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Art Director
Paul Carpenter

Art Editor
Shelley Gray

Editorial Office
14 Rathbone Place
London W1P 1DE
01-637 7991

Advertisement Director
Stephen England
01-636 4461

Assistant Advertisement Manager
Patrick Dolan
01-636 4462

Advertisement Executives
Margaret Burton
01-636 4463
Jacquie Hancock
01-631 1682

Production Manager
Dick Pountain

Typesetter
Jane Hamnell

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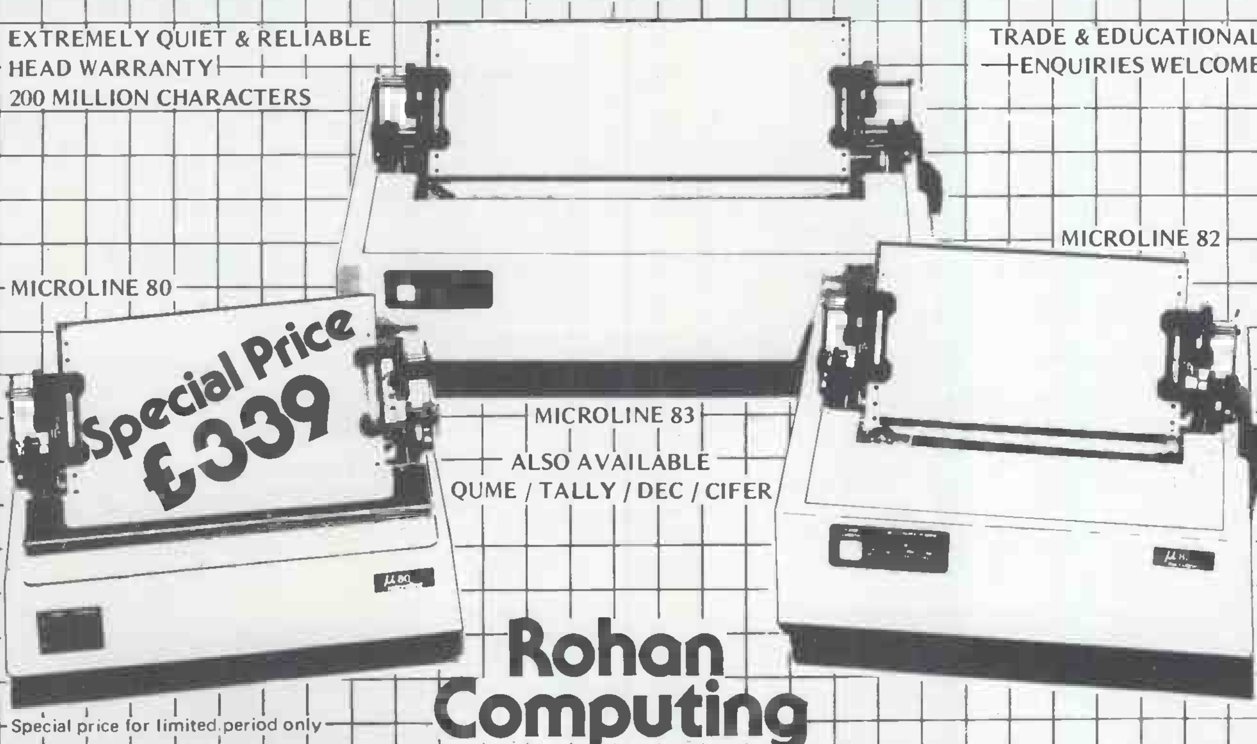

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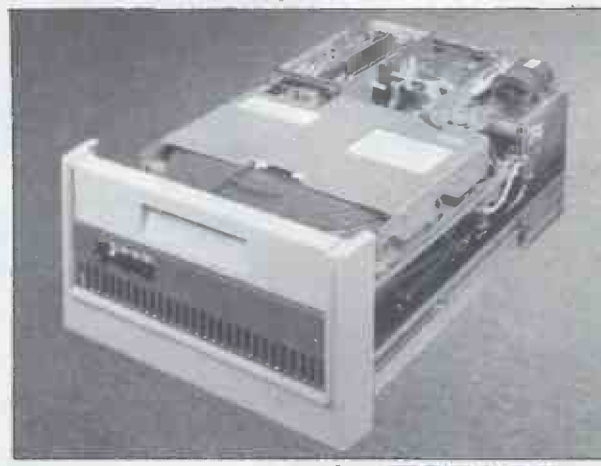

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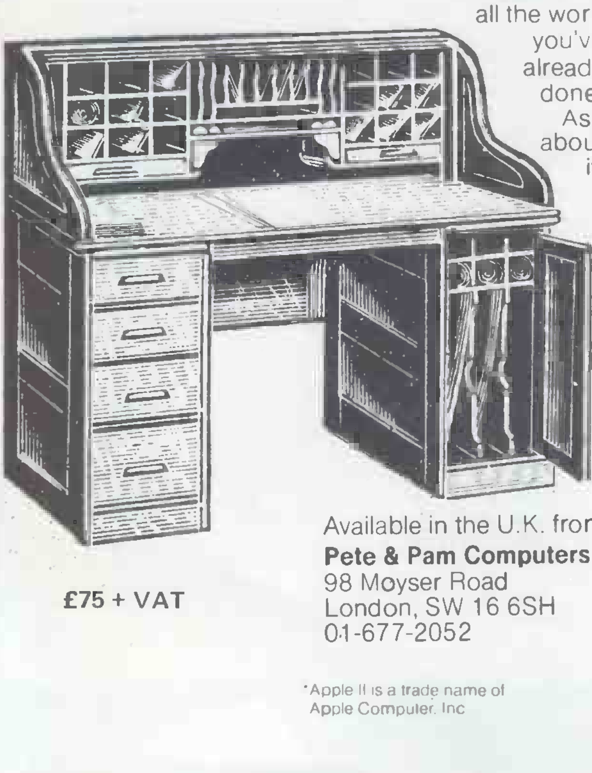

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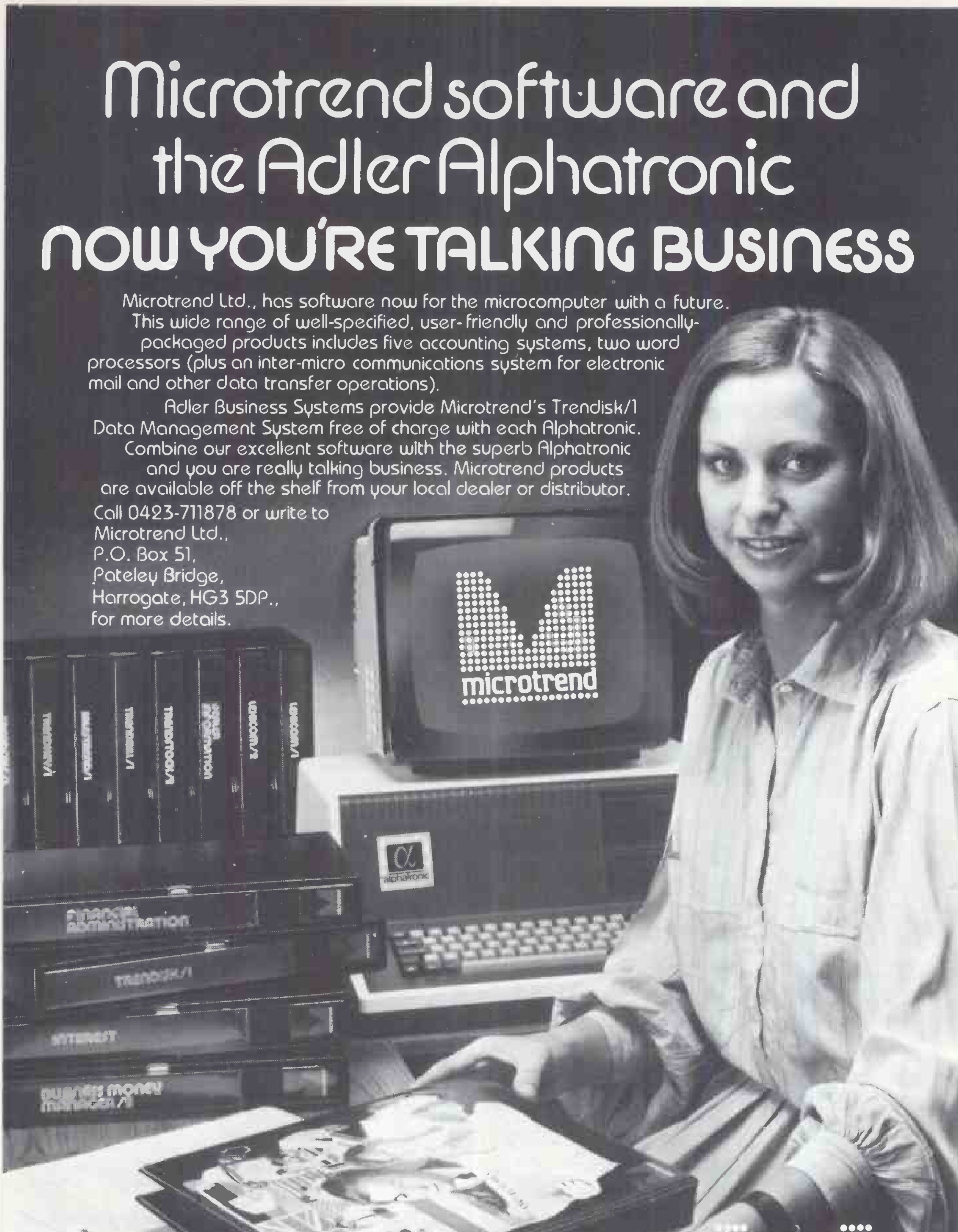
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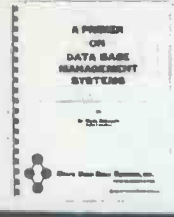

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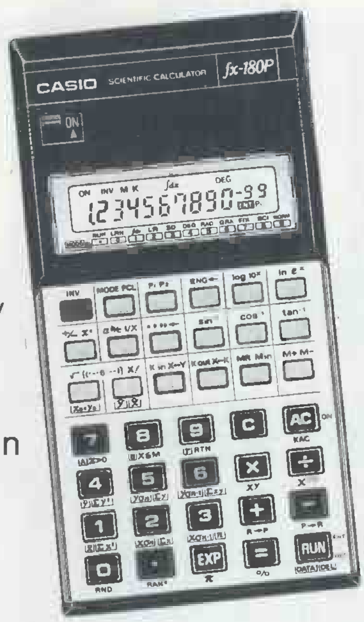

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7407	36
7408	17
7409	20
7410	17
7411	25
7412	20
7413	32
7414	38
7416	30
7417	30
7420	19
7421	38
7422	25
7423	28
7425	28
7426	43
7427	32
7428	35
7430	19
7432	27
7433	36
7437	35
7438	32
7440	20
7441	68
7442	58
7443	120
7444	116
7445	105
7446	132
7447	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
74122	50
74123	65
74125	50
74126	45
74128	45
74132	55
74136	55
74141	75
74142	185
74143	250
74144	250
74145	90
74147	150
74148	125
74150	130
74151	70
74153	70
74154	120
74155	75
74156	75
74157	70
74159	165
74160	99
74161	99
74162	99
74163	99
74164	120
74165	120
74166	130
74167	205
74170	205
74172	375
74173	110
74174	100
74175	82
74176	80
74177	85
74178	110
74179	150
74180	90
74181	280
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
74249	189
74251	110
74265	66
74273	267
74278	249
74279	99
74283	149
74284	350
74285	350
74290	107
74293	135
74297	236
74298	185
74365	95
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74367	95
74368	95
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LS10	20
LS11	32
LS12	32
LS13	40
LS14	60
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
LS76	45
LS78	50
LS83	105
LS85	80
LS86	38
LS90	50
LS91	125
LS92	75
LS93	60
LS95	115
LS96	120
LS107	45
LS109	75
LS112	40
LS113	75
LS114	40
LS122	70
LS123	75
LS124	180
LS125	45
LS126	45
LS132	60
LS133	35
LS136	55
LS138	70
LS139	70
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	350
LS247	135
LS248	135
LS249	135
LS251	130
LS253	95
LS257	95
LS258	120
LS259	160
LS261	450
LS266	75
LS273	180
LS275	320
LS279	88
LS280	250
LS283	90
LS290	130
LS293	130
LS295	215
LS298	215
LS299	420
LS300	175
LS302	175
LS323	270
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
LS377	199
LS378	140
LS379	215
LS384	250
LS385	420
LS386	85
LS390	140
LS393	140
LS395	210
LS396	199
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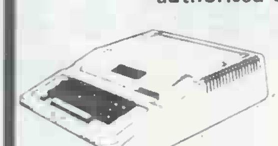

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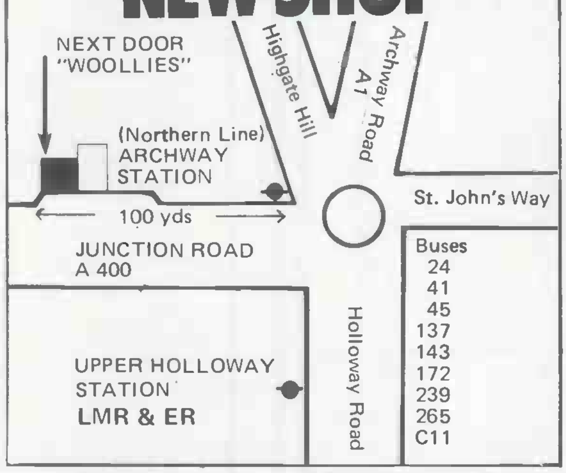

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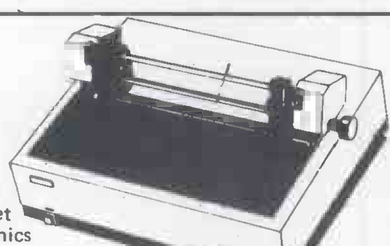

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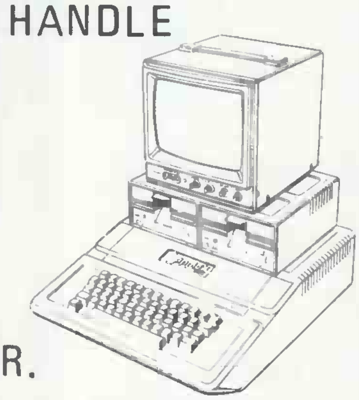

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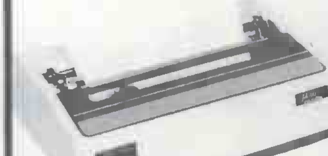

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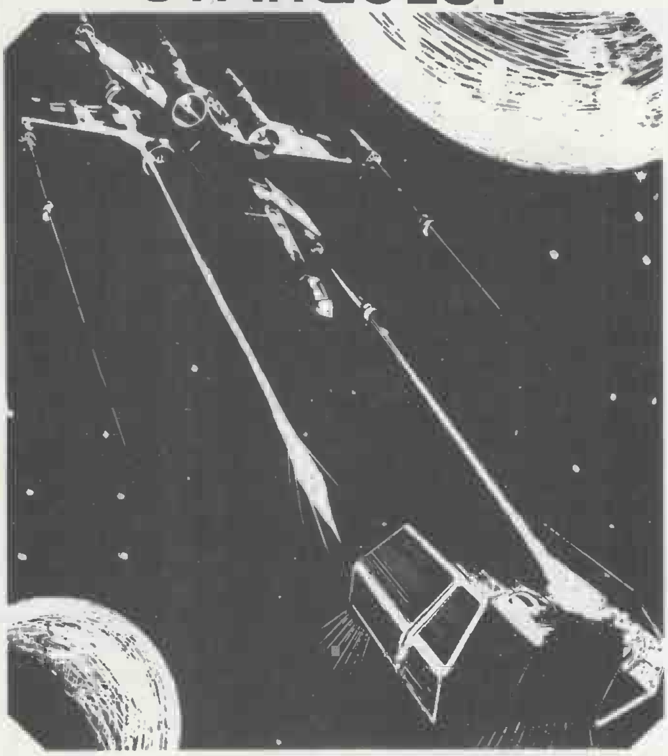

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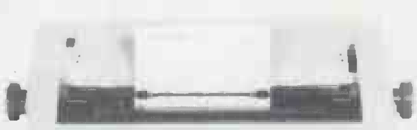

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Z89

NEWSPRINT

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

CRA cuts three teeth

The appointment of the CRA's three-man steering committee is no surprise to readers, I hope, after the irritation felt in Commodore circles recently. My phone was still warm from the imprecations of a Commodore dealer complaining of the treatment meted out in this column to said company, when he rang again, having rapidly changed his tune.

'Have you seen,' he asked 'the new terms and conditions? I don't know, just as you think they've turned over a new leaf they come out with something stupid like this — the Computer Retailers' Association is in an uproar. . .' and so on.

The story goes something like this. Last year, an ambitious company called Isher-Woods went bust. The proprietors sold the company off, lock, stock and barrel, for a song. Isher-Woods was a PET dealer. In stock at the point of bankruptcy was a fair old heap of PET equipment which had not been paid for and when Commodore rolled up to collect its share of the debris, it turned out that it wasn't going to be paid for, either.

Apparently Commodore had failed to put in a fairly standard clause to the effect that it was entitled to a priority share of the money raised by selling the equipment, or that the machinery belonged to Commodore until it was sold. Commodore accordingly retired to lick its wounds and redraft its terms and conditions of sale.

The clause which says that a dealer's stock of PETs remains the property of Commodore until it is paid for is one result and not many PET dealers would argue with that. What *has* enraged one or two of them are two extra clauses. One, rather astonishingly, claims that 'time is not of the essence' in delivery and the other insists on a trust fund for the money received from any PET sales.

The 'time' clause is explained as follows: if goods from Commodore are delayed, then a dealer has to wait for two weeks 'minimum' before he can contact Commodore and insist on prompt delivery. As one dealer said, angrily, 'If we get goods on 30 days credit and can't sell them for at least two weeks, then it becomes 14 days credit at most.'

If the other clause is invoked (Commodore says it won't be) then the dealer won't be getting even 14 days. All the money he gets from the sale of the equipment has to go into the bank. Not his bank, but a special account belonging to Commodore. He has, in effect, to pay cash.

Hence the setting up of a special PET division within the CRA and, for good measure, special Apple and Sharp divisions, too, representing the dominance in the UK market of the three machines.

The Sharp division couldn't happen in America, because there is a deal between Sharp, and Zilog, which gave Sharp the licence to make the Z80 micro for the MZ-80K from its own design. The deal prohibits Sharp from selling into Zilog's patch. Mind you, this nice little carve-up is close to ending. Watch the American press for the announcement of the next Sharp over there, deal or no deal.

Medical marvel

'Doctor, I need another tetracyclene prescription — the symptoms are easing encouragingly but I feel prognosis will be greatly enhanced by taking a prophylactic attitude to reinfection and I'll collect the form from you this afternoon.'

Well, you might just as well, mightn't you? The doctor has no real idea of whether s/he prescribed only one week's supply last time or two, and whether you did or didn't have the second prescription. S/he can find out, but just writing all the repeat Px forms can take over four hours each day.

Medicom, which is moving into surgeries with micros, has now produced a system to keep track of repeat prescriptions. It also does other practice managment jobs, but repeats alone will pay for it, they say. Details 01-579 5845.

Which Cobol?

We can expect some interesting fights in pubs among people who like writing programs in Cobol on micros. Some of them will be staunch supporters of the Cobol compiler which Micro Focus supplies and which runs on several orthodox 8-bit micros plus the powerful Intel 8086 16-bit micro.

Others will be enthusiastic about a new Cobol called Alpha Cobol, a version which coverts Cobol into instructions for the Alpha Microsystem, a machine that uses the S100 bus, but in most other respects looks like a good old-fashioned 'big mini', rather like a DEC PDP -II in fact.

The proponent of the new Cobol is Angusglow, whose proprietor is Tony Sale. His claims for the compiler include: 'The only true multi-user (concurrent compilation); the fastest compiler; the most intelligent (error detecting and correcting); the fastest in execution; produces the most compact code; has the most extensive level 2 implementaction (?).'

Contact him on 02302 2788 or his agent, Leo Scheiner, 01-486 0702.

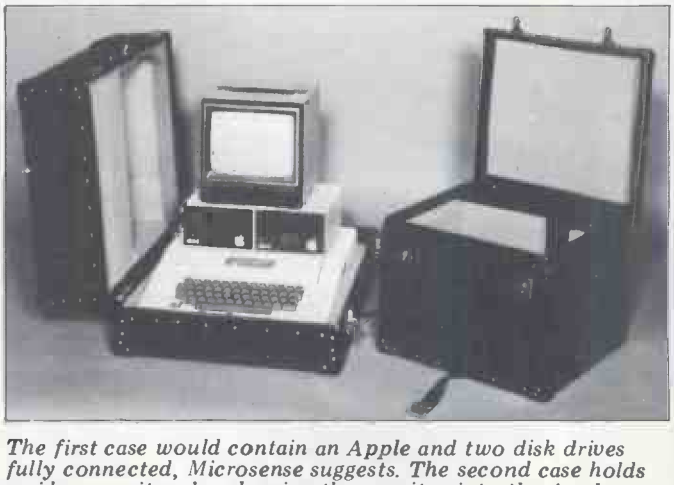
ZX80 wisdom

It is more important to tell an operator what to do after pressing RUN, than it is to tell the operator why the computer does what it does when you do.

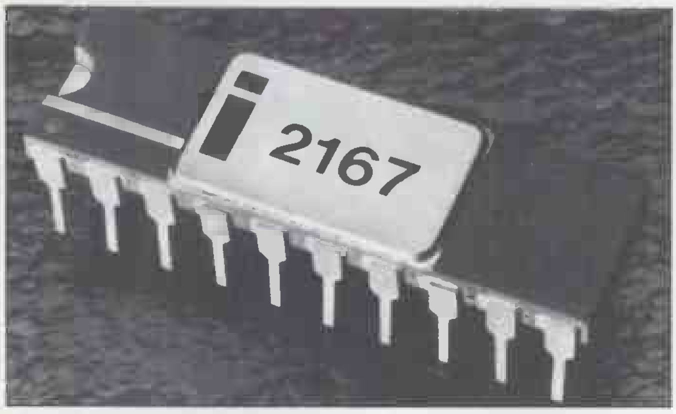
That gem of wisdom is contained in my latest copy of the ZX80 micro user *Interface*, which emerges from the National User Club every so often.

It comes after a neat list of standards (standards being things that computer people love to play with) which you need if you are going to swap programs with other ZX80 users. And it is in an equally neat list of reasons why you should avoid most documentation, this being something else which computer people love to play with.

I'd welcome some reader-thoughts on documentation; and you can start from this thought that there are two types of documentation: first, there is the documentation you add to your own programs so that while you are writing them you can find out what you've done wrong. And second, there is the sort of documentation you add to a program which somebody else will run, so that they can run it.



The first case would contain an Apple and two disk drives fully connected, Microsense suggests. The second case holds a video monitor; by plugging the monitor into the Apple and plugging the lot into the mains, you have an instant Apple demonstration kit for a mere £60. Phone Hemel Hempstead (0442) 48151.



They don't write numbers like this any more; Intel's latest offering is a 16-kbit static *RAM chip. It's cheaper than it it might be, because it has spare transistors on the chip. Like the chip soon to be released by Inmos, Our Own Taxpaid Chip Company, this memory chip can be tested on the production line — any dud columns of transistors can be switched out of the array and new ones switched in. So Intel gets more good chips and so it charges less. Still doesn't make the chip all that cheap, but one day it will. . .*

It's the first sort that Tim Hartnell is talking about, of course, when he says 'if the algorithm is not transparent, document.' He has in mind the time when you want to change the program and won't be able to understand the brilliant flash of insight which produced the code late one night. The second sort is much more important to someone who is trying to sell 1000 copies of his code; he wants to make sure that nobody who didn't pay for the program can run it. Not, that is, without the little booklet that tells him what to do to avoid the disaster-trap he has set (and it is the booklet which costs £15, not the cassette or disk).

Standards on the ZX80 are more important than on many micros because it has no printer yet so you have to type out your programs by hand. And standards such as 'the symbol * signifies a blank that is necessary in a PRINT statement' are essential in this case. So write to Unit 3, Woodthorpe Road, Ashford, Middx TW15 2RP for the Users Club, and send an SAE for details.

MZ-80K hot up kit

Newbear just can't leave well alone on the Sharp MZ-80K micro — it has launched more additional functions, in software, available on cassette. Apparently you get 11 additional functions without the use of any extra memory. The package costs £12.50. They are: Break, Trace, Single step, Block delete, Renumber, Auto number, String inequalities, Logical operators, Set Reset, USR(x) and Print cursor control. Details on 635 30505.

Enter the heavies

Big companies find it hard to do original things, mainly because they don't run out of money. So it was that the network of computer dealers in Britain appeared courtesy of no large established companies, not even the ones like IBM, ICL or Univac or even Digital Equipment, Zilog or Intel, who could have been expected to have some idea of what to do. Now that many of the pioneers are rich and established, it is much harder to get into the market and so, here come the big guys at last.

Curry's was the first and now Xerox has climbed in. It has opened two stores in London, calling them 'one-stop business efficiency stores' in massively expensive, prestige offices in the city centre. Well, the West End, actually. And it is planning more in other major towns over the next 18 months.

I notice it sells Apple. A good move — as long as it doesn't fall for the Apple III (see story elsewhere).

Details on 01-370 6971

Smooth scroller

You will have noticed my fondness for the *Hitch Hiker's Guide to the Galaxy* in the past. Accordingly, you will have dutifully glued yourselves to the screen of your telly, now that it is out from behind the modest shrouds of radio, and you will have noticed that the Book (electronic, containing useful information on 100,000 planets) has the dinkiest little video display. And it's only a couple of inches thick!

Well, save the excitement — it's a fake. That screen doesn't have a single computer generated line, word or letter on it — it's all animation from an art studio — and is in fact a standard cinema screen. The projector is out of sight.

That said, you will have noticed that there was a nice, smooth system for moving all the lines of text up one line when the page was full — unlike the abrupt flicker you're used to on your micro.

That, surprisingly enough, is available on a real computer terminal. Unfortunately, it's not only very expensive (it is Digital Equipment's VT100) but DEC can't make enough to give one to everybody who likes them.

So you can buy a little machine which emulates it, from Mostek, using its own version of the Zilog Z80 micro. It'll produce a split screen, just like the *Guide*, and the lines will scroll smoothly. But it won't make God vanish in a puff of logic. Details on 01-294 9322.

Intel EAROM

Intel's latest clever chip is a memory which has the ominous-sounding ability to be reprogrammed from a distance.

It is a 'permanent' memory chip like the ones which most micro builders use to hold the monitor program (the one which runs constantly on every machine, waiting for you to press a key and then deciding what that key means) but unlike the normal permanent chip (EPROM) which can only be changed by completely erasing everything in it with ultraviolet light, this one can be erased by electricity.

That means, theoretically, that Transam's idealistic service to users of its original Triton kit — it supplies all new software free to users of the old software — could be done by phone. The Transam computer could phone yours, and tell the circuitry to erase this chip, then load in new data.

This is one of several exciting possibilities which Intel is suggesting in an attempt to wake us all up to the arrival of the new chip. When it actually arrives. . .

Posh printer

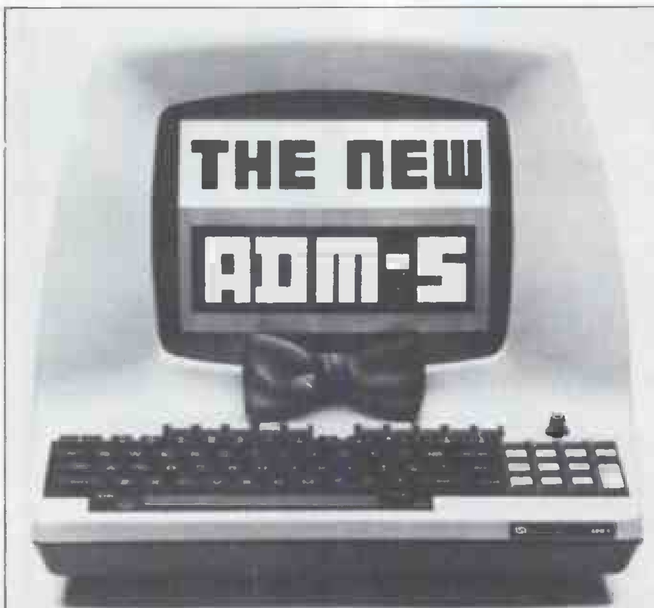
Anybody who has ever watched in fascinated horror as someone leans over the printer and puts his foot in the box of concertina-folded continuous paper, will understand why Data Dynamics is so pleased with its £995 fast (120 characters per second) terminal. It has the paper inside, out of cigarette-end and coffee-spill dangers. And the price looks good enough for them to quote in their announcement, usually a good sign. Details on 01-848 9781.

Authors wanted

Successful Software for Small Computers is a book which you may have read recently, especially if you use Tandy's TRS-80 Model I.

The next publication from the same house could be absorbing reading for your computer because the publishers, Sigma Technical Press, is looking for software authors.

Sigma sees two types of publishable software: collections of small- to medium-size programs and large, specialised business programs. The big



This is Lear Siegler's latest dumb terminal but it is actually a bit smarter than a truly dumb terminal, says Lear. But it's not smart. Ask Lear, not me: they're on 04867 80666.

business software will be supplied on tape or disk with a booklet to back it up. The smaller stuff will be supplied in a book, with optional tape or disk back-up. Either way, the author will receive royalties exactly as if he'd written an ordinary book. Details on 0625 531035, or write to 5 Alton Road, Wilmslow, Cheshire SK9 5DY.

Forth sally

It has always been rather frustrating to those of us who waited to find out how to write programs in the language Forth to be told that virtually the only micro which could understand it was a strange beast supplied by RCA.

Since the claims made for Forth include the suggestion that it takes a tenth of the time needed to get a Basic program working properly, the frustration was felt quite keenly.

So a Forth compiler at £100 looks like a brilliant idea. It comes from someone called F Donavan, whose address looks very similar to that of one of this magazine's own consultants, and the price includes 'a comprehensive manual, the *Using Forth* book, two sample programs, and the compiler itself.'

The only snag is that I can't afford the Research Machines RML 380Z which the compiler runs on. A lot of schools already have these machines, of course, but the rest of us will have to wait for a version for the 6502 micro (found in PET, Apple, Acorn and Microtan). The formation of a new subset of the RML user group is similarly good news for them but not for most of us.

Donavan explains the choice: 'I am a non profit making enterprise, existing to promote the easy exchange of software amongst 380Z owners.' He or she is at 35 St Julians Road, St Albans, Herts.

Ah well, just have to get the £120 Forth package from Digital Devices which runs under CP/M. It's one of several CP/M compatible packages written by the US company Supersoft, which DDL is selling here. Details on 0892 37977.

ZX80 active display

The one thing that nobody was ever going to do with a Sinclair ZX80 toy computer was to play Space Invaders. It couldn't be done because the computer can't generate the picture of green meanies at the same time as it decides where to move them, or whether one has been exterminated. So much for theory.

Ron Bissell and Ken Macdonald of Solihull have blown theory right apart by producing a program called Amazing Active Display. You can get it two ways, possibly three. First, you can buy Tim Hartnell's book *Making The Most Of Your ZX80*, where the program is listed and explained, as one of several examples of how to program the computer. Second, you can buy the active display program for £5 from Ken Macdonald, who wants an SAE sent to him at 26 Spiers Close, Knowle, Solihull, West Midlands B93 9ES. Third, Clive Sinclair himself, the proprietor of the ZX80, is tickled pink by the amazing display because it can make Space Invaders possible after all. And he is setting up a software division, much to the disappointment of ACT Petsoft which had hoped to have his exclusive franchise. This software division hopes to sell programs from everybody, including Bissell and Macdonald. It doesn't stock Space Intruders (that's the ZX80 version) yet, because it wants a version that will fit into the memory of the standard ZX80 and at the moment Bissell's code needs most of 2 kbytes, twice that of the standard machine.

Speech recognition

PCW's editors made an interesting visit to the National Physical Laboratory a week or two back. They saw what is claimed to be a new approach to speech recognition by computer — in this case an LSI-11. NPL suggests that recognition systems which depend on words or phonomes are pretty limited in their application and not only that: most systems available at the moment are trained to recognise only one voice. NPL's system overcomes these disadvantages by accepting speech continuously and 'cleaning' it of its natural colour — intonation, pitch, speed and so on. The resulting 'speech' sounds weird but is just about recognisable for humans.

During this stripping process, the number of bits required to represent, say, one second of speech are drastically reduced from 80,000 to 1600, therefore speeding up the next stage — that of matching the input with sounds, words and phrases held in the ccmputer's memory. At the moment, this table is limited to around 64 words because of the time taken to match the incoming patterns with each table entry *as they came in*. Of course, if time didn't matter then the table could be as long as you like — have a few megabytes on disk, why not?

The NPL system doesn't mind too much if you're in the habit of running your words together; it could pick three words out of 'notinews' — if the match table contained the words not, tin and news, for example. All this talk of matching tables has probably diverted attention from the fact that the system actually works as a sub-phoneme level using 16 speech features. There are more, in fact, but they haven't been implemented yet. The features are stuck together to form a pattern for each word or phrase to be matched.

