswich, tel 714716.

ICL 7074. . . Termiprinter quality band printer with keyboard, ASCII code, 10/20/30 char/sec, 78 cols, many options (FF, VT, etc), RS232 int, make offer around £175 (under ½ normal 2nd-hand price). Tel John, 021-743 3442 eves.

HP19C. . . scientific 98-step prog, continuous memory, printing, with manuals, charger, spare paper rolls, £60. Also HP25 scientific 49 step, £25. Tel Birch, Rickmansworth 76067.

PET 2001 8k. . . old ROM, extension calc keys, micro graphics, modulator, int, data & AY—3—8910 sound chip & data, neither fitted. Over 80 progs inc games, tutorial, music, etc. Suit to fit micro and sound chip. £400 or with speech recognition, £450 no offers. Tel 01-840 3610 after 5.30 weekdays, anytime w/ends.

Exidy Sorcerer. . . 16k inc leads, TV mod, manuals, games tape, almost new, user upgrading, £370 ono. Tel P Summer, 01-629 8361 day, 01-359 9929 eves.

ITT 2020 48k. . . Applesoft in ROM, manuals, leads, colour graphics, disks: Little Genius & Visicalc with manual, tapes: Integer Basic, dragon maze, colour demos, test progs, £600. Tel 01-394 1678.

Open University. . . course in Microprocessor & Product Development, with kit unit, used only for 1 hr, £150. Tel 01-767 3257 eves & w/ends.

NETWORK NEWS

Personal computer networks have been springing up all over the States for 18 months or more and now we have two in Britain. As more networks appear — and as more facilities are added to existing networks — we'll report them in this section, which appears monthly.

Forum 80. . . operated by Frederick Brown, tel: Hull (0482) 859169. No access charge, open to any micro owner. Operating Tues & Thurs 1900 — 2200, Sat & Sun 1200 — 2200. Facilities: bulletin board, program library for downloading programs (all in Microsoft Basic), program uploading for adding your own progs to library; Forum 80 Users Group (membership free) enables access to programs not in public domain.

National TRS-80 Users' Group. . . being set up at time of writing, will be available to all micro users, not just TRS-80 owners. Initially access charge will be a £10 sub, but as more join, this will be reduced and refunds made accordingly. Facilities: bulletin board & programs for downloading. Contact: Brian Pain, tel 0908 566660 (office).

USER GROUPS INDEX

These are updates/new entries received since our last full listing. The next complete list will be printed in our August issue.

INTERNATIONAL

DENSPET: group specifically for exchange or original programs for MTU 200x320 dot matrix hi-res PET add-on. Send sample of your work or £2.50 ($5.00) & receive sample in return plus newsletter sub & lists of available programs. Contact: DENSPET, Rock House, Ballycrog, Westport, Co Mayo, Eire.

NATIONAL

EZUG — Educational ZX80/81 Users' Group, an offshoot of MUSE. Caters specifically for education uses and users of Sinclair micros, has over 400 members. Contact: Eric Deeson, Highgate School, Belsall Heath Rd, Birmingham B12 9DS.

BASUG — British Apple Systems User Group. Now incorporates the UK Apple User Group. Caters for all current and prospective Apple/ITT 2020 users. Publishes magazine called *Hard Core*, meets fortnightly at Park Street, just south of St Albans. Contact: Martin Perry, BASUG, PO Box 174, Watford WD2 6NF.

AVON

Worle Computer Club: meets alternate Mondays, 1900-22.30 at Woodsprings Inn Function Rooms. Contact: S Rabone, 18 Castle Rd, Worle, Weston-Super-Mare, Avon, tel: 0934 513068.

Brunel computer club: meets alternate Wednesdays, 1900-2200 hrs at St Werburgh's Community Centre. Contact: Mr R Sampson, 4 The Coots, Stockwood.

BEDS

Bedford Amateur Computer Club. Recently started, no further details as yet. Contact: Mr R Bird, 7a High Street, Great Barford, Bedford MK44 3LB, tel 0234 870763.

YORKSHIRE

South Yorks Personal Computer Group. Meets 2nd Wed monthly, 7.30pm in General Lecture Theatre, St George's Building, Sheffield Univ. Contact: Mr S Gray, 11 The Meadway, Sheffield S17 3EB, tel Sheffield 351440.

MERSEYSIDE

Wirral Microcomputer Users' Group. Meets at Mons at Birkenhead Technical College. Contact: J Phillips, 14 Helton Close, Nocturum, Birkenhead, Merseyside L43 9HP. Tel 051-652 0268.

Merseyside Nascom Users' Group. Now independent, with 150 members. Meets 1st Mon monthly, 7.30pm at Mona Hotel, James Street, Liverpool. Contact: T Searle, 14 Hawkeshead Close, Maghull, Liverpool L31 9BT.

HUMBERSIDE

Scunthorpe & Dist Microcprocessor Society. Contact: G Hinch, 21 Old Crosby, Scunthorpe, S Humberside DN15 8PU.

Leeds Microcomputer Users Group. Meets fortnightly on Thurs eves in Leeds, new members welcome. Contact: Paul O'Higgins, 20 Brudenell Mt, Leeds 6, tel (0532) 742347 after 6pm.

Here's a complete list of CTUK! centres up and running as of mid-April:
John S Bone, CTNE: 2 Claremont Place, Gateshead, Tyne and Wear NE8 1TL, tel: 0632 770036.
Andrew Holyer, ComputerTown Horsham: 10 Masons Field, Horsham, Sussex RH13 6JP.
Pete Shaw, Colchester Computer Club: 15 St Vincent Road, Clacton-on-Sea, Essex, tel: Clacton 25156.
Philip Joy, ComputerTown Romford: 130 Rush Green Road, Romford, Essex.
Derrick Daines, ComputerTown Sutton-in-Ashfield: 18 Cuttings Avenue, Sutton-in-Ashfield, Notts.
Vernon Gifford, ComputerTown Croydon: 111 Selhurst Road, London SE25 6LH.
ComputerTown Eastcote: 7 Collins Drive, Eastcote, Middlesex HA4 9EL, tel: 01-866 1179.
Mike Baker, ComputerTown Ealing: 5 Edinburgh Road, Hanwell, London W7 3JY, tel: 01-840 0030.
Pete Rowan, COMICS: 10 Lambton Road, Jesmond, Newcastle-on-Tyne NE2 4RX.
Tom Graves, ComputerTown Street: 19a West End, Street, Somerset BA16 0LQ, tel: 0458 45359.
Bill Gibbings, ComputerTown Retford, tel: 0777 706923.
Alan Waring, ComputerTown Enfield: 50 Drayton Gardens, Winchmore Hill, London N21, tel: 01-360 8020.

DIARY DATA

Milan, Italy	International Electrical and Electronic Technology Exhibition — INTEL Contact: INTEL, Via Luciano Manara 1, 20122 Milan	23 — 27 May
Paris, France	Computer Software Exhibition —SOFT. Contact: Executive Conference Organisers Ltd, Acorn Studios, Barnes, London SW13 9HP. Tel: 01-748 0287	1 — 3 June
Utrecht, Holland	Europe Software Exhibition. Contact: ECC (Exhibition Agencies) Ltd, 11 Manchester Square, London W1M 5AB. Tel: 01-486 1951	2 — 4 June
Melbourne, Australia	Computers, Communications and Electronic Technology Exhibition conference — CETIA. Contact: CETIA '81, PO Box 259, Roseville, Sydney, NSW 2069	2 — 5 June
London	(Earl's Court) *Sunday Times* Business to Business Exbn. Contact: Silver Collins & Co, 01-407 4046	7 — 10 June
London	(Earl's Court) Electronics Comp Ind Fair COMPONENTS '81. Contact: Ind & Trade Fairs Ltd., 021-705 6707	9 — 12 June
Southampton, England	(Guildhall) Business Efficiency Exhibition. Contact: BETA, 8 Southampton Place, London WC1A 2EF. Tel: 01-405 6233	16 — 18 June
London,	(West Centre Hotel) International Commodore PET Show. Contact: Baroness International on 01-734 2907	18 — 20 June
London	(Wembley Conf Centre) Int Word Processing Exbn & Conf. Contact: Business Equipment Trade Assoc, 01-405-6233	23 — 26 June
Sydney, Australia	Consumer Electronics Show. Contact: Riddell Exbn Promotions, 166 Albert Rd, S. Melbourne 3205	13 — 19 July
London	(Wembley Conf Centre) Microcomputer Show. Contact: Online, 09274 28211	13 — 19 July

LEISURE LINES

by J J Clessa

March's problem was obviously more difficult than usual — I would have thought that a micro was essential to solve it, but several managed to get the answer by manual methods.

For those who want to know how the problem could be solved on a computer, a program would have to be written which generated all possible combinations of the letters, starting at the first, from which four two-letter combinations can be produced; from these, you'd form 16 three-letter combinations, 64 four-letter combinations, etc. Clearly the number of combinations would very quickly get out of hand, unless you included a way of avoiding further processing of those combinations which would obviously never produce English words. This could perhaps be done by displaying all combinations on the screen as they are generated, with the operator having the option of letting them continue to be expanded or dispensing with them.

Anyway, all 35 entrants got the correct solution, DOUBLES, made up of the first letters of Debates, Oratory, Undying, Barters, Lasting, Eastern, and Sternly.

Congratulations to the randomly selected winner, Paul Shanley of South Wimbledon, who must have done the puzzle manually since he says his calculator doesn't have alpha facilities.

Quickie

As usual, no prizes, so no answers required for this one. Write down the next number in this series: 18, 46, 94, 63, 52, ?

Prize puzzle

Here's another problem to flex your micro's muscles.

1. Using the integers 1-79 inclusive, generate perfect squares as follows:
a) Each perfect square must be the sum of two or more of the 79 given integers;
b) Any perfect square may only be generated once;
c) Each of the 79 given integers may be used once only.
2. Score three points for each perfect square that is the sum of two of the integers; score four points for each perfect square that is the sum of three of the integers; score five points for each perfect square that is the sum of four of the integers; and so on.
3. Deduct from the total score one point for each unused integer.
4. Send me the final score, together with the list of perfect squares and their components (yes, you can get it all on a postcard if you've small enough handwriting!).

Send your *postcards* (letters get binned!) to: Puzzle 22, *PCW*, 14 Rathbone Place, London W1P 1DE, to arrive no later than 30 June. This month's prize is an automatic pencil.

PROGRAMS

UK 101 Zor

by J Hulme

Here's a maze game with a difference. The maze appears as you go along. The walls have been poisoned and Zor is out to get you. If he traps you, you have just one shot in your phaser gun with which to knock down a wall and escape. Zor is impervious to your gun. Beware of double walls!

```
60 KE=57088:C=53260:BT=54221:ZO=90
70 POKE530,1:POKE15,46:POKE11,0:POKE12,253
80 GOSUB780:PRINTTAB(17)"Z O R
90 FORL=1TO7:PRINT:NEXT
100 INPUT"Do you want instructions";A$
110 IFLEFT$(A$,1)="Y"THEN420
120 IFLEFT$(A$,1)<>"N"THENGOSUB770:GOTO100
```

PROGRAMS

```
  130 INPUT"Skill level - 1 (Easy) to 5 (Hard)"
;DF
  140 IFDF(1ORDF)5THENG30
  150 IFDF)3THENNV=DF-3:DF=3
  160 REM **** SET UP SCREEN
  170 GOSUB660
  180 FORL=C+44TOC+938STEP64:POKEL-44,96:POKEL-
45,96
  190 POKEL,96:POKEL+1,96:NEXT
  200 FORL=C+961TOC+1004:POKEL,5:NEXT
  210 MN=C+1:M=MN:POKEMN,29:GOTO320
  220 REM **** KEYBOARD
  230 POKEKE,127:K=PEEK(KE)
  240 IFK=127THENMN=MN-1:GOTO320
  250 IFK=191THENMN=MN+1:GOTO320
  260 IFK=223THENMN=MN+64:GOTO320
  270 IFK=239THENMN=MN-64:GOTO320
  280 IFK=247THENF=1
  290 IFRBTHENGOSUB460
  300 GOTO230
  310 REM **** HIT WALLS?
  320 POKEM,32:IFPEEK(MN)=187ORPEEK(MN)=96THENP
OKEMN,3:GOTO530
  330 M=MN:POKEM,29
  340 REM **** SUCCEEDED?
  350 IFM)C+896THEN620
  360 REM **** DISPLAY NEW AREA OF MAZE
  370 FORJ=-64TO64STEP64:FORL=-2TO2
  380 IFPEEK(L+J+M)=96THENPOKEL+J+M,187
  390 IFPEEK(L+J+M)=ZOTHENRB=1:R=L+J+M:POKER,24
8
  400 NEXTL,J:GOSUB460:GOTO230
  410 REM **** KILLED BY ZOR
  420 FORL=1TO2000:NEXT:GOSUB780
  430 PRINTTAB(10)"ZOR CLAIMS ANOTHER VICTIM!
  440 PRINT:PRINT:GOTO570
  450 REM **** MOVE ZOR
  460 IFRND(6)).5THENRM=INT(RND(6)*3)-1:GOTO480
  470 RM=INT(RND(3)*3-1)*64
  480 IFR+RM)542210RR+RM(53301THENRETURN
  490 IFPEEK(R+RM)=187THENRETURN
  500 IFPEEK(RM+R)=29THEN420
  510 POKER,32:R=R+RM:POKER,248:RETURN
  520 REM **** HIT WALL
  530 IFF=1ANDF1=0THENF1=1:POKEMN,42:GOTO340
  540 FORL=1TO2000:NEXT:GOSUB780
  550 PRINT"YOU ARE POISONED.....
  560 PRINT"   Zor will eat you at his leisure!
  570 PRINT:INPUT"Another go";A$
  580 IFLEFT$(A$,1)="Y"THENRUN
  590 IFLEFT$(A$,1)()"N"THENGOSUB770:GOTO570
  600 POKE530,0:END
  610 REM **** YOU WIN
  620 FORL=1TO2000:NEXT:GOSUB780:PRINT"WELL DON
E!
  630 PRINT:PRINT"   Now all you've got to do i
s find an empty
  640 PRINT"starfighter and make good your esca
pe!":GOTO570
  650 REM **** DRAW MAZE
```

PROGRAMS

```
  660 GOSUB780
  670 PRINT" GOOD LUCK! YOU WIN IF YOU REACH TH
IS LINE";
  680 POKEC+1003,32:Z=DF/15+.75:FORL=C+65TOC+89
7STEP128
  690 FORJ=0TO43:IFRND(7))ZTHEN710
  700 POKEL+J,96
  710 NEXTJ
  720 FORJ=64TO107:IFRND(8))ZTHENPOKEL+J,96
  730 NEXTJ,L
  740 FORL=0TONV
  750 POKEC+INT(RND(6)*40)+2+INT(RND(8)*14+1)*6
4,ZO
  760 NEXTL:RETURN
  770 PRINT" Please Answer Y or N.":RETURN
  780 FORL=1TO16:PRINT:NEXT:RETURN
  790 REM
  800 REM     INSTRUCTIONS
  810 REM
  820 FORL=1TO16:PRINT:NEXT
  830 PRINT"    You are captured by the enemy du
ring the
  840 PRINT"Galactic war and are sentenced to f
ace ....
  850 PRINT:PRINTTAB(17)"Z O R":PRINT
  860 PRINT"    He is a man-eating creature of u
nthinkable
  870 PRINT"lust for human flesh .. ESPECIALLY
YOURS!
  880 PRINT:PRINT"    Your only chance is to pas
s through the
  890 PRINT"dark tunnels to the exit (if there
is one!)
  900 PRINT"before you starve or before he gets
you!
  910 PRINT"    You have only one energy cell le
ft in your
  920 PRINT"ray gun which you may use to blast
down a
  930 PRINT"wall once, BUT IT IS USELESS AGAINS
T ZOR!
  940 PRINT:PRINTTAB(14)"Press any Key";:POKEBT
+27,32
  950 U=USR(U):GOSUB780
  960 PRINT"    A word of warning - Zor uses a p
owerful
  970 PRINT"poison on the walls so don't walk i
nto them!
  980 PRINT:PRINT"    To load your ray gun press
 '5' (best done
  990 PRINT"at the start).  When you want to bl
ast a wall
 1000 PRINT"just move into the section require
d and
 1010 PRINT"then out the other side (Beware of
 double
 1020 PRINT"thickness walls!).":PRINT
 1030 PRINT"    To move LEFT press '1', RIGTH '
2', DOWN '3'
 1040 PRINT"and UP '4'.":PRINT
```

PROGRAMS

```
 1050 PRINT"The lair will unfold as you proce
ed....."
 1060 PRINT:PRINTTAB(30);:INPUT"Ready";A$
 1070 IFLEFT$(A$,1)="N"THEN 820
 1080 IFLEFT$(A$,1)<>"Y"THENGOSUB770:GOTO1060
 1090 GOSUB780:GOTO130
```

PET Chords by Jeff Aughton

Are you a would-be guitarist? If you are then you'll find this program a great way to learn your chord fingering.

```
  10 REM CHORDS-JEFF AUGHTON
  20 REM
  30 GOSUB800:Z$="                    "
  40 DIMN%(30),S(6),C$(12,9),T$(9),R$(12),A%(100)
  50 FORI=1TO6:READS(I):NEXT
  60 FORI=1TO9:READT$(I):NEXT
  70 FORI=1TO12:READR$(I):NEXT
  80 FORI=1TO30:READN%(I):NEXT
  85 FORI=1TO12 FORJ=1TO9
  90 READC$(I,J):NEXTJ,I
  95 S=59464:Q=3:X=0:D$="■■■■■■■■■■"
 100 PRINT"PRESS SPACE TO START AND TO CHANGE CHORD
 105 GETA$:IFA$<>" "THEN105
 110 PRINT"■■■":FORI=1TO9
 120 PRINTTAB(26);I;T$(I)
 130 PRINT:NEXT
 140 POKES+3,16:POKES+2,16:POKES,0
 150 X=X+1:GOSUB500
 160 GOSUB600:PRINT"ROOT NOTE";
 170 INPUT"  .■■■";A$
 180 FORI=1TO12:IFA$=R$(I)THEN260
 190 NEXT:IFA$<>"X"THEN160
 200 PRINT"■TEMPO - 0=FAST,9=SLOW■
 210 INPUT"YOUR CHOICE";Q
 220 PRINT"■":FORM=1TOX-1
 230 N=INT(A%(M)/10):T=A%(M)-10*N
 240 GOSUB500:GOSUB350
 250 NEXT:GOSUB600:GOTO910
 260 N=I
 270 GOSUB600:PRINT"CHORD TYPE";
 280 INPUT"  .■■■";A$
 290 T=ASC(A$)-48
 300 IFT<1ORT>9THEN270
 310 GOSUB350
 320 GETA$:IFA$<>" "THENGOSUB360:GOTO320
 330 A%(X)=10*N+T:GOTO150
 340 REM SUBROUTINES & DATA
 350 GOSUB600
 360 PRINT"■■";R$(N);" ";T$(T)
 370 FORJ=1TO6:FORI=1TO3
 380 Z=ASC(MID$(C$(N,T),I,1))-65
 390 H=INT(Z/5):L=Z-5*H
 400 A$="o":IFHTHENA$="●"
 410 PRINT"■■■■■";SPC(4*I+1);LEFT$(D$,2*H+1);A$
 420 Z=N%(S(2*I-1)+H):GOSUB480
 430 A$="o":IFLTHENA$="●"
 440 PRINT"■■■■■";SPC(4*I+3);LEFT$(D$,2*L+1);A$
 450 Z=N%(S(2*I)+L):GOSUB480
 460 NEXTI
 470 POKES,0:RETURN
 480 POKES,Z:FORK=0TO12*Q:NEXTK:RETURN
 500 PRINT"■■■■■■";Z$
 505 PRINT"      ┌─┬─┬─┬─┬─┬─┐"
 510 FORI=1TO5
 520 PRINT"      │ │ │ │ │ │ │"
 530 PRINT"      ├─┼─┼─┼─┼─┼─┤"
 540 NEXT:RETURN
```