The hard work, that of reducing speech down to the minimum recognisable size, is done by nine analogue processors working in parallel. Each board is responsible for reducing a different speech feature to its its component parts. The results are then blended together to form the input to the LSI-11.

Now, the main reason for this news item is to announce a Speech Recognition Club which is open to commercial establishments (subject to committee approval) who feel that they could contribute to and benefit from an association with the speech recognition unit at the NPL and with other companies working on related projects. For example, a manufacturer joining the club may well find a software house already involved in producing programs which he could use in his systems. There is an entry fee of around £8000 but which is varied according to the benefit derived from the association. No-one joining the club will have to reveal anything about their developments other than that which they wish to reveal. The NPL will share its accumulated experience in speech recognition and, hopefully, will see its brainchild incorporated in commercial products.

The man to contact is Dr David Schofield, NPL, Teddington, Middlesex, TW11 0LW. Telephone: 01-977 3222.

PCW *'Reader Survey' (inexplicably referred to last month as 'Printer Survey') winner Larry Woods of Birmingham's Aston University, pictured receiving his prize, a Sharp MZ-80K. Larry, an assistant librarian at the university, will be able to use the machine as part of a microcomputer project he is undertaking. Pictured from left are: Derek Bailey, of Camden Electronics, Small Heath; Larry Wood; Ron Bailey, also of Camden Electronics; and Paul Streeter, Sharp national sales manager. Our thanks to Sharp for donating the computer and to the 7000-odd readers who took part in the survey.*

Happy ending

For a few horrible moments, it looked as though Britain's pioneer micromaker, Tangerine, might have to polish up its image.

The company has just launched a £200 'black box' which turns your ordinary television (rented, even) into a Prestel terminal. So what could go wrong with its image?

Administrative confusion is one answer, unnecessary suspicion of their customers could be another. Either way, it seems the problem has been solved, a tremendous relief for the British computer kit business. It started as a joke. For *Datalink's* Xmas issue we invited people who had trouble in their relationship with their computer to write to one of the paper's less feminine staffers, Benjamin Wolley, for instant psycho-system analysis.

In amongst all the wisecracks was a plea from a Tangerine customer whose kit had been lost in the post and who had been trying for four months to find out where it had gone and who was responsible. Tangerine had written a rather unsympathetic letter, he said, stating that he should seek compensation from the Post Office (maximum £10 or so, since the parcel was uninsured).

We were all delighted to find, when we contacted

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If you buy just any make of microcomputer you could find yourself on your own. And that's serious. Because without first class software and support, all you're left with is a box of wires.

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But how can Commodore offer so much? Well, we've been in the high technology business for over 20 years, whereas many of our competitors have just started out. We even manufacture the silicon chips for other microcomputers. This enables us to keep our costs to you down, so you can buy a self-contained PET for £450, or a complete business system from as little as £2,000 (+ VAT).

Of course, you could buy a box of wires for about the same price. But all you'll get from our dealers is sympathy.

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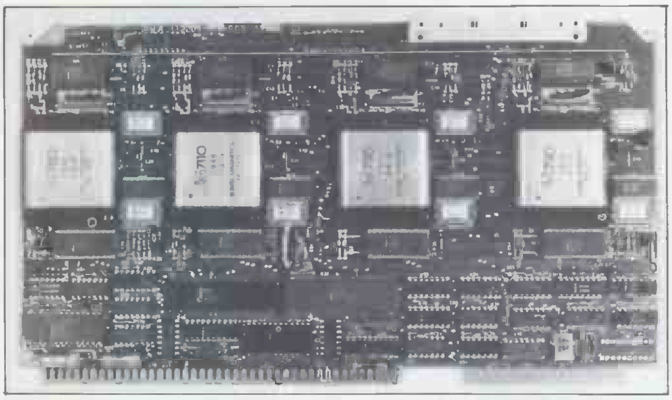

Remember how once we all speculated that bubble memory might get so cheap that we'd use bubbles instead of floppy disks? You didn't? Well I did and I'm still wrong. This shows why: on this highly costly card is as much memory as you get on one floppy disk — half a megabyte. But that explains why diskettes are getting cheaper, doesn't it?

Tangerine ourselves, that in charge of the problem was a company director called Mike Rose. It wasn't only his name which pleased us, it was the speedy way he moved into top gear, got the system crunching and despatched a new Microtan to our microlorn reader the very same day.

Apparently something (they didn't specify what) had given the Tangerine man who had originally written to the customer the notion that he was perhaps trying to get an extra machine. Once assured by *Datalink* of the man's sincerity, all was sweetness and light and he received his machine by return of post.

Not content with that, Tangerine tells us that it has 're-assessed its delivery system' to make sure that the same problem doesn't recur.

Most parcels that the Post Office is given get where they are sent (providing the label doesn't get unstuck) so it is quite realistic of Tangerine to save the 30p insurance per parcel it would cost to give £100 cover. But I do think that if a company decides to save this money, it should compensate unhappy buyers without question and Tangerine obviously agrees.

Just a small memory from the past to wind up with: ten years ago I ordered a stereo pre-amp and two power amplifiers from Sinclair. They arrived and I couldn't make them work, so I sent them back with a snooty letter. Sinclair didn't receive them. When I wrote again a month later, having checked with the Post Office, I had no doubt that I had fallen into the hands of big, indifferent bureaucracy and would never see my amplifier again. I was right. By return of post, with no questions asked, Sinclair refunded not the amplifier but the full cost of the system, together with a note hoping that my sad experience hadn't deterred me from buying again. As a result, I have always trusted Uncle Clive's mail order ethics and, in future, I shall feel similarly about Tangerine.

Communicate with PET

Connect your PET to other computers — not just ICL ones but even networks of them, with a program called Intercomm, or a program called Syncomm, from Cortex in Bedford.

It enables you to get all the central computer's data set up locally and squirted through as fast as possible. It also allows you to dig out information from the central network and to do this from a central database management system (it doesn't say which). The only thing against it is that Intercomm on disk costs a mere £350 an and Syncomm on disk a piddling £1700 including extra bits of hardware and installation costs. Cortex is in Tavistock House, 34-36 Bromham Road, Bedford; tel 0234 213571.

Coventry courses

Somebody who knows nothing about computers but has £75 to spend can spend a day at the Coventry management training centre in Leamington Spa, where they believe that 'the only reason for not using computers in more aspects of business is people's reluctance and lack of knowledge.'

Fees include lunch, coffee, tea and VAT, and the course covers such essential details as input, output, processor and memory, plus information on types of system, something on Basic, and a chance to use a computer.

For somebody with a bit more money (around £167) there is another course, lasting three days, based on the Commodore PET. And if you can bring your own PET you get a discount of nearly £25. This course aims to teach you to program in Basic. Details on 0926 36621.

6809 board

People who buy cars are not interested, advertising men have discovered, in how powerful, flexible, multi-cylindered, overhead-cammed or other magic words apply to the engine. Write an ad about the engine and watch them all turn the page unread. Daft.

Similarly, people who buy microcomputers do themselves no service when they regard the microprocessor inside it as an irrelevance. And such people will certainly not be attracted by an out-of-the-ordinary machine with a very out-of-the-ordinary micro chip inside it, the Motorola 6809.

This can be said with confidence. Acorn has been selling a 6809-based board for a year. Well, offering one but selling. . . no, not really. South West Tech has a 6809 processor available — powerful, but the number means nothing even to the people who buy it, it seems.

Now an independent consultant, D A MacDonald, has produced a board using the 6809 — designed to appeal to people who in the past used its ancestors, the Motorola 6800, and the Synertek System 65 based on the 6800's cousin, the 6502. MacDonald's system is a single board, and he claims it is compatible with the rather expensive boxed system of multi-cards which Motorola called the Exorciser when it was launched six years ago. That should mean, compatible with the then popular D2 development evaluation board, too.

Details on 04892 81108

Solicitor's software

It has been said that Solicitors' Accounts are the most complicated form of book-keeping there is. It was said by PK Microsystems, in fact, a company connected with Keith Jones of The Software House — and PK has just produced a system which solicitors can use to keep their accounts on an Apple II microcomputer. It had better be good; the programs cost £1500 and with a complete system thrown in, including disks, you pay up to £5300. Details on 01-637 2108

North Star stats

Infoworld, the US fortnightly magazine, described as 'the best on the market' a piece of software from a company called Ecosoft. The program runs on North Star micros and is called U Microstat — a statistics package which consists of programs which perform the most common statistical procedures. It needs a minimum of 32 kbytes, a dual drive disk system, and a good video and versions are available for the different operating sys-

This shows the scene inside the Bristol area school Portway, in Shirehampton, where pupils are setting up a commercial computer programming service, based on a Cado 20 computer supplied by the man with the beard, Robin Laney, who is managing director of DRG Business Machines. It's part of the Young Enterprise scheme — they're going to computerise the school's accounts.

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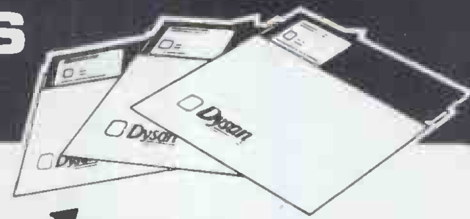

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Printout Business Forms

You may never have thought of your pocket calculator as a fire hazard; nonetheless, there is a very small chance that it could generate a spark when you press the keys. This micro-terminal from Burr-Brown may also generate a spark, but since it is guaranteed waterproof there is no chance of fumes or petrol vapour or gas reaching the spark. Clever, huh? Costs £300. Details on 0923 33837.

tems, either CP/M or North Star DOS.

UK agent for the software (and all other Ecosoft packages) is Digital Devices Ltd, also a Horizon dealer. Contact Val Long in Southborough, Tunbridge Wells, on 0892 37977.

Sorcerer software

Games still come top of most lists of software sent in. Whether 'Know Your Sorcerer' counts as a game or as serious software for the Exidy Sorcerer or not is hard to judge, but Liveport has put the three £6 programs under this title at the top of its list of 20 packages now available for this machine. Most of the next 17 packages have typical names — 'Shoot Em Up Cowboys' and 'Stranded in Deep Space' giving way to a couple of mathematical routines, plus something called 'Mortgage and Interest', which almost certainly isn't much good in the UK since the whole batch was written in America by North American Software. However, for serious programmers, there is a disassembler to analyse the programs written for the Zilog Z80 micro inside the Sorcerer. There is also a Basic macro renumber and linker program, one of the three most expensive at £17. Details from Liveport on 0736 798157.

Creative change

We at *PCW* have all the time in the world for an American magazine called *Creative Computing*, because we have good taste. So now that David Ahl and his mag have changed address, we will share it with you to prove how informative we are. The new address is 39 East Hanover Avenue, Morris Plains, NJ 07950. The new building also contains *Microsystems*, and *SYNC*, plus the book, software and consulting sides of the group. *SYNC?* It's the ZX80 mag over there.

Chip chat

Chips, chips, and more chips — on show with masses of plugs, sockets, and other bits and pieces — are to be discussed in serious papers at Seminex a show from 23 to 27 March at Imperial College. Details from Seminex Ltd on 0892 38664.

May the fourth be with us soon

You know what the Apple II and III are; now, what do you think Apple IV and V will be? The answer is: soon. Apple is the bright new star of the American stock market, having put its amazing growth up for grabs and having hit the jackpot. The next thing to happen could well be a stock value dive, for two good reasons.

First, a lot of people who bought stock did so because they knew it would resell for a lot more than they paid for it. People inside the company with advantageous stock options, (for example did you hear about the Apple director who made all his stock over to his wife a few years back, when it was worth a few pennies and since got divorced, leaving her with $25 million and him with a few thousand?), or just good horse-backers who saw a winner. They will sell because they planned to.

Others will start to hear worrying things about the Apple III, most to the effect that nobody wants it and that Apple is going to drop it.

The idea that nobody wants it is not altogether accurate. Dealers like Apple III because it offers a good profit margin. Profit, however, only comes on sale, and I'm blessed if I can see what will cause the dealers' customers to buy the thing. It offers one or two facilities but for so much more money compared with the old Apple II that most users will settle for the old one. Especially with all the old software and add-ons you can get already and can't yet get for the III.

American dealers are already letting it be known that they want none of it. And in order to stop the share price going down too embarrassingly, the company is likely to start leaking details of its next, exciting, world-shaking products — the Apples IV and V. Apple V is the answer to Commodore's Vic. It should be exactly what Sinclair and Acorn have proved people want — something to get started on for as little as possible.

Apple IV is The Big One however. Its existence is still officially secret but it came out through Motorola contacts who couldn't resist crowing about the multi-million dollar order they just had for the 68000 chip.

The 68000 is still the biggest, most powerful single bit of silicon you can plan to buy and some think it will be the world's biggest micro even after Intel produces its 32-bit version. Apple is putting that 68000 micro into the IV and will attach a version of the software Bell Labs developed for running disk storage — Unix — plus a wide range of other language options. I still don't have details or price. Apple is being a bit paranoid about this one.

As plotters go, this may not be right up to architect/draftsman standards. As matrix printers, go, it's a damn fine plotter. Roxborough makes it in enough versions that you can connect it to Apple, PET, HP and any other sort of cheap micro using a Centronics or RS232 port standard. It looks like a useful printer, too. Details on Rye (079 73) 3777.

Tandberg tries again

Tandberg, best known for its tape recorders, has passed through an unfortunate phase of trying to sell its own design of microcomputers to schools. Instead it has picked up an American machine, the Boles 3450 micro. The microsystem itself is well worth considering. It isn't quite down there with the Gemini and Superbrain, by the figures I've seen, but it is a reasonable price, something which nobody could expect after the original Tandberg system.

This one just so that you don't get confused, is called the TG3450. It is made 'to Tandberg's specifications' according to Mike Keenan of Tandberg, but it is being marketed in this country by Boles & Co (UK) Ltd, the UK arm of the American trading company (Boles Inc) which produced it. Details on 0372 65461; talk to Alan Marchant.

S100 graphics

Plug in a board and get cheap graphics on a system. All you need is the S100 bus inside the system to plug the board into. The product is the board from Almarc Data Systems and the company claims it is usable with all Vector Graphic systems in conjunction with a standard Vector Graphic memory board holding 8 kbytes of RAM. Details on 0602 625035.

Atom club

I am having some trouble debugging the official software supplied with my Acorn Atom. Since there are now around 5000 other users, I assume that some of them are having similar irritating problems — isn't there somebody out there trying to start a user group? Get in touch with me, (via *PCW*) and I'll publicise it. I might even join.

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.

Just check the coupon at the foot of the page.

Please send me __ PCW Binders at £2.95 each

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Send coupon to PCW (Binders), 14 Rathbone Place, London W1P 1DE. Allow at least 14 days for processing.

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

It's good news once again — this month we announce ComputerTown Gateshead. This has been started by John Stephen Bone plus ten computer-owning volunteers. This particular ComputerTown, like Sutton-in-Ashfield before, is closely affiliated with a computer club — Newcastle Personal Computer Society, in fact. Anyone in the Tyne & Wear district who'd like to join in the fun, please contact John at 2 Claremont Place, Gateshead, Tyne & Wear — he'd love to hear from you. More news from John when we hear how his first day went (he started on Saturday 10 January).

Since we launched ComputerTown last November we must have had letters from at least 30 people, but so far we've only heard about three ComputerTowns actually starting. Are there more of you out there who haven't told us about your activities, or do some of you need a gentle reminder? We'd really like to have the time and money to ring everyone up periodically and whisper words of encouragement, but sadly we have neither, so it's really down to you, individually, to find the enthusiasm and drive to get your local ComputerTown started. Don't pretend that it will take up too much of your time — Eastcote gets around six hours' attention per month from each of its volunteers. The sessions are run twice a month for two hours each. Demand is increasing quite heavily but then again we are meeting quite a few people through the project who are capable of running ComputerTown evenings themselves. This should mean that those with little time to spare should not necessarily have to increase their commitment. Surely you can find just six hours per month?

Another thing that's beginning to happen in Eastcote is that adults are coming along and seeing their children getting stuck in to the computers without any fear or problems. Six-year-olds arrive and, within ten minutes, are operating the PETs as if they'd grown up with them. The problem for the adults is that they're frightened of making fools of themselves in front of all the children. Even worse, we suspect, is the thought of a child explaining how to use the machines. Accordingly, there is a movement in favour of adults-only evenings or even some sort of formal lessons away from ComputerTown as such. At the moment it's fairly tentative but if the pressure increases then we'll be taking one or other of these alternative approaches.

The third thing that adults find disconcerting is that ComputerTown works on the 'discovery' principle of learning. If they run into difficulties they can chew the problem over with the inevitable group of onlookers and, if that fails, they know they can come to one of the three or four qualified organisers. I suspect that this all appears pretty chaotic to those used to a more formal learning environment. Enough, enough — let's move on to the other news of the month.

Arthur French from Crawley Teachers' Centre has kindly sent us a cassette tape for the new ROM PET called 'This is a PET and this is what it *does*'. The program occupies 10k and is really quite excellent — we shall be using it at ComputerTown Eastcote next Tuesday. Any other ComputerTowns who'd like a copy should send a cassette and the return postage to CTUK! at 7 Collins Drive, Eastcote, Middlesex We'll send your cassette back with the program encoded on both sides but we will only provide this service to those running ComputerTowns, needless to say.

It looks as if a ComputerTown West Bromwich will come into existence soon. Sorry to be a bit mysterious — but if you're in the area and interested in contacting the organisers then we at CTUK headquarters will pass your letters on. Similarly, anyone in the Winslow area of Buckinghamshire who might be interested should write to us here and we'll pass your letter on to someone in that area.

Have a peek at this month's 'Commons Report', you'll see that ComputerTown has caught the imagination of Ian Lloyd MP. Needless to say, we have offered to run a ComputerTown Houses of Parliament whenever he likes. We shall pursue this idea and keep you posted.

Nick Green of Commodore kindly sent us a couple of cassettes containing 40 programs. These form the basis of Commodore's Workshop Software which is used by educational establishments around the country where teachers are learning about microcomputing. According to Kit Spencer, these programs are considered to be in the public domain and anyone associated with ComputerTown is free to copy them. At Eastcote, where we evaluated the programs, we chose seven as being particularly suitable for use in ComputerTowns. Anyone interested in using these programs should write to us and we'll pass your address on to Commodore, who'll do the rest. Once again, this only applies to bona fide ComputerTowns.

Anyone in Aldershot who's interested in starting a ComputerTown should contact David Williams at 94 Gloucester Road, Aldershot, Hants GU11 35H. At the moment David is looking for kindred spirits. A trip home on the underground following the *PCW* Christmas festivities may pay dividends. Les Ord of RAF Uxbridge expressed great interest in the idea so anyone else in the area should write to Les there. Incidentally, we already know that he'd get a sympathetic hearing from Mr Colehan, the borough librarian, if he wants to use library premises. We also bumped into Frank Fadipe who lives at 1 Brook Close, Ruislip. He's got an Apple and would be interested to hear from others in the Ruislip area who would be interested in getting something going there.

Julian Allason (founder of Petsoft and now publisher of *Printout)* came up with a smart idea the other day. Knowing how busy we are running *PCW*, he suggested that we might find people prepared to take over the central organisation of ComputerTown at colleges and universities. It seems that such establishments are often looking for real projects for students to run in order to gain practical experience. It sounds like a great idea to us — any offers?

Pete Shaw kindly wrote from Clacton-on-Sea in Essex to offer us help in London; he also mentioned that he might be getting something going near where he lives. Anyone interested write to us here and we'll pass your letters on. Another Essex man, Philip Joy, writes from Romford to say that he'd like to start a ComputerTown in his area. Anyone else in the area who'd like to join him write to Philip at 130 Rush Green Road, Romford, Essex.

Simon Withers, who is 13, writes from Wigan to volunteer his services to anyone willing to start a ComputerTown in his area. Simon can be contacted at Kilmartin, Bellingham Mount, Wigan Lane, Wigan WN1 2NJ.

Lovely Cherry Watret of Microsense thinks that Hemel Hempstead is ripe for its own ComputerTown. Accordingly, she visited Eastcote recently to see how things operate there. Someone else who has visited Eastcote is Ian Thomasson and he is now planning to start a ComputerTown of his own in Rayners Lane. Anyone in the area who is interested should contact Ian at 16 High Worple, Rayners Lane, Harrow, Middlesex.

Look out for your local ComputerTown in our quarterly User Group Index — it will be listed under the National section.

Finally, thank you all very much for all your enthusiasm and interest in ComputerTown. Please keep in touch and tell us how things are going in your neck of the woods. Remember, we'd like to see thousands of ComputerTowns all over the country! We look forward to hearing from you.

YANKEE DOODLES

Tom Williams reports on the American side of the microscene

There are times when news of the mundane has implications that could be called sensational. In this case, that news is that the manufacture of small 5¼in Winchester disk drives is becoming routine and that instead of pioneering new technology, manufacturers are sticking to 'conservative' design and manufacturing principles. What this means, in turn, is that the small and *inexpensive* Winchester drive will soon turn from technical wonder to commonplace.

ler and data separator while adhering to the Shugart interface standard. Manufacturing Winchester drives is the product of experience and that investment in experience will soon begin to pay off in reliable volume production.

It is well known that one of the main reasons Apple did not include a hard disk option in the Apple III is that there was no source of drives that could produce in the volume that Apple would require to meet its needs.

'..the small and inexpensive Winchester drive will soon turn from technical wonder to commonplace.'

Manufacture of 8 and 14in Winchesters is gearing up something fierce in Silicon Valley, with a new company called Quantum recently formed for the express purpose of manufacturing drives that are compatible with the Shugart interface. There is quite a bit of carping among drive manufacturers about the Shugart interface, but like the S100 bus it has a foothold that is not likely to disappear. Of greater interest to users of personal computers, however, are the goings-on in the 5¼in Winnie world.

First to market a 5¼in drive was Shugart Technology, a company formed after the founder of Shugart Associates was eased out of the company he started (a not uncommon occurrence in this industry). Shugart Technology has since been renamed Seagate, and the original Shugart is now announcing its own 5¼in drive. The other serious contender in the market is IMI, a Cupertino-based company which is located right across the street from Apple.

Indications are, that as production volume increases, these highly reliable drives will be selling in OEM quantities for around $800. That means that a 6 megabyte disk system should be available to end users for around $1500 in the near future. But, as in the past, users will probably become *blase* and treat even this phenomenal amount of storage as the norm.

Another question is that of the controllers. IMI has built in its own control-

Now that production looks like it is indeed going to come up to a decent volume, there are rumours that Apple is planning to include that option.

There are even rumours that Apple will begin to manufacture its own 5¼in Winchesters, either independently or under licence from an established manufacturer. At any rate, if these rumours are true, Apple will have to initially buy in pretty sizeable numbers in order to keep up with the current trend toward these fantastically small mass storage devices.

Rumours

Now here is a super rumour, so if it doesn't happen, don't blame me, but if it does, you heard it here first. According to obscure sources, Sperry Univac is reputed to have a true Josephson computer working in the lab. Josephson junctions are those circuits that operate best at a temperature near absolute zero. The Sperry machine is said to operate around 2 degrees absolute, and Sperry's solution to the repair/service problem is supposed to be simple replacement. If all goes well, the machine should be announced in about two years. There has been no word about how the company plans to ship such a product, but many inane suggestions come to mind. Perhaps it'll set up a plant at the north pole.

Another it-should-happen-soon report concerns a personal computer that will fit in a case small enough to fit under the seat of a plane and be complete. By complete, I mean full keyboard, 64k RAM, CRT display, 5¼in floppy drive and running CP/M. The little bird who told me this one has not been known to be wrong very often in the past, but, of course, I can't say which bird it is.

The trend towards practical voice I/O is receiving another boost from Centigram Corporation with a new improved version of their Mike voice terminal. Mike incorporates both voice output and voice recognition. The terminal can be trained to recognise up to 99 separate words, which it converts to codes and sends to the host computer via an RS232 channel.

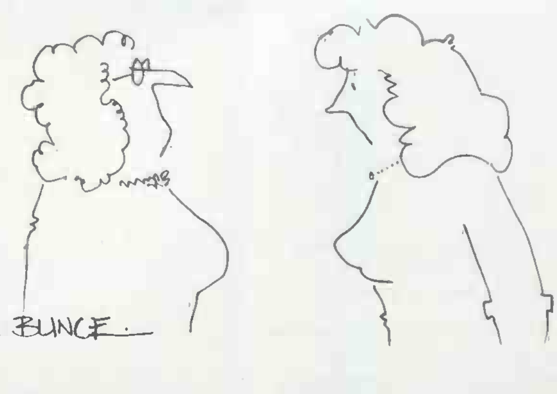
Mike is not limited to that set of 99 words, either; the host computer can dynamically swap word sets in Mike's memory so that the operator can work with an arbitrarily large number of sets of 99. The computer can also limit recognition possibilities to subsets of the current 99 so that there will be less chance of confusion within the current set.

Mike uses a method of digital recording which generates patterns by analysing words spoken into it by the operator. Centigram says it has achieved 100% lab accuracy when training Mike and then testing the terminal against a tape recording. At the same time, it recognises that voice I/O is still in its infancy and there is not really a practical limit to the refinements they feel would really be desirable.

'.. a personal computer that will fit under the seat of a plane.'

The world of local networking is getting another boost from Giltronix, a Palo Alto company specialising in automatic switching (mostly of the RS232 variety) among computers and various peripherals. The company started out producing simple RS232 switch boxes, so you could switch, say, between a CRT terminal and a hard copy terminal. It has recently come out with an intelligent controller (run by an 8085) that can control traffic between five serial ports, an IEEE-488 interface, two parallel ports, and 16 DPDT DIP relays.

This little wonder sells for $599 in kit form and is positioned midway between the manual switches and a $40,000 unit meant for the big boys. The service it provides at an amazingly righteous price is a traffic centre for data acquisition, multiple computer communications, and very versatile process control. My 'Fearless Forecast' is that Giltronix will be heard from loudly in the near future.



'Honestly mum he never speaks to me these days. He just leaves me the occasional floppy disk.'

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.**

Easier entry

As a half-blind, one-fingered keyboard-poker, I have found that the easiest way of entering a long program single-handed from written matter is to dictate it first onto tape on an ordinary tape recorder; then, using headphones, type it in at a rate appropriate to one's ability. This way leads to far fewer errors (spaces for example, can be counted aloud both on dictating and on playing back), far less fatigue and is much quicker. In addition the listing can be much more easily checked (again via the headphones) and it seems to allow much earlier understanding of the program.

The method is so successful that I am considering modifications to my PET to allow the built-in cassette to be used for the job.

Peter Tyler, Attenborough, Notts.

MW for WP

Your penetrating article on the Microwriter (November *PCW*) rightly lists its values as a portable word processing system but makes the peculiar suggestion that the terminal price, around £400, is too costly.

As a marketing consultancy with no connection whatever with Microwriter, we were one of the first MW users two years ago and our system has proven the equal of dedicated WP setups costing thousands more — with the added benefit of true portability. Like any WP system, it has seen continuous use in producing personalised direct mail letters and standard documents requiring successive updatings. But unlike others, it has also enabled me to cope personally with secretarial chores when staff are absent and confidential correspondence that cannot be routed through a secretariat.

To gain the cheapest comparable WP facilities with VDU and letter quality printing would require at least a Superbrain or Superpet 8000 plus peripherals at upwards of £3000. And you cannot put a PET in your briefcase and write your reports at home or during train journeys, as you can with the MW.

The usual objection to the MW, its non-qwerty keyboard, is actually beneficial in learning the system. I was using the MW fluently within a week, whereas our new Superpet with Wordcraft (acquired for its large disk memory) will take our secretaries weeks of training before it shows any real gains in productivity.

It beats me how your writer can suggest that under £2000 is too much to pay for a full word processing system, including *all* peripherals and with the benefit of portability, when you could pay the same again for a comparable system, that was non-portable and more difficult to learn!

Nick Robinson, Datanews Services, Luton.

It is not possible to compare the Microwriter system directly with more expensive, conventional word processors (and such a comparison was deliberately avoided in the review) because the latter offer many facilities which are not available on the MW we tested — automatically searching for and substituting strings, for example, or reading names and addresses from a separate file when printing direct mail letters. The extra facilities of more complex WP systems contribute to the longer training periods which they require — Ed.

Sord not 'defunct'

We would like to formally request a retraction of the statement '(not to be confused with the long defunct Japanese Sord)' in 'Yankee Doodles', January *PCW*.

As one of the two importers of the Sord range of microcomputers into the UK we feel very strongly that such sweeping statements, which are very detrimental to our business, should be published without first checking the facts. We are already finding that questions over the security of Sord are being asked by prospective purchasers.

Sord is not only still in existence but is one of the leading manufacturers in Japan. The basic unit, the M223 Mk III, is based on a Z80A CPU with an AM9511 APU, integral VDU and twin 350k Teac disk drives. The unit is very flexible and has expandability options of add on 8in IBM compatible floppy disks, 8 mbyte hard disk with magnetic cartridge backup and a complete range of peripherals including colour graphics, paper tape, extra VDUs, data pads, etc.

For 1981 Sord is introducing two new ranges of products. Firstly, the M243 which has as standard 192k bytes of RAM (and can be extended to approximately 1 mbyte) and 8in IBM compatible units; hard disk, etc, are all available. Secondly, a new series of 16-bit computers, the M400 series, based on the 8086 CPU and with up to 1 mbyte RAM and with internal 8 mbyte hard disk.

As you can see, progression is fast and to state that Sord is defunct is a gross error.

Paul Whitehead, Exleigh Business Machines Ltd, Penzance.

'Yankee Doodles', of course, reflects and reports the situation in the USA where, we understand, Sord products are no longer sold. We're glad to assure readers that, as Mr Whitehead states, the company itself is by no means defunct and that its products continue to be sold in Britain. — Ed.

No LIST

B Mistry's method of preventing listing on Ohios or UK101s also prevents the program from running.

The following routine causes the computer to jump to the machine code monitor if the program (which runs as normal), is stopped or exited:

10 POKE 4,0 : POKE 5,254

If somebody tries to list the program they will discover that it is impossible to get to command mode. To RUN again, stay in the monitor, put C3H into 0004H and A8H into 0005H. Type '.' then A274G — and run or list as required.

10 POKE 4, 17 : POKE 5,189 will cause a cold start and make things even more difficult! For automatic start of Basic programs after loading, first save the program. When OK appears, stop the tape using the pause control, type "? POKE 515,0 : RUN", release the pause control and hit RETURN.

Dave Henniker, Edinburgh

Printer interface

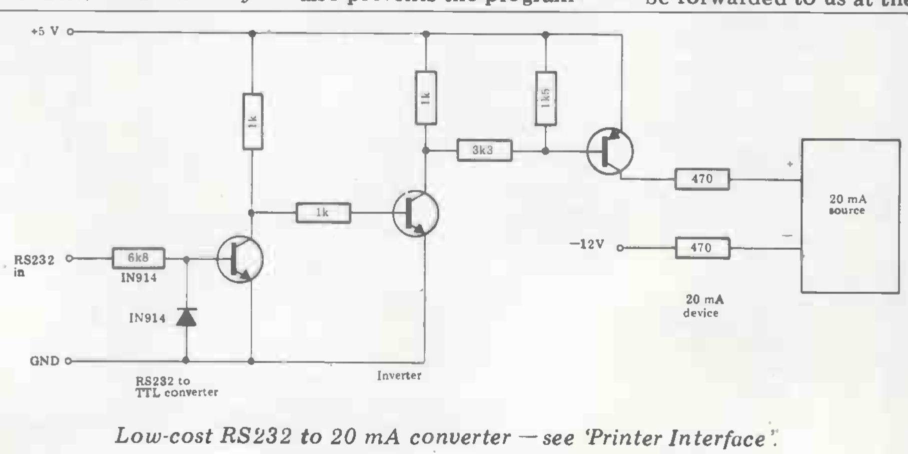
This is a very low-cost RS232 to 20 mA converter for those guys that don't want to spend mucho pounds on a commercial converter. I use it between my Explorer 85 RS232 printer port and an LA 36y printer.

Les Solomon, *Popular Electronics*, New York

1211 problem

Many thanks for mentioning the 'PC-1211 Users Club' in the December edition of *PCW*. I would like to offer the services of the club to help solve any problems readers of *PCW* have with their PC-1211/TRS-80 pocket computers in the same way that the ZX-80 Users Club appears to be of service.

Any queries sent in can be forwarded to us at the



Low-cost RS232 to 20 mA converter — see 'Printer Interface'.

address below and we will solve them as quickly as possible.

Also, we were pleased to see the PC-1211 information in 'Calculator Corner', but please remember that it is a computer, not a calculator.
Robert Valt, PC-1211 Users Club, 281 Lidgett Lane, Leeds LS17 6PD, Yorkshire

Telesolution

Recently, a telecommunications problem in my office started a thought process which rapidly led to my concluding that the problem could be solved using existing technology but in a novel manner. Furthermore, the idea has world-wide application potential and could be patented. Hopefully no-one has a similar system in their lab! Are any fellow *PCW* readers interested? If so, please make contact.

New readers may be interested to know that I started reading *PCW* last autumn after reviewing two other magazines: the choice was an easy one. I hope *PCW* maintains the educational items in particular; I recommend the magazine to other newcomers.
T R Armstrong, 21 Merdon Ave, Chandlers Ford, Eastleigh, Hants SO5 1EH

Image digitiser

In the July 1980 *PCW*, Dr Steve Abbott requested information regarding the eventual availability in England of the Periphicon image digitiser.