PROGRAMS

```
600 PRINT"■";Z$;"■";:RETURN
620 DATA 1,6,11,16,20,25
630 DATA MAJOR,MINOR,MAJ.7,MIN.7,AUGMENTED
640 DATA SIXTH,SEVENTH,DIMINISHED,NINTH
650 DATA C,C#,D,D#,E,F,F#,G,G#,A,A#,B
660 DATA 188,177,167,157,148,140,132,125,117,111,104,98,93
670 DATA 87,82,78,73,69,65,61,58,54,51,48,45,43,40,38,36,34
680 DATA SKF,SFI,SKA,QII,DLF,DMF,DNF,KHH,SNS
690 DATA JQL,ELK,JQG,CLK,FRL,GQL,JTL,BKK,YTY
700 DATA KCR,FCQ,KCM,FCG,LXR,KER,KCH,HBB,KCF
710 DATA QIX,LIW,QIS,LJM,RFD,QII,LIN,KHH,GIL
720 DATA CLA,CKA,CGA,CKP,DLF,CLK,CLP,BKK,CBC
730 DATA IRG,IQG,FRF,ISV,FRL,ICQ,IHG,HBB,IHI
740 DATA OXM,OWM,OSL,OMM,LXR,OXW,ONM,KHH,ONO
750 DATA RAD,BSS,MAC,QAQ,RFD,RKP,RAB,BKK,RCB
760 DATA XGJ,WGY,XGI,MGB,DLF,XGV,XGH,HBB,LGH
770 DATA AMK,AMF,AMO,AKF,FRL,AMM,AKK,KHH,AMD
780 DATA GSQ,GSL,GRQ,GQL,LXR,GSS,GQQ,BKK,GBG
790 DATA MYW,MYR,MXW,MWR,RFD,MYV,MHC,HBB,LMM
800 PRINT"■              GUITAR CHORDS■"
810 PRINT"GIVE ME THE ROOT NOTE,FOLLOWED BY THE■"
820 PRINT"TYPE OF CHORD (1 TO 9-SEE KEY) AND I'LL■"
830 PRINT"SHOW YOU HOW TO PLAY IT.USE NO FLATS-■"
840 PRINT"ONLY SHARPS.FOR EXAMPLE:■"
850 PRINT"          B FLAT = A SHARP = P#■"
860 PRINT"CONNECT A SOUND BOX AND YOU CAN HEAR ME■"
870 PRINT"PLAY!!■":PRINT"AT THE END OF THE SESSION TYPE X FOR■"
880 PRINT"THE ROOT NOTE AND I WILL PLAY ALL THE■"
890 PRINT"CHORDS YOU HAVE GIVEN ME IN SEQUENCE.■"
900 RETURN
910 PRINT"WANT TO HEAR IT AGAIN? (Y/N)"
920 GETA$:IFA$="Y"THEN200
930 IFA$<>"N"THEN920
940 PRINT"ANOTHER SEQUENCE? (Y/N)■"
950 GETA$:IFA$="Y"THEN95
960 IFA$<>"N"THEN950
970 POKE5+3,0:END
```

Sub Set continued from page 131

```
;/LENGTH:    66
;/TIME STATES:  25 244 max.
;/PROCESSOR:  Z80

SBAD4:  PUSH  BC        ; put number              C5
        PUSH  DE        ; on stack.               D5
        LD    C,A       ; save A                  4F
        RL    B         ; get sign into Cy        CB 10
        SBC   A,A       ; propogate it through A  9F
        CALL  C,SNEG4   ; get absolute and new sign  DC XX XX
        CCF             ; manipulate signs and A  3F
        ADC   A,+1      ; to give 1st sign in Cy and Z set if  CE 01
        LD    A,C       ; error. restore A.       79
        POP   DE        ; resore absolute value   D1
        POP   BC        ; to BC,DE                C1
        RET   Z         ; or return if not.       C8

        PUSH  HL        ; save initial point.     E5
        JR    NC,SKIP5  ; skip if positive        30 07
        LD    (HL),2DH  ; else place "—" and      36 2D
        INC   HL        ; move point.             23
        JR    SKIP5     ; conserve Z flag.        18 02
LOOP5:  BIT   7,A       ; set Z for each digit.   CB 7F
SKIP5:  PUSH  AF        ; build up digit stack    F5
        PUSH  HL        ; with HL RAM point on top.  E5
        EX    DE,HL     ; number into BC,HL.      EB
        LD    D,+32     ; bit count for division.  16 20
        XOR   A         ; clear accumulator.      AF
DIV5:   ADD   HL,HL     ; shift dividend          29
        RL    C         ; left                    CB 11
        RL    B         ; into                    CB 10
        ADC   A,A       ; accumulator.            8F
        CP    0AH       ; skip if                 FE 0A
        JR    C,DEC5    ; less than ten           38 03
        SUB   0AH       ; else subtract ten and   D6 0A
        INC   HL        ; set result bit.         23
```

```
DEC5:   DEC   D          ; repeat                          15
        JR    NZ,DIV5    ; 32 times.                       20 F0
        ADD   A,30H      ; convert to ASCII.               C6 30
        LD    D,H        ; put number into                 54
        LD    E,L        ; BC,DE and                       5D
        ADC   HL,BC      ; test for 0.                     ED 4A
        POP   HL         ; get RAM point off stack and     E1
        JR    NZ,LOOP5   ; repeat if not finished          20 DF
LOOP6:  LD    (HL),A     ; else get each digit off stack and 77
        INC   HL         ; into RAM until                  23
        POP   AF         ; orlginal AF with                F1
        JR    Z,LOOP6    ; Z reset is popped.              28 F8
        POP   DE         ; pointer 1st byte of ASCII string. D1
        LD    (HL),20H   ; terminate with ASCII SPACE.     36 20
        RET              ;                                 C9
```

```
DATASHEET

;= SNEG4 — Four Byte Signed Integer Negation
;/CLASS: 1
;/TIME CRITICAL?: No.
;/DESCRIPTION: Negates (2's complement) 4 bytes on top of stack,
;/ACTION:        Point HL at Least Significant Byte
;/                ┌ A←0                    ┐
;/                │ A←A — (HL) — Cy        │
;/                │ (HL)←A                 │
;/                └ HL←HL + 1              ┘ 4 times.
;/SUBr DEPENDENCE: None
;/INTERFACES: None
;/INPUT:     4 bytes on stack with L.S.Byte highest on stack.
;/OUTPUT:    Top 4 bytes of stack negated. Cy copies Sign.
;/           Z set if = 0.
;/REGs USED:Flags
;/STACK USE:4
;/LENGTH:    23
;/TIME STATES: 255
;/PROCESSOR:  Z80

SNEG4:  PUSH  HL         ; save HL                         E5
        PUSH  BC         ; and BC                          C5
        LD    C,A        ; and A in C                      4F
        LD    HL,+6      ; point HL at Least Significant   21 06 00
        ADD   HL,SP      ; byte on stack.                  39
        LD    B,+4       ; byte count.                     06 04
        OR    A          ; clear cy.                       B7
LOOP:   LD    A,+0       ; clear A and subtract byte with  3E 00
        SBC   A,(HL)     ; cy. from last byte and replace  9E
        LD    (HL),A     ; positive by negative.           77
        INC   HL         ; point at next byte.             23
        DJNZ  LOOP       ; 4 times                         10 F9
        RL    A          ; sign into cy. Z set if cy. was 0 CB 17
        LD    A,C        ; restore A                       79
        POP   BC         ; BC                              C1
        POP   HL         ; and HL.                         E1
        RET              ;                                 C9

;= SMUL4 — Four Byte Signed Integer Multiplication
;/CLASS: 1
;/TIME CRITICAL?: No
;/DESCRIPTION: Multiplies two signed 32-bit integers in the
;/             range 80 00 00 01 to 7F FF FF FF giving error
;/             information in flags.
;/ACTION:    Compute product sign.
;/           Make values absolute.
;/           Clear 32-bit accumulator.
;/             Shift left accumulator
;/             shift left multiplier
;/             if cy. then add multiplicand to accumulator
;/             repeat 32 times.
;/           Negate if product sign demands.
;/SUBr DEPENDENCE: SNEG4 (negate 4 bytes on stack)
;/INTERFACES: None
;/INPUT:     BC,DE * IX,IY
;/OUTPUT:    IX,IY always returned unaltered
;/           No error: Z reset, product in BC,DE, Cy copies sign.
;/           Error: Z set, BC,DE returned unaltered
;/             Cy set: 80 00 00 00 was input
;/             Cy reset: overflow
;/REGs USED: BC DE IX IY Flags
;/STACK USE: 22 (including CALL and use SNEG4).
;/LENGTH:    99
;/TIME STATES: 6264 max.
;/PROCESSOR:  Z80

SMUL4:  PUSH  IX         ; get multiplier sign in H        DD E5
```

```
        EX    (SP),HL ; and save HL.          E3
        PUSH  HL      ; save IX               E5
        PUSH  IY      ; and other             FD  E5
        PUSH  BC      ; input                 C5
        PUSH  DE      ; registers.            D5
        LD    L,A     ; save A                6F
        LD    A,H     ; get IX sign and XOR with  7C
        XOR   B       ; B to give product sign.   A8
        LD    A,L     ; restore A and         7D
        PUSH  AF      ; save A and Sign flag. F5
        PUSH  IX      ; put IX,IY             DD  E5
        PUSH  IY      ; on stack              FD  E5
        ADD   HL,HL   ; move sign into Cy and 29
        CALL  C,SNEG4 ; complement if negative. DC  XX  XX
        POP   IY      ; restore absolute value FD  E1
        POP   IX      ; to IX,IY              DD  E1
        JR    C,ERR3  ; else error if still negative. 38  3B
        PUSH  BC      ; repeat                C5
        PUSH  DE      ; procedure             D5
        RL    B       ; with                  CB  10
        CALL  C,SNEG4 ; BC,DE.                DC  XX  XX
        POP   DE      ;                       D1
        POP   BC      ;                       C1
        JR    C,ERR3  ;                       38  30
        SBC   HL,HL   ; clear HL and put on stack ED  62
        PUSH  HL      ; to make HL,IX the accumulator E5
        EX    (SP),IX ; and (SP),IY the multiplier. DD  E3
        LD    A,32    ; set bit count.        3E  20
LOOP3:  ADD   IX,IX   ; shift left            DD  29
        ADC   HL,HL   ; accumulator           ED  6A
        JR    C,OVFW3 ; and jump if overflow. 38  13
        ADD   IY,IY   ; shift left            FD  29
        EX    (SP),HL ; multiplier in         E3
        ADC   HL,HL   ; (SP),IY to get next   ED  6A
        EX    (SP),HL ; bit into Cy.          E3
        JR    NC,DECA3 ; skip if 0            30  06
        ADD   IX,DE   ; else add multiplicand DD  19
        ADC   HL,BC   ; to accumulator.       ED  4A
        JR    C,OVFW3 ; jump if overflow.     38  05
DECA3:  DEC   A       ; repeat                3D
        JR    NZ,LOOP3 ; 32 times             2D  E9
        LD    A,H     ; move bit 32 of product 7C
        ADD   A,A     ; into Cy for overflow test. 87
OVFW3:  POP   BC      ; remove multiplier from stack. C1
        CCF           ; overflow if Cy reset  3F
        JR    NC,ERR3 ;                       30  0C
        POP   AF      ; restore AF            F1
        POP   DE      ; replace multiplicand on D1
        EX    (SP),HL ; stack by absolute     E3
        PUSH  IX      ; value of product and  DD  E5
        CALL  M,SNEG4 ; negate if necessary.  FC  XX  XX
        LD    H,+0    ; prepare for Z reset.  26  00
        JR    END3    ;                       18  04
ERR3:   POP   HL      ; restore A keeping     E1
        LD    A,H     ; flag information      7C
        LD    H,+1    ; prepare for Z set.    26  01
END3:   DEC   H       ; okay or error in Z flag. 25
        POP   DE      ; restore multiplicand or D1
        POP   BC      ; product.              C1
        POP   IY      ; restore               FD  E1
        POP   IX      ; multiplier            DD  E1
        POP   HL      ; and HL.               E1
        RET           ;                       C9
```