We are pleased to inform you that we stock both the 32x32 and the 64x64 pixel models in Denmark, complete with housing, cable and TV camera lens. We have started using this interesting device in industrial robotics mainly and have developed a range of supporting software. As one example of its applications, we can mention that it is used on the Champion Spark Plug production line to control preset spark plug gap as well as electrode quality.

One application which we would find very interesting, but which we have no time to develop, is a character recognition device, perhaps combined with one of the new language dictionary chips, to enable direct reading of normal printed manuscripts. Perhaps that would be an idea for Dr Abbott!

The price for the 32x32 unit is about £300, and for the 64x64 unit about £800.
E-C Data Inc, Tornevangsvej 88, POB 116, DK-3460 Birkered, Denmark

NEW tip

Having recently purchased a UK101, I have found it is possible to retrieve programs after typing NEW.

When NEW is typed, the 101 places zeros in locations 769 and 770, which are the top of program pointers in RAM. By keeping a note of the various values which the locations contain for your programs, it is possible to retrieve them after you have typed NEW.
P Mirams, Northwich, Cheshire

Micros in libraries

I am an external postgraduate student at Loughborough University and I am writing a thesis for a Masters degree in Library Studies entitled 'The Microcomputer and the Library'. I would be very glad to hear from anyone operating or using a microcomputer in any form of library or information work, to learn what systems they are using and to hear about their problems and successes.
Andy Dawson 53 Downton Avenue, London SW2 3TU

The Basic saga

The dispute between Malcolm Peltu and D McFarlane ('Communications', December 1980) is akin to deciding whether Robin Cousins or Sebastian Coe is the greater sportsman — like is not being compared with like.

Basic was designed to enable beginners (not necessarily programmers) to make use of a computer as a mathematical and analytical tool as quickly as possible, while Cobol was aimed at the business programmer. Basic programs tend to be short and short-lived, while Cobol programs (outside 'real-time' transaction processing applications) tend to be large, may have to run regularly for years and will handle far greater combinations of data than the average Basic program. The accounting package described in the NCC book reviewed by Peltu (September Bookfare) is almost certainly typical.

Thus, professional programmers take many man-hours to make sure that their programs are 'right', and to document them so that other programmers and their successors can understand the logic in order to amend it correctly when necessary (large systems tend to change, even while the programs are being written!). Less than 50 percent of a programmer's time is spent in writing code.

It would not be *possible* to write the average Cobol program in standard Basic. On the other hand, few professionals would attempt to write a predominantly mathematical routine in Cobol, although the facility to link subprograms written in different languages would enable them to write, say, a control and file-handling routine in Cobol, which would invoke a Fortran routine to perform statistical analysis on the input data. (Not being a mathematician, I wonder how much better Fortran is than Basic — apart from being compilable, I mean.)

I hope Mr McFarlane does not ignore the wider world of programming altogether. I do advise him, though, to use the System 4 Cobol reference manual as a doorstop or bookend until he can scrounge a copy of an ICL Cobol training manual (System 4, 1900 or 2900 versions, though the former probably describes the simplest implementation) which will be much more readable.

Having said all that, I agree that Mr. Peltu has gone out on the wrong limb for once. I believe that the real conflict is the one which will occur between the 'complete language' Ada and Cobol (or Fortran or Basic, not to mention Jovial, Coral 66 and RTL2), and which is prefigured by the Pascal v the others debate.
Frank Little, Swansea

'No we can't tonight Gerald, it's not safe!'

Oh Oh Guy

It's the privilege of user groups to moan and to dream of the ideal machine, but Guy Kewney (Oh Oh Ohio in last issue's Newsprint) certainly got the wrong idea! He quoted the piece out of date and out of its user group context, which assumes that everyone knows the good points of OSI's kit. The standard Superboard like all machines has a few limitations but a typical member's machine has one and a half times the screen display and three times the Basic speed of the TRS-80 for example, a screen editor and extensive machine code monitor built-in, and plenty more besides, all for around £250. And despite Guy's comments the kit is robust and consistently reliable — something that I believe can't be said of the 'Big Three' systems. All of our moans in the piece quoted have since been resolved — even the documentation, now produced for Ohio by the Howard Sams publishing group.

For more details contact the dealers, or the user group through me.
Tom Graves, 19a West End, Street, Somerset.

Computing philatelist found!

In answer to Nigel Stokes' query about computing philatelists, I am one such! I use an Apple II with disk drive to store want lists of stamps needed in files by country. These I then update and send to my correspondents around the world.

I am also working on the planning stage of a catalogue program to update the value of my collections and to diagnose the areas showing the greatest appreciation, etc. I would be very grateful to hear from anyone else working in similar, or other, philatelic fields.
John Oldfield, Calle Galatxo 29, Capdella, Mallorca, Spain

Big keys please

One of our customers is the Spastic Centre of NSW, sheltered workshop and training centre, in Sydney. We supply them with software for their nine Apples. The Director has asked me to try to find a source of special keyboards with large letters, with the keys having separation one from the other. They would have to be connectable and compatible with the Apple, of course. The object is to allow those with spastic problems to use the Apples and make fewer mistakes.

Apple education in Cupertino doesn't know of a suitable supplier, I wonder if any of your readers can help?
Keith Stewart, Seahorse Computer Services, PO Box 47, Camden NSW 2570, Australia.

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BENCH TEST

ONYX C8002





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A few years ago, computers could be divided (by word-length) into mainframes and minicomputers — fewer than 20 bits to the word and it was a minicomputer; otherwise, it had to be a mainframe. When the microcomputer came along with an 8-bit word length, it fitted in neatly below the mini but when the 32-bit 'superminis' were announced, the dividing line began to blur and it became necessary to find other ways of classifying machines. Some people just said, 'a mini is a computer produced by a minicomputer manufacturer' and left it at that. Now that microcomputer manufacturers are producing 16-bit machines which compete directly with minicomputers, it is difficult to know whether it is appropriate to think in terms of 'supermicros' or to treat them as normal minis. In either case, the Onyx C8002 is the first of the 16-bit Z8000-based systems to be made available in this country.

The Z8000 processor has an interesting history. Originally it was designed to be supplied in two versions: the Z8001 had a total of 45 distinct instructions (or 105 mnemonics or 187 instructions including all variations — it depends on what you want to count) and could address eight Mbytes via memory management hardware, while the Z8002 had a straightforward 64 kbyte addressing range (no fancy hardware extras) and slightly fewer instructions. Both processors offered 16 16-bit registers, or eight 32-bit registers or four 64-bit registers. If desired, the first eight 16-bit registers can be further subdivided into 16 8-bit registers. Recently, Zilog announced that a third version which incorporates hardware paging will emerge. In the course of events, the Z8000 design, particularly in its Z8001 form, seems to have run into more revisions than even Zilog can be happy with, with the result that a number of OEMs have been unable to deliver the memory managed systems they had designed in advance of quantity production.

In the meantime, Onyx has hedged its bets: it, too, wanted a large-memory Z8000 system but began with the more readily available Z8002 and then designed its own memory management system to expand the Zilog processor's addressing range from 64 kbytes to 1 Mbyte. It was this ploy which enabled Onyx to win the race to provide the first commercially available supermicro system. Confusingly, although this system is known as an Onyx C8002, the other system which Onyx offers, the C8001, incorporates a Z80A processor rather like the Z8001 implied by its designation.

Having resolved the hardware question, there was still a requirement to provide enough software to compete with the established minicomputers and once again two choices were available. Firstly, one could beef up the current 8-bit software, offering (for example) MP/M 8000, exploiting the rudimentary scheduling offered by MP/M. It is doubtful, however, whether this package would behave as flexibly and coherently as a modern minicomputer operating system designed in and built for the type of processing environment at which this product is aimed. As an alternative, one could adapt a ready-written, well-established minicomputer operating system to run on one's own hardware. Accordingly, Onyx has obtained a licence to provide Western Electric's Unix V7, running under the name Onix.

In fact, this 'lock, stock and barrel' approach has left a few, for the most part fairly cosmetic, patches showing. For instance, at login, the system comes up with 'UNIX' rather than 'ONIX' and there is the occasional reference to 'PDP11' in the documentation. Finally, for the British user, it is somewhat disconcerting to work on a computer which insists on telling the time according to Silicon Valley (Pacific Standard) Time.

Hardware

The least impressive feature of the Onyx is its looks — it's not that the box is particularly ugly but one expects such a 'big' machine to need more than a 22 x 17 x 8in, 60lb metal cabinet with a key-type on/off switch and a single on/off light at the front. Installation involves releasing the carriage-lock which stops the disk heads from flopping about, plugging a terminal into the 'console' slot at the back, plugging the machine into the mains and switching on. As the fans start (one for the disk, the other for the rest of the system) so does the Winchester drive sounding like a jet engine warming up until it gets up to speed (3600 rpm) and settles to a steady hum.

In the meantime, the system puts itself through a series of hardware tests, displaying the message 'C8002 SELF TEST COMPLETED' on the console when it is finished, followed by the prompt. Of course if something is wrong then a suitable message appears instead. A simple carriage return will initiate loading from the disk while a 'T' will load from magnetic tape.

Immediately beneath the cover are two printed circuit boards (side-by-side) which completely span the box so that the first impression is that it is packed full of components. However, further examination reveals a second layer of PC boards, beneath which lie the Winchester drive unit, the magnetic tape unit (accessed through a slot in the front), the power supply and fan. The top two boards comprise the processor board and a 256 kbyte memory board, while the next layer provides a second 1/4 Mbyte of RAM and the mass storage controller board. All boards are interconnected by cables along their common edge across the middle of the box so there is no backplane as such.

The processor board contains a 40-pin Z8002 which, according to Zilog, has a cycle time of 250 ns and executes everything but 'multiply' faster than a PDP11/45. This is supplemented by the AMD 9512 floating-point processor capable of 64-bit floating or fixed point arithmetic, incorporating its own stack and capable of interrupting the Z8000 on completion of computation. Unfortunately, there was no way to access this device through the software supplied with the review machine. Apparently an imminent operating system revision will, once implemented, allow this feature to be used.

All the I/O ports stem from the processor board — they are wired onto a plate at the rear of the cabinet via 25- and 37- way D-sockets. There are ten serial ports; nine of them are RS232C, of which one supports a standard synchronous modem employing bisync or SDLC protocols, while the other eight are for terminals or printers. The console port has hardware switches on the processor board but all the rest have software selectable baud rates from 300 to 38.4 k. The tenth serial port is a high-speed (880 kbits/sec) RS422 port designed for local networking with other C8002s. There is a single parallel port — 16 bidirectional, buffered and terminated TTL lines (eight for data, eight for control) for a parallel printer or similar peripheral.

The rest of the processor board contains circuitry to drive a DMA channel for communication with the disk controller and for the Onyx special, the Memory Management Controller, which extends the Z8002's address range from 64 kbytes to 1 Mbyte via a mapping system (based on a 2 kbyte page) which effectively generates a 20-bit address. In addition, this device makes it possible to maintain separate program and data areas for each process, each area being addressable up to the maximum 64 k. This represents an improvement over many 16-bit minis where the 64k limit must include both instructions and data.

The memory modules are each composed of four 64k banks of 4116s (16k dynamic RAMs) together with refresh hardware and parity checking. The cards supplied filled the cabinet, although, according to Francis Kelly of Keen Computers, systems with 1 Mbyte (ie two additional cards) would be supplied fitted with a larger top cover which allows more room.

The mass-storage controller on the fourth board incorporates a Z80A processor with 64 kbytes of memory. Some of the memory is used to hold the software necessary to control the disk and tape hardware and the rest is used as a disk sector cache. Frequently accessed sectors will not initiate any disk-seek activity as they will still be left in this memory from the last access. Transfer is from disk memory to main memory via the 8-bit DMA channel. The controller is capable of supporting a total of eight disk drives (10 Mbyte, 18 Mbyte or 40 Mbyte). However, the system as a whole cannot support more than one controller so that there is no likelihood of improving efficiency by separating filestore from paging memory.

The disk drive on the review machine was the IMI 7710 Winchester with a capacity of 10 Mbytes when formatted and which is also used in the Corvus sub-system and the Cromemco Z2H. The special Winchester read/write heads together with the two actual disks (providing three data surfaces or 350 data cylinders, depending on which direction you look) are enclosed in a sealed, contamination-free clear plastic container. The specification claims zero preventative maintenance and a half-hour repair time, which sounds as though they just throw away the broken unit and stick a new one in. Mean access time is rated at 50 ms.

A magnetic tape drive is built into the Onyx to enable an external backup. The 4 x 6 x ¾in cartridges are inserted through a slot in the front panel of the cabinet and have a capacity of about 12 Mbytes. An entire 10 Mbyte disk can be dumped in about 15 minutes. Alternatively, it is possible to transfer individual named files from disk to tape and vice versa so that any given user can, on a multi-user system, maintain a personal backup cartridge. Finally, the operating system can be loaded from tape.

During the time we had the review machine a number of different terminals were attached (without any difficulty) to the system, including our own ADDS Regent 25 and Cossor Unitels and as well as Hazeltines and ITTs at Queen Mary College. Keen Computers supplied an Ann Arbor Ambassador as the console device. Unfortunately, with such an exciting computer at the other end we didn't have much time to investigate the facilities offered by this intelligent (Z80A controlled) terminal. Physically it features a 15in P39 phosphor non-glare screen with a detachable (up to 4ft) 94-key keyboard divided up into a qwerty area, an editing/numeric key pad (programmable) and a programmable 12-key top row (24 functions via the shift key). The display screen provides 60 lines of 80 characters. This gives a pretty cramped screen of smallish characters but the line count can be decreased by the operator down to a minimum of 18 lines of correspondingly larger characters. In fact 30 lines was a perfectly comfortable compromise.

A 'Setup Mode' can be invoked within which all terminal-type functions such as baud rate and scrolling/paging can be defined. Once these specifications are made the information is stored in RAM which is maintained by battery when the terminal is switched off so that it doesn't have to be reset every time it is used. In addition, it is possible to define a window anywhere on the screen and to restrict operator access to this region; further, you can define fields (in 'form-filling' mode) within which operator entry may be forbidden, curtailed (eg numeric only), formatted (eg right-justified), or hidden (eg passwords). Such fields may be selectively transmitted to (or omitted from transmission) to the host machine or to a printer.

Software

On completion of the boot-up procedure, the console will have to be placed within the Onix operating system. Since none of the other terminals will be 'live' at this point, the console is in single-user mode, useful for certain operations (eg, backing up the disk) when it would be dangerous or a nuisance to have other users on the system. As soon as the console is logged out (Ctrl-D), the multi-user Onix system boots in, enabling all attached terminals for logging in. Onix is the Onyx implementation of Unix V7. It would seem to be appropriate to try to give some idea of what the system feels like, particularly for readers accustomed

to a single-user system. (A fuller description appears in a separate Unix article in this issue).

In response to the 'login:' prompt, the user is required to type a directory name followed (after another prompt) by a password which is not echoed on the screen. The directory name refers to the user's own file space and the password guarantees the user privacy of access. After logging in, the command 'ls' will produce a list of all the entries in the directory. These entries may be the names of files containing programs, or data, or text, or the names of other subsidiary directories. In fact, the user's own directory name is simply another entry in some higher-level directory so that the entire file-structure is a massive tree-like hierarchy stemming from a ROOT directory. (This is the directory the console is logged into after booting up.) For security reasons it is possible for users to prohibit access by other users to one or more of their files, the access attributes of a file defining whether or not it is readable, writeable and executable. An executable process (including 'system' processes such as editors, translators and utilities) can be initiated simply by typing its name; two or more processes can, in one command, be initiated for sequential or parallel execution and a file containing a series of commands can be created, made executable and run. Finally, no practical distinction is drawn between I/O devices and disk files (eg the Serial Line Printer is a 'write-only' file called 'slp').

The question is : Is Onix really Unix? We decided that, since every reference on the screen is actually to 'Unix' rather than 'Onix', it must be, but then wondered how successfully Unix had migrated from its birthplace in the PDP architecture. This is not such an easy question to answer so we sought the assistance of the Computer Systems Laboratory at Queen Mary College. This unit, under Professor George Colouris, runs a network of three PDP11s, all running under Unix, and has developed a quantity of software, including some for computer-to-computer communications. The Onyx was linked into this network with no difficulty and communications established. With the 11/34 behaving as a terminal, a small C program was typed into the Onyx This was compiled with the Z8000 C compiler and then used to handle the handshaking while a much larger program (a QMC editor) was transferred at a much higher speed.

C is a high-level system language in which almost the entire Unix operating system is written. It has specially convenient data-types for system work and, because it is a high-level language, it is fairly easy to use. It is thus a straightforward matter to modify or adapt Unix to specialised applications. To transfer Unix to a new machine one needs a C compiler that will generate the machine code of the target system and a few device-specific handlers. The whole operating system can then be compiled like a normal program and executed on the new system.

However, there are bound to be a few chinks in software which has migrated in this way. For instance, at run-time, the little communications program flagged an OVERFLOW error which seems to have been caused by the Z8000 C compiler allocating register space more economically than its PDP 11 counterpart (ie, an 8-bit register). There were no such problems with the (much larger) editor so we must assume that portability from the PDP will be fairly straightforward — and, of course, this sort of problem would not arise with anything developed on the Onyx itself. We were able to crash the system by creating absurdly large arrays — not very nice in a multi-user environment. More serious was the fact that the system could be crashed by omitting the EXIT instruction from a C program. The compiler really should be able to pick up faulty syntax of this kind.

Other software on the system included a Pascal compiler (based on the UCSD system but without GET or PUT) which generates native Z8000 code rather than p-code, and a special Z8000 implementation of adb (the Unix assembler/debugger). Apart from these, most of the system routines and facilities seemed to be direct recompilations of the PDP originals, as described above. These included bc and dc, the Unix desk calculator programs and nroff and eqn, the Unix text-formatting packages. There was a slight feeling of fragility about the system (the occasional unexpected occurrence or unusual error message) as though not all utilities had been completely tested. As the software matures, however, we can expect this to fade and certainly the new (forthcoming) releases promise to incorporate more of the features which make up the 'standard' Unix system, including:

- access to the floating-point hardware;
- f77, the Fortran '77 compiler;
- Basic, apparently a special Z8000 version of Microsoft;
- Cobol ANSI '74, level 2 with multi-key ISAM;
- UUCP communication software, the Bell equivalent of the QMC routines which we used.
- a screen-oriented editor;
- the GAMES package, SPELL & CRON;
- Codasyl DBMS (Microseed);
- the portable C compiler.

The Pascal compiler, which was not supported by any documentation, was slightly slower than we had expected. In addition, on one trial we hit a series of run-time errors which, when corrected, revealed a batch of unrelated but previously unflagged compile-time errors. It is difficult to be certain about the mechanism which gives rise to this phenomenon but it is clearly undesirable for compile-time errors to be masked in this fashion.

Overall, however, we were impressed with the power and flexibility of Unix and with the fidelity of the Onix implementation, as far as it has gone. Our thanks to the Computer Systems people at Queen Mary College for their enthusiasm and instructive help.

Timings

Unix provides a program called TIME which can be run in association with a specific process and with which most of the figures given below were obtained. When a process has finished, TIME provides three figures:

Real — elapsed time measured on the system clock (rounded to the nearest second);

User — time actually spent executing the program. (When we ran the same job several times simultaneously, this produced a wide variation in results so we think it needs attention before it will be accurate.);

System — time spent obeying system calls initiated by the program.

In fact, TIME samples the processor every 60th of a second in order to discover which process is actually running at that instant, so that the figures given for user and system are 'statistically' accurate rather than 'absolutely' accurate, as one would expect with stopwatch timings. There is a certain amount of system time required regardless of the number of tasks being executed so when the system was run as a single user system the sum of the user and system time was a smaller percentage of the real time than when several tasks are run. (Similar system overheads built up when a large number of jobs were run.) Real is taken off the system clock and is slightly longer than a stopwatch timing since TIME itself is a program that is running during the interval that the process is being timed.

As a final caveat, it would be unreasonable to expect identical timings for two runs of the same job, even in single-user state, owing to the system activity inherent in managing a large block of memory (paging) and an even larger backing store (disk access is optimised through a very large buffer). Nevertheless, we felt that the figures obtained under the 'real' heading were sufficiently meaningful, particularly as a basis of comparison one with another, to be worth recording here.

The first tests to be run were the multi-user tests described in a previous article. Test 1 is designed to tie up the processor (it is Basic Benchmark 7 translated into Pascal) while Test 2 is an I/O test (listing the character set onto the terminal 100 times). Tests 3 and 4 write and read records to and from the disk. Test 3 opens and closes the file between each access while Test 4 simply opens the file once to write and once to read. All tests are run with one, two, three and then four users, the idea being to measure the effects of increasing usage on the system. Only (the longest) real timings are shown, since it is the effect on actual time elapsed which is being sought.

As was expected, system overheads accounted for most of the time on the processor test so that the four processes took markedly less than 4 x 1 process would. For the I/O test, we unfortunately had to use two terminals at 9600 baud and two at 2400 (all we had). The timings show, though, that this job was completely limited by the terminal speeds (that is, sending characters to four terminals is no slower than sending to one). By comparing the figures for tests 3 and 4 it is possible to get some idea of the weight of system calls necessary to open and close the diskfile between accesses although these tests did not seriously test the file I/O owing to the size of the disk buffer (64k) compared to the file size (12.8k). Overall, however, although these tests were probably not as successful (or stressful to the system) as we would have liked, it is probably true to say that the system can cope very well with four users at the level of activity indicated by the tests and that no catastrophic loss in response time occurs at this loading.

We felt the need to push the system quite a bit harder by increasing both the loading and the number of users. Compiling a Pascal program seemed to place pressure on the system and so, for this test, we decided to compile the first multi-user test. Compiling makes ample use both of the processor and of disk accesses and should therefore provide a realistic loading.

As the figures show, the system seemed to cope best at about four users and still offered good response up to six users. After that, response drops off badly as the system struggles to meet all the demands made on it, spending more time moving code backwards and forward from the disk and correspondingly less time on the user programs. (The ultimate catastrophe, known as 'thrashing' would occur when all its time is spent on these disk transfers.) As it is, with eight users executing programs on the system, a 40-second compilation would take nearly ten minutes to complete. (Timings would have been even worse if the users were compiling different language source code as all the compilers are re-entrant, so on our test only one copy of the Pascal compiler was being used.)

While we had the review system in our possession, we were fortunate to be able to link it into a network of PDP11s, all running under Unix in the Computer Systems Laboratory at Queen Mary College. We were able to compare its performance, in single user mode, against that of a PDP11/34 (also single user) with 192 kbyte of memory (in single user mode the amount of memory is irrelevant) and a massive 132 Mbyte Winchester disk system. These tests were devised by the QMC Computer Systems Laboratory and were written in C. The first one was designed to tie up the processor by initialising a 10000 element array 100 times while the second listed a large file to the terminal using the NROFF text formatter (an I/O test). The final one wrote single characters into a large disk file and then read them back. Everyone was surprised at how well the Onyx performed against the pricier 11/34, especially in the I/O test. The 11/34 seems to beat the Onyx when accessing disks, as is shown in the 'system' times.

Finally, the Pascal Benchmarks were run on the Onyx in single-user mode but without the 'arithmetic' tests (MATHS, REALARITHMETIC, REALALGEBRA), owing to the absence of floating point facilities. The figures from TIME varied quite a bit between runs and, since we felt it was unfair to compare these, which included the TIME overhead and went from load to completion against those of other machines which went from S to E, we ran the whole lot through again with a stopwatch.

As expected, the stopwatch timings are all below the figures from TIME, although the differences varied more than we would have liked. The compiler produced Z8000 object code. When these figures are compared with those obtained for OMSI Pascal running on a PDP11/04, a slower processor, it seems that there is scope for a more efficient compiler.

Potential

There seem to be two major areas where the Onyx can make an inpression. The first is probably in educational institutions both for teaching programming and computer systems and as a research tool. Unix provides a good development environment for programmers and an especially gentle entry into the arcane world of systems programming. With a sound implementation of Pascal, Fortran, Basic and Cobol, the system should adequately provide for high-level programming teaching regardless of the programming philosophy adopted. However, the absence of a backplane rather rules out specialised hardware-dependent laboratory or control applications.

The second area should be small scale commercial software houses. Facilities exist within Unix for the creation of highly effective turnkey systems and when Microsoft's Bascom is implemented, commercial development work could take place on the Onyx and the finished software downloaded for distribution on single and multi-user micros. Moving in the other direction, with a fairly extensive Cobol compiler, a relational database and good networking facilities (all promised), mainframe-scale development work could be undertaken. In either case, the size and scope of the Onyx system seem well suited to offer a flexible environment for a wide range of commercial applications. In addition, since little of this type of application software exists at present, there is the opportunity to establish an early footing in what could turn out to be a rapidly expanding software market.

Documentation

The review machine was accompanied by three large Unix manuals, draft copies of the Onyx C8002 User's Guide and Software Release Notice and user manuals for the Ann Arbor VDU and the Anadex printer. The Unix manuals are the standard Bell labs set — The Programmer's Manual and the two-volume Supplementary Documents. This material is also supplied on the system — a good idea since software updates can incorporate amendments to the documentation and, in addition, the user can reproduce as many copies as required. Onyx doesn't seem to have taken advantage since there are still references to PDP 11s within the text. The first manual is divided into eight sections: Commands; System calls; Subroutines; Special files; File formats and conventions; Games; Macro packages and language conventions and Maintenance. Each section describes every program pertaining to that section so there is a certain element of repetition in the descriptions. There is also a great deal of cross-referencing but, since 'the obvious is often left unsaid in favour of brevity,' this makes the manual hard to use unless one adopts a scholarly approach and makes intense use of the index which accompanies the text.

In contrast, the supplementary text contains 38 essays and tutorials on a variety of topics (Unix for beginners, The editor, The C language, etc). These are carefully and clearly written and an excellent way of learning about Unix for anyone willing to submit themselves to the 'tutorial' discipline and pace. For reference purposes though, it's a pity there isn't something between the exhaustive tutorials and the laconic Programmer's Manual.

The 33-page draft C8002 User's Guide describes how to install and run a C8002, but too superficially to be really useful to anyone who needs more than straightforward 'operator knowledge' about the system. There really is a need for a more detailed description of the system and its procedures. The seven-page Software Release Notice simply lists the software available and repeats the tape-loading sequence found in the User's Guide. There was no Pascal manual at all.

Expansion

The minium system configured for four users comes with 256 kbytes of memory, the 10 Mbyte Winchester and magnetic tape backup. The system can be expanded to an eight-user system with up to eight 40 Mbyte drives and 1 Mbyte of memory (according to Keen — the sales literature says the top memory is ½ Mbyte). It would probably be unwise to think in terms of eight heavy users on the full complement of disk drives, particularly with the 4 MHz processor and comparatively slow (only one controller) disk system.

On the software side, there is the hope that the vast and ever-increasing quantity of PDP originated Unix software will migrate quite happily onto the Onyx C8002.

Prices

Now for the bad news — the Onyx system is totally unbundled. Thus the review system was priced at £19,060 plus VAT, which breaks down as follows:

C8002/512/10Mb	£13,700
Onix/8	£2300
C Compiler	£550
Pascal Compiler	£550
Onix Manuals	£70
Ann Arbor Ambassador VUD	£995
Anadex 9500	£895
Total:	£19,060
Other prices quoted by Keen are:	
Four user systems:	
C8002/256k/10Mb	£11,800
C8002/256k/18Mb	£13,050
Onix/4	£1400
Eight user systems:	
C8002/512k/18Mb	£14,950
Add-on hardware:	
10Mb add-on disk	£3300
18Mb add-on disk	£4450
256kb memory board	£2400
Additional software:	
Microsoft Z8000 Basic	£375
CBasic II Compiler	£150
Fortran IV	£475
RM Cobol	£550
Bysync Comm Package	£475

We have stated that the Onyx C8002 competes in the traditional minicomputer market and it is interesting to see how competitive it is. The closest match we could find (to the bottom of the range) was a Comma Hawk (PDP11/23 with 256k, 5Mb fixed, 5Mb removable) four user system for £10,200. This price doesn't include the Unix licence (free for educational users,

$20,000 for commercial users) and so is only worth considering in an educational environment.

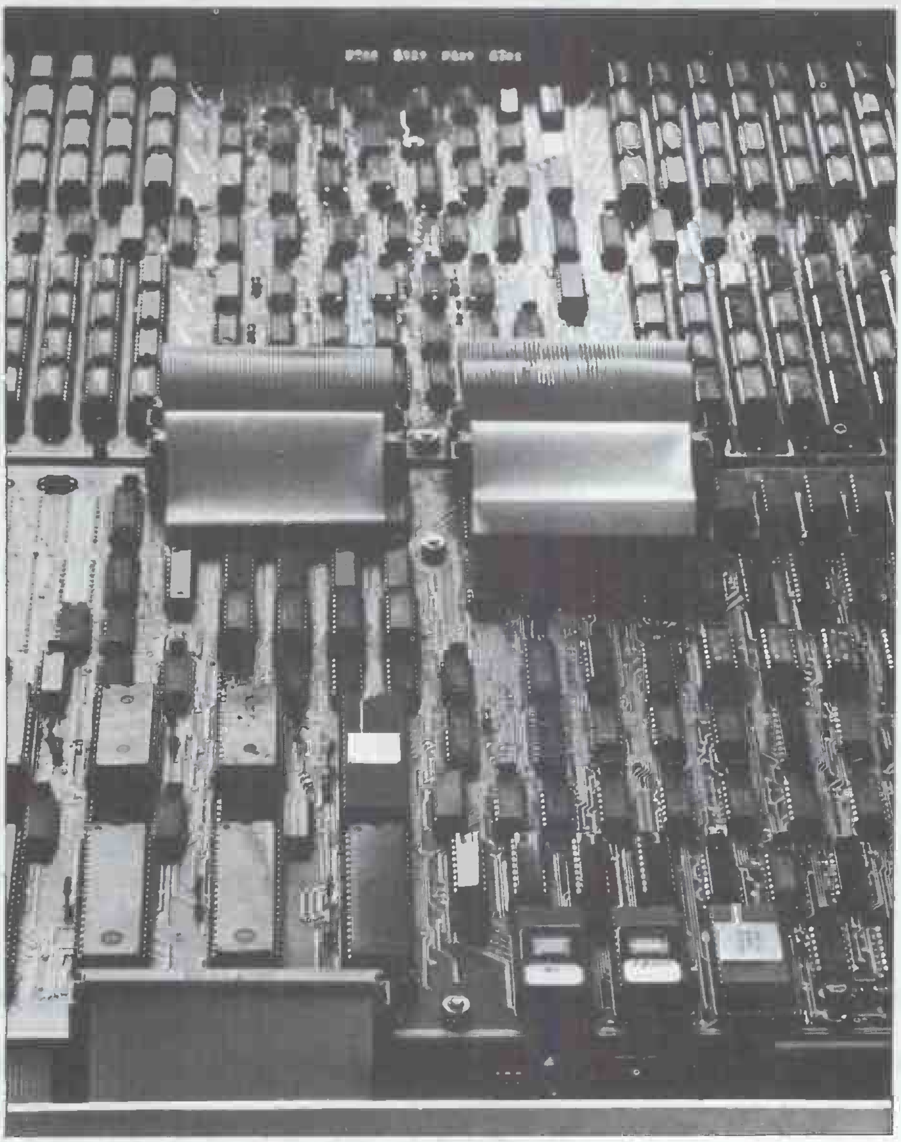
Conclusion

Did we like it? Definitely — it was exciting to have such compressed computing power humming away in the front room throughout Christmas and New Year but then all we had to pay for was the electricity. For those who must pay more for their programming pleasures there are other considerations. The hardware seems reasonably reliable — occasionally it took two goes to boot in — but Keen Computers remedied the only real problem we encountered — a memory failure, probably due to lugging the system about too much — with commendable rapidity. The software is a bit limited at present but this should expand and improve in quality and the PDP Unix software is obtainable (not to say available). The Z8000 assembler is a software plus and the current lack of floating point facilities a definite minus.

With the forthcoming crop of multiuser systems, we are likely to face uncertainties similar to those which abounded in the early days of eight-bit micros. In this context, Onyx seems a good bet because it seems to have selected the correct processor to guarantee early production and to have adopted sensible software. It is difficult to know when the expansion limit of 1 Mbyte of main memory, eight Winchesters all on one controller and no proper backplane, will become a handicap — that really depends on what configurations the other designers can come up with.

For the educational user, the facilities offered are slightly greater than those available on a PDP 11/23 — only 64 kbytes of user memory (for program and data) and 256 kbytes memory in toto — but a less flexible range of disk-drives and a higher price-tag. For the commercial user the promised software (Cobol '74, Fortran '77, DBMS and BASCOM) should prove superb tools for giving a competitive edge to production software provided these arrive before the competition can get their systems to the market. For the Unix enthusiast, Onyx will supply the sources for the device-drivers and those parts of the system for which any licence-holder can show a need.

It would be misleading to end on anything but a positive note... therefore, it is a pleasure to welcome the first of the supermicros into the British computing arena.



TECHNICAL SPECIFICATION

CPU:	Z8002 4 MHz, ZBOA 4 MHz on mass memory controller board
Memory:	256k to 1 Mb dynamic RAM and 64k dynamic RAM on mass memory controller board
Keyboard:	94 keys including numeric, cursor and function keys
Screen:	18 to 60 lines of 80 characters
Printer:	Anadex 9500
Cassette:	4 track 3M DC300 type 12Mb
Disk Drives:	1—8 Winchester Drives 10Mb, 18Mb or 40Mb
Ports:	10 serial, 1 parallel (16 lines bidirectional)
System Software:	Unix Version 7
Languages:	Z8000 Assembler, C and UCSD Pascal Basic, Cobol and Fortran 77 promised

Pascal Benchmarks

Benchmark	Real (from TIME)	Stopwatch
magnifier	1	0.5
forloop	7	6.1
whileloop	6	5.9
repeatloop	7	5.4
literalassign	8	6.7
memoryaccess	8	6.9
vector	24	22.7
equalif	10	9.9
unequalif	10	9.9
noparameters	8	7.4
value	9	8.0
reference	8	7.9

Test		PDP11/34	ONYX C8002
Processor	Real	27	22
	User	22.2	17.6
	System	0.3	0.1
I/O	Real	137	58
	User	73	35
	System	5	10
Disk	Real	723	770
	User	16	9
	System	533	622

Timed against a PDP11/34 with 96Kword and a 132 Mbyte Winchester drive

Multi-User Tests

Users	1	2	3	4
Test 1	3	4	5	6
Test 2	32	32	63	65
Test 3	19	32	47	63
Test 4	12	21	31	40

Compiling a small Pascal program

Users	1	2	3	4	5
Time	40	68	105	114	157

Users	6	7	8
Time	237	392	582

YOUNG COMPUTER WORLD

Compiled by Derrick Daines

Rip off

Let's put the record straight, for a start. The true author of the Ski-Jump Simulation program that we published three months back was Clive Riches of Sprowston, Norwich, and not as credited at the time.

The story goes like this — four months ago 'YCW' received four programs from a reader, and very nice they were, too. One of them was subsequently published but no sooner was the issue on the newsagents' stands than we got a letter from Clive.

'Oi!' he said, 'that program is mine! It's a straight steal of one I did for my A-levels, and I can prove it!'

Getting to the bottom line, Clive was right — he had been ripped off by a youth who had been able to make straight copies from disks held at Norwich Polytechnic. Not only had he copied Clive's program, but those of three other students, too! Then he simply stripped off any identifying lines and coolly submitted them to this page for publication and payment!

In the end, justice was done. The real author received payment and the thief has been blackballed, but I can't help wondering what sort of an idiot would do a thing like that in the first place.

I can imagine only two reasons: (1) the honour and glory of seeing his name in print over a published program, and (2) the money. If the first was his motivation, then the supposed honour is sour; when he proudly flashes the magazine about, *he knows* that his friends' congratulations are undeserved. If the second, then the idiot might have guessed that the original author would spot the publication and the events would take the turn that they did. Or perhaps he was simply taking a chance on it? Either way, his action was contemptible.

In point of fact, I suspect that it was money he was after, because I am told that he wants to set up in business selling software — preferably someone else's, I suppose. You could be sure that he won't be allowed to advertise in *this* magazine, but readers in the Norwich area had better look to the security of their programs!

Security

Time was when the whole society of computer users was a sort of scattered village, with everyone knowing everybody else, but one of the results of the explosion in computer use is that all sections of society can get to use them — and that means the young and the old; honest and dishonest; wise and foolish; adequate and inadequate; law-abiding and criminal. New forms of crime are enabled as fast as old ones are rendered difficult by computers. Clive Riches is only one victim among what will, without doubt, be a vast army of victims of a type of crime impossible a few years ago.

Computer users will have to come to terms with this and take what precautions they can — especially as the Law has not yet caught up with new methods of data storage. It must be recognised that storing programs on disk in a College or Polytechnic is virtually the same as leaving them lying about in a public place. This isn't much help to young folks like Clive, who are dependent upon what is provided, and college authorities must recognise that as they provide lockers for students to store books, sports gear and suchlike, so it is their duty to provide secure storage for computer data and programs. The method is easy, once the need has been recognised — students log in and are given access to a restricted number of files.

We have the technology — why are we not applying it?

There are two human failings here that I would like to draw your attention to. The first is that, because we work and study with another person, we are loath to think of them as thieves. 'Our school isn't like that!' we say, or, 'I can't believe he would do a thing like that!' That is a failing that crooks take advantage of.

The other failing is that once a school — or any individual or group of individuals — gets a reputation for harbouring crooks, it is extremely difficult to get rid of it. 'Give a dog a bad name. . .' That human failing is the one that dishonest people whine about the most, of course. For a school, it means that in order to undo the dishonesty of a few, thousands must labour long and hard. That is why I hate thieves and vandals so much — and why I crack down on them so hard in my own school.

Programs received

PET subroutines by Neil Stoker (16) of Gateshead.
Planet Predictor by D H Matthews of Brussels.
Anti-Aircraft Gun by Daniel Brown (13) of London.
Space Station Alpha by Jonathan Lansdell of Wokingham.
Shootout by Matthew Sargaison (11) of Berkhamsted.
Mole Hunter by Carl Birks (14) of Southport.

The submission from Jonathan Lansdell was particularly interesting, although we cannot publish it. It is very long — some 19 pages — but represents not an actual program so much as an idea. At first sight, spending this much time and effort into refining an idea might seem pointless, but it isn't. With a complex notion such as Space Station Alpha, getting the idea down onto paper is a necessary first step — it's much easier to make changes at this stage than it is when you have begun to write the program, or even when flowcharting has begun.

Jonathan is also right in supposing that ideas are saleable. I once had a friend who wrote for the film industry and who earned £30 (a lot of money in those days) for an idea scribbled on the back of an envelope. (Yes, it was eventually made into a film.)

No — the main reason that we are not publishing is because of its great length. It is also somewhere between an 'idea' and a 'program'; what the film industry would call a 'treatment'. One also suspects that when our friend comes to translate his treatment into a program, he may find that he needs more computer memory than most of us have available; a common failing with treatments.

Still — 'You Gotta Have A Dream!' — and why not?

I was also happy to get Matthew Sargaison's program. Regular readers may recall that we published a Space Defence program by Stewart Sargaison some time ago — well, Matthew is Stewart's kid brother. That's quite a computer family they've got going there in Berkhamsted; I was privileged to meet them all at the *PCW* Show — kids, dad, even grandad — all interested in computers. Great!

Talking of grandads reminds me: a kind old gentleman came to see me at the *PCW* Show to say that he thought that I was writing no not only for young readers, but also (as he put it), 'the young in heart'. Thank you sir — I hope so. All the kids that I know have a very-well-developed sense of what is 'fair' and will, I hope, agree with my comments about program theft.

TRS-80 L2 GRAPHICS

by Torstein Kongshem

```
3 PRINT"INPUT SCREEN SIZE (HORIZONTAL & VERTICAL)"
4 INPUT H:INPUT V
5 H=H-1:CLS
6 B=RND(5)+1
1Ø FOR A=Ø TO H STEP B
2Ø SET(A,Z)
3Ø NEXT A
4Ø Z=Z+1
45 IF Z=V,LET Z=Ø:GOTO 6Ø
5Ø GOTO 6
6Ø C=RND(5)+1
7Ø FOR D=Ø TO H STEP C
8Ø RESET(D,K)
9Ø NEXT D
1ØØ K=K+1
11Ø IF K=V,LET K=Ø:GOTO 6
12Ø GOTO 6Ø
```

TAKING THE LID OFF UNIX

All you ever wanted to know about Unix — courtesy of Chris Sadler and Sue Eisenbach.

The December 1980 issue of the American micro magazine *Byte* carried an item which commented on the number of 'Unix-like' operating systems which were being advertised. The author, Sol Libes, mentioned three: Xenix, from Microsoft, for all the 16-bit processors, OS-1 from Electrolabs and a third, for Z80s, from Morrow Designs. Had he read the advertising copy for that very issue, Sol Libes would have been able to add Cromix (from Cromemco), Uniflex (from Technical Systems Consultants), Idris (from Whitesmiths) and OS-9 from Microware. Even then he would have missed out Onix, Omnix, Tynix and Zilog's plans to sell Unix proper on its Z8000 systems.

Now, most of the above will work only on one processor or another; and some of them have been designed from scratch (incorporating Unix-like features) while others have been transferred directly (under licence) from the Bell Labs system sources, but all exist because of the high regard in which the system software community holds Unix.

Unix was developed in Bell Labs (the research and development company of AT&T) in 1969 by Ken Thompson, whose main objective was to create a hospitable environment for software development. By 1971 Thompson, who had been joined by Dennis Ritchie, had produced the first single-user version, running on PDP 7s and 9s and drawing somewhat on some of the features of Honeywell's Multics mainframe operating system which had been developed at MIT. The second version was on a PDP 11/20 while the third incorporated multi-programming and could run on the entire PDP 11/34-70 range. The fourth version could run on the Interdata 8/34 as well as a PDP. Nowadays, most installations run Version 6 on PDP 11s although Version 7 exists, running on large PDP 11s and the VAX 11/780. Apart from the new micro-versions catalogued above, Amdahl last November announced a version running on one of their mainframes.

Bell Labs is a branch in a tree of companies, the root of which is the corporation AT&T (see Figure 1). A series of legal judgements in the United States during the fifties has led to the application of major monopoly constraints (the AT&T family of companies is to be involved in communications only) to its marketing policy. This colours almost everything about getting and implementing Unix. It appears that, although Western Electric (the marketing company of AT&T) will take your money when you buy Unix, it is not allowed to treat you like a customer. For instance, it is not allowed to advertise, there is no maintenance or support, no warranty and no trial period. The terms are strictly cash in advance and the amount paid varies from $4000 to $40,000, depending on who you are and what exactly you buy. For customers who only require Unix to run the products they sell, binary code should be sufficient. Western Electric allows object code to be sold for the same price as source for a second CPU. It also makes special arrangements with large software suppliers (Onyx, Microsoft) who supply object code only. Purchase price covers the licence only, the handling charge (expenses and medium) being extra. Bona-fide degree-giving educational institutions only have to pay the handling charge. The software comes on a nine-track magnetic tape with one set of manuals.

It is a comment on the quality of Unix that, even though Western is forced to treat its customers (about 2000 sites) as shoddily as this, and even though the bulk of distribution goes to educational users (65 percent), the revenue obtained from Unix is big enough to have featured in one aspect of AT&T's recent reorganisation (ie it is recognised as a significant source of income).

What's so special about Unix?

In order to discover why so much fuss has been made of this piece of software, it is necessary to look at those features which constitute any operating system and see which aspects Unix implements in a special way. Every interactive operating system incorporates at least two things — a command interpreter to decode instructions input by the user and act on them and a peripheral management system so that I/O devices, data files, and user and system programs can be located and manipulated at will. In addition, a multi-user system must have a scheduling algorithm and a file-security system in order to allocate the system resources among competing users. The first of these tries to ensure a unique share of the processing facilities for each user while the second provides a unique share of the storage facilities.

A good operating system will have a concise and logical command format that is easy to learn and quick (and consistent) to use. In addition, the peripheral management system should make efficient use of disk space. There are many other features which are highly desirable in an operating system but it is probably best to look first at the four essentials: a command interpreter; a peripheral management system; a scheduler and a security system to deal with the extras afterwards.

The Unix command interpreter is a program called the *shell*. The basic command format for the shell is a single word (generally two letters), which will normally be the name of a particular program which performs the action commanded, eg

$ls ($ is the Unix prompt)

will execute the program 'ls' whose function is to list the user's filenames on the terminal screen. Similarly,

$who

will execute program 'who', which displays a list of all users currently on the system. Should the called program require parameters, these will be passed with the command line. The shell assumes that the user's terminal is the default input/output peripheral, although this can be easily over-ridden by means of the operators '<' and '>' such that

$ prog > filename (where filename may be a perhipheral)

will have the effect of executing the program 'prog' and directing the output to the specified file. Likewise

$ prog < filename

will execute 'prog' accepting input from 'filename'. There are other operators which can be used in shell command lines and these will be discussed later.

The shell's mode of operation is quite complex. Once the required command has been interpreted and the requisite program located on the disk, a 'fork' process is initiated (any program in a state ready for or during execution, is called a 'process' in Unix). What the fork does is to create two versions of the shell, one called the parent process and the other, the child process. At this point a second program (exec) loads in the code for the child process and begins to execute it. All the information available to the parent process (ie the information about the 'environment', which terminal to talk to, which files are accessible, etc) is inherited by the child (see Figure 2). In the meantime, the parent process is still active, although in some cases it may not have anything to do until the child process completes. For instance, any command terminated by '&' will pass control back to the shell while it is executing, so that the shell can deal with the next command in parallel. Commands separated by a ':' will be handled in sequence. This is the first hint that Unix is a clever operating system.

The filing system owes its strength to its simplicity — merely a tree-structure whose root is a directory (a list of names of other files) and whose final branches are the programs and data files of the system and the users (see Figure 3). Disks full of files, organised into subtrees, may be attached (mounted) onto the main tree at any point. Each file (including directories) comprises a sequence of characters terminated by the end of file marker (CTRL-D). (No record structure or file headers exist.) At any given time, a logged-in user will occupy some position in the tree. Any file to which access is required will lie in a directory and the 'path' is the route taken from one point to another. Paths can be stipulated either in absolute terms (eg /usr/chris/notes) or sometimes relative terms (eg '. . ' means 'next highest level ') in commands to the shell. Additionally, I/O devices are treated simply as entities in a directory dev so that it is straightforward to direct output to, say, a line, printer (ie, $ file >/dev/slp where 'slp' regers to 'serial line printer'. Finally, the shell can interpret an extremely generous selection of wildcard designations so that '?' refers to any character in the sense that 'a?e' stands for 'aae', 'ale', etc. Similarly, [. .] means 'in the range' so that [a. .c]xyz stands for axyz, bxyz, cxyz. Finally * stands for 'everything' or 'any string'. So, *ing will find 'string', 'writing', 'laughing', etc. More than one wildcard can be used in a single string.

Security is dealt with by a password system. Each user logs into a named area on the file tree and must supply a password to gain access. All the passwords are held in a publicly available (at least for reading) file called 'passwd' — but in encrypted form. In addition, every file reference in a directory includes a string of bits which grant (or withhold) access rights as follows:
r = permission to read;
w = permission to write (if a file does not have write access, Unix doesn't write it back to the disk after usage);
x = permission to execute a file (files created using an editor don't have this permission unless the user specifically changes a file's access rights).

Access rights are granted on three levels:

rwx	rwx	rwx
(owner)	(group)	(world)

The above describes a file which is wide-open. Utilities exist which make it possible for the user to protect files from, or to make them available to, users in his *group* (a special designation of users) or to all users.

The designers of Unix have been at great pains to make operations concise and efficient for its users, who have repaid with fierce loyalty. But Unix makes very little attempt (short of giving some error diagnostics) to keep its users from making mistakes — the user is assumed to be intelligent. This is in contrast to some operating systems (particularly on mainframes) which assume their users to be button-pushing morons who must continually be stopped from doing something stupid. Nevertheless, with all the attention paid to the user, Unix does not seem to have the capacity to save the machine much work — it is known to need comparatively large amounts of memory and disk space and the scheduling algorithm is perhaps not as sophisticated as it could be . Still, if a system has to be kind to users or kind to machines, few would choose the latter.

Adaptability

The previous section attempted to give some idea of the sort of face Unix presents to the user. Some may be impressed by the power of the shell, others by the simplicity of the filing-system, but every development user will know that no off-the-shelf operating system can exactly match the particular requirements of the current programming job. The real strength of an operating system lies in its adaptability — its capacity to accept patching or rebuilding as the programming environment evolves.

Several powerful operating systems seek to meet this requirement by offering a wide variety of 'building' options. When the operating system is set up, a 'generation' program asks the user which of the available options should be built into the system. The result is a more-or-less customised system. The Unix approach is completely different.

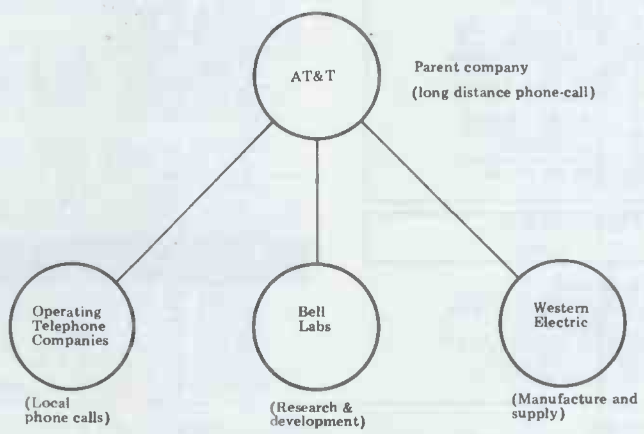


Fig 1 Structure of AT&T

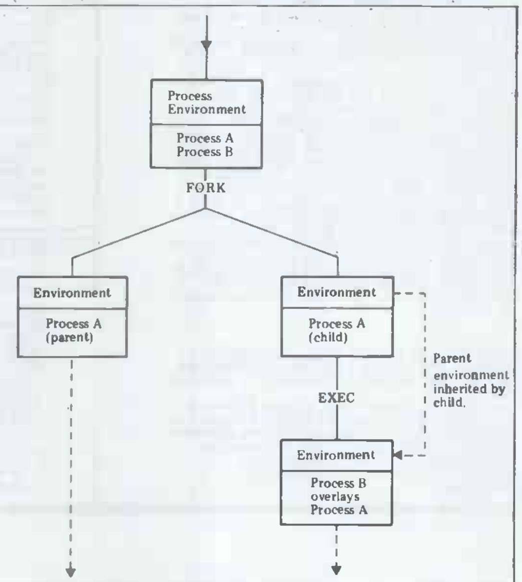


Figure 2 Fork process

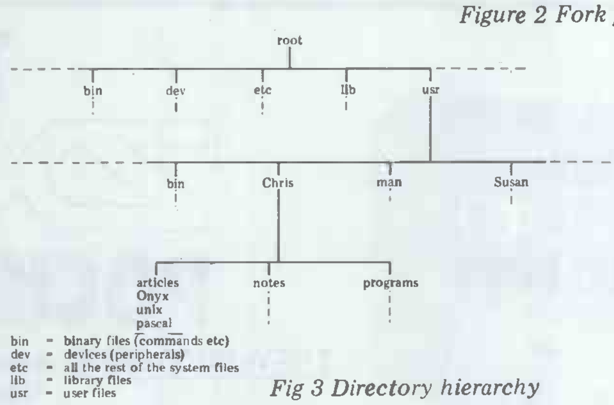


Fig 3 Directory hierarchy

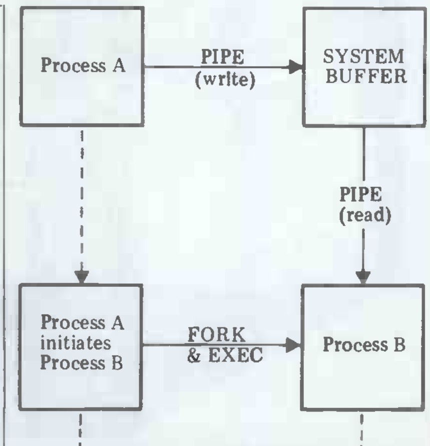


Fig 4 The pipe

PROGRAM POWER

NASCOM 1 & 2

LUNAR LANDER SURPEME (16K/G/B) — classic spacecraft-landing simulation. Short, medium & long-range scans show planet surface in arying detail. Continuously updated STATUS REPORT gives vertical, horizontal & relative velocity, altitude, fuel level, G factor & surface scan for suitable landing site. 8 skill selections. Brilliant graphics £13.95

STARTREKII (32K/G/B) - enthralling, real-time version from our Invasion Earth author, using M/C code sub-routines to great effect. Special features include larger galaxy, shielded homing warheads (fired by Klingons), time slots & non stop action. £13.95

INVASION EARTH (MC/G) - New improved version! 4 complexity ratings. 10 overall speeds. Variable shot speeds & alien descent rate. 4 invader types. Intelligent homing, exploding, angled, direct, multiple warhead & radio-jamming missiles. £10.95

INVASION EARTH (MC/G) - as above with SOUND EFFECTS using AY-3-8910 CHIP £12.95

"NASCOUNT" — PEROSNAL FINANCE (16K/MC) - Make life simpler with this finance planner. Budget income/expenses month by month and highlight likely surpluses & deficits. Can be used to check bank account & record past income/expenses 50 entries eachperiod. Five digit codes with analysis by code & sub-code. Calculate cumulative cash flow to specified month end. Output to cassette & printer. £12.95

CONSTELLATION (16K/B)- Turn your screen into a telescope & view the stars from any point in the Northern Hemisphere at any time & date. Display stars by magnitude, identifying number or constellation. The telescope can be raised & lowered, zoomed in & out. Also output of star map to printer.

** NASCOM 1 — COTTIS BLANDFORD cassette interface for N2 format, reliability & fast load. £14.50 or £11.50 with program order.

B = Nascom BASIC (State Tape BASIC if required). MC = Machine Code. G = Nascom Graphics. 8k RAM required unless otherwise stated. Ask for NAS-SYS or T4 versions.

ALL PROGRAMS SUPPLIED ON CASSETTE IN CUTS/KANSAS CITY FORMAT.

WORDEASE — WORD PROCESSOR (MC)

Professionally written 4K word processor:
— 14 line window on text buffer & extnesive on-screen editing facilities. Insert & delete characters, lines & paragraphs. Text manipulation — copy from one section of text to another, or read in additional material from tape to any point in the text. FIND & REPLACE facility. Text buffer size according to available memory.
Exceptional formatting cpapability: — commands embedded in text allow complete flexibility e.g. variable tab position, indent, line length & page length. Use of up to 10 'MACROS' permits automatic inclusion of headings, footings & other 'text repeats', & also automatic page numbering.
Ouput to printer — can vary character delay, inhibit line feeds & force upper case if required.
An extensive manual is supplied (itself prepared on Wordease).
(MANUAL ONLY — £1/refundable against program order) £25.00

DRAUGHTS (B/G) — by a Country Player & member of English & American Associations, this program plays the standard E.D.A. rules & employs advanced end-game tactics. 6 levels & large clear graphics mean real value for beginners & experts. Hints/instructions included. State if games graphics ROM version required £9.95

BACKGAMMON (16K/B) — 5 levels of play are offered in this game, played to the standard rules. Program includes instructions. Available to run on its own or excellently presented using our special games graphics ROM £9.95

WRITTEN ANY PROGRAMS?
We pay handsome royalties

List of programs as follows:- Super Startrek (16K/B) £9.95, Cowboy Shoot-out (MC/G) £6.95, Alien Labyrinth (16K/B/G) £8.95, Musical Break-out (MC/G) £6.95, Super LIFE (MC/G) £8.95, Driver (B/G) £6.95, Cliff Invasion (B/G) £8.95, Labyrinth (B/G) £6.95, Space Fighter (B/G) £7.95, Death Run (B/G) £6.95.

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The bulk of the operating system was written in C, a high-level system language (also developed at Bell Labs). There was a time when 'high-level' and 'system' were mutually exclusive when applied to languages. Although C is not the only such language around, it is a fairly powerful example of its kind and has the right sorts of control and data structures to make it relatively easy to set up activities at system level. It also produces very efficient run-time code. (It is said that Zilog's interest in Unix stems from its discovery that C was more efficient than PL/Z, Zilog's own 'system' language.) In addition, Unix provides a large number of routines which provide access to the system tables and other information which is essential to system programming.

Further, since the shell has very little processing capability in its own right, it relies on calls to lower-level utilities. Since the source for these utilities is written in C, it is a simple matter to modify or replace these to suit one's purposes and still make them available via the shell. Finally, Unix can migrate to foreign hardware more easily than most operating systems (which is why you are likely to see it around quite a lot) because one simply needs a good C compiler generating the required machine code and, apart from device handlers, a few hardware-specific routines and a few time-critical routines, the whole system can be built like an ordinary program.

At a higher level, the shell will execute any filename which it is supplied so that a file containing a sequence of commands can be submitted to the shell which will process them, one command at a time, as directed. This is known as 'programming the shell' and has developed some very powerful features:

1. Commands can be strung together with & or ; or on consecutive lines;
2. Parameters can be passed into dummy string variables;
3. The control structures
if <condition>then<action> fi
case < instance > in <list>)< action> ;;<action> ;; .. ;; esac
for <instance> in <list> do <action> done
while <condition> do <action> done
are implemented;
4. Output from one program can be directed (as input) to another program running in parallel, without requiring an intermediate datafile or explicit synchronisation, by means of the 'pipe' function (:). Thus, $nroff <text : pr will invoke 'nroff' (see later) to process file text and output to program 'pr' (the line printer) line by line. Figure 4 illustrates this mechanism.

These facilities enable the system programmer (or anyone else who wants to spend the time) to create a custom-built environment with utilities which perform exactly the tasks required, invoked by appropriate names — eg 'chatty' Unix would have a file 'remove' which contained the single (standard) Unix command rm followed by $1, a dummy string variable for the filename; alternatively CP/M could be emulated by calling this file ERA. In fact, it is even possible to replace the entire shell (in its role as the place which users log into) so that users find themselves in a special environment (turnkey, or dedicated to one function).

For the most part, however, programmers will be happy to accept the bulk of the Unix environment as they find it, as it contains a broad range of system facilities. The Unix ethos distinguishes between: 'commands' which are utilities directly available for invocation at the terminal, like editors & compilers; 'subroutines', which are self-contained segments of code available to users within their programs: and 'system calls' which are far from self-contained, burrowing into the inner workings of Unix itself to achieve some system function like accessing a file or loading and executing a program. Both commands and subroutines can and do make implicit use of system calls, but Unix is especially flexible in making the naked system calls so easily available to the general user.

Commands

Standard Unix comes with ed which is a fairly ordinary line-oriented editor with a few irritating features (eg no prompt at the beginning of each command line). Anyone in this country either has, or should, be able to get hold of em (an improved line-oriented editor or, better still, ded (a screen-oriented editor) — both emanating from Queen Mary College, London University. One unusual feature of these editors is that it is possible to pass commands out to the shell from within the editor.

There is a C compiler, obviously, as it's the father of the Unix system in the sense that everything else sprang from the digital equivalent of its loins. A utility called lint will accept a C source program and perform 'strong' type-checking and a number of other checks (presumably the actual compiler is a bit sloppy about these things, probably to cut down on compile-time). Developers are advised to use lint on all completed programs, particularly those which may have to travel (see Onyx review). Alternatively, there is a portable C compiler which should aid in producing less troublesome transfers.

There is a Fortran compiler and in version 7 this is the full (structured) Fortran 77 implementation called f77. The Unix approach to Fortran is somewhat mixed — rumour has it that the first Fortran IV compiler was produced in a fortnight for a bet! Any language deserves more respect than that. And yet there is Ratfor — the structured preprocessor for Fortran which lies at the heart of 'Software Tools' — yet another Bell Labs development. Under Unix, Fortran porgrammers are encouraged to write their programs in Ratfor. Failing that however there is struct which will convert a Fortran program into a Ratfor one. This is then fed to the Ratfor preprocessor which produces another Fortran program for onward transmission to f77.

The standard Pascal compiler under Unix is Tanenbaum's 'Amsterdam' Pascal which generates a pseudocode (not p-code) with great efficiency and some thorough error checking. It is also possible to compile directly into native PDPP11 machine code (assuming you have a PDP11). This is a longer process but produces faster code since the psuedo-code interpretation phase is eliminated. On the Onyx, the UCSD Pascal compiler was used. For both of these, the compiler outputs to a fixed-name file (typically a.out) from which the user is expected to extract the object file. This could be a great nuisance during heavy program development.

Other offerings under Unix include APL, Lisp. BCPL (an ancestor of C), ALGO68s (from Manitoba) and POP-11 (from Sussex).

There is a wide range of development tools including:
— yacc (for 'yet another compiler compiler') and lex (a lexical analyser), for building your own compiler or cross-assembler;
— make for maintaining (ie making global amendments to and then re-compiling) a suite of (usually interlocked) programs;
— adf a debugger featuring core-dumps, breakpoint execution etc;
— ld (for 'loader'), a link loader which enables the assembly of collections of self contained object-modules into something executable;
— ar (for 'archive'), a library creation and manipulation package, and
— as an elementary assembler.

Text-handling is a part of the *raison d'etre* for the entire Unix project at Bell, so there is an unusually large range of programs which transfer, format and otherwise manipulate text files. Chief among these are nroff and troff which can detect formatting commands embedded in text-files and implement these on a line-printer or photo-typesetter respectively. In addition, however, there are egn, which enables the user to insert mathematical equations into text — tbl, which offers the same facilities with tabular formats — spell — which will check the spelling of every word in the text-file against 30,000 (American) English words (this will only be valuable in this country when the project to Anglicise all these words has been completed) and a large number of smaller-scale programs which search, sort, count and otherwise manipulate the words and letters in text-files. Finally, pr and cat handle the output of these files onto the printer or terminal.

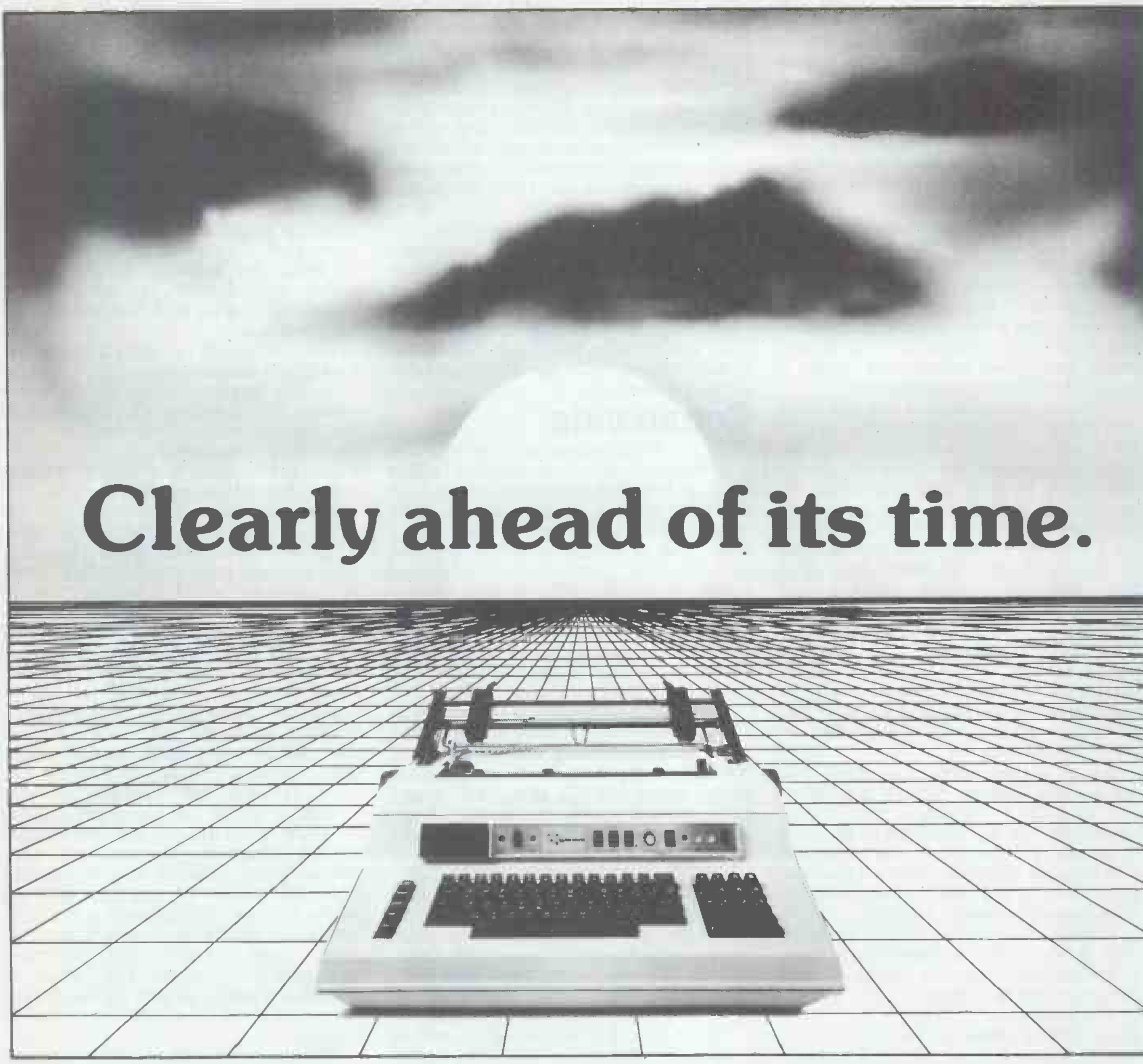
There are programs to pass messages from one user to another, whether the recipient is currently logged-in or not. There are other programs which permit (and control) communications between different Unix systems, interconnected in some way.

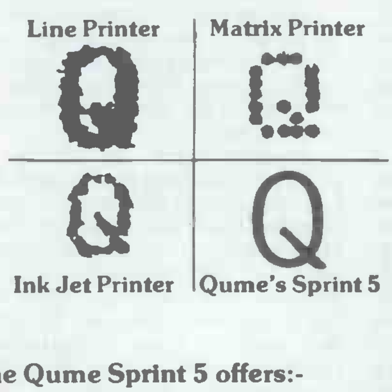
Finally, there are all the 'extra' programs such as a games package which includes chess (another Bell speciality), Othello, Blackjack and Moo (numerical Mastermind). The program learn accepts input in programmed-learning format and uses this to control 'lessons', there being six such files to introduce the new user to Unix. Unfortunately the feedback mechanism is not sufficiently sensitive for this program to be a particularly powerful educational tool. There are a pair of 'desk calculator' programs, dc which provides immediate mode, Polish notation arbitrary precision arithmetic capabilities and bc which is simply a pre-processor which allows one to pass input to dc by means of C-type syntax.