BOOKFARE

Continued from page 126

although it could be argued that there is an element of overkill in applying structured programming to this depth with a language like Basic. However, it would be very easy to learn another language with the grounding provided by this book, a course actually suggested by the author.

The other two books depend much more heavily on flowcharting as the major tool for problem analysis, although this is not to imply that they adopt the same approach to programming. David Heiserman adopts an informal experimental sort of style, setting up complete programs (not fragments) and then talking them through, pointing out good and bad features or techniques as he goes along. His programming philosophy is summarised by the observation that 'there is a good answer to *every* problem (my italics)'

and without advocating anything as formalised as structured programming to achieve this quality, he does attempt to give his readers some guidelines for judging and producing 'good' programs. Carter and Huzan limit themselves to a fairly cursory chapter on Program Testing but taking the book as a whole, I found no evidence of a coherent programming philosophy, simply a description of how to get a machine to work in Basic. Page 64 contains a program which purports to demonstrate the 'rules' governing FOR. . . NEXT loops but which, instead, advocates every known bad practice (eg, modifying the index within the body of the loop) associated with these constructs.

The third problem, that of describing how to handle the keyboard and deal with the Basic run-time commands, is made especially tricky by virtue of Basic's many variants and the wide variety of machines on which it is likely to be found. *Programming in Basic for Personal Computers* is obviously specially for microcomputers, although Heiserman further restricts this by concentrating on Microsoft Basic and the TRS-80. Under the circumstances, this is a sensible choice and he is often at pains to point out some of the more common divergences. The first chapter, which deals explicitly with the machine usage aspect, is particularly good. The other two books betray their mainframe origins and are much less helpful in this regard. Carter and Huzan, for instance, offer the advice: 'Find out which commands you need. . . and then practise with this program' but it is just the business of 'finding out', especially in a large anonymous, multi-user environment, which could prove insuperable to the 'teach-yourself' type of user they are trying to reach.

This covers the points on which I feel books like these should be judged; in conclusion, here's a brief summary of each of them:

Structured Basic and Beyond (W pages, £8.00) is a solid, formal introduction to programming in Basic using structured constructs and pseudocode with chapters on file-handling, string-handling and 'computer-science' topics like trees and queues. (Presumably this is where the '. . . and Beyond' comes in.) It has the format of a coursework book with exercises at the end of each chapter, an index and a bibliography which suggests other languages one might learn and various topics in computer science. I would recommend it to anyone who wishes to devote some time to getting a 'professional' start in programming and who has access only to Basic facilities.

Programming in Basic for Personal Computers (David Heiserman, Prentice-Hall International, 333 pages, £5.50) has, in many senses, a less complete although certainly a more informal and more practical approach. It has a nice style with key descriptions and definitions being well laid out (in boxes embedded in the text), a few exercises at the end of the chapters and some 'fun' working programs. It is more closely geared to the microcomputer user, particularly the TRS-80 owner, although it is not completely dependent on this machine.

Computer Programming in Basic (L R Carter and E Huzan, Teach Yourself Books, 163 pages, £1.75) is poorly organised — there are constant forward references as in Chapter 5 on Program Testing: 'In Chapter 7 you will learn other Basic instructions which will allow you to instruct the computer to execute different sets of instructions in your program.' Surely it would be more helpful to discuss branching before the chapter on program testing?. There is an appendix giving the ASCII codes in binary when they are only useful (in CHR$ statements) in decimal. I believe that some of the methods used or recommended are wrong and others are at least confusing and I cannot recommended so perfunctory an excursion into Basic.

CALCULATOR CORNER

Continued from page 133

incorporated into a program which generates the 'magic number' and positions input digits correctly into a final string; I leave this as an exercise for you. (The alpha characters could be assigned to keys P0—P4 for such a purpose.)

iii) The F character

No one has found a way of producing the F op code. I suspect that this is because it is a hard wired function, possibly the E code with an extra bit or byte which tells the display to blank the bottom stroke. It certainly has no place in the hexadecimal scheme of things and is therefore probably unproducible.

iv) Indirect jumps

Several readers have pointed out that I

was wrong about the destinations of the 'bizarre indirect jump'. The correct version is:
IND GOTO ^{0} searches for 0, P for 1, C for 2, E for 3, — for EP (decimal point), and β for EE (π or exponent).

v) The secret register

A whole new ballgame seems to be in the making, which doesn't strictly involve the hex characters. This concerns the way in which the L-registers hold intermediate results and the inferred existence of another register (or set of registers) which hold the two most significant digits. Of this, and of the way in which the 502 searches for GOTO and GSB destinations, I shall write in next month's column.

Finally, I must apologise to any new readers to whom this column must be hard going. Space doesn't allow me to recap previous discoveries, and so you should refer to Jan '81 *PCW* for the background information.

Operation	Display
Construct 'code' number	1133156666
Add magic number and INT	—ββββββββ
Produces string with 'window' zeroes	PEEP 0000
Subtract 1,000,000,000 to give 'inverted' string	—CC—P0000 *
Add 1,000,006,357	PEEP 6357

Table 1

BRIDGE

Continued from page 83

books on defensive play. When the program must lead to a trick, it chooses the appropriate card from the suit at the need the services of one or more good top of the desirability list. If it must play second to a trick it will normally play the lowest card of the led suit, while playing third it will play the highest card unless that card has already been beaten. When forced to discard from a different suit (ie, the card that was led is from a suit in which the defending player is void), the program should discard a card from the suit that is currently bottom of the desirability list.

Bibliography

Berelekamp, ER: 'A Program for Playing Double-Dummy Bridge Hands', *Journal of the Association for Computing Machinery*, 1963, No 3.

Next month I shall be writing about Shogi (Japanese chess). Anyone who would like to see this fascinating game in action should watch the Shogi tournament at the Charing Cross Hotel, London on 6-7 June.

Listing continued from page 95

```
6CDE 00        0114.01        NOP             ;SPACE FOR CALL
6CDF 00        0115.01        NOP
6CE0 F3        0116.01        DI
6CE1 3E03      0117.01        LD A,03H
6CE3 D302      0118.01        OUT (2),A       ;DISABLE OWN INTERRUPTS TILL
6CE5           0119.01                        ;READY FOR NEXT CHARACTER.
6CE5 21016D    0120.01        LD HL,TCS       ;ADDR OF TEMP CH STORE
6CE8 3600      0121.01        LD (HL),00H     ;CLEAR IT
6CEA 3EFF      0122.01        LD A,0FFH
6CEC D300      0123.01        OUT (13),A
6CEE 3ABF6C    0124.01        LD A,(TABLE1-2) ;9600/BAUD RATE
6CF1 1F        0125.01        RRA             ;HALVE IT TO COUNT 1/2 PULSE
6CF2 D30D      0126.01        OUT (1D),A      ;RESET AND RESTART CHAN 13
6CF4 3E07      0127.01 JP2:   LD A,7          ;NO. OF PULSES TO COUNT
6CF6 32026D    0128.01        LD (PCTR),A     ;TO PULSE COUNTER LOCATION
6CF9 F1        0129.01 JP2:   POP AF
6CFA E1        0130.01        POP HL
6CFB D1        0131.01        POP DE
6CFC C1        0132.01        POP BC
6CFD FB        0133.01        EI
6CFE ED4D      0134.01        RETI
6D00           0135.01 ;-------------------------------------
6D00           0136.01                        ;NOW SOME MEMORY LOCATIONS
6D00 00        0137.01 SHIFT:   DEFB 00H      ;0 FOR LETTERS,32 FOR FIGS
6D01 00        0138.01 TCS:     DEFB 00H      ;TEMP CH STORE
6D02 00        0139.01 PCTR:    DEFB 00H      ;PULSE COUNTER
6D03           0140.01 ;-------------------------------------
6D03           0141.01 PLSINT:                ;PULSE INTERRUPT ROUTINE CALLED
```

```
                0142.01                 ;WHEN CHAN 1 = 1 ZERO
6D03 C5         0143.01         PUSH BC
6D04 D5         0144.01         PUSH DE
6D05 E5         0145.01         PUSH HL
6D06 F5         0146.01         PUSH AF
6D07 3A026D     0147.01         LD A,(PCTR)     ;PULSE COUNTER 2 TO 0
6D0A FE07       0148.01         CP 07H          ;IS IT MID START PULSE?
6D0C 200C       0149.01         JR NZ,JP2       ;GO IF NOT
6D0E F3         0150.01         DI
6D0F 3EFF       0151.01         LD A,0FFH
6D11 D30D       0152.01         OUT (13),A
6D13 3ABF6C     0153.01         LD A,(TABLE1+3) ;5000/BAUD RATE
6D16 D30D       0154.01         OUT (13),A      ;SET TO COUNT FULL PULSE LENGTHS
6D18 182F       0155.01         JR DECPCT       ;DEC PCTR,RETURN
6D1A B7         0156.01 JP2:    OR A            ;IS (PCTR) ZERO?
6D1B 200B       0157.01         JR NZ,JP4       ;GO IF NOT
6D1D F3         0158.01         DI
6D1E 3E79       0159.01         LD A,79H        ;NEAR END OF STOP PULSE SO
6D20 D30D       0160.01         OUT (13),A      ;DISABLE TIMER INTERRUPTS AND
6D22 3E83       0161.01         LD A,83H        ;ENABLE START INTERRUPTS
6D24 D302       0162.01         OUT (2),A
6D26 1825       0163.01         JR JP8          ;RETURN FROM INT
6D28 FE01       0164.01 JP4:    CP 01H          ;IS (PCTR)=1? IF SO IN MIDDLE
6D2A 2013       0165.01         JR NZ,JP6       ;OF STOP PULSE  GO IF NOT
6D2C F3         0166.01         DI
6D2D 3EFF       0167.01         LD A,0FFH
6D2F D30D       0168.01         OUT (13),A      ;SET TO TIME HALF A PULSE
6D31 3ABF6C     0169.01         LD A,(TABLE1+3)
6D34 1F         0170.01         RRA             ;HALVE 5000/BAUDS
6D35 D30D       0171.01         OUT (13),A
6D37 CDACCE     0172.01         CALL DECODE
6D3A CD5E6D     0173.01         CALL PUSHCH     ;DECODE CHARACTER,PUSH TO STACK
6D3D 180A       0174.01         JR DECPCT       ;AND EXIT
6D3F 210160     0175.01 JP6:    LD HL,TCS       ;HERE IF (PCTR)=6,5,4,3,2
6D42 DB00       0176.01         IN A,(0)        ;STATE OF RTTY INPUT PORT TO A
6D44 17         0177.01         RLA
6D45 17         0178.01         RLA             ;BIT 6 NOW IN CY
6D46 00         0179.01         NOP             ;SPACE FOR CCF IF NEEDED
6D47 CB16       0180.01         RL (HL)         ;ROTATE CY FLAG INTO (TCS)
6D49 21026D     0181.01 DECPCT: LD HL,PCTR
6D4C 35         0182.01         DEC (HL)
6D4D F1         0183.01 JP8:    POP AF
6D4E E1         0184.01         POP HL
6D4F D1         0185.01         POP DE
6D50 C1         0186.01         POP BC
6D51 FB         0187.01         EI
6D52 ED4D       0188.01         RETI
6D54            0189.01 ;-------------------------------------
6D54            0190.01 CLRSTK:                 ;ROUTINE TO CLEAR RX STACK
6D54 2AA26D     0191.01         LD HL,(BOS)
6D57 229E6D     0192.01         LD (STKIP),HL
6D5A 22A06D     0193.01         LD (STKOP),HL
6D5D C9         0194.01         RET
6D5E            0195.01 ;-------------------------------------
6D5E            0196.01 PUSHCH:                 ;ROUTINE TO PUSH CHARACTER
                                ONTO STACK
6D5E ED4B9E6D   0197.01         LD BC,(STKIP)   ;STACK INPUT ADDR
6D62 2AA46D     0198.01         LD HL,(TOS)
6D65 2B         0199.01         DEC HL          ;HL=1 LESS THAN (TOS)
6D66 B7         0200.01         OR A            ;RESET CY, PRESERVE (A)
6D67 ED42       0201.01         SBC HL,BC
6D69 3005       0202.01         JR NC,JP9       ;JUMP IF NOT AT TOP
6D6B ED4BA26D   0203.01         LD BC,(BOS)
6D6F 0B         0204.01         DEC BC          ;BC=(BOS)-1
6D70 03         0205.01 JP9:    INC BC          ;INC INPUT POINTER
6D71 ED439E6D   0206.01         LD (STKIP),BC
6D75 02         0207.01         LD (BC),A       ;ASCII TO STACK
6D76 C9         0208.01         RET
6D77            0209.01 ;-------------------------------------
6D77            0210.01 GETCHA:                 ;USR(2)-GETS ASCII FROM STACK
6D77 2A9E6D     0211.01         LD HL,(STKIP)
6D7A ED4BA06D   0212.01         LD BC,(STKOP)
6D7E AF         0213.01         XOR A
6D7F ED42       0214.01         SBC HL,BC
6D81 2003       0215.01         JR NZ,JPA       ;GO IF NOT EMPTY
6D83 47         0216.01         LD B,A          ;AB=0-RETURN ZERO IF EMPTY
6D84 1814       0217.01         JR JPC          ;GO TO USR VALUE RETURN
6D86 03         0218.01 JPA:    INC BC          ;INCREMENT STACK O/P PTR
6D87 2AA46D     0219.01         LD HL,(TOS)
6D8A AF         0220.01         XOR A
6D8B ED42       0221.01         SBC HL,BC       ;IS STKOP>TOP OF STACK?
6D8D 3004       0222.01         JR NC,JPB       ;JUMP IF NOT
6D8F ED4BA26D   0223.01         LD BC,(BOS)     ;ADDR OF BOTTOM OF STK
6D93 ED43A06D   0224.01 JPB:    LD (STKOP),BC
6D97 0A         0225.01         LD A,(BC)
6D98 47         0226.01         LD B,A
6D99 AF         0227.01         XOR A           ;ROUTINE 442AH RETURNS USR
6D9A            0228.01                         ;VALUE AS IN A (MSBYTE) B (LS)
6D9A CD2A44     0229.01 JPC:    CALL 442AH
6D9D C9         0230.01         RET
6D9E            0231.01 ;-------------------------------------
6D9E A86D       0232.01 STKIP:  DEFW $+10       ;NOW SOME STORAGE LOCATIONS
```

```
6DA0 A86D      0233.01 STKOP:  DEFW $+8
6DA2 A86D      0234.01 BOS:    DEFW $+6
6DA4 A86E      0235.01 TOS:    DEFW $+260
6EAC           0236.01         DEFS 262    ;SPACE FOR STACK AND SPARE
6EAC           0237.01 ;-----------------------------------
6EAC           0238.01 DECODE:             ;DECODE ROUTINE
6EAC 3A816D    0239.01         LD A,(TCS)  ;BAUDOT CODE TO A
6EAF E61F      0240.01         AND 31      ;RESET BITS 5,6,7
6EB1 21006D    0241.01         LD HL,SHIFT ;POINTS TO SHIFT STORE
6EB4 FE1B      0242.01         CP 27       ;IS CODE A FIGS SHIFT?
6EB6 2005      0243.01         JR NZ,JPD   ;GO IF NOT
6EB8 3620      0244.01         LD (HL),32  ;SET FIGS OFFSET
6EBA 00        0245.01         NOP
6EBB 00        0246.01         NOP         ;SPACE FOR FURTHER CALL
6EBC C9        0247.01         RET
6EBD FE1F      0248.01 JPD:    CP 31       ;IS IT LETTERS SHIFT?
6EBF 2806      0249.01         JR Z,JPE    ;GO IF SO
6EC1 FE00      0250.01         CP 00       ;IS IT A NULL CHARACTER?
6EC3 2802      0251.01         JR Z,JPE    ;GO IF SO-TREAT NULLS AS LTRS
6EC5 1805      0252.01         JR JPF      ;SHIFTS
6EC7 3600      0253.01 JPE:    LD (HL),0   ;SET OFFSET 0 FOR LETTERS
6EC9 00        0254.01         NOP
6ECA 00        0255.01         NOP
6ECB C9        0256.01         RET         ;SPACE FOR CALL
6ECC 86        0257.01 JPF:    ADD (HL)    ;A=BAUDOT+SHIFT
6ECD 4F        0258.01         LD C,A
6ECE 0600      0259.01         LD B,0      ;BC=OFFSET
6ED0 21D66E    0260.01         LD HL,LOOKUP ;CHANGE WITH POKES FOR ENGLISH
6ED3           0261.01                     ;OR RUSSIAN TABLES
6ED3 09        0262.01         ADD HL,BC   ;HL PTS TO ASCII CODE
6ED4           0263.01
6ED4 7E        0264.01         LD A,(HL)   ;GET IT INTO A
6ED5 C9        0265.01         RET
6ED6           0266.01 ;-----------------------------------
6ED6           0267.01 LOOKUP:             ;NOW BAUDOT-ASCII CONVERSION
6ED6           0268.01                     ;LOOKUP TABLE
6ED6 00540D4F  0269.01         DEFB 0,'T',13,'O'
6EDA 20484E4D  0270.01         DEFB 32,'H','N','M'
6EDE 0A4C5247  0271.01         DEFB 10,'L','R','G'
6EE2 49504356  0272.01         DEFB 'I','P','C','V'
6EE6 455A4442  0273.01         DEFB 'E','Z','D','B'
6EEA 53594658  0274.01         DEFB 'S','Y','F','X'
6EEE 41574A00  0275.01         DEFB 'A','W','J',0
6EF2 55514B00  0276.01         DEFB 'U','Q','K',0
6EF6           0277.01                     ;NOW FIGS ENGLISH
6EF6 00350D39  0278.01         DEFB 0,'5',13,'9'
6EFA 20232C2E  0279.01         DEFB 32,'#',44,46
6EFE 0A293426  0280.01         DEFB 10,')','4','&'
6F02 38303A3B  0281.01         DEFB '8','0',58,59
6F06 332B243F  0282.01         DEFB '3','+','$','?'
6F0A 2736212F  0283.01         DEFB 39,'6','!','/'
6F0E 2D320700  0284.01         DEFB '-','2',7,0
6F12 37312800  0285.01         DEFB '7','1','(',0
6F16           0286.01                     ;NOW RUSSIAN LETTERS
6F16 00470D63  0287.01         DEFB 0,'G',13,'C'
6F1A 20524275  0288.01         DEFB 32,'R','B','U'
6F1E 0A444E50  0289.01         DEFB 10,'D','N','P'
6F22 48434D49  0290.01         DEFB 'H','C','M','I'
6F26 45615654  0291.01         DEFB 'E','a','V','T'
6F2A 59734153  0292.01         DEFB 'Y','s','A','S'
6F2E 464B4F00  0293.01         DEFB 'F','K','O',0
6F32 5A554C00  0294.01         DEFB 'Z','U','L',0
6F36           0295.01                     ;NOW RUSSIAN FIGS
6F36 00350D39  0296.01         DEFB 0,'5',13,'9'
6F3A 202F2E2D  0297.01         DEFB 32,'/','.','-'
6F3E 0A223427  0298.01         DEFB 10,'"','4',39
6F42 38303A3B  0299.01         DEFB '8','0',':',';'
6F46 332B4A27  0300.01         DEFB '3','+','J',39
6F4A 22367A2F  0301.01         DEFB '"','6','z','/'
6F4E 65320700  0302.01         DEFB 'e','2',7,0
6F52 37315100  0303.01         DEFB '7','1','Q',0
6F56           0304.01 ;-----------------------------------
6F56           0305.01 DISINT:             ;USR(0)-DISABLES ALL INTERRUPTS
6F56 3E03      0306.01         LD A,3
6F58 F3        0307.01         DI
6F59 D302      0308.01         OUT (2),A
6F5B 3E79      0309.01         LD A,121
6F5D D30D      0310.01         OUT (13),A
6F5F C9        0311.01         RET
6F60           0312.01 ;-----------------------------------
0003           0313.01 END 0003H
```