Conclusion

Many of the features described here deserve more attention than we have been able to give them and there are many other useful or interesting features which we could have discussed,

GOTO page 146





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SECRETS OF SYSTEMS ANALYSIS

PART 7: THE FIRST STAGE IN SPECIFYING A PROGRAM

Lyn Antill continues her series aimed at bridging the gap between the micro expert and the would-be user.

So far in the series we've looked at the need for systems analysis, the means of analysing the user's requirements and at the way in which a buyer can go about looking for hardware and software. All these jobs can be done by someone who didn't know anything about computers when he started, because they rely so much on knowing what the micro is going to be used for. The user is the one who knows about the job that is going to be done on the micro. If he can put that knowledge in terms of requirements that the computer people can understand and if he can ask the right questions about the systems he is offered, then he can make a sensible choice of system. At least he can if there is a system on sale which meets his requirements.

If you have not managed to find a suitable program package and a machine to run it, and if you still feel that a microcomputer system is going to be the best solution for your problems, then you have to start breaking new ground. You will have to write your own program, or get someone else to write one for you. One thing that you have to accept before you embark on such an enterprise is that it will not provide you with a quick solution to anything (except, perhaps, for the problem of how to use all that spare time and cash you didn't know what to do with!). In other words, writing a program takes time, and having a program written for you takes time and costs money, and it's only justified if it saves you more of both in the long run.

Specifying a program is probably the most difficult part of systems analysis for the non-programmer to come to terms with. Indeed, many people who are good programmers themselves would find it very difficult to write a specification for someone else to program from. All sorts of information has to be communicated to the programmer. Some of it is straightforward. Some aspects may be difficult but still perfectly clear-cut, eg, calculating PAYE, where, even though the rules are complicated, there is a standard way of doing things and knowing whether the answer is correct. Unfortunately, there are also areas where there are no rules and where people have relied on their common sense to decide how the work should be done. Obviously computers do not have common sense so the work must be spelled out in detail if it is to be programmed. If you leave it to the programmer to do this you may well find that his view of common sense does not agree with yours, or that he simply does not allow for the odd-ball situations that you know keep cropping up. Another thing which has to be communicated is the sequence in which different tasks have to be done, especially the occasional jobs like end of month and end of year.

Because there is so much information involved in a computer program specification, this is one area that has been thoroughly investigated by the NCC, and most of their forms are devoted to various aspects of program specification. There is so much involved, and it is so important to get it right, that I will be spreading the subject of specifying a program over two months.

What machine are you writing for?

As well as deciding who is going to write the program, you need to decide what machine you are going to buy. There is more freedom of choice here because there is not the problem of teaming it up with an existing program package. Before you decide, you should have worked out what constraints your program is going to make on the choice — what memory; does it need a full size screen; graphics; disks? You will want to choose a programmer who is familiar with the machine (or a machine your programmer is familiar with) and the particular features of the machine will have to be borne in mind when designing the programs.

It's a toss-up just how soon to buy the machine. You don't want to part with all that money before you have to, but then you don't want to find that deliveries are late and your programmer is twiddling his thumbs in your time. So, once you've decided on a machine, you need to check out two things — how long it will take to get one delivered (and functional), and how long it will take to get hold of a programmer and get him to the stage of sitting down at the machine. If you're thinking of writing the programs yourself, get hold of a machine as soon as possible, because it always takes longer than you think it will to learn your way around the machine and the language. This means that the more time you have to spend on playing around the better. It also means that you have more time to ask questions about all the snags you're bound to hit as you try to find your way through the manual.

Who's going to write the program?

Before looking at the job of writing a specification, I would like to look at the question of who is going to use that specification. This is because you can get away with less formality if the program is to be written by you or someone close to you. Many teachers of systems analysis would regard that statement as a heresy and would point out the danger that the lack of formality may hide a lack of clear thinking that would lead to disaster later on — and, of course, that danger does exist. Nevertheless, it is clear that good programs are sometimes written from informal specifications by people who know what they're doing. The important part is to specify the overall pattern correctly, the skeleton, or, more properly, the structure. If the structure has been laid down clearly, then an informal specification can afford to be sketchy about the details, eg, 'prepare invoice' is a perfectly good instruction to someone familiar with the way you prepare your invoices, but would need to be spelled out in more detail to a stranger.

Well, could you write the program yourself? You may already have decided that you don't want to or don't have time to, or that what you want is far too complicated for a novice. But if you're toying with the idea, and can't decide whether it's feasible, the only way of finding out for sure is to try. The only trouble with this is that you may have used up quite a lot of time before you discover that the answer is 'No', and this could be very frustrating. But if you want to try (for the experience if nothing else) then you need to start on a simple problem, or at least a problem with a simple solution. You will probably go for Basic as this is the most popular language on micros, and it is the easiest one to write simple programs in (although this is a rather circular definition of simplicity). Basic was designed for doing calculations and for passing information to and from the operator. If this is the sort of program you had in mind, you stand a fair chance of learning enough Basic to write the program satisfactorily. Also, it's much easier to test this sort of program because you can see whether you are getting the right answers to the calculations by working out a few of the answers yourself.

Files were added to Basic as an after-thought and different Basics have different ways of handling them — some nicer than others. It's more difficult to test file handling programs, because you have to write another program to read back the file you've written and if the results are not what you expected, it's not always obvious whether it's the reading or the writing that has gone wrong. It's more disastrous if a file handling program goes wrong because not only will you have wrong answers this run but you will have duff input to the next run unless you re-create your data. File handling programs also call for greater thought about security and backup procedures and this relies on better knowledge of the operating system for taking copies, renaming files, etc. Students are quite a way through a course in Basic (or Pascal) before they do any file handling. Cobol is the only language available on a micro where you start with file handling but you have to learn quite a lot of Cobol before you write any programs at all. So, if yours is a file handling program, I would think very hard (and possibly take some tuition) before embarking on that as a first foray into programming.

Experimenting

Whether you are thinking of writing the program yourself or getting someone else to do it, you may well want to start off by doing some experimental programming — trying out different ideas to see what looks best. This is rather like an architect drawing sketches of a building showing what it might look like and getting his client to decide what he wants before the detailed plans are made. This is not something that you will find recommended in a textbook, probably because it is not really feasible on a mainframe, although it is precisely what I intend doing this year at work where we are toying with the idea of creating a database on our mainframe. It is a technique that I have always used but it probably only works for me because I am a user and a programmer as well as an analyst. This is very rare in mainframe situations, but quite common on micros. For this reason, the program sketch is worth writing into the textbooks, as an early stage in the design process.

If you are writing your own program and it's not too complicated, you may well be able to go from the experimental program to the finished product without writing down a formal specification. This only works if you can keep the whole of the program in your mind's eye while you are working. What tends to happen is that things go fine for a while and then you start adding bits, or making corrections, and you patch the code to cater for things you forgot the first time through. The patches get patched again for the second round of amendments and the program starts getting into a mess. You forget which is the latest version of the program and the listing and try amending the wrong one. And so on. Most programmers (except perhaps for a few youngsters brought up on a strict diet of structured programming) will have gone through the galling experience of each new patch creating several new bugs. This is bound to catch up with you at some point as your programs get bigger, but you always think it won't until some time after it has.

This is the biggest pitfall for the programmer (layman or professional) so even if you think you can tinker around on the machine, experimenting with ideas and refining them, do make sure that you take a long cold look at what you have done — see to what extent it meets your requirements and don't be afraid to throw away a first attempt when it appears to be getting too messy. You won't have lost the ideas, but they will be better for being put back together in a more coherent structure. (If it's any consolation I shall have to throw away the first draft of this article because I've caught myself writing this under the wrong section heading. When you read it it'll be in a different place. PS: the second draft got thrown away, too, because I'd started to tackle things in the wrong order!) Don't be afraid to doing a bit of redrafting — but if you're doing too much of it it's because you didn't think the problem out properly in the first place, or because the problem was more difficult than you realised or knew how to handle.

If you want to get a professional programmer in, or you want to do a professional job yourself, then you must write the specification out properly. This is the culmination of the systems analyst's job.

Run chart

The first thing to specify is the way in which programs fit in with each other and with the user's clerical procedures, and the way in which files are passed from one program to another or from one run of the program to the next. If you have only one program and no data other than DATA statements in the program, then the run chart becomes trivial and can be ignored. In all other cases it should be drawn even if it appears to be very simple. A Run Chart is drawn up from the Systems Outline Charts, and shows how data is input to a particular program to be processed, how programs store data on files, or read stored data from files produced by other programs, and create output on the screen or on the printer. It is a flowchart and uses different symbols to indicate the different elements involved.

It is customary for the Run Chart to be produced at various levels of abstraction, but on a micro it is probably quite satisfactory to draw it at the programmer's level, using actual files and programs, rather than talking generally about processes and storage. The symbols used are shown in Figure 1, and Figure 2 gives an example of a

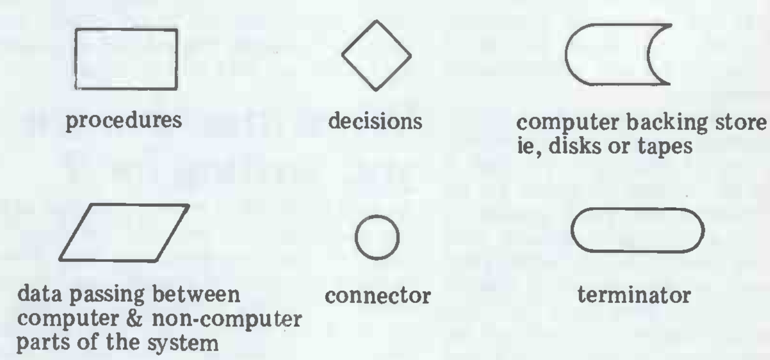


Fig 1 Run chart symbols

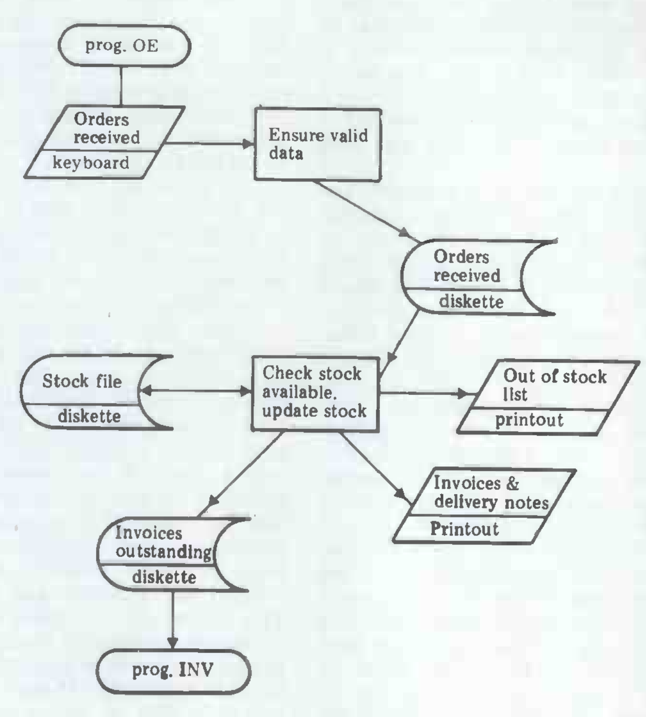


Fig 2 Specimen run chart

Run Chart in use.

All flowcharts should observe several general principles. They start at the top and work down to the bottom. Standard symbols should be used so that their meaning is immediately apparent. The symbols should be joined by lines (which should never cross) with arrows on them to indicate the direction in which the diagram is to be read. On a run chart this arrow represents the flow of control within the program. It should be clear where data enters the program from the outside and where the flow starts and stops. The flowchart is not intended to be a confusing bit of techno-jargon. It is the simplest way of representing flow through a variety of processes. If it is not self-explanatory this isn't because it's a flowchart but because it's a bad one. Simplicity is the key both to clear thinking and to good communication.

Several things are identified in the Run Chart which then have to be specified in detail later on. These are screen dialogues, reports and printouts, files, programs. I like to tackle them in this order, if only because that puts the easiest ones first. Every other part of the specification should be cross-referenced to its place in the Run Chart.

Screen layout charts

These are done on a piece of glorified graph paper. Ordinary graph paper would do but it won't convey quite the right shape for the letters. The correct paper has oblongs rather than squares. A full size screen is usually 80chs wide and 24 lines deep, but many screens are less than this. So the first thing to do is to check the size of screen that you'll be using.

Unless the screen format is particularly important, or you want to create interesting graphics effects, then it is probably sufficient to draw up samples of each dialogue on ordinary paper and leave the exact spacing to the programmer. The main danger here is of trying to fit in more characters than you have available, especially with a smaller screen. But this can be avoided by remembering to count any long lines, and also allowing a character position for each punctuation mark.

Printer layout charts

The same goes for these as for the screen layout charts. The first thing to check is the size of your printer. If you have particular requirements — like wide forms that have to be printed — then these will have been taken into account when you bought the printer. Normal requirements for reports, etc, where the exact spacing is not critical, can be drawn up on ordinary paper, but if you are using pre-printed forms, eg, to print invoices, where much of the information has been printed on to the paper and the computer has only to fill in the gaps, then these must be specified formally on the correct paper. This is the only way in which the programmer can work out the exact spacing required to get the items to print in the right places. This sort of exact printing is far easier to do in Cobol than in any other language I have come across, because it permits you to incorporate the complete format of each different sort of line into the data definitions within the program. With Basic you have to mess around with TAB statements with every field you print.

Some printers have variable spacing, which could have some effect on the use of printer layout charts for specifying fields to be filled in one pre-printed forms, but this shouldn't cause any real problems. Other printers have facilities for printing double size letters for headings. Again, any use of this should be indicated on printer specifications.

Figure 3 shows an example of a printer layout chart.

Error messages and reports

These aren't really a separate item. Every time an error might occur, there should be an indication of the message which should be sent to the operator indicating what has gone wrong and what should be done about it. This is always the area where the operator needs the most help and the most thought should, therefore, be given to this type of message. There is nothing more frustrating for the user than to be confronted with a message he doesn't understand and to be stuck in a situation he can't see how to get out of. One of the worst situations for the operator — and the one where he is most likely to lose confidence in the competence of the programmer — is where the program suddenly drops out of Basic and announces 'SYNTAX ERROR AT LINE 99'. The ability of Basic to produce such messages for the programmer is one of its strengths, but statements such as these are completely meaningless to the non-programmer. What is more, the operator has no idea what has happened to any data that was being processed, files have not been properly closed, and any pretence at security and control over the program has been lost. This message indicates that the program has failed to test for potential errors, and has blindly tried to execute something impossible.

The user should have a good idea of the sorts of clerical error that might occur, eg, trying to post an amount to an incorrect account because the account number has been mistyped. However, s/he may not be too clear about what sorts of errors could occur from the computer's point of view. Things which it is easy for a human to check may be difficult for a machine and vice versa. A user may also not be familiar with the program instructions that are being used, or the way in which data is stored and retrieved by the use of certain commands. This often makes it difficult for the user to imagine the sorts of errors that are going to occur in day-to-day operation. Conversely, it is often difficult for the programmer to put himself in the position of the operator who has no idea of the logic of what is being done inside the machine and so has no idea of why mistakes are occuring, or what to do about them.

The only way in which a satisfactory solution can be worked out is for the programmer and the user (and that includes the keyboard operator as well as the boss) to sit down together and discuss what is going on, both in the office and in the machine.

Forms design

You may be trying to write programs to use your existing forms, in which case you must make sure that the programmer has copies of all of them and knows how they are used and how they fit in with the other parts of the program specification. There again, you may be designing new ones. I have already outlined the way in which the layout is specified for the programmer, but there are a few other things to be borne in mind.

Forms are fed through the printer in different ways on different machines. On a typewriter, they are always fed through from the back, and there is always a chance to open the carriage and correct the adjustment of the paper if necessary. A typewriter uses a friction feed, normally works on single sheets of paper and can be adjusted for a variety of paper thicknesses including multiple copies. Some printers have a friction feed and have hoppers for single sheets. Others will only work on rolls of paper (like a Telex machine) others have a sprocket feed mechanism and have to use fan-fold paper with

GOTO page 145

Layout for aged debtors report. prog ADR

Page No 99

Aged Debtors Report
As at DD/MM/YY

Account No	Name	Date Due	Amount
999999	xxxxxxxxxxxxxxxx	DD/MM/YY	££££9.99
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.

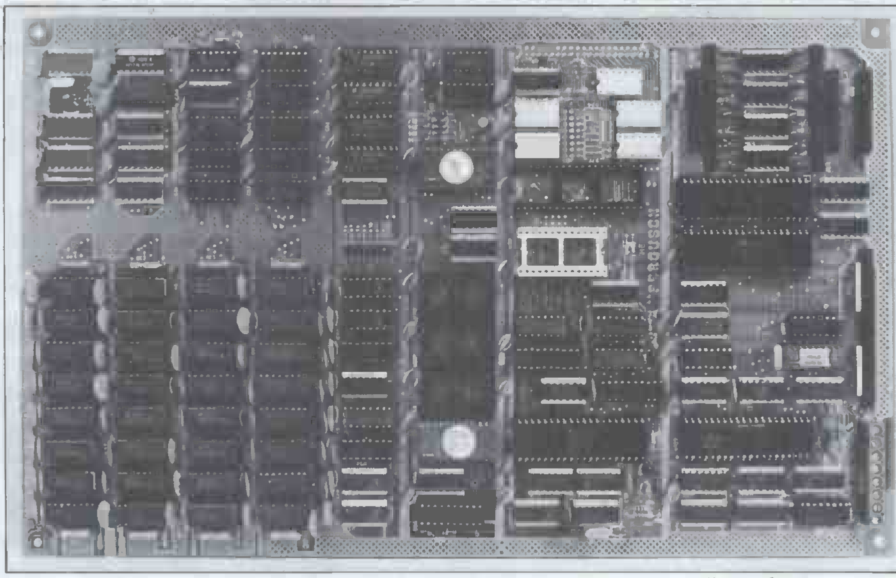
Total on this page ££££££9.99
Total so far ££££££9.99

N.B. '9' indicates any number
'x' indicates any character
DD/MM/YY shows that the date is to be printed in the English style.
£ indicates that the £ sign should precede the first significant digit.
Each page should carry the same page header and trailer. The final page should conclude with the following:
Total No Debts = 999999 Total Amount ££££££9.99

Fig 3

BENCH TEST

BIGBOARD



PCW *welcomes Dr Neil Cryer to what we hope will be the first of many Benchtests by him.*

The name Bigboard reflects the facilities offered by this single board computer, rather than its size. At only 8½ x 13¾ in, it is small enough to fit into a large keyboard case, which was how I first saw it at the Breadboard exhibition in November, 1980.

At the moment, it is available only as a kit and is advertised as being suitable for people with some hardware/software experience. It comes without the necessary ancilliaries of an ASCII keyboard, a power supply and a video monitor, and with no floppy disks. For review purposes, however, the suppliers, Maclin-Zand, provided a ready constructed board, tested to the minimum configuration advertised.

Facilities

Bigboard comes with a floppy disk controller, and gives a full 64k of RAM. Maclin-Zand says that it will eventually be available made up and in a case as a complete system.

The minimum configuration has no spare ports; the existing two drive the floppy disk system and the ASCII keyboard. Extra kits are available — one supplies an extra PIO giving two spare 8-bit ports, and another is available for adding two serial ports with software programmable baud rates (50 to 19.2 kbaud), while a third provides a counter timer chip to give a real time clock, together with floppy disk shut down after any 30 second period of inactivity. No further expansion is intended, which some users may find limiting.

I see Bigboard as providing the heart of a system comparable with Superbrain.

Construction

The instructions in the construction manual are clear, concise and adequate for the manufacturer's target customers experienced with hardware and software. Other users might find them too brief, as there is no advice on such things as identifying resistors and soldering.

To put myself in the position of someone making up the kit, I asked the agents to supply me with the components for the serial port so that I could see how easy it was to construct using the instructions. I consequently fitted six ICs, a crystal and 20 sundry other components. There were no problems. The component positions were marked on the board in the usual way and the soldering was no finer than with most other computer boards.

As with any kit of this type, there is little documented help for anyone unlucky enough to have a system which doesn't work first time. The instructions do offer a few suggestions as to the areas of the circuit which may be responsible for certain faults, but essentially the user would have to be experienced enough to trace through the circuit using suitable equipment. Maclin-Zand does, however, promise a full back-up service.

Installing the system

The system will operate without floppy disk drives, but since I imagined that most people would be buying it largely because of the controller, I wanted to incorporate this. So I connected two 8in Shugart SA800 units.

The video section provides a 60Hz frame signal for a monitor which gave no problems. I would not advise anyone to fit their own modulator for running this board on a normal television because any display of 80 characters per line is generally unreadable on a normal television. Although Maclin-Zand says that later versions of the board will operate with a 50Hz frame frequency, I would still advise use with a monitor.

Memory arrangements

Bigboard has a full 64k of usable RAM, plus 2k of video RAM, plus up to 8k of EPROM type 2516. The video RAM and EPROM are addressed at the cost of temporarily switching out some of the 64k main RAM. Bigboard switches between alternative memory blocks by addressing an appropriate output port location.

On power up, Bigboard switches out the first 16k of RAM and makes the 8k block of EPROM available instead. It starts by executing the monitor program in this EPROM at address zero. The first instruction is the Z80 block move, which relocates the monitor to the top of RAM. Bigboard then makes a simple jump to the new copy of the monitor in RAM which then switches the bottom block of RAM back into use. Pressing the reset button does the same trick. 6k of the EPROM are not used at the moment and so are free for user programs. The memory-mapped video display similarly block switches between video and normal RAM. For the rest of the time, the whole of RAM is available for use in whatever way the user wishes. This contrasts with systems where some of the memory addresses are taken up permanently with EPROM.

Bigboard's ports, in common with all Z80 systems, are addressed by separate IN and OUT commands and don't take up memory locations. Its port addresses are used not only for the usual input and output from the board, but also to control the baud rate of the serial ports, scrolling for the video, and block switching of the memory as described above.

The character set

Like many systems giving 24 lines of 80 characters, each of Bigboard's characters is formed using a 5 x 7 dot matrix. I found these characters rather difficult to read and I was particularly unimpressed by the way lower case is presented as a smaller version of upper case. I would have preferred a true lower case, although I appreciate that, with so few dots available, it would have required some compromise in displaying the descenders of letters, like y and g.

This character set would detract from Bigboard being used as the basis for a word processor unless a separate serial terminal is used with its own character set. Alternatively, if a suitable program was written, Bigboard could drive a daisywheel printer to give a quality printout.

The system commands

Bigboard powers up to display the message '. . . system 3.3 . . .', followed on the next line with an asterisk and a dash as a non-flashing cursor. Eleven single letter commands are available before CP/M is called up: in particular, D to display the contents of a block of memory; M to display the contents of successive individual memory locations to allow them to be changed; R to read a sector from disk into memory; and of course B to boot in CP/M.

Two commands strike me as unnecessary: one to test memory and the other to verify that two memory blocks hold the same information. I feel that these are only needed if the system has problems with corrupted data in memory, and that for a properly debugged system there are many more useful commands that could be supplied instead, for example, to write a block of memory out to disk.

Bigboard requires all commands with numbers to be typed in with only commas as separators and with no extra spaces anywhere. This is simple to get used to, but might be a little annoying at first to anyone used to a freer format.

I see purchasers adding other commands to the monitor program which, at present, makes no use of the scroll and cursor movement facilities, available as subroutines. I think it's a pity that Bigboard doesn't come with these; it would seem a relatively simple matter to provide full cursor control and on-screen editing, which would make such a difference.

Keyboard

Any keyboard should be suitable, provided it supplies the ASCII codes directly along seven wires (bits 0 to 6) together with a strobe signal going high or low when the data is ready. The strobe line prevents there being significant problems with contact bounce. All power supply lines are available on Bigboard's keyboard connector.

Floppy disks

Bigboard uses the 1771 controller chip and can drive up to four SA800 or similar disk drives. Connections are standard. It powered up without trouble and, on typing B for boot, came up with the message '60k CP/M version 2.2'.

With the use of CP/M, a wide range of software should be available for purchase, although any with specialised screen displays may have to be modified. As it is too early for any commercial software to be advertised for Bigboard, and as the review board was supplied with no software other than CP/M 2.2, I borrowed a copy of Basic from another CP/M system. I found no problems running it.

I checked a large number of the disk copy, verify and editing commands without any problems.

Video

The video is memory-mapped in a 2k section which Bigboard block switches; it is therefore independent of the main RAM at the same address, 3000H.

When the screen is written to, it fills from the top down and, when it is full, the display moves up each time a new line is entered. The screen may also be scrolled up or down by writing to an appropriate port, in which case any lines moving off the top will reappear on the bottom and vice versa. I see few occasions for using this facility.

Writing to the screen is by means of a subroutine in the monitor and occurs at the current cursor position which may be moved up/down, left/right. The user could also block switch in the video RAM and write direct to it, but the method of scrolling the screen would have to be taken into account which would make the programming trickier.

Expansion possibilities

Bigboard has been designed to be complete in itself, and no external bus connector of any sort is provided. The system should be used within the facilities offered, and should not rely on later expansion, as this may not be simple or indeed possible.

Documentation

Bigboard is supplied with an 11 sheet construction manual, a seven sheet user manual, a seven sheet theory of operation manual and very clear circuit diagrams. The manuals are rather brief, but are in accordance with Bigboard, being for people with some expertise.

Technical Data

CPU:	Z80 2.5 MHz
Memory:	64k dynamic RAM +8k EPROM type 2516 (Only the 2k system monitor supplied) +2k video ram
Bus:	Not available
Ports:	2 serial, 2 parallel uncommitted + ASCII keyboard port
System: S/W:	Monitor with 11 commands, CP/M

OPTIONAL ANCILLIARIES

For full potential an 8M Shugart SA power supply is needed.
+2k video RAM
800 compatible disk drive and associated power supply.

NECESSARY ANCILLIARIES
(Not supplied with the kit)

Power supply:	+5V 3A + 12V .25A −12V .2A

ASCII keyboard with strobe line
Video monitor

At a glance

Bigboard has some very attractive features, in particular the incorporated floppy disk controller and the full 64k RAM.

In summary, Bigboard's ports could drive a printer, a modem, a serial terminal and an ASCII keyboard and still have one 8-bit port spare. As no software is supplied to run the system, the user would have to write it himself.

With Bigboard, a system of video monitor, keyboard, 8in floppy disk with CP/M and power supplies can be put together for less than £1000, which is certainly not unreasonable.

Overall I consider Bigboard to offer good value for money. I found it easy to set up and use and I suspect that for those with some experience it would be fairly straightforward to build from a kit. The lack of a bus arrangement limits expansion considerably but then you do get quite a system for your money. The ability to use CP/M makes an enormous number of packages available to the user and that, coupled with the 64k memory, must be one of the strongest points in Bigboard's favour.

PRINTERFACING

Peter Faff concludes his series on hooking low-cost printers to micros.

Printina MP 18S electro-sensitive print mechanism

The MP 18S is a fairly compact electro-sensitive printer that functions in an unusual but very clever fashion. The print needles are mounted on a plastic arm that moves in and out of the printer frame itself, while the connection to the print needles is made by seven wiping contacts, plus a separate set that generates the timing signals. Due to its method of construction this printer needs to be ordered with a special printed circuit board, which serves two purposes. Firstly, it provides a mount for the printer and enables the paper feed to function, and, secondly, it carries gold-plated tracks that enable the connections to be made to the print needles. The print mechanism and the mounting board are both available from Seltek Instruments Ltd at £58 and £4.25 respectively.

The mechanism itself is simple and there is little to be said about how to use it. Printing is carried out from left to right in a serial fashion: that is, dot column by dot column. The timing tracks on the board indicate when to turn off the motor power at the end of a line and when to start printing a new line. Print format is 5x7 bit, and the unit can print up to about 21 characters on the paper. The spacing between dot columns is determined by an external dot clock. By varying this clock frequency you can alter the number and the size of the characters that are printed.

As the unit is so simple I will only give a brief description of the control logic required. A block diagram of the control circuit is given in Figure 1. When the motor is started, one of the moving contacts will indicate when the start of the line is reached; when this occurs you must allow a short delay before starting to print. This delay will give the left hand margin. The frequency of the dot clock determines the dot spacing and should be varied to taste.

The next stage is the column counter, which determines which of the five possible seven-bit data words is output by the character generator. This counter should count from 1 to 7, then reset to 1 and start counting up again. The first five counts will select the five possible columns of the 5x7 character cell while the next two counts will give a space between the characters.

A further stage is the character counter. This addresses the line store RAM and selects the 6-bit data for each character in turn. These six data bits go to the character generator where they select the correct page of 5x7 data. This character counter is incremented by one each time the column counter resets from 7 to 1. The counter's upper limit is determined by the number of characters you wish to print. When the counter reaches its maximum count, the line of print is finished and the various stages should be reset ready for the next line. Power to the motor should be turned off when indicated by the timing contact. You can see that this printer builds up characters from left to right and that the characters to be printed are sequentially read out of the RAM until the line is finished. The motor requires a supply of approx 5V. The print head supply should be somewhere in the region of 40—60V between the paper roll and the print needles. The pulse width required to print a dot should be adjusted to give good print density. If you wish to print large characters, you will find that the individual dots are not very clear; one way around this problem is to print two adjacent dots instead of one. This will complicate the circuit slightly but the resultant print is much more legible.

Olivetti series PU1828 & PU1840 parallel thermal printers/plotters

These two mechanisms look like stretched versions of the PU-1800 printer described in January. The main difference is that both units have a modified timing disc which enables them to print a continuous field of characters or dots; both units can thus be used as printers or plotters. The PU-1800 cannot be used as a plotter because it can only

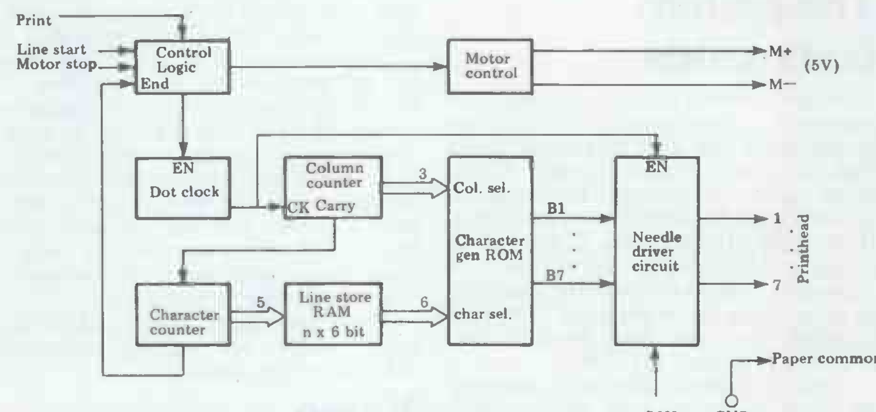


Fig 1 MP18S control circuit block diagram.

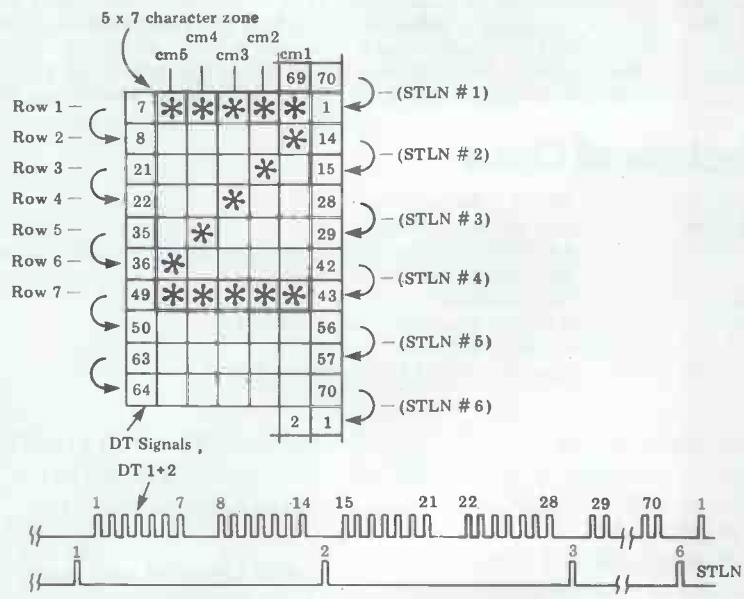


Fig 2 Diagram of character cell covered by each thermal element and relationship of DT 1+2 and STLN timing signals to character matrix for PU 1828 printer.

print columns of five dots. The PU-1828 and the PU-1840 are both available from Roxburgh Printers Ltd and cost £40.50 and £76.50 respectively. The PU-1828 is a 28-character printer that has one element for each character field; the PU-1840 is a 40-character printer that has one element for every two characters.