SECRETS OF SYSTEMS ANALYSIS

Continued from page 91

obvious mistakes in the program when you get it. The programmer ought to be able to make sure that it does what the spec says it should and that there are no obvious weaknesses in it. There are many details that will not be written into a specification. A good programmer

will pick up a good few of these and discuss them with you, or go ahead and build in his own safeguards. However, many programmers lack either the time or the experience to notice loopholes in the specification.

The main part of testing, as far as the user is concerned, is testing the program against the specification. This is essentially the same process as examining a program package to see whether it does what you want. It is also 'acceptance testing'. If you have hired a temporary or freelance programmer, or bought in the services of a software house, then this business of acceptance becomes critical — there is a point at which you will have to pay up and beyond which any additional changes will have to be charged extra. For this reason, it is particularly important that you give some attention to deciding on tests that will satisfy you. Even if you are writing your own programs, there still comes a time when you have to make the decision to go ahead and get the program working on real data. This is the implementation stage which I shall be covering next month.

SINCLAIR ZX81

Continued from page 70

disks being developed and he gave the same enigmatic answer he gave a year ago when I asked the same question about the ZX80: 'We're working on it.' Draw your own conclusions.

Conclusions

He's done it again. Uncle Clive has come up with a lovely product which will have enormous appeal to people wanting to find out more about computers, but without it costing them an arm and a leg. The idea of producing a superior machine to the ZX80 and selling it for a lower price is absolutely wonderful. I'm full of admiration for the man. Most people would have upped the spec and held the price ('It really hurts me to do this') or even increased it slightly. The product is clearly aimed at the home market and I'm sure that it will do extremely well there, far better in fact than the ZX80. And *that's* rapidly becoming the biggest selling micro in the world!

People who are wondering about its relevance to business or serious work at home ought to sit down and do a few calculations on just how much information they need to hold and how they wish to access it. You could hold 100 or so names and addresses or keep track of around 600 financial transactions in one load of the 16k memory. These figures allow for a fairly simple entry and enquiry program in each case. By abbreviating information you can clearly cram more in. By splitting your information across several tapes you can build a substantial file of information but each tape would have to be managed by a separate version of the program.

If you know nothing about computers and you want to enjoy finding out about them, then this machine offers a value for money way of doing just that. Children will love the ZX81, there can be no question about that, and I suspect that more than a few people who are already familiar with computers will buy one, just to have a bit of fun.

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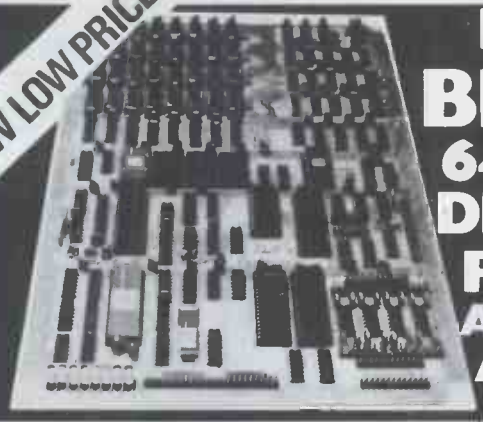

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6502 HARDWARE MANUAL
6502 SOFTWARE MANUAL
APPLE II BASIC PROGRAM MANUAL
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DOS 3.2 MANUAL
APPLE II BASIC TUTORIAL MANUAL
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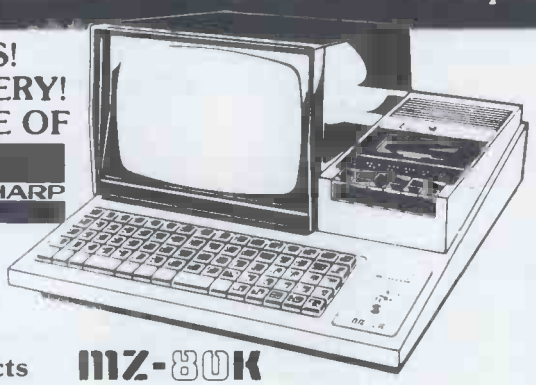

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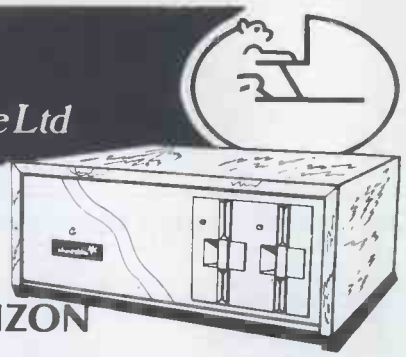

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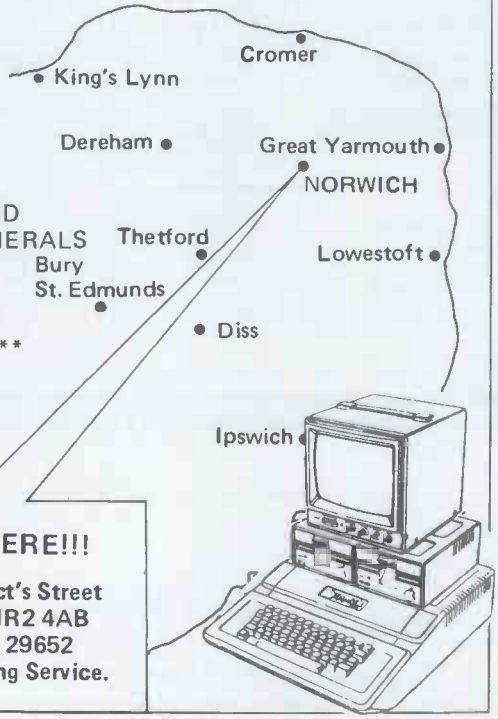

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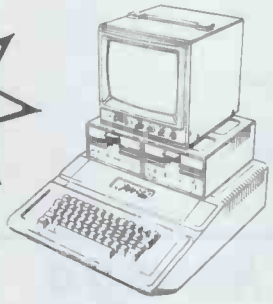

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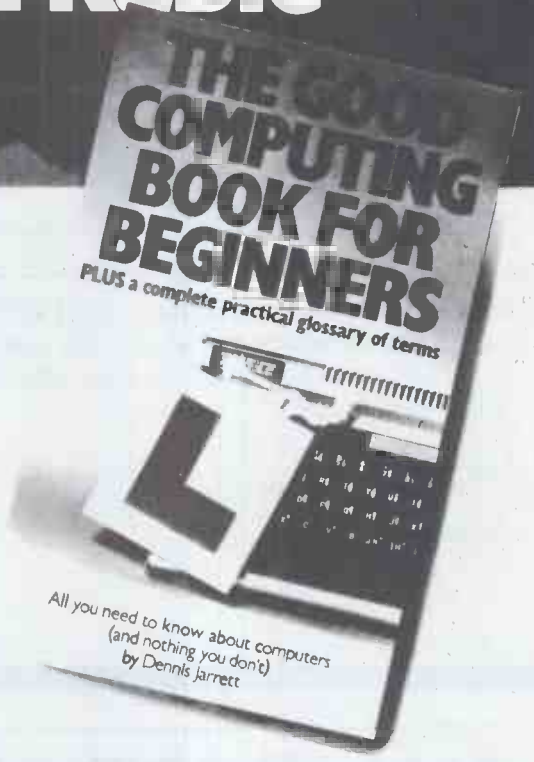

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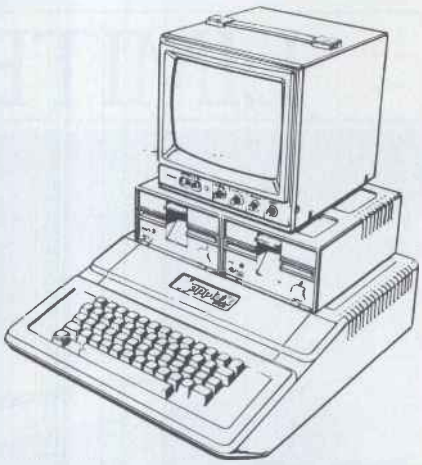

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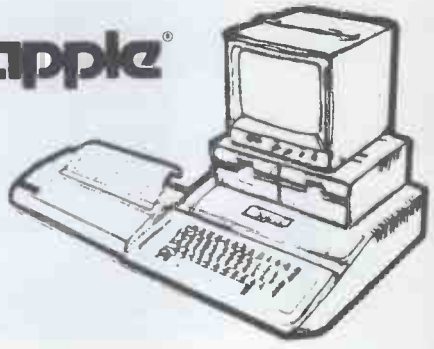

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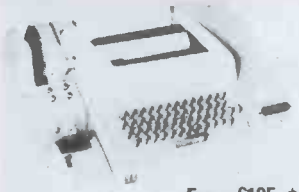

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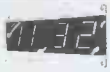

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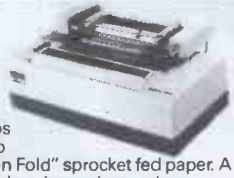

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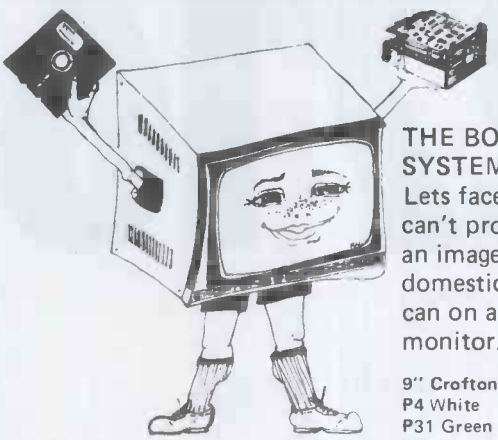

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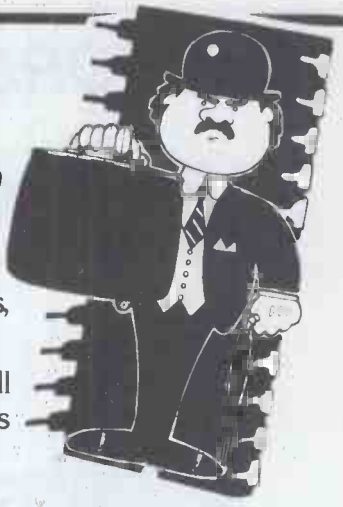

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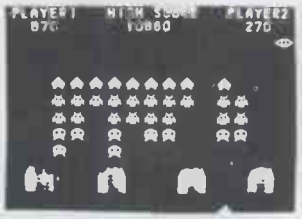

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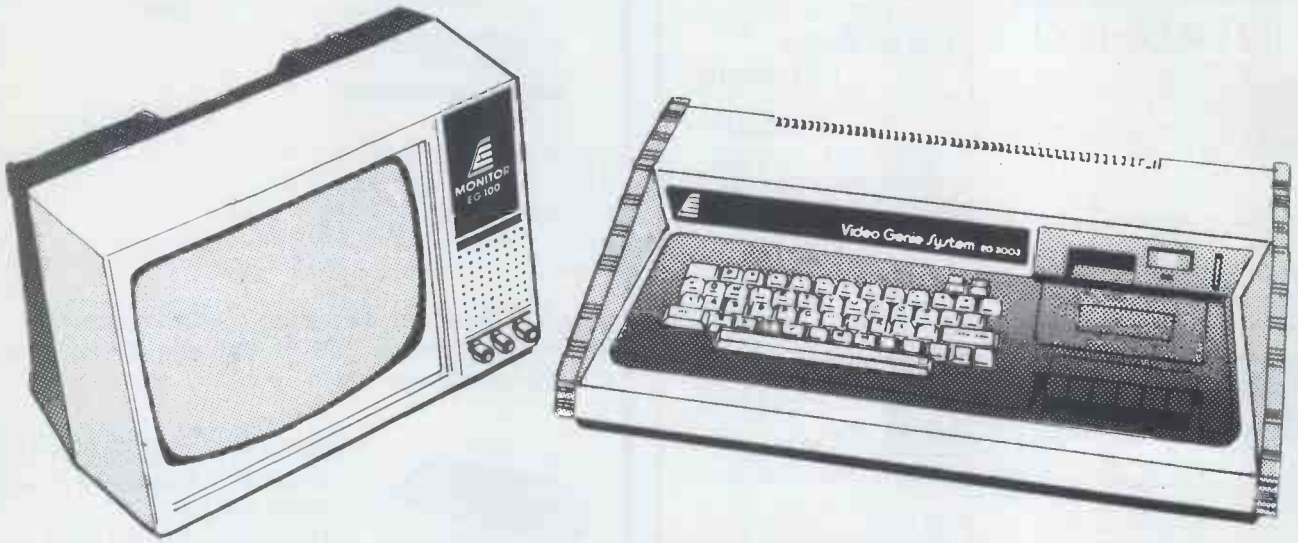

video genie system

Features

16K RAM, expandable to 48K
12K Microsoft BASIC in ROM
TRS-80 Level II software compatible.
Plugs directly into a 625 line TV.
Connects to second cassette recorder.
Video output for monitor.
Completely self-contained. Easily portable.
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Guide Prices

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Technical Manual	£5.00
Programming Guide	£5.00

All prices exclude VAT (if applicable)

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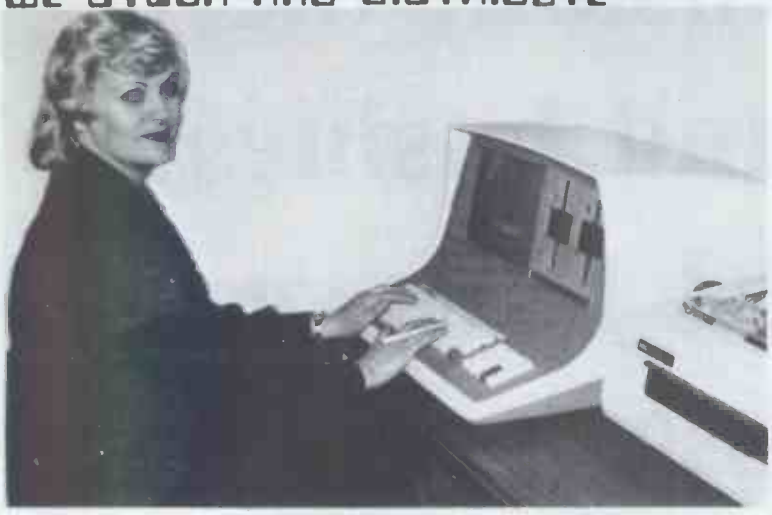

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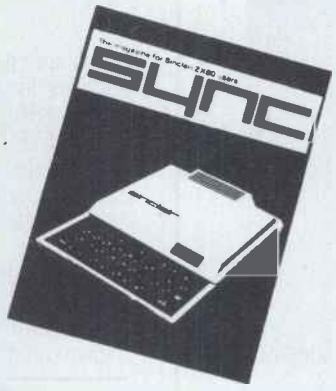
The Sinclair ZX80 is innovative and powerful. Now there's a magazine to help you get the most out of it.