The PU-1828 differs from the other units in that it has one print element per character, which makes it somewhat easier to drive because there is no need to work out which character out of two is being printed. When designing a control circuit for this printer, you first need to know which dot in the character zone is to be printed next. After the DT1 and the DT2 signals have been ORed together and debounced by a suitable monostable, the resultant pulse train should go to a counter. At the start of the print cycle, this counter should be set to zero. The first DT1+2 pulse to occur will then set this counter to 1, indicating that the next character to be printed is the first in the character field. The control logic must now load the first dot of the 28 characters to be printed into the 28-bit latch. When the next DT1+2 pulse occurs this will enable the latch outputs to print a line of 28 dots. This pulse will also increment the counter indicating that the next dot to be printed is the second one in the character field; the control logic must now load the state of the second 28 dots into the latch ready for the next DT1+2 pulse. Each successive DT1+2 signal thus enables the latch outputs and increments the counter by one. When the counter reaches a count of 6, the dot selection logic should be disabled; the next DT1+2 pulse to occur is the last of the first group (see Figure 2). This pulse should reverse the count direction so that the next pulse to occur will cause the counter to count down from 6.

At this point, the print head also reverses the direction of its travel and the paper is spaced up by one dot line. The next DT1+2 signal is thus the first of the second group, decrementing the counter by one to 5. The counter now indicates that the fifth dot of the dot line can now be loaded into the 28-bit latch ready to be printed by the next DT1+2 pulse to occur; this pulse will also decrement the counter to 4. This process continues until the counter reads 1; the logic now loads the first dot of the second dot line into the latch ready to be printed by the next DT1+2 pulse, which also decrements the counter to 0. The counter is now reset to 0 by the STLN signal and the count direction is set to 'up'; as this occurs, the print head again reverses and the paper is moved up by one dot line again.

The next DT1+2 signal to occur is the first of the third group and this increments the counter by one to indicate that the next dot to be printed is the first of the third group. The cycle then continues as outlined above so that, at any time, the control logic can look at this counter to find out which dot is next in line to be printed. The next step is to determine which row is being printed. The best way to do this is to use a counter that is reset to 1 by the first STLN pulse to occur after the 'print start' command. This counter will thus indicate that the first row is being printed. After seven DT1+2 pulses, this counter will increment by one to indicate that the second row of dots is being printed, and so on. In this way you can keep track of which row is being printed at any one time.

Now that you know which row and column is being printed, you can identify any dot out of the 5x7 character matrix. As explained above, the state of this dot now has to be loaded into the 28-bit latch; since there are 28 latch positions the loading routine must be carried out 28 times, once for each character position. The dot counter and the row counter remain fixed for each line of dots. You now have to determine the state of the first dot. To do this, the first RAM location is addressed and the resultant 6-bit output is fed to the character generator ROM. This ROM outputs seven-bit slices out of a 5x7 character zone; a 3-bit address from the coloumn counter will indicate which of the five possible 7-bit slices will be output. This 7-bit word is then further processed by a data selector (controlled by the row counter) which selects one of the seven bits and outputs it. The single bit of data that results is then loaded into the first location of the 28-bit latch. The next RAM location is now selected by a counter and the stored character data is output to the character generator ROM; the row and column counters do not change while this is going on.

The single bit data output of the data selector is then loaded into the second latch position. This process continues until all 28 latch positions have been filled, at which point the cycle stops, and when the next DT1+2 pulse occurs the latch outputs will be enabled and the 28 elements will simultaneously print a complete line of 28 dots. As this occurs, the column counter will increment by one and the row counter may also change. The control logic must now cycle through the 28 RAM locations again in order to load the data for the next dot into the latch. The cycle continues as outlined above until the entire row of characters is printed. When the row counter reaches eight, the selection logic should be disabled; the power to the motor should be turned off when the next STLN pulse occurs, and a dynamic break circuit should be employed to bring the motor to a swift halt. When you wish to print another line, the motor power should again be turned on and the control logic must wait for the next STLN pulse, which will initialise all the counters and allow the cycle to continue as outlined above. If you refer to Figure 6, you will find a block diagram of the control circuit as described above, which should help you to understand the circuit operation.

The PU-1840 is a 40-character print-

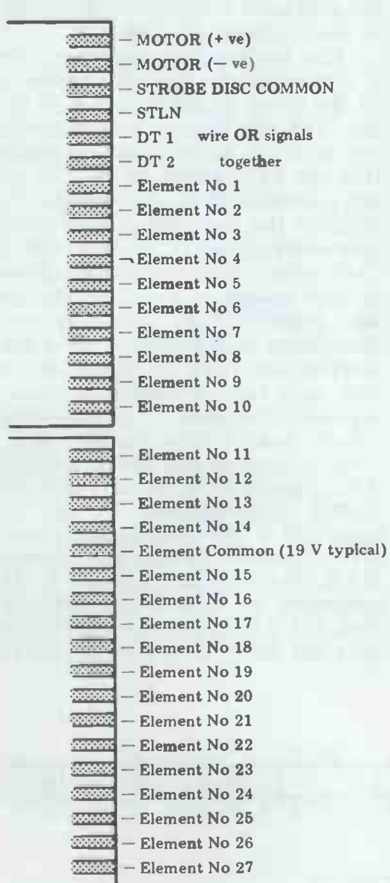


Fig 3 Connection diagram for PU 1828 flexible connector.

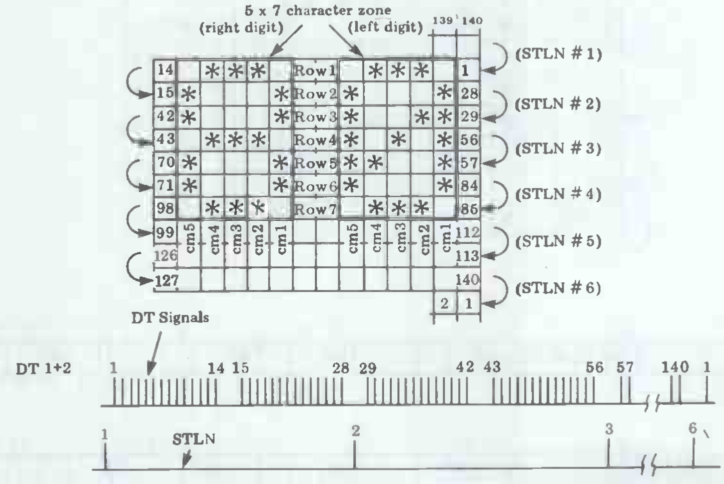


Fig 4 Diagram of character cell covered by each thermal element and relationship of DT 1+2 and STLN timing signals to character matrix for PU 1840 printer.

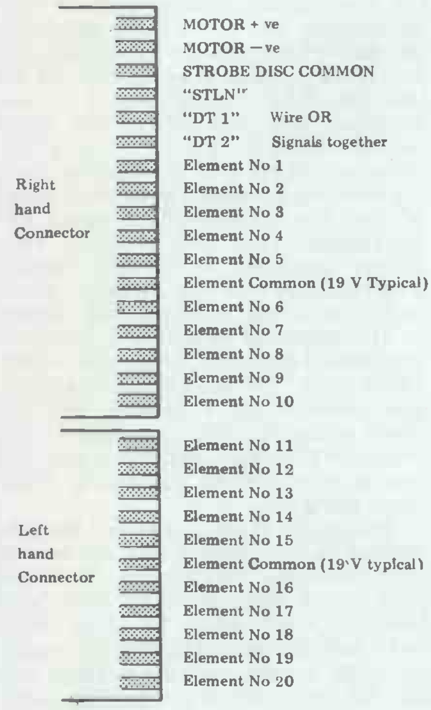


Fig 5 Connection diagram of PU 1840 flexible connectors.

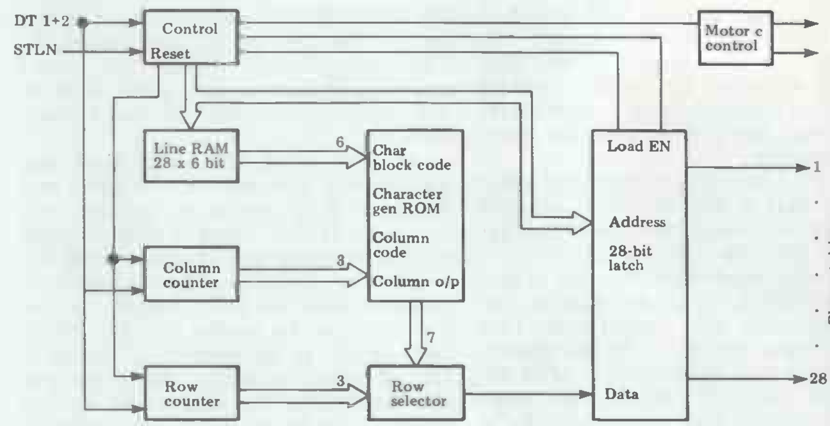


Fig 6 PU 1828 suggested control circuit block diagram.

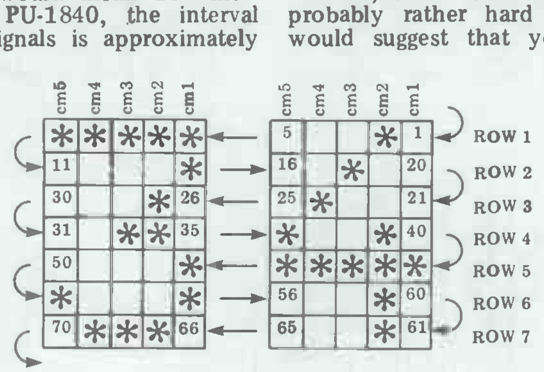
er that uses 20 thermal elements. Each element covers an array of 14 x n dots which can contain two 5 x 7 character cells as shown in Figure 4. This printer could be used with a modified version of the control circuit suggested for the Olivetti PU-1800 thermal printer in January's 'Printerfacing', but for the purposes of this article I will suggest an alternative circuit that you may like to try out.

With the circuit described in January, most of the processing required to determine which dots are to be printed next is carried out in the interval between DT signals. Further, this processing must be repeated for every thermal element. In the case of the PU-1840, this would mean 20 times. Now for the PU-1840, the interval between DT signals is approximately 2.7 ms; you therefore have only about 130 μs in which to read a character out of the line store RAM into the character generator, select the correct bit from the resultant character column output and load this bit into the correct position of the 20-bit latch.

This might seem to be pushing things slightly, so I have devised an alternative circuit where all the processing is carried out before the start of the print cycle. With this circuit, the data for each element is stored in a shift register, from which it can be read out and sent directly to the print element drivers with the minimum of fuss. This approach is probably the best to use with a series parallel printer that has a large number of columns, such as the PU-1840. By referring to Figure 7 you will see how each print element of the PU-1840 scans through two character cells within the 14 x n bit character zone. The diagram below this figure shows how the information required to print these two characters would be stored in a 70-bit shift register. Each group of five dots that makes up each row is stored in the sequence that it will be required by the print element.

Now, since 70-bit shift registers are probably rather hard to come by, I would suggest that you use a RAM instead. For instance, a 256 x 4 bit RAM could be used to replace four 70-bit shift registers — these days RAMs are also very cheap. The PU-1840 has 20 print elements so you will require five RAMs. By referring to Figure 8, you will be able to get a rough idea of how the circuit functions. The first section is the address counter for the line store RAM. When the print cycle is started, this counter should be reset. The least significant bit of this counter can be set independently of the rest and it determines which character is to be printed, ie, left to right. The counter itself cycles through a count of 1 to 20. The resultant 6-bit address goes to the line store RAM. The character stored in the selected RAM location is then output to the character generator.

Also feeding this character generator is a row counter that determines which of the seven possible rows is to be output. This row counter is incremented by one after the address counter has cycled through a full count of 40. The character generator thus outputs the five-bit data for the first row of each of the 40 characters stored in the line store RAM. The output of the character generator is then loaded into one of the four 5-bit parallel load serial output bidirectional shift registers. When the first rows of the first four right hand characters have been loaded into these shift registers, the data is shifted out and serially loaded into the first five locations of one of the 256 x 4 bit RAMs. The direction in which the data is shifted is determined by the control logic and it will reverse after the second set of five-bit data is shifted into the RAM. The five 256 x 4 bit RAMs are addressed in turn and eventually the first five RAM locations will contain the data for the first row of 20 right hand



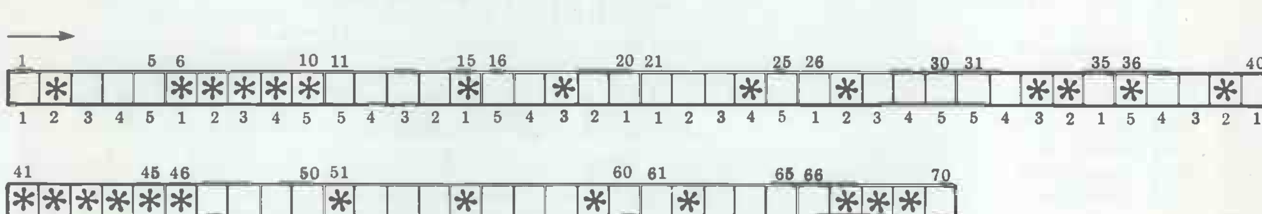


Fig 7 How data for one thermal element is stored in a 70-bit shift register.

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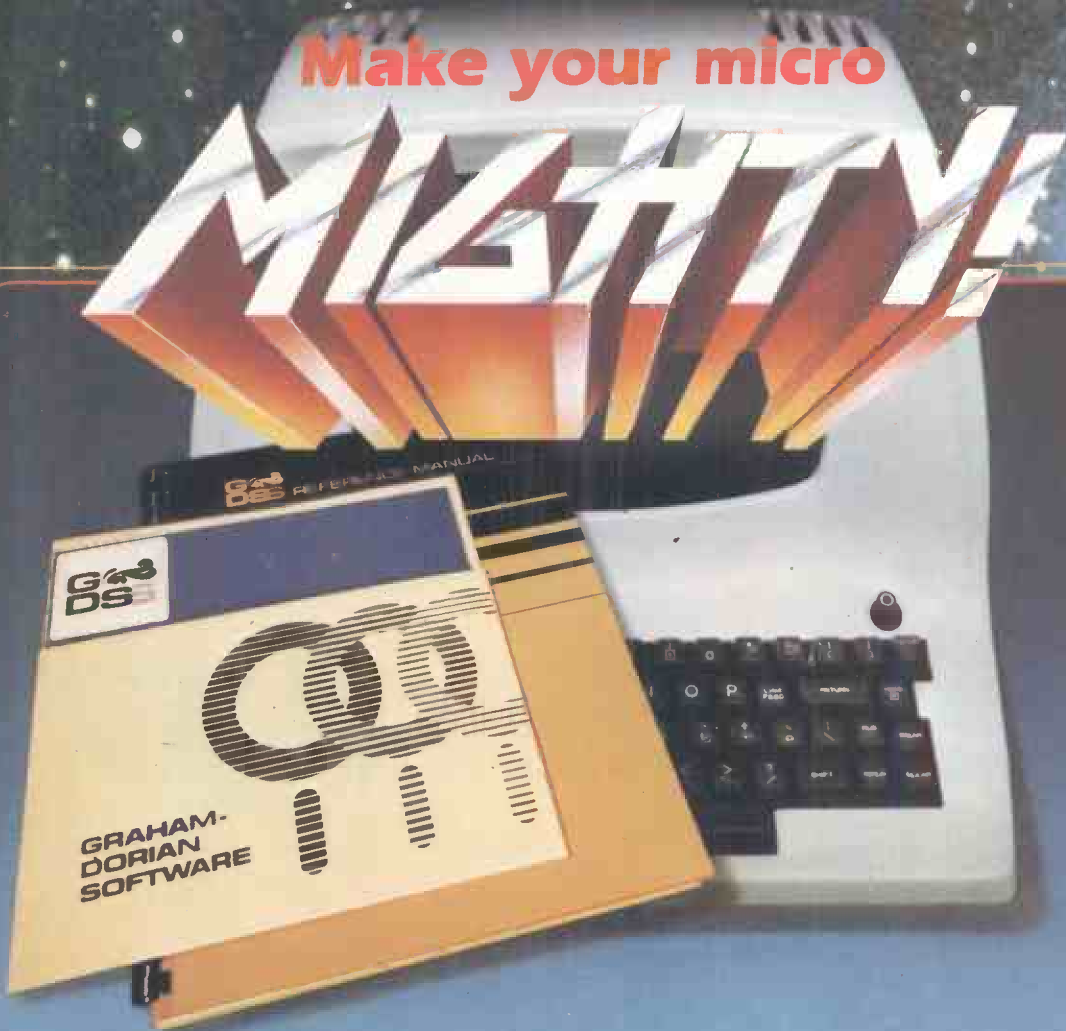

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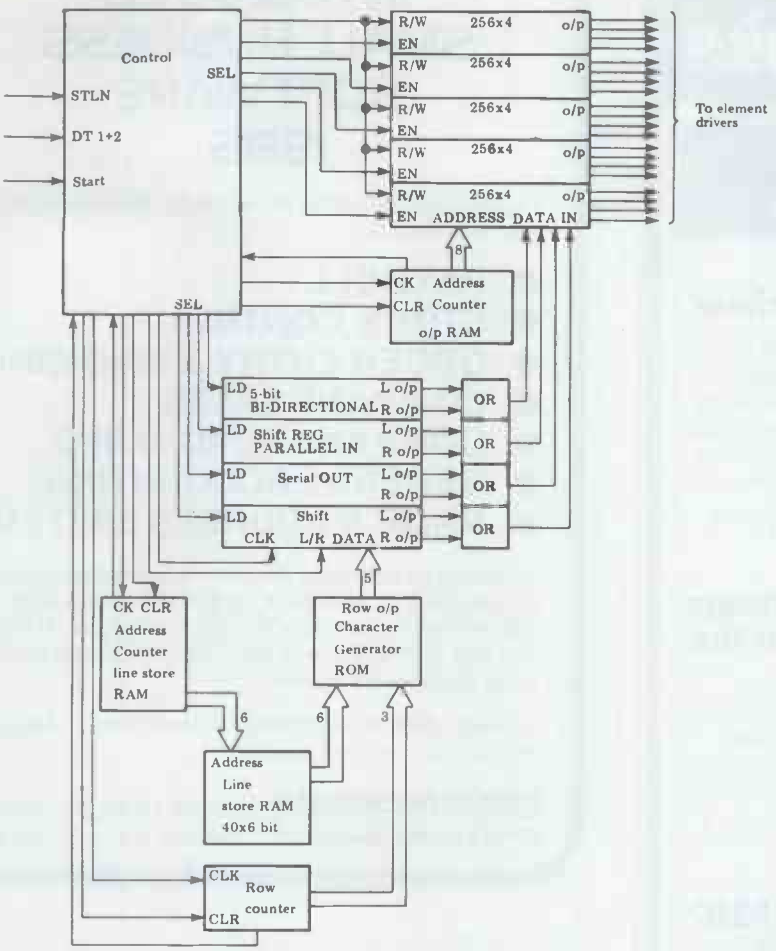

Fig 8 Block diagram of alternative control circuit for PU 1840 etc.

characters.

This process is repeated again, but this time the address counter selects the 20 left hand characters stored in the line store RAM. The first row of data for these 20 characters is then loaded into the second set of five RAM locations. When the first ten RAM locations have been filled, the row counter selects the next row of character data stored in the character generator and the data for the 20 left and right characters can again be loaded into the output RAM, only it now goes into the second set of ten RAM locations. Since the row counter has changed, the data will have to be reversed and so the control logic changes the shift direction of the shift register. This ensures that the data is again loaded into the output RAM in the correct sequence required to drive the elements. This process of cycling through the line store RAM is repeated until the data for all seven rows have been correctly stored. When the cycle stops each 256 x 4 bit RAM will contain a 70-bit long data stream that corresponds to that shown in Figure 7.

The 20 RAM outputs can thus be used to control a thermal element directly. When the print cycle proper is then started, the logic will wait for the next STLN signal and when this occurs the DT1+2 signals will be used to clock the output RAM address counter and the stored data will be read out to energise the thermal elements in the correct sequence to print a line of 20 characters dot by dot. With the PU-1800 printer, the DT1+2 signals could be used directly but when using the PU 1828 or the PU 1840 you will have to allow for the two-dot space between characters and also the single-dot space at the edge of the 14 x n bit character field.

If you wish to use the PU 1828 or the PU 1840 for plotting, you will have to try a different approach. I suggest dividing each 14 x n bit character field into two 7-bit columns. You can then load the 7-bit data word for the 20 left or right hand columns into shift registers in groups of four. The data in these shift registers could then be left or right shifted into a 256 x 20 bit RAM array. When 140 bits of data have been loaded into the RAM, the character zone will have been filled and the data stored in this RAM can then be directly clocked out by the DT signals and fed to the element drivers. This is again very similar to the process outlined above for the character-only printer.

Anyway, that just about sums up the Olivetti thermal printer series. Please bear in mind that the ideas given above are just suggestions and will require further development to suit your particular application. Remember that you can always contact me by *writing* to (*not* telephoning) *PCW* if you run into difficulties. I will try to help out anyone who bothers to ask.

Datac DMI 40 print mechanism

The DMI40 is a 40-column series-parallel impact printer with five solenoids mounted on an oscillating frame, each covering eight character cells. The mechanism can also be used for graphics and plotting because the print is not constrained by a preset timing disc to print only in columns. In order to print a complete line, the print head must make seven passes over the paper as well as two passes for the line space. It operates at approximately two lines per second. The basic mechanism prints on pressure-sensitive paper only, but a version fitted with a roll holder will shortly be available. The DMI-40 is available from Datac Ltd and costs approximately £139.

The DMI-40 is rugged and should therefore give years of trouble-free service. The motor and the five solenoids both require a 12V DC supply. The dot timing signals are generated by a slotted strip and a LED and phototransistor assembly. This timing assembly generates one dot pulse DTS for each dot position. Using a 5x7 character matrix, each dot line will contain 240 dots; each print element thus prints 48 dots for each pass across the paper. By referring to Figure 9 you will see the zone that each print element covers; each zone contains eight characters and there are five zones across the width of the paper. During operation the five zones are printed simultaneously.

Designing a control circuit for this printer will pose problems similar to those posed by the Olivetti series-parallel printer mentioned in January. From Figure 9 you will see that each print element prints eight characters. The print element moves from left to right and then from right to left down through the column of eight characters. On each pass, an element can print up to 48 dots. The timing strip generates 48 pulses as the print head moves across the paper; at the end of each dot row a fairly long home region is located where no pulses are generated. During this home period, the print head reverses and the paper is spaced up by one dot line. Figure 10 shows a block diagram of a suggested control circuit. The four important stages on this diagram are the column counter, the character

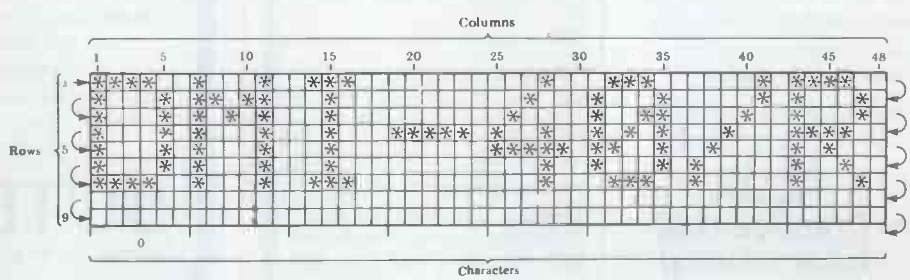

Fig 9 Character zone covered by each print element.

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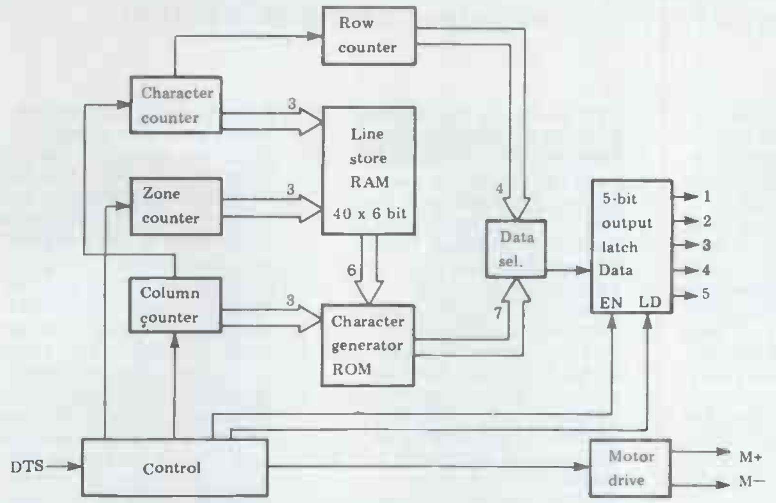


Fig 10 Suggested DMI 40 control circuit.

counter, the row counter and the zone counter. The column counter keeps track of which column is to be printed at any one time. At the start of a print cycle when the control logic detects the home signal, the various stages are reset. At this time the column counter will read 0 to indicate that the first column is to be printed. Some time after the leading edge of the DTS signal all the processing will have been carried out and the 5-bit latch will contain data for the first dots to be printed. The control logic will then print these dots and then on the trailing edge of the DTS signal the column counter will be incremented to read one, indicating that the column number one is next to be printed. This continues until the counter reaches a count of five, which is the space column and so no dots will be printed.

The next DTS pulse will cause the counter to reset to zero, thus indicating that column number zero is to be printed next. In this way, the control logic always knows which dot is being printed next and therefore it has time to get the next series of dots loaded into the 5-bit latch. The column counter is an up/down counter; for the first eight characters it counts up from zero to five and for the next eight characters it reverses its count direction and counts down from five to zero. This is to allow for the print head reversing after every row of dots and is under the control of the control logic.

The next stage is the character counter. This counter keeps track of which character is being printed. The counter is clocked by a carry signal from the column counter; this carry is generated every time that the column counter resets. From start, this counter will count up to seven which is the last character of the first row. The next carry pulse now causes the counter to reverse its count direction. The next carry will now decrement the counter to six, and so on. When the counter now reaches zero it will again be reversed by one carry pulse and the next carry pulse will increment the counter to one again. In this way, the character counter keeps in step with the print head as it zig-zags across the paper.

The third stage is the row counter which keeps track of which row is being printed. This counter is incremented by a carry pulse that is generated every time that the character counter reverses. From reset this counter counts up to nine, when the motor should be stopped, as the print cycle plus line space is now finished. The four-bit output of the row counter goes to a data selector which selects one bit from the seven that are output by the character generator ROM. This bit will belong to the row that is being printed at that time.

Next is the zone counter, which cycles through the five zones that cover the paper while the other stages remain fixed. The zone counter cycles through a count of zero to four selecting, in turn, five blocks of eight characters each from the line store RAM. The 3-bit data from the zone counter also goes to the output latch where it selects the bit that corresponds to the character zone being printed. This allows five bits of data to be loaded in turn into the output latch ready for printing. Thus, as the zone counter cycles through the five blocks of data, one of the eight available data words is being selected by the character counter. The five data words that are thus selected go in turn to the character generator, which outputs a 7-bit data word which is sent to the data selector where one of the seven bits is passed and then loaded into the five bit output latch in the position pointed to by the zone counter. You can see that the dot selection process only has to be repeated five times, whereas the Olivetti series-parallel printer required that the selection process be repeated ten times, which is a little bit more difficult. This circuit might seem a little complex at first but if you spend some time studying Figure 9 so that you become familiar with the print format and how the data bits have to be selected in turn, you will understand the operation that much better.

The block diagram and the description is given only as a guide to point you in the right direction and you will have to undertake a certain amount of development work before you have a working printer, so good luck.

Conclusion

I hope that you have enjoyed this short series of articles, which was inspired by a letter in 'Communications' last July by reader H P Stearn, who asked if it was possible to interface a cheapo calculator type printer to a KIM computer.

In order to make this series useful to as many people as possible, I have refrained from any mention of specific microprocessor systems, and have given a short survey of the various cheap dot matrix printers that are available in this country. I have also explained how the units work and suggested ideas for control circuits. Since the interface requirements of most peoples' systems will differ, this side of the construction has been left to you.

With the circuits given you will have to load the ASCII data for the line to be printed into the block that is shown as the line store RAM on my block diagrams. All the circuits suggested are self-contained in that they only have to be loaded with a line of data and told to print. This means that the micro is not tied up controlling a peripheral that could function on its own. Since you will be building the unit yourself, the extra work and cost involved is not too important. I estimate that for between £50 and £100 you should be able to build a control circuit for the printer of your choice.

At the end of the exercise you will have a printer that costs less than a commercial unit and you will also have had the satisfaction of building the thing yourself. You could, of course, write suitable software that would enable your micro to control the printer directly. This approach is certainly far cheaper but it does have the disadvantage of tying up your processor when it could be doing other things. Remember that if you run into any problems you can contact me via *PCW* and I will do my best to help you out.

Suppliers of units mentioned are: Seltek Instruments Ltd, The Old Pied Bull, High Street, Stanstead Abbots, Herts SG12 8AB, tel 0920 871094. Roxburgh Printers Ltd, 22 Winchelsea Road, Rye, East Sussex TN31 7BR, tel 07973 3777. Datac Ltd, Tudor Road, Broadheath, Altrincham, Cheshire WA14 5TN, tel 061-941 2351/2.

Is it good? My dear fellow, this is the very machine that wrote the last 600 episodes of 'Crossroads'!

BOOKFARE

Malcolm Peltu reviews more books on social and political microimplications.

Makers or breakers?

Mindstorms sounds like the title of a John Lennon song. It represents the kind of cultural and personal thoughtquakes and whirlpools of ideas which helped to shape Lennon and which, in turn, he helped to create.

Mindstorms (at least as far as this 'Bookfare' goes) is also the title of an important new book by Seymour Papert. In it he explains why he believes that computers could become an educational aid which will overcome 'mathophobia' and the cultural blocks which have divided people from an early age into arts/ humanistic/'creative' or maths/scientific/'boring'-technological ghettoes.

Architect or Bee?, on the other hand, sounds like the start of a children's ABC or a constructively censored version of the old Birds and Bees tale. It is, however, a question based on a phrase from Karl Marx and the title of another thought-stirring book which examines the relationship (or possibly the power struggle) between people and technology.

The author of this book, technologist and active trade unionist Mike Cooley, uses the Marxist analogy because it encapsulates his fear that computers are being used to emasculate creative skills.

Marx wrote: 'A bee puts to shame many an architect in the construction of its cells; but what distinguishes the worst of architects from the best of bees is namely this. The architect will construct in his imagination that which he will ultimately erect in reality. At the end of the labour process, we get that which existed in the consciousness of the labourer at its commencement.'

Supported by a range of practical examples, Cooley shows how computers have been used to human creativity from many jobs, such as toolmaking and engineering design, thereby diminishing human beings and making them 'subordinate to the machine.'

Unlike many left-wing critics of technology, however, Cooley also shows how computers could be used as a human-enhancing, liberatory form of technology. He shares with Papert a belief that, in the right political and cultural environment, computing could be a positive social force.

Cooley states unequivocally 'Human ingenuity, expressed through appropriate science and technology, could do much to free our world from squalor and disease and fulfil our basic needs of food, warmth and shelter.' Papert believes that, by placing computer power in the hands of many people, the personal computer explosion will open new opportunities for imagination and originality. 'There might be a renaissance of thinking about education,' he concludes.

They also agree that the determining factor in the direction taken by computing will not be technical but political and cultural. Mindstorms are needed, they argue in their different ways, in order to create an environment which places the fulfilment of individual creative potential as well as community well-being as a prime social goal. 'The bottom line for such change is political,' as Papert inelegantly expresses it.

Papert, however, is a technological optimist who believes that the capitalist environment could, after some mindstorming, be a suitable base for nourishing the darling buds of computer creativity. Cooley, on the other hand, believes that the forces currently dominating most societies (and he is critical of Russian communism as well as Western capitalism) are so strong that computing will be used by those in power to 'gain control over human beings' because, as a headline in *The Engineer* once stated: 'People are trouble but machines obey.'

Cooley quotes positive examples of the use of computers in 'human-enhancing' roles but regards them as insignificant drops in the political ocean compared with the majority of industrial applications. Papert, however, quotes his own personal experiences with one computer educational project as proof of the potency and practicality of his vision.

Papert is a professor of both mathematics and education at the Massachusetts Institute of Technology (MIT). Since 1967 he has been developing a special computer language for use by children called Logo. The Logo group in the Artificial Intelligence (AI) laboratory at MIT has used Logo with a movable device called a Turtle as a means of teaching mathematical concepts like geometry and the Newtonian laws of motion as well as computer programming techniques and structured systems thinking.

Papert, however, predicts that the mindstorms set off by computer techniques like Logo will create new approaches to the whole process of education and training. He explains the twin objectives of Logo by pointing out that the Greek word 'math' meant 'learning' and that Logo has applications both in mathematics and in ' 'mathetic' (learning about learning) techniques.

He believes that the computer can make formal, abstract ideas concrete and personal to a child. Even 'difficult' concepts like differential geometry can be translated into Logo programs which control the movement of the Turtle. The child views Turtle geometry partly as a game which tries to create different shapes made up of simple program steps which move the Turtle forwards, to the right, etc.

For example, a child could be asked to: 'Play Turtle. Draw a circle.' After experimenting with Logo programming, the child will realise that drawing a circle involves the repetition of a large number of very small Logo programming steps of the form FORWARD 1 RIGHT 1 1, where '1' indicates to the Turtle to 'move a little bit'.

This is effectively an intuitive analogue of the differential equation, a concept that is fundamental to traditional applied mathematics. Differential calculus describes growth by explaining what is happening at the growing tip; the Turtle program describes the difference between where it is now and where it shall be in a moment.