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**.

Hard-Hitting, Objective Evaluations

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.

Order SYNC Today

Right now we need all the help we can get. First of all, we'd like you to subscribe to **SYNC**. Subscriptions are posted by air directly from America and cost just £10 for one year (6 issues), £18 for two years (12 issues) or, if you really want to beat inflation, £25 for three years (18 issues). **SYNC** is available only by subscription; it is not on newstands. We guarantee your satisfaction or we will refund the unfulfilled portion of your subscription.

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
SYNC

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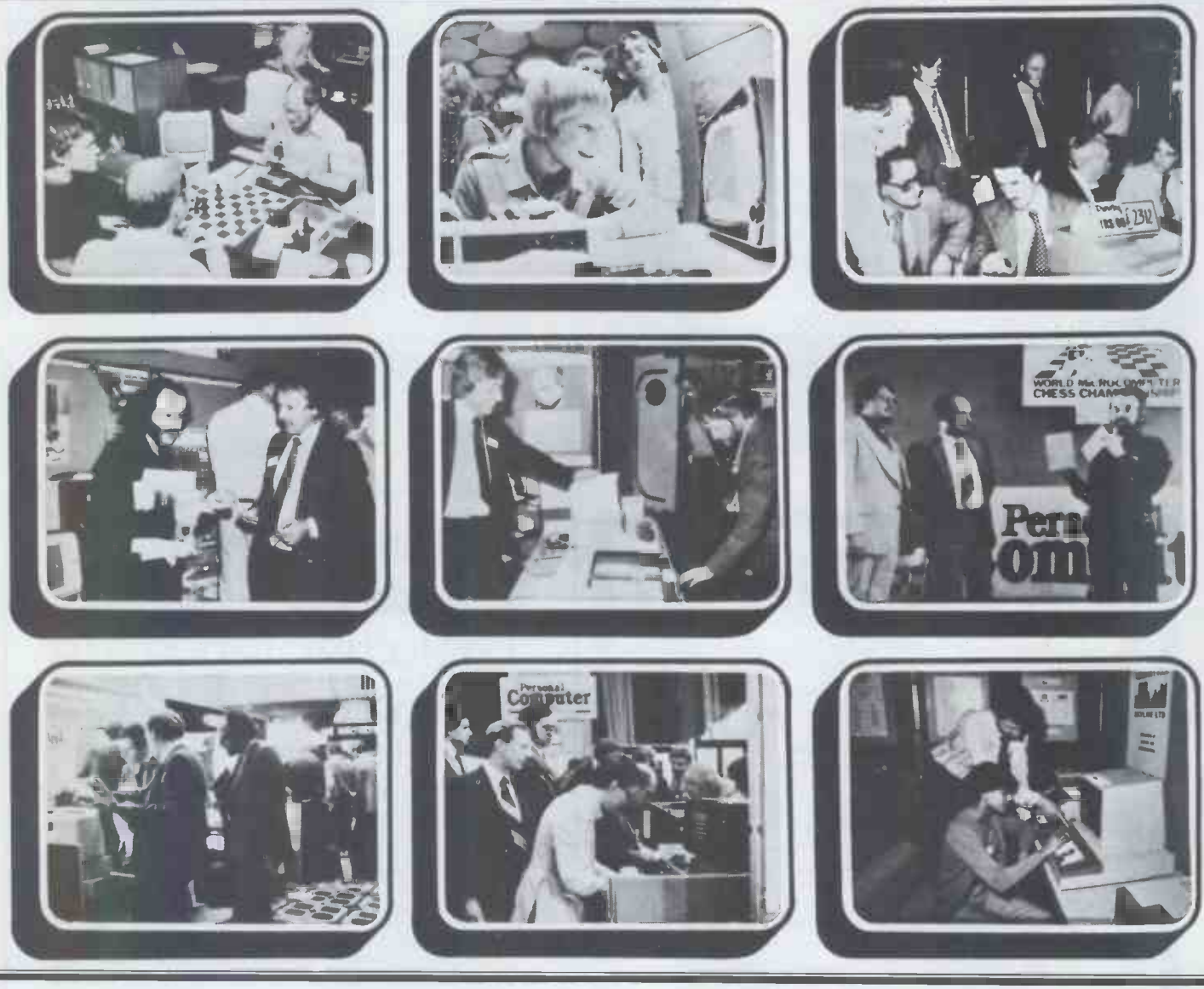
The 4th Personal Computer World Show

Cunard Hotel Hammersmith 10-12 September 1981



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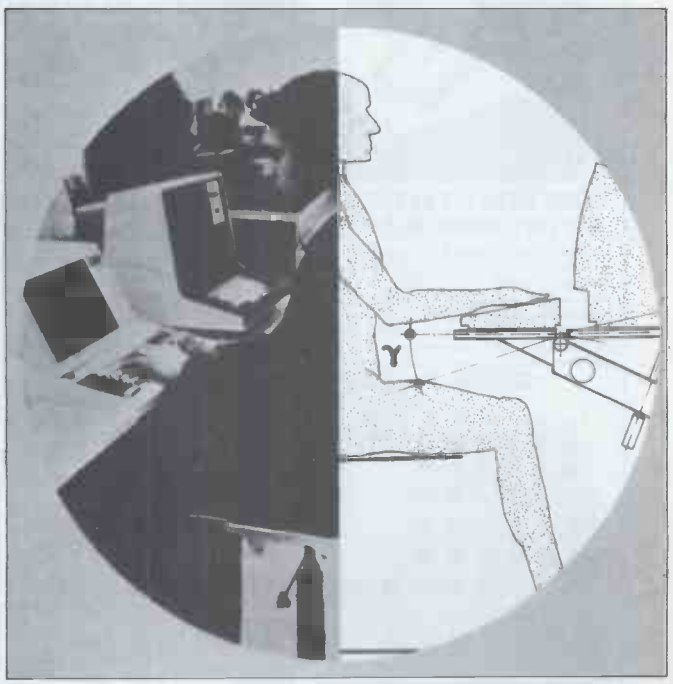
To discuss how the 4th Personal Computer World Show could form the focus of your 1981 promotional calendar contact Timothy Collins on 01-486 1951 or write to him at Montbuild Ltd, 11 Manchester Square, London W1.

ADVERTISERS INDEX

CHIP CHAT

Commodore flew a party of microhacks to Hanover in the 'PET Jet' recently. Turns out the jet is an Israeli-built Westwind, seats seven, and comes complete with gold-plated fittings, telephone, coffee machine, wine cooler (extensively tested by said hacks) and *colour radar*. Also a pilot looking uncannily like 'JR'. As the jet climbed away from Hanover, CBM's UK marketing manager Keith Hall, forced to return by public transport, heard his British Airways captain apologise for the delay in taking off, caused by 'all these damned executive jets'. . . Do you know what ICL's initials stand for? It Can't Last. . . Micro guru Mike Gurr recently finished wiring his whole house up to a computer. Centrepiece of the system was a voice recognition device which enabled him to dispense with keys and locks for his front door. It worked fine until he and his wife returned from a night out to find they had a power cut and Mike was reduced to having to break into his own home as, in his enthusiasm, he hadn't installed a back-up battery. . . Some people never learn. In France, PET sounds like a rude word so you have to call the machine a P.E.T. Now we hear of similar embarrassments with the new VIC, which sounds like an even ruder word in German. . . Anyone wanting their computer products endorsed by Ronald Biggs ('There's no holding back the XYZ123. . . ') should contact our very own David Levy who, incredibly, happens to be Biggs's literary agent.



It seems that VDUs can damage your health — look what's happened to this poor chap's naughty bits as a result of not taking a rest of 10.38 minutes every hour. (See this month's Bookfare.)

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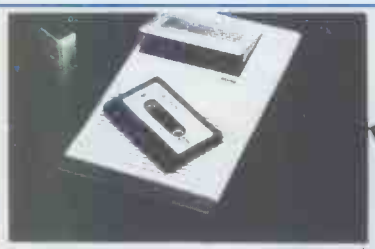

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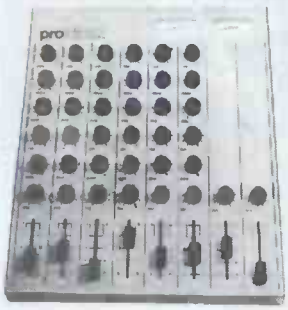

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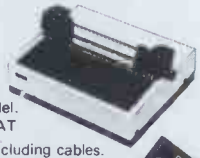

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