Although the child will not be immediately aware of the relationship between the Logo circle program and the differential calculus, Papert believes that the knowledge which the child learns in a concrete way will become a point of reference when learning about wider mathematical ideas.

Most significantly, claims Papert, the child will be learning the languages of mathematics in a natural way and will not feel excluded from the world of mathematics as do so many children when faced with traditional, formalised classroom maths.

Papert describes the learning environment created by Logo and the Turtle as a Mathland in which children can learn the language of mathematics as naturally as English children learn English in England and French children learn French in France. What is more, he argues that procedural and systems thinking inherent in computer techniques and systems 'powerful intellectual tool'.

As one child working with Logo described it, structured programming techniques break complex ideas into 'mind-sized bites'. The child may initially learn the benefit of this when trying to draw a figure with the Turtle but finds bugs in the program. An unstructured program is difficult to debug but the fault in a well-organised modular program is more easily identified and rectified.

Working in the Turtle Mathland, children therefore learn a systematic approach to generalised problem solving. The child knows why, for example, overall complex problems should be broken into simpler, 'mind-sized bites' and can be related to problems that are already understood. From drawing a circle, more complex problems can be explored. The notion of debugging teaches a child that there are no simple right/wrong solutions to the process of exploring new ideas and that a key question is whether the overall 'theoretical' structure is 'fixable' or basically incorrect.

From a cultural point of view, this type of use of computers to 'concretise' formal ideas could help to break through what he calls the 'balkanisation of human knowledge which children come to see as a patchwork of territories separated by impassable iron curtains.' Difficulty with school maths is frequently the first step of an 'invasive intellectual process that leads us all to define ourselves as bundles of aptitudes and ineptitudes, as being "mathematical" or "non-mathematical", "artistic" or "non-artistic",' he says.

Echoing the McLuhanism 'the medium is the message', Papert expects that the versatility of computing could, in the appropriate political and social environment, break through the shackles of traditional school maths which were created by the inadequacies of teaching tools in the past.

As he explains, 'A major factor that determined what went into school maths was what could be done in the setting of school classrooms with the primitive technology of pencil and paper.' This forced an emphasis on tasks like drawing graphs and writing formulae and created the notion of maths as an abstract, formal technique.

Yet, as Papert explains, mathematics can be based on physical actions. For example, Descartes apparently invented analytical geometry by observing the movements of a fly on his bedroom ceiling and Papert himself related mathematics to his childhood understanding of how the gears of a motor car worked. He has used Logo to analyse a supposedly purely physical activity like juggling into mathematical notions of structured thinking just as the 'physical' act of drawing a circle should be used to illustrate the theoretical concept of differential equations.

The challenges posed by Papert to traditional educational notions and description of possible learning innovations makes *Mindstorms* a stimulating book but more as a mind-rippler than a mind-stormer. Although his theory is a general one, Papert uses Logo as the only specific example, so that the book becomes mainly a justification for Logo. It also gets bogged down in a great deal of educational theorising which is an example of the 'thought balkanisation' which Papert so dislikes.

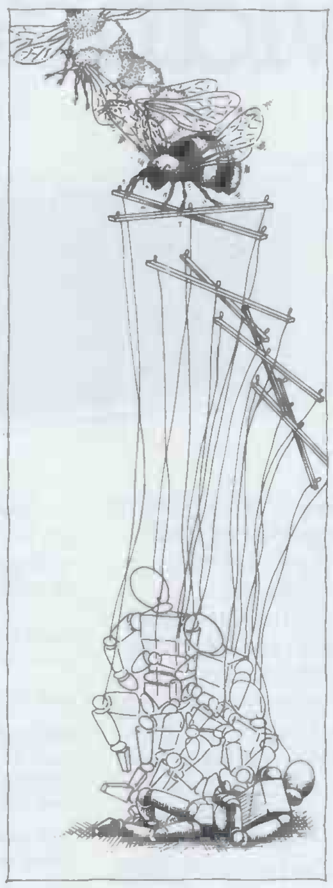
If ycu are an educationalist to whom 'Piaget's epsitemology', is second nature then you will not, as I did, begin to feel excluded from a special 'education psychology club' in parts of the book. The fixation with Logo and a too liberal sprinkling of educational jargon makes *Mindstorms* a book of specialist interest to those already involved in computing and/or education rather than a major work of general importance, which its thesis could have justified.

Papert also dismisses criticism of his beliefs too glibly. He accepts that the use of computers in education may not have the effect he intends. In most cases of existing educational use, he admits, computers are being used primarily to put children through their traditional arithmetic or spelling paces, reinforcing traditional school drill and practice techniques and imposing rigid, automated methods on children. Instead of becoming a tool, like a 'pencil', that children can use to experiment with, to think and to make things with, the computer imposes its way on the child.

His only answer is to say that he has seen children interact creatively with Logo and that he hopes experiments like Logo will stimulate a major change in 'how things might be'. In other words, he has little more to offer than wishy washy wishful thoughts.

Mike Cooley takes a much harsher and, to me, more realistic view of the equivalent dichotomy between experience and promise in the application of computing to employment.

He describes how humans and computers *could* interact creatively at work. It is possible, for example, to program a numerical-control machine by allowing the skilled craftsman to instruct the machine directly through a physical medium, such as turning a crank or moving a joystick, rather than using a symbolic programming language. This is close to Papert's Turtle concept of 'programming through doing'. There is also a technique of computer-aided design in which the designer's special skills and aptitudes for assessing complex situations and making intuitive leaps is emphasised, with the computer acting best as an excellent analyser and computational machine.



Cooley has also been actively involved in the Lucas Aerospace Combine Shop Stewards' Committee which has been internationally recognised as a major contribution to creating an environment in which industrial democracy is used to direct technology to socially beneficial uses. When faced with the prospect of redundancy, the Combine Committee created a corporate plan which included the development of a special vehicle for children with spina bifida, a life support system to help people with heart attacks to get to hospital, solar collecting equipment and a vehicle that could run on rail and roads. They would also like to have money to build kidney machines.

Unlike Papert's promotion of Logo, however, Cooley does not build a revolutionary mountain by clutching at these few positive straws. He uses these examples, however, to get to the political and economic 'bottom line' when he quotes the secretary of the Combine Committee who said, 'It is outrageous that our members in Lucas Aerospace are being made redundant when the state has to find them £40 a week to do nothing except suffer the degradation of the dole queue. . . Our workers should be given this money and allowed to produce socially useful products such as the kidney machine.' Social usefulness, however, is a not a bottom-line profit-making criterion in business.

Cooley provides many examples to show that a major management aim in introducing new technology is to reduce reliance on human skills and to improve productivity. He quotes an American systems designer, Robert Boguslaw, who put into words the usually unstated assumption and objective of many managements. Boguslaw says that systems designers should analyse the ways in which human behaviour can be controlled and to create the instruments which can achieve that control. In systems design, he says, the 'human operating units' have many disadvantages. 'They are somewhat fragile, unreliable and limited in memory capacity. But beyond all this, they sometimes seek to design their own circuitry. This in a material is unforgivable and any systems utilising them must devise appropriate safeguards.'

The bluntness of this quote is appalling, regarding people as 'materials' and 'operating units'. But many computer systems are designed precisely to this specification — to design human creativity and 'unreliability' *out of* rather than into the system. As an advert for a computer-aided design package put it: 'If you've got a guy who can produce drawings non-stop all day, never gets tired or ill, never strikes, is happy on half pay, with a photographic memory, you don't need (the name of the package).'

Cooley detects a trend towards developing library, medical, educational and other systems in which human/computer interaction communication replaces 'the rich interaction which comes from people discussing work problems with each other.' He fears, quite rightly, that this could lead to the loss of the open-ended cross fertilisation which flows from natural human interaction and that 'human beings could become industrial Robinson Crusoes in an island of machines.'

Apt and vivid phrases like these bring Cooley's work to life. The book is liberally peppered with crisp force people to become 'operating units' and discards them when they become too old or unreliable to obey the machine's commands.

It is a pity, therefore, that he should fall into the simplistic Marxist cliche that the potential of technology to free rather the enslave workers 'can only become actuality' when workers 'own the means of the production' and 'the object of their labour.' However, he also points out that Lenin believed that 'capitalist' techniques of automation should be the foundation of 'socialist' organisation and the Soviet Union espoused with enthusiasm the management notion of Taylorism or Scientific Management. This was introduced in the first wave of manufacturing automation in the early 20th Century by Frederick Winslow Taylor who summarised its aim as; 'In my system the workman is told precisely what he is to do and how he is to do it and any improvement he makes upon the instructions given to him is fatal to success' (sounds just like Boguslaw).

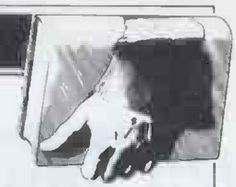
The means of production in 'socialist' countries clearly does not in itself harness technology to more humanistic ends. Solving the problems so lucidly posed by Cooley will need a much subtler, more complex approach than Cooley's solution.

Two other criticisms slightly tarnish Cooley's otherwise refreshingly stimulating book. Firstly, it is unworthy of his otherwise highly perceptive technological descriptions to suggest that, because IBM operating systems have hierarchical structures and use words like 'supervisor', the technology intrinsically implies a particular management philosophy; such technical developments were related to available technology and to solving the practical problem of scheduling multi programming and multi-access to systems, not to imposing a fascist organisational regime.

Secondly, and this is acknowledged by Shirley Cooley who edited the book, it is not so much a book but a compilation of various writings and speeches; as such, it is a bit disjointed and repetitive in places but this is overcome by the vigour and clarity of most of the text.

Between them, Cooley and Papert raise many urgent and important questions about the application of computer technology. From their different perspectives

Illustration by Gillian Lockhart



they converge on the belief that computers could enhance human life, although they can also impose inhuma inhumane conditions at work and in education.

Their interplay between practical politics and philosophical, humanistic thoughts would have appealed to John Lennon. Unfortunately, as Lennon's death showed, mindstorms can prove to be insufficient to overcome the forces of fear, violence and frustration created in a society where individuals feel alienated and part of a soul-less machine rather than a living, caring community.

Myth tickle

The *Myth of the Micro* by Ridney Dale and Ian Williamson is like a tasty and nourishing Christmas pud coated in shocking-pink marzipan. The startling cover may attract attention but spoils the wholesome goodies inside.

As with many other of the flood of books about the microelectronics 'revolution' the *Myth of the Micro* has been tarted up to try to appeal to the mass market created by the Horizon 'Chips' TV programme and Dr Chris Evans' *Mighty Micro* book and TV series. The Dale and Williamson twist is to disguise a very lively and readable introduction to micros and programming techniques as an attack on the micro 'myth' makers.

This leads them to scatter some sour-grapeshot against the pundits who have predicted the future importance of microelectronics. They reserve particular bile for Chris Evans and the title of the book seems clearly aimed at his *Mighty Micro.*

They make much of their attack using a generalised, guilt-by-implication technique. 'Futorologists have the misfortune to be spectators, divorced from the game — perhaps disinterestedly observing the play from the sidelines,' they comment.

Who are they talking about? Surely not Chris Evans? At the National Physical Laboratory, he was in the thick of micro developments and his team was one of the first in the UK to make innovative uses of the micro, particularly in socially useful activities like the Mavis aid to the disabled or the Mickie hospital patient interviewing system. Yet Evans is high on their list of myth makers.

Or could they be talking about a person who helped to trigger the fears about mass unemployment caused by the micro because of a report he helped to produce? But then Iann Barron, director of Inmos, minicomputer pioneer and co-author of *The Future with Microelectronics* could hardly be described as 'divorced' from the micro game. So, come on, Dale and Williamson — name some names please.

They quite blatantly state that 'Having thoroughly aired the scepticism with which we approach the myth of the micro what dare we ourselves say constructively about the world we face in the coming decade?' Without pausing for breath to at least attempt a justification, they launch into almost 50 pages of mainly superficial futurology and micro myth-making.

Without giving any real contradictory evidence and without stating who said that micros would be the only factor in increased unemployment, Dale and Williamson dismiss fears that information technology could contribute to the 'collapse of work' using the standard argument of 'we will lose more jobs if we do not use technology.' In fact it is they who create myths. Clive Jenkins, Barrie Sherman, Colin Hines and others who have written and spoken about the micro threat to unemployment have based their projections on the fact that rapid micro-inspired employment changes is happening *at the same time* as factors like world recession and a population bulge caused by the early sixties baby boom are already increasing unemployment throughout the world.

Yet, by their own calculations, they accept it is not unreasonable to project the loss of ½ million jobs in manufacturing industry in the 1980s and that in the service industry, 'the less privileged and organised members of society will no doubt be sacrificed in the interest of economy.' If this is not a cause for concern, if the human suffering likely to be created is not cause for voiciferous, emotional questioning, then what is? It is *not* myth making to call attention to the possible exacerbation of such human problems.

Dale and Williamson also mount a superficial, uninformed attack on Chris Evans' notion of Ultra Intelligent Machines. As is typical of many critics of artificial intelligence, they virtually define intelligence as that which a computer cannot at present do. When a computer can do something that was once regarded as a sign of human intelligence, like playing a good game of chess, it is dismissed as no sign of intelligence at all.

Compared with the substantial, stimulating analyses by Papert and Cooley earlier in this books reviewed earlier in this 'Bookfare', the futurology and sociology of Dale and Williamson is lightweight punditry.

To concentrate on what I regard as the distasteful wrappings of the *Myth of the Micro* is unfair to the bulk of the book which is a readable, witty, intelligent introduction to concepts like algorithms, binary arithmetic, computer architecture, software, microchip making and other basic microelectronics and computing techniques.

It does get quite heavily into the details of circuitry and binary rather emphasising the uses of information technology and, as such, might lose people who want to relate the technology to their real working lives.

Dale and Williamson do, however, use familiar metaphors and examples of micro-control, say, in a washing machine. Anyone wanting to get into bits and gates is therefore likely to find the *Myth of the Micro* accessible and informative.

The book's publishers and the authors have, however, led with their glass chins by emphasising the superficial shock-horror anti-myth mythology of the book with slogans such as 'Don't be fooled by technofear', on the cover. Don't be fooled by publishers' blurbs and authors' wild hobby horses is my advice. Despite them, you might actually get to the succulent goods that lie behind the gaudy wrappings.

Basic bashing

In the December *PCW*, I was taken to task by reader D McFarlane for my frequent attacks on Basic. In *Mindstorms* (reviewed above) Seymour Papert provides some more ammunition for my Basic bashing.

He calls Basic a typical example of the QWERTY phenomenon. The layout of the standard typewriter keyboard (with QWERTY as the top alphabetic row) was designed to overcome the way keys jammed on manual typewriter keyboards if the typist went too fast. But when this technological limitation was overcome, the QWERTY design remained because so many typists had been trained on it.

In the same way, he says, Basic took root on micros because it was possible to have Basic on systems with the small memory capacities of early microcomputers. But when the technical constraints were removed and hardware became cheaper, Basic lingered on.

'Complex arguments are invented to justify features of Basic that were originally included because the primitive technology demanded them or because alternatives were not well enough known at the time the language was designed,' comments Papert.

He continues: 'An example of Basic ideology is the argument that the language is easy to learn because it has a very small vocabulary. The surface validity of the argument is immediately called into question if we apply it to the context of how children learn natural languages.

'Imagine a suggestion that we invent a special language to help children to speak. This language would have a small vocabulary of just 50 words, but 50 words so well chosen that all ideas could be expressed using them. Would this language be easier to learn?

'Perhaps the vocabulary might be easy to learn, but the use of the vocabulary to express what one wanted to say would be so contorted that only the most motivated and brilliant children would learn to say more than "hi".

'This is close to the situation with Basic. Its small vocabulary can be learned quickly enough. But using it is a different matter. Programs in Basic acquire so labrinthine a structure that in fact only the most motivated and brilliant ("mathematical") children do learn to use it for more than trivial ends.'

Of course, this seems to contradict the experience of many schools where it appears that children find it 'easy' to learn Basic. Papert's answer is that 'Most teachers do not expect high performance from most students, especially in a domain of work that appears to be as "mathematical" and "formal" as programming. Thus the culture's general perception of mathematics as inaccessible bolsters the maintenance of Basic, which in turn confirms these perceptions.'

Ultimately, he believes, Basic 'neutralises the potentially revolutionary nature of computer technology,' which he believes could transform maths and other teaching methods. And there endeth my latest sermon on the evils of Basic.

Reviewed in this month's 'Bookfare' were:
Mindstorms by Seymoure Papert (The Harvester Press, Brighton, £9.95)
Architect or Bee? by Mike Cooley (Langley Technical Services, 95 Sussex Place, Slough SL1 1NN, £2.50 plus 50p post and packing)
The Myth of the Micro by Rodney Dale and Ian Williamson (Star paperback, £1.50.)

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MICRO MUSIC MAKING

Don Finlay analyses the music-making method used by the MTU Instrument Synthesis Software Package.

In principle, it is easy to turn a series of binary-encoded numbers into analogue voltages, which then drive loudspeakers to produce sound. The broadcasting and recording companies are using this process very successfully to achieve high quality and low noise, without the distortion of normal tape recording processes.

To synthesise sound, however, is not so easy if natural or interesting effects are wanted. The lack of repeated patterns means that either the digital samples must be calculated as needed, a job which is still beyond any computer at the rates necessary for high quality, or they must be calculated at lower rates and then stored on tape for playback at normal rates, a process which involves expensive buffer stores to smooth the rate of output of the taped samples. A tape store is needed because, as yet, no electronic memory is feasible for the size required. A small computer with 32k memory can give only one second of sound at a reasonable sampling rate of 32 kHz, needed for hi-fi.

So we are driven to using repeated patterns in our personal computers. I have described, in previous articles, how to generate organ-like notes and play tunes with them in a Nascom 1 system (*PCW* Vols 2, 8 and 3, 5) and how a package by Micro Technology Unlimited uses similar principles but adds four waveforms to get four-part harmony in a PET (*PCW* Vol 4, 1). The method adopted in both systems is to set up a 256-byte waveform table and scan through it repeatedly, skipping samples as necessary to get the frequencies of the equal-tempered scale.

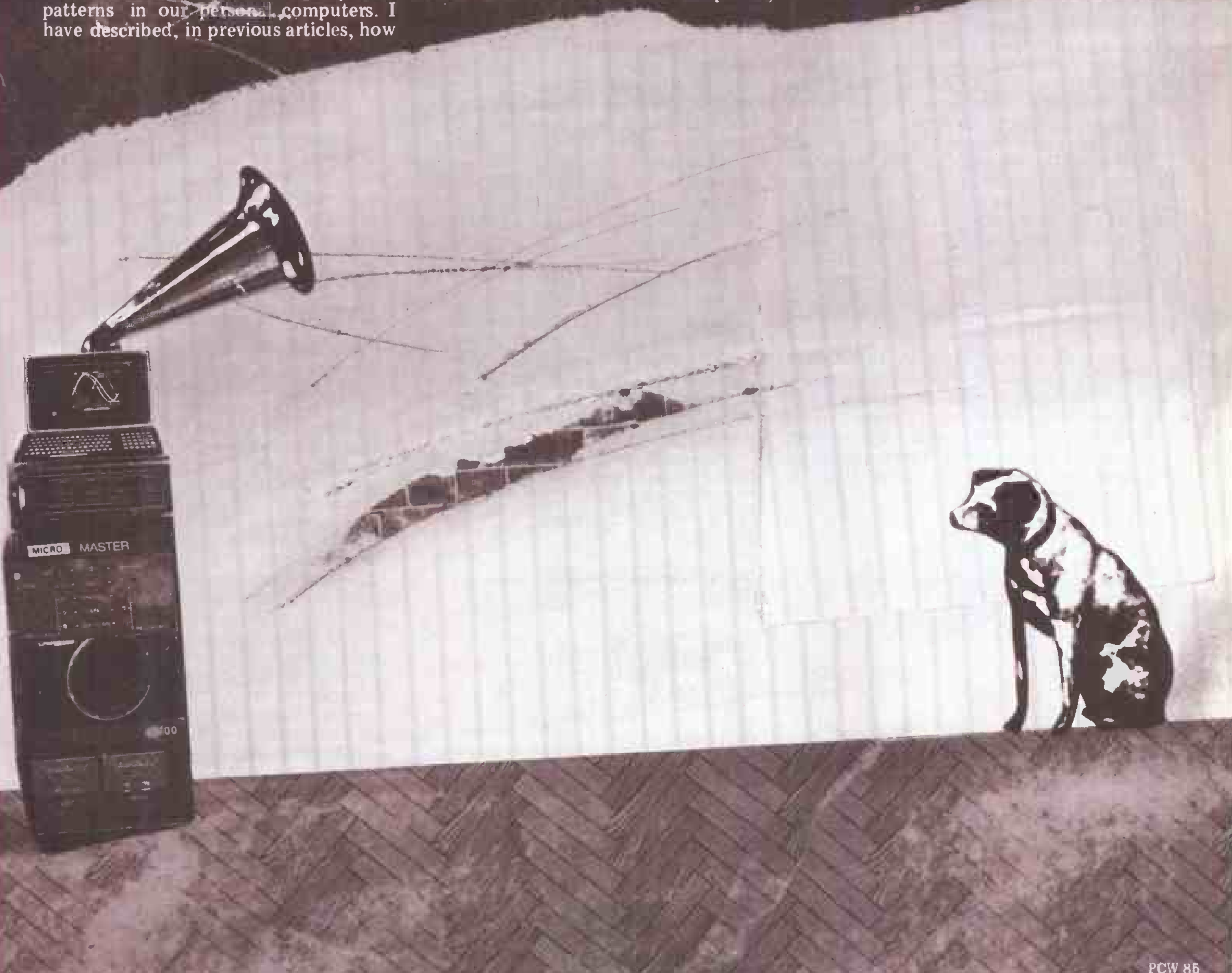
But why limit the table length to 256 bytes? Could there not be a compromise between this and 32k? In fact there can, and the methods of setting this up are the main advances offered in the 'Instrument Synthesis Software Package', again by MTU, written by Frank Covitz and Cliff Ashcroft, and made available for the 6502-based PET, KIM and AIM systems. Obtainable from IJJ Design Ltd, 37 London Road, Marlborough, Wilts SN8 2AA, it consists of a 55-page booklet and a cassette and costs £30 plus VAT. It is intended for use, initially, with a hardware board carrying a single digital-to-analogue converter and 500 mW audio amplifier, which gives mono output and is sold with the simpler software at £57 plus VAT, as described in the January 1981 issue of *PCW*. However, stereo options are provided for in the new software, so that the four 'voices' could be distributed as required between two outputs if the hardware were available. Much more interesting sounds can be produced and many of the effects of an analogue synthesiser can be imitated.

Principles

In a musical instrument which is sounding a steady tone, such as an organ pipe, there is a fundamental frequency and a number of harmonics of this frequency which give a periodic waveform. This can be reproduced reasonably well by storing just one cycle of the waveform in a table, usually occupying one page of memory, and scanning it repeatedly.

However, it takes time to build up a steady tone in a pipe, and it also takes time for the tone to die away when the wind supply is stopped. If sudden

Illustration by George Snow



switch-on and release are allowed in a computer simulation, the imitation is not so good. It is far worse when simulating other musical instruments which do not have a steady tone at any time, such as plucked string types — guitars and harpsichords, for instance. So a first approach is to control the build-up and decay of amplitude of a waveform with a fixed harmonic content, allowing also for a steady portion ('sustain') if wanted. We could have a sequence of several cycles for the attack stored in a section of memory several pages long, then a repeatable sustain page and another sequence of several page/cycles for release.

However, even this technique occupies too much memory. Our 32k memory contains only 128 pages, so a 440 Hz waveform (concert pitch A) would scan through the whole memory in only 128/440, or about a third of a second. This is less than the decay time of many real instruments.

There is another aspect to consider. This is that, during the attack and decay cycles, the harmonic content of the waveform also changes. A simplified explanation is that, for example, in a plucked string, air friction is greater for higher harmonics, so these die down more rapidly. So any method of specifying attack and decay waveforms should allow for amplitude variations of each harmonic.

Figure 1 shows a simplified example with a fundamental and second harmonic only. The harmonic rises immediately to a value greater than the fundamental but dies away more rapidly. The waveform, and its analysis into fundamental and harmonic, are shown in (a) and (b) respectively.

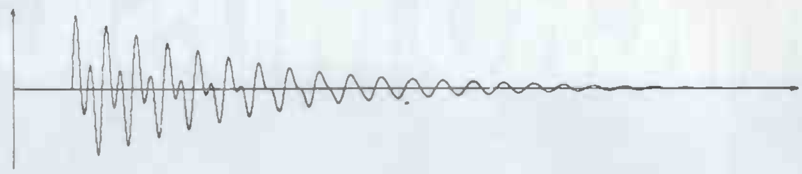


Fig 1(a)

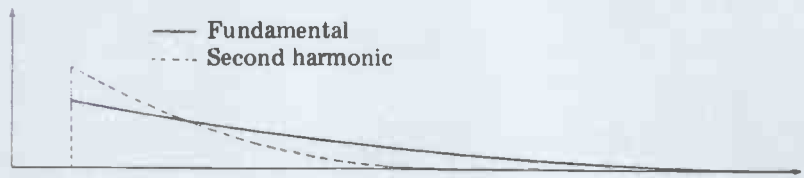


Fig 1(b)

To avoid having to use all our memory in reproducing this waveform, we approximate it into a number of steps — a form of quantisation. Figure 2(a) shows an eight-step approximation to the analysis of Figure 1(b). For each step, we can carry out a Fourier synthesis and create a waveform page containing the appropriate level of fundamental and harmonic, so this will occupy only eight pages of memory. Now, in playing through these waveforms, we should ideally use interpolation between the tables but this would again be too slow for real-time playing. Instead, we repeat each page as many times as needed before moving on to the next one, making the total time the same as for the original waveform. Figure 2(b) shows the waveform produced by this 'stair-step' approximation. It is simplified, showing only three cycles for each waveform instead of 32; even so, to make the figures less complex, eight steps is rather a small number, and 20 is more typical for the steps to be inaudible.

Figure 2(a) is calibrated in 'tempo periods' rather than seconds. This is because the tempo setting in a piece will affect the timing but not the tempo periods. A tempo period is in fact equal to 'tempo setting' multiplied by 'sampling time' (118 microseconds). This time between samples is determined by the software loop which has to get samples from each of the four sets of waveforms (or four samples from one waveform, etc), add them, output them, and increment the pointers ready for the next samples. The 6502 is extremely efficient at this because of its 'zero-page indexed addressing' mode. Surprisingly, even a 4 MHz Z80A could not better it. Even so, the time taken limits the range of frequencies to a maximum of 3.5 kHz.

In the tempo period scale in Figure 2(a), for example, a tempo setting of 80 decimal gives 80 x 118 microseconds, ie, just under 10 ms per tempo period. The whole time axis then occupies about 2.5 seconds. Each tempo period corresponds to scanning one page, so each of the eight pages is scanned 32 times in succession.

Although setting up the waveform tables according to this diagram implies decaying sound, scanning in reverse order can give a controlled attack. Varying numbers of repetitions of individual waveforms may be used to alter the rate of change, or to improve the resolution. Figure 3 shows two other sequences.

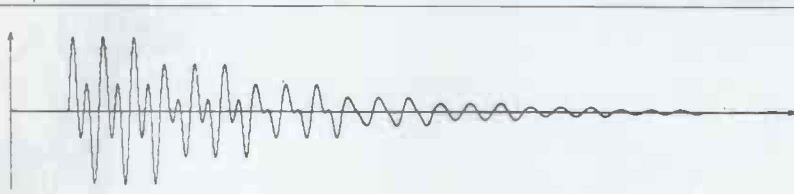


Fig 2(a)

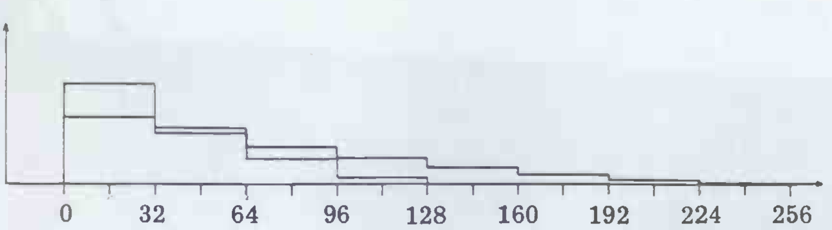


Fig 2(b)

Two data tables per 'instrument'

In addition to the set of waveforms, we need instructions telling the computer which waveforms to use and how many times they are to be repeated. So we have a 'waveform set' and a 'waveform sequence table'. Any waveform set can have several sequence tables controlling it at different times. For convenience, a waveform sequence table is always allowed one page of memory, so occupies much less than the waveforms. In cases where the sound must decay to zero in a time less than provided for by the 256 tempo periods, the end table entries are made to scan a 'silent' waveform, consisting of a page of 80s (hex), since offset binary coding is used.

Software implentation

All the MTU software is carried out in machine code, as for the earlier version. There is just one line of Basic, which clears the screen and calls up the starting address of the machine code routine. Program execution is automatic after loading the PET from a cassette and it can be re-executed by the usual RUN command.

However, we are promised a 'human interface' with a graphical entry mode or alphanumeric mode for very large pieces and this should be available any time now. At present, all instructions and data have to be turned into hex-coded bytes and entered into appropriate memory locations. The codes have nothing to do with the 6502, but are interpreted by the MTU monitor software according to principles which are, on the whole, very well explained in the software book. Each command resembles an instruction to a microprocessor, in that it has a single byte operation code followed by one or more bytes of data or address operands. Execution follows the command string from an address SQSTRT (sequence start) whose location depends on the computer being used, but is 0E00H in the PET.

Constucting a waveform set

It would be very tedious for the programmer to have to work out the amplitudes of several harmonics in each of about 20 waveforms in a sequence, and then get the microprocessor to calculate each waveform in turn. Instead, it is assumed that each harmonic grows or decays in a linear manner between breakpoints specified by the user and the monitor interpolates between the breakpoints for the intermediate waveforms. The command consists of the operation code F5H, starting and end page numbers relative to a memory boundary LOWLIM (page 20 in the PET), and a series of x-y co-ordinates for each harmonic, where x gives the page number of a breakpoint and y the amplitude of the harmonic in that page. Terminators FFH are inserted after each harmonic, and 00H ends the command. The waveforms are then calculated and entered into the correct pages by this command; since this sometimes takes several seconds it is best done before a piece is played.

A noise component can also be specified by this command, using hex numbers 80 or more in the position of the harmonic number.

In creating this waveform set, amplitudes are not normalised, because the versatility of the system requires the user to retain control of amplitude. It is necessary, though, to guard against overflow and against too small an amplitude, which will give poor signal-to-noise ratio. Rule-of-thumb advice is given to aim at a total harmonic amplitude sum of about 350 for a large number of harmonics, or 300 for only a couple, on the basis that the theoretical maximum of 255 results in smaller waveforms because of cancellation effects between harmonics.

Constucting a waveform sequence table

The obvious way of telling the computer how to scan the waveform set is to type the waveform page numbers one at a time into the appropriate page of memory reserved for the waveform sequence table. For the simple example of Figure 2, the first page number would be typed 32 times, then the next 32 times, and so on, until the page is filled with eight sets of 32 repeated page numbers.

Rather than do this, we use the 'arbitrary waveform sequence table' command. In this, the op code, F8H, is followed by an instrument identity number (one nibble — allowing up to 15 instruments, since zero is reserved for a silent instrument; the other nibble of the byte is not used); then pairs of bytes, the first of which gives the relative waveform page and the second the number of repetitions; and finally, a terminator FFH. So the table for Figure 2 could be constructed using commands which occupy only 19 bytes instead of 256.

However, for many instruments a useful sequence can be constructed even more simply. For struck or plucked-string instruments, there is a sharp attack and then a decay which decreases more slowly as time goes on, as in an exponential decay in an electric circuit. So a sequence which can generate a decreasing rate of decay automatically could be very useful.

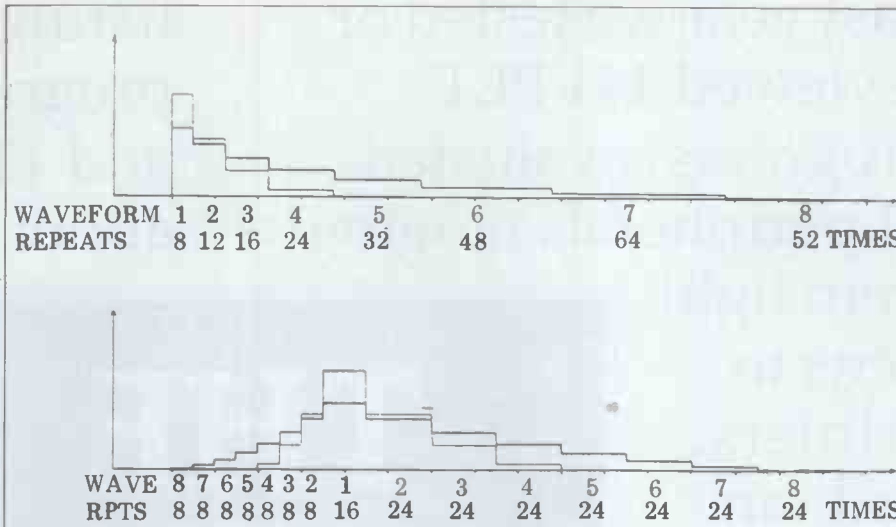


Fig 3

This is done in the 'simple stretch' option of the 'build waveform sequence table' command, which needs only five bytes. The first one is the op code F6H, and in the second one are two nibbles which define the simple stretch option (using zero) and instrument identity number. The third byte specifies the degree of stretch to be used; its first nibble defines the length of the initial block in the table and its second defines how many times a block is to be repeated. The fourth and fifth bytes define the starting and end page numbers. For instance, if the initial block length is one and each block length is repeated once before incrementing the block length, we may get a table of this form: 05 06 07 07 08 08 09 09 09 0A 0A 0A . . . . etc.

A little thought reveals that this would turn a linear fall of amplitude into a quadratic one or, to use MTU's description, it gives 'quadratic stretching'. The same sequence in reverse would give a rising waveform amplitude whose rate of rise decreases with time, giving an inverted quadratic. Since the sets of waveforms are built using linear interpolation, this is a very powerful pair of commands, on which the authors should be congratulated.

Generating attack, sustain and release (ASR) sequences

For sustained wind instrument sounds such as trumpet, clarinet, and horn, we need a more complex sequence table. The 'simple stretch' option nibble in the F6H command set is now changed so that it is an odd number, and used to determine the length of the sustain phase. This length is in fact made equal to 32*INT(X/2), where X is the nibble, and the last waveform of the attack phase is scanned this number of times for the sustain period. Three more bytes are added to the command to determine the release sequence.

ADSR envelopes, as used in some analogue synthesisers, are not mentioned by MTU. The extra letter refers to decay before the sustain period and is sometimes wanted to simulate, for instance, the decay of a piano string vibration after the key is struck but before the key is released. Probably the arbitrary sequence command should be used here, as the stretch options do not allow for three sections.

As might be expected, an even value of X in the sustain-length nibble is made to do something different from when it is odd. In fact it is made to give a pseudo-tremolo effect which the authors describe, fairly, as 'warble'. In this mode, during the 16X table entries of the sustain period, the sequence cycles through the last three waveforms in the attack set, playing them twice each to and fro, so that they take eight table entries per cycle. For a typical tempo setting, this gives a rate of about 13 Hz.

Strumming sounds

One more command is provided for creation of a waveform sequence table. This one simply modifies an existing table by taking the first block of entries from it, and repeatedly copying them into the new table until the page is full. This uses the op code F7H, with two nibbles for source and destination instrument identities and one more byte for the block length to be copied. Uses include synthesis of strumming sounds for plucked or struck instruments.

Note coding

So far, I have summarised the methods of creating musical instruments within the computer. We now have to look at the way in which notes are coded. In the previous software (*PCW* Jan 81), each note of the scale was given a single byte which had to be entered into a song table. This byte was used to access an address where a two-byte code for the frequency (in fact, the skip needed in incrementing the sample pointer) was stored. This was a little trying to use, as the codes bore no resemblance to musical notation. In the latest version, it is even more trying, because each note has four possible identity codes!

The reason for this is that sometimes we need to change the computer specification for an instrument according to the note it is to sound. A natural

musical instrument covering a wide range of notes has different characteristics of timbre, volume, attack and decay for different notes, so the requirements of good simulation must take account of this. In addition, aliasing can occur if there are too many harmonics in a computer-generated waveform, which can happen in high notes; but if we cut down on the harmonics in these high notes, the lower versions will sound impoverished. Ideally, we should have a waveform which is individually controlled for every note. As always, compromise is made, and in this system any particular note can use any of three instruments, created as already described.

A note code occupies one byte. Of this, the six least significant bits select 63 notes (zero is used for a rest) and the other two select the three instruments or a 'sustain' mode. The sustain mode is necessary to allow tied notes to carry on sounding when other parts are changing in a new musical event. This means that, usually, the programmer does not have to regard a break between repeated notes as an event, as in the previous software, since normal decay will take place, and sounding the note again by using the sustain code will have the required effect. In this sense, programming is easier. In another, looking at the printed page which shows 252 codes against an enlarged pair of musical staves, it is certainly not!

There has to be a command to specify which instruments are called up by the different modes for the four voices. This uses the op code F1H, and it is followed by bytes defining the mode table and the four instruments used by the four voices. I found this section of the software difficult to grasp as there isn't a clear example, but eventually worked out the following sequence of commands to provide one:

```
F1 01 45 67
F1 02 89 AB
F1 03 CD EF
```

In this, voice one uses instrument four for mode one; voice two uses instrument five for mode one; voice three uses instrument six for mode one; etc . . . and voice four uses instrument FH for mode three. The order of the four voices is implied by the position of the nibbles of the last two bytes in each line.

As before, the song table, which corresponds to a musical score, comprises a series of groups of bytes. If four parts are being used, each group starts with one byte for the duration of the event and the remaining four are the note codes for voices one to four in order. Where a voice is inactive, a zero is inserted. The principle to follow in coding for the three optional instruments is to use one of the modes one to three for the initial entry of any voice but if it is to carry on sounding without repeat then use the sustain code in the next event. Codes up to 3FH represent the sustain mode.

Transposition

The restriction of the note range to 63 may not always be acceptable, so two commands are provided to shift the notes by 'offsets'. One enables any or all of four voices to be shifted down one octave or up two octaves, and the other gives absolute offsets of —12 to +24 half-steps (semitones) or relative offsets of —15 to +15. Absolute offsets cancel previous ones. My criticism of the previous software, that transposition was limited to an octave upwards, has been fully overcome.

Finally, in the set of commands, two more set the number of voices to be interpreted from the song table and the tempo, and there is, of course, one to locate the start of a song table sequence to be played.

User impressions

I received the cassette carrying the 'INMUS MONITOR' software with three demonstration programs some time before the 'Instrument Synthesis Software Package Release 1' arrived. The difference from the previous package was immediately apparent. The first program is a demonstration which can be run in an 8k system, although this is really inadequate for the package. This contains short note sequences of scales and arpeggii, and a chord sequence, to be played in one, two and four voices as appropriate, with changes of instruments giving different effects: plucked string instrument, trumpet-like instrument (using the three modes), weird metallic instrument, constructed with only fifth, seventh, tenth and fifteenth harmonics, oddball instrument using the warble effect, and a chiming instrument made by modifying the previous one. The software booklet contained the complete listing for this program in assembler language format with explanation column, so I was able to study it in detail. The instrument descriptions I have listed here are those given by MTU in this listing, and are apt.

As before, no knowledge of 6502 code is needed to use the package.

The sounds produced by the demonstration program show the versatility of the system in a very effective way. They are marred to some extent by noise, which is inevitable in an 8-bit system where sometimes only six bits are being used (one-voice note sequences). Slight clicks can be heard occasionally and there are long pauses between playings of the note tables while new waveforms are created. Truly, music is one of the most demanding applications for a computer!

Also on the cassette is a program based on Bach's *Sinfonia No 14.* This produces some good harpsichord sounds and some unconventional ones, and requires 16k of memory. Finally, there is Tchaikowsky's *Dance of the Reed Flutes* from the Nutcracker Suite, requiring 32k and giving a fair imitation of orchestral sounds. No listings are provided for these two programs, although they can be examined by entering machine code mode on the computer and looking at the memory. The command and note sequences for the Tchaikowsky occupy only locations 0E00H to 1B4EH in the PET, so it wouldn't be necessary to look at the whole 32k. However, the commands for some of the instruments used in these programs are listed in a very useful 'Library of Instrument Definitions' in the software book. Twenty instruments are specified, each defined by a pair of instructions to build the waveform set and the waveform sequence table, and some with extra sequence tables.

You don't really understand a system, though, until you have tried to program it youself. I decided to write a short program to see if I could generate a number of instruments and use them in the three modes, as they had caused me trouble in the reading. There's a natural tendency to 'switch on Bach' when you have a twangy sound available, so I programmed the first few bars of his *Toccata in D major* (BWV-912) and entered the 'plucked catgut' instrument from the library, plus two softer versions of it which I invented for the other two modes, and used there for all four voices.

Memory allocation was the first problem. There is a lot about this in the software book, which seems overwhelming. Anyone working in machine code faces this — you have to specify where you are putting your codes as there is no high level language to do it for you. However, examining the default settings carefully showed that I had plenty of room. The playing sequence code starts at 0E00H and goes upwards through memory, being followed normally by the song table, which has to be called up from memory addresses specified in the playing sequence. There is a 'LOWLIM' boundary at 2000H; waveforms are constructed in pages counting up from here, but waveform sequence tables count down from it, so there is a danger of song table and waveform sequence tables colliding. Also, a silent waveform is entered into page 20H (all 80H) and its corresponding sequence table into page 1FH (all 20H). If you don't construct your own waveform, a sinewave is entered into page 21H and its sequence table into page 1EH (all 21H). This isn't written out in so many words in the booklet, so I checked it by examining memory.

I wanted to create three instruments, so their waveform sequence tables would occupy pages 1EH, 1DH and 1CH, over-writing the sinewave. This would leave pages 0EH to 1BH, available for the playing sequence table and song table — ample for this need.

The three sets of waveforms would use 11H pages each, so would occupy pages 21H to 53H. Even this simple program requires more than 16k of memory, which would give only up to page 3FH, so it's fortunate that my PET had 32k.

The command sequence code turned out to occupy memory from 0E00H to 0ECCH, so I started the song table at 1200H, leaving plenty of space for afterthoughts on instruments. If I eventually code the complete toccata — unlikely, as it is a very long work — I would have to move LOWLIM up, or possibly use the top of memory, for the song table. This is allowed for in the monitor.

I wrote out the command sequence on paper first, so that I could add memory locations and keep a check on where I had reached when entering it; it went in with only one major error, which took some time to find by studying sequence tables to see which had gone wrong. The song table was more difficult; I have already mentioned the problem of reading the four possible codes for each note, and when it goes in as sets of five bytes but has to be entered using the PET cursor on a block with lines of eight bytes of memory, the

GOTO page 146

GATEWAYS TO LOGIC

CHAPTER 8: PERIPHERALS

Derrick Daines continues his series on teaching microcomputing to others.

So far the microprocessor has been discussed almost entirely in connection with computing. Now is the time, however, to stress that although computing is an important application, it is only one among many. Hazarding a guess, I would estimate that less than ten percent of all micros in use today are in computers and that this eventually will level off at about three to five percent. The rest will go into an infinite variety of industrial, commercial and domestic appliances.

It is not that the actual numbers of computers will drop — on the contrary, they will increase as never before — but that there will be an explosive growth in the range of products using the micro. Where this process will end is anyone's guess and it is this very fact that endows the long-term future with its most exciting aspects.

Earlier in the series we stressed that microprocessors can be put to an amazing variety of uses simply by attaching different peripheral devices. A peripheral is any device that can be coupled to the micro, by means of which the micro is controlled or communicated with, and through which the micro can communicate with and/or manipulate the outside world. It can be extraordinarily simple as in the case of a switch, or fantastically complicated like an electronic typewriter keyboard. (Figure 7 in chapter 3 shows some peripherals.)

Switch inputs

Any on/off switch can communicate with a micro. Apart from switching the power supply on or off, or resetting all contents to zero, the switch can also be used to input information of one kind or another. An example would be a road pad to count the number of vehicles, or a light-operated switch to count the number of articles passing along a conveyor belt. A few years ago a switch of this type was used to count bees entering and leaving a hive.

The switch may also be used to program the micro. Impecunious souls with patience may easily rig up a set of switches that are used to input binary-coded information into memory; the Open University has for years used just such a device (called 'Opus') for teaching the rudiments of computing. One sets up the eight binary switches and then, when satisfied, presses a push-button to transfer the data into memory.

A slight extension of this idea provides a restricted keyboard. The addition is a dedicated chip which turns hex to binary, so all that is needed are 16 simple pushbuttons labelled 0 to F. Such microcomputers are available for as little as £40 in kit form, with 256 bytes of memory, which would provide very useful computing facilities and enable the control of peripheral output devices.

Computer terminals

Ideally, a terminal should be in two halves to stress the fact that it comprises two separate units. One part is an extended keyboard (with its associated electronics) and the other is a Visual Display Unit (VDU), like a television set without the sound. Many installations will indeed use an unmodified television in the same way that TV games do.

Some of the mystery of the VDU will disappear if the student is encouraged to examine the display very closely, when it will be found that each character consists of a pattern of dots or very short dashes (see Figure 1.) The characters are coded by circuitry in the VDU in a manner similar to the ASCII system detailed below but working in reverse. Figure 2 is an example of a 7 x 5 matrix.

Computers with graphics capability use a variation of the technique in order to draw diagrams and pictures of all kinds. The screen is divided up into a very large number of cells, each one of which is accessed by one particular memory location within the computer. By addressing the memory the cell can be turned on or off — white or black. The definition varies from one manufacturer's product to another and of course depends upon the number of cells on the screen. Other computers allow for different numbers to be loaded so that the circuitry can then decode it and display the cell in a choice of colours. Home computers boasting colour graphics are becoming very popular.

Newspaper photographs can be used to illustrate the basic idea, and no doubt many will have seen the type of computer photograph that prints the image in close typescript, wherein the shading is produced by different printed characters. What is important with all of these ideas is not the fine technical detail but the main outline of the technique involved.

Another offshoot of all this work is the enhancement of photographs by computer — a technique that was used on the pictures sent back by Mariner

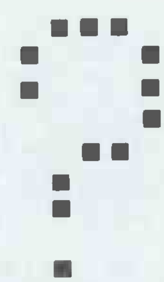


Fig 1

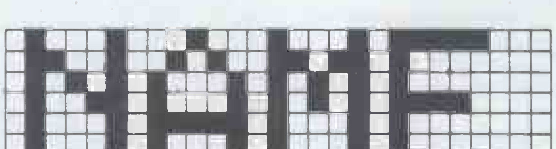


Fig 2

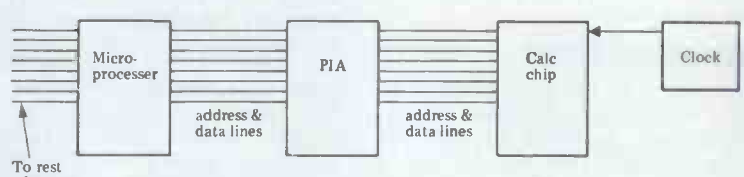


Fig 3 To the micro, the PIA looks like just another block of memory.

from Mars, for example.

The typewriter keyboard is the principal method by which the human communicates with the computer. The basic principles have been taught already, with the dedicated chip turning the number input into binary code. With the introduction of a full keyboard, students will want to know how the computer deals with letters, spaces, brackets, etc. The answer lies with the ASCII code, which is given in Table 1. ASCII stands for American Standard Code for Information Interchange and was originally designed for the transmission of news reports, telegrams and the like over wire. Although other systems have been tried, the ASCII code remains the most popular, sometimes with local variations. (There is no £ sign, for example.)

ASCII code

To change a character to its hex equivalent, find the character on the chart, note the number of the column and then the number of the row. (MSB stands for Most Significant Bit.) Thus 'A' in hex is 41, while the lower-case 'a' is 61. To change from hex back into script is obvious — find the column, then the row. Thus 3F is ?

In passing it might be noted that this adds a slight complication to computing since (eg) 3F can stand for a question mark, an instruction to stop or the numeric value 63 (decimal), depending entirely upon the context. As far as the micro is concerned, however, it is still either an instruction or data in the manner described in a previous chapter. When instructed to print, it sends the data to the printing device which decodes it back into characters.

The complication is more than offset by the advantage of having a binary code for script, making it easy to use the micro for text manipulation. Perhaps the most spectacular application of this is in programs for word processing, but all computer programs make use of it to a greater or lesser extent.

A very useful program for those with a 6800-based computer is contained in Table 2. Children of 8 years old and up will happily translate their name or other short message into ASCII-coded hex and then trot over to the terminal. The computer asks them to type in their list of hex numbers, automatically printing a space after each pair of input symbols. The child signals the end of his input by typing RETURN, which prompts the computer to translate the hex into a row of script. It then waits for the next inputs. This has been found to be a most successful program with a number of points to commend it. (1) It accustoms children to the ASCII code; (2) it restricts the child's use of the keyboard to the numeric keys and A—F; (3) the child learns of the computer's infinite patience; (4) the principles of coding generally are absorbed; (5) the lesson is self-correcting and (6) the child is highly motivated.

Need it be added that the program is also great fun? Somewhat deliberately, there is no way that a keying error can be corrected. With coding errors added, the printout frequently causes great hilarity plus, of course, great satisfaction when something is printed out correctly.

LSB \ MSB	0	1	2	3	4	5	6	7
0	NUL	DLE	SP	0	@	P		p
1	SOH	DC1	!	1	A	Q	a	q
2	STX	DC2	"	2	B	R	b	r
3	ETX	DC3	#	3	C	S	c	s
4	EOT	DC4	$	4	D	T	d	t
5	END	NAK	%	5	E	U	e	u
6	ACK	SYN	&	6	F	V	f	v
7	BEL	ETB	'	7	G	W	g	w
8	BS	CAN	(	8	H	X	h	x
9	HT	EM	)	9	I	Y	i	y
A	LF	SUB	*	:	J	Z	j	z
B	VT	ESC	†	;	K	[	k	{
C	FF	FS	,	<	L	\	l	\
D	CR	GS	—	=	M	]	m	}
E	SO	RS	.	>	N	∧	n	~
F	SI	US	/	?	0	—	o	DEL

Notes: SP = space.
CR = Carriage Return
LF = Line Feed
BS = Back Space
BEL = Bell
DEL = Delete

The other signs need not concern the general reader.

Table 1 ASCII to hex conversion table.

This program accepts a series of Hex numbers and prints out their ASCII equivalent.

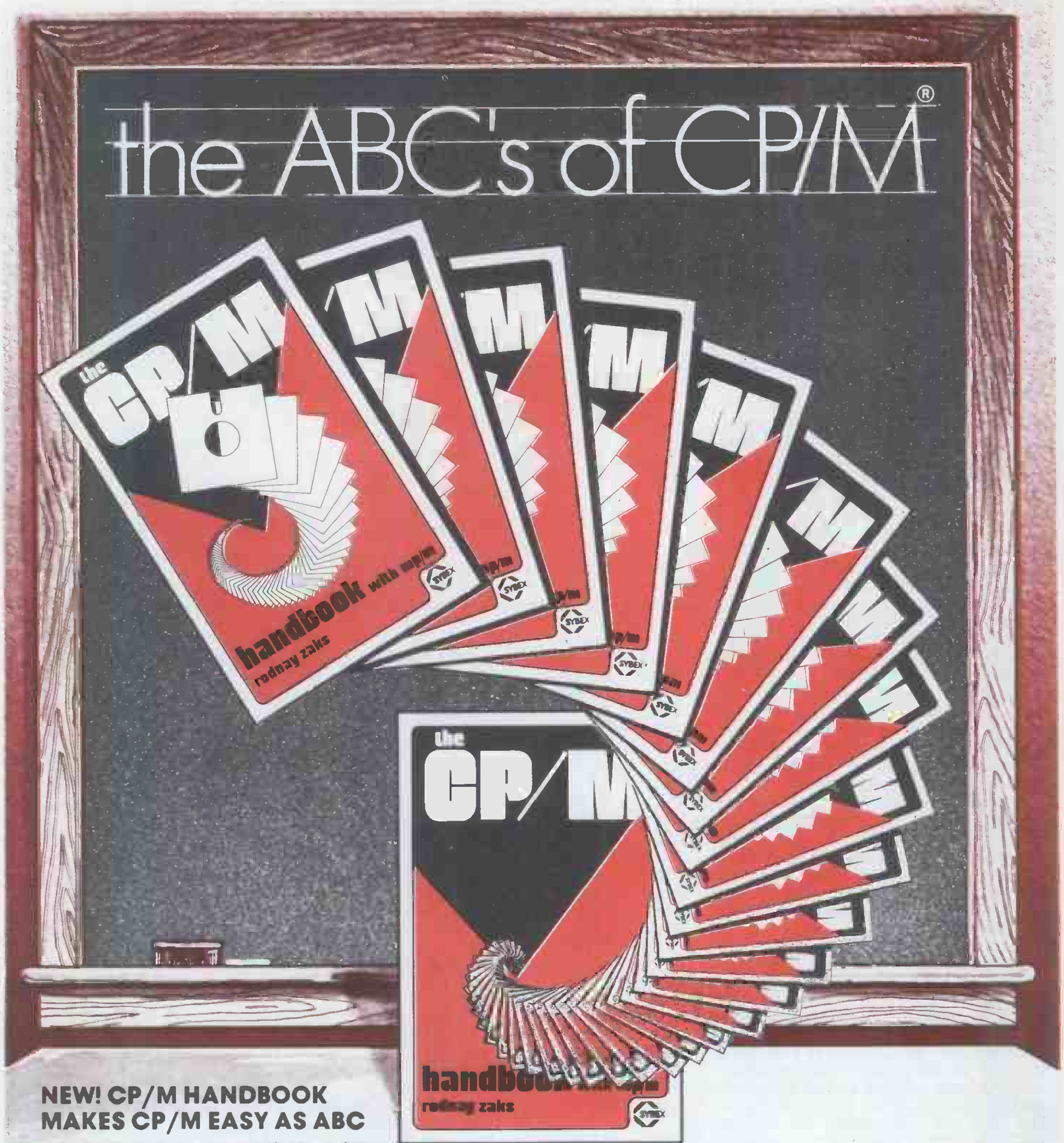
0100	CE 0200	LDX	Starting address of title text
0103	BD E07E	JSR	Print intro text
0106	CE 000	LDX	Routine start to clear all temp storage.
0109	4F	CLR (A)	
010A	A7 00	STA,X	Store A, indexed.
010C	8C 00FF	CMP X	Has index reached 00FF?
010F	27 03	BEQ	
0111	08	INX	Increment index
0112	10 F6	BRA	Branch always
0114	CE 021E	LDX	Start of instruction text
0117	BD E07E	BSR	Print text
011A	CE 0000	LDX	Point to first empty store
011D	BD E1AC	BSR	Fetch 1st digit from keyboard, put in A
0120	81 OD	CMPA (A)	Is it C/R?
0122	27 1F	BEQ	If so, done with entries
0124	16	TAB	Copy in B
0125	BD E1AC	BSR	Fetch 2nd digit, put in A
0128	80 30	SUB (A)	Subtract ASCII bias
012A	81 09	CMP (A)	
012C	23 02	BLS	
012E	80 07	SUB (A)	
0130	58	ASL (B)	
0131	58	ASL (B)	
0132	58	ASL (B)	
0133	58	ASL (B)	
0134	1B	ABA	Add A to B. (Result is ready-to-print hex code in one memory)
0135	A7 00	STA (A), X	Store A, indexed
0137	BD EOCC	BSR	Print a space
013A	08		Increment X by 1
013B	8C 00B4	CMPX	Has index reached allowable limit?
013E	27 03	BEQ	
0140	7E 011D	JMP	to step 011D above; repeat input
0143	86 04	LDA	with ASCII code, "end of text"
0145	A7 00	STA (A), X	
0147	CE 0238	LDX	Start address "Your code was"
014A	BD E07E	BSR	Print text
014D	CE 0000	LDX	Point to first
0150	BD E07E	BSR	Print to end of text
0152	7E 0100	JMP	To start; begin all over again

TEXTS

0200	C/R, L/F,	NUMBER CODE 04
021E	C/R, L/F,	Please type your code C/R, L/F, L/F, 04
0238	C/R, L/F,	Your code was — 04

Program begins at 0100.

Table 2 Decoding program.


the ABC's of CP/M®
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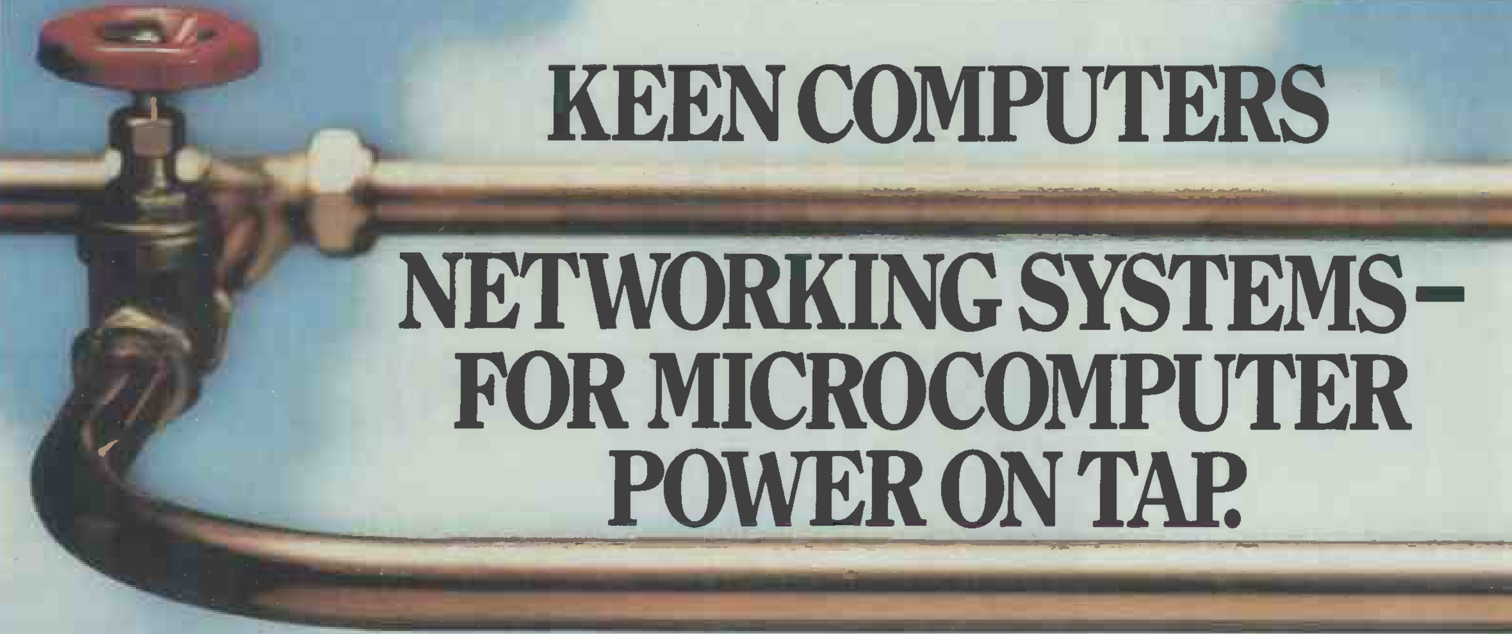
SYBEX



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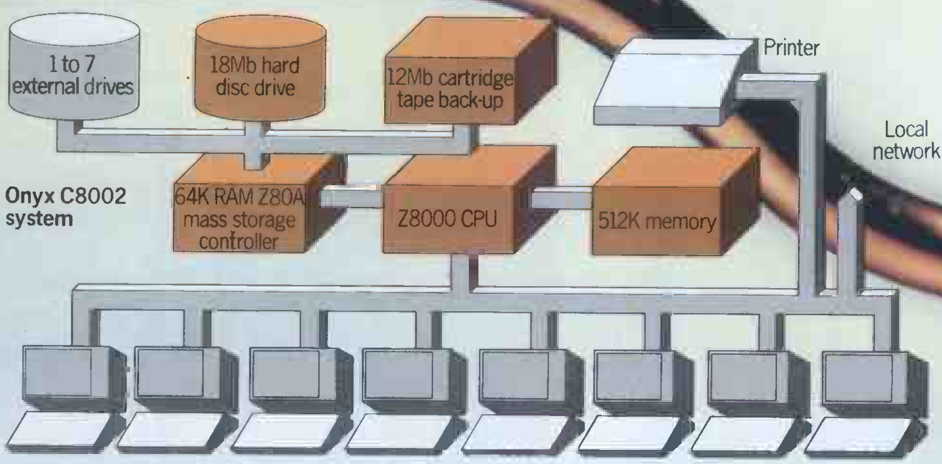

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At the heart of the C8002's advanced systems architecture and powerful throughput is the UNIX 7* timesharing operating system. This enables up to eight users to share files (subject to security constraints) and to compile or execute programmes written in BASIC, COBOL, FORTRAN, UCSD PASCAL, C and MUMPS – concurrently and independently. Memory allocation and management uses techniques previously unavailable on microcomputers.

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Calculators

It may seem odd that hitherto I have made no mention of calculators. This is because we have been concerned with the mainstream of technological development and where that stream is likely to take us. Although fascinating and worthy of a study in itself, it is my view that the calculator stands a little aside from the mainstream, an end in itself without the potential for future development that the micro has.

The programmable calculator is a hybrid, standing between the calculator and the computer proper. Certainly the programmable calculator has considerable potential as a teaching aid with which to illustrate the stored program concept and give students sufficient practice at writing simple programs, but needless to say, such programs will be of the number-crunching variety.

It is one of the small ironies of history that up until about 15 year ago, all research and development went into designing computers that did considerably less than the average hand-held calculator of today. What was termed a computer then we now call a calculator. There is the blessing that now mathematicians have nearly all they ever wanted in the programmable calculator, the close identification of the computer with higher mathematics has been relaxed. It is also true that the manufacturing techniques that went initially into the calculator have been turned with benefit to the computer as we know it today.

Both the calculator and the computer use binary arithmetic but their internal structure or architecture — how the bits and pieces are fitted together — makes the calculator good at number-crunching and good at control. Certainly the computer can impress you or I with its speed and accuracy but, compared with the calculator, it is neither fast nor accurate. It is, in fact, extremely difficult to program a computer to do mathematics, as anyone who has studied such a program will tell you (I mean, of course, in machine code. When we use Basic, for example, it includes a floating-point arithmetic program in its structure).

The calculator chip therefore makes an excellent peripheral for the micro, especially in the computer. The micro takes care of all the control functions — switching gates on and off, shunting data about, running programs and generally being a busybody — and when it needs operations on numbers, it flings the details to the calculator. It's all rather like the boss of an international corporation having an accountant at his elbow — he could do it himself, but it is more efficient to let the other do it. Quick as a flash the calculator chip flings back the answers and the micro deals with them. Both chips are doing what they do best and obviously the installation of a calculator in a computer speeds up the operation of most programs.

Figure 3 gives a block diagram of the installation, based upon the National Semiconductor MM 57109 calculator chip. The PIA (Peripheral Interface Adaptor) is simply a device that allows the two chips to talk to each other, while the separate clock shown is for the use of the calculator only, allowing it to run at its own speed once it has been given a job to do. Within the calculator chip itself, apart from the obvious calculating circuitry (see Figure 4), are a number of registers and a memory, which is rather like the accountant having his own scratchpad or jotter. It should be obvious that the user cannot access the memory directly, but must in effect say to the micro, 'Please ask the calculator what it has got in its memory, so that you can tell me.' Because of this, perhaps the hardest part of having such a calculator coupled to the micro is learning to trust it.

Since the chip has full trig functions, squares, roots and pi, can operate in degrees or radians as well as utilise its memory as a constant and deal with brackets embedded four deep, the calculator constitutes a very powerful adjunct to the computer.

Printers

A very wide variety of printers are available as peripherals. Perhaps the simplest would be the Morse ticker-tape printer that might make a suitable project for boys to make out of Meccano. Stepping up from that are 20-and 40-column printers that use rolls of adding-machine paper. These are very widely used for program development and for some types of accountancy work. In a more expensive bracket still are full-width printers mainly of two types. The first are dot printers employing a set of solenoid-driven needles which are driven forward in a matrix pattern on the lines of Figure 2. The other is based on the electric typewriter and is the most expensive of all.

The latest developments in this field do not rely on the impact of some

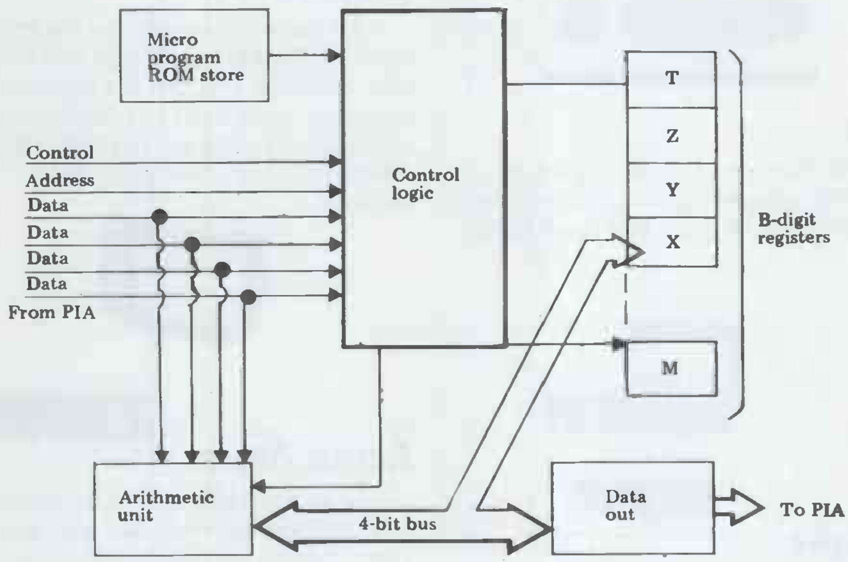

Fig 4 Calculator block diagram

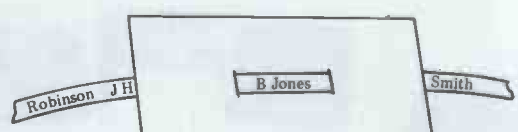

Fig 5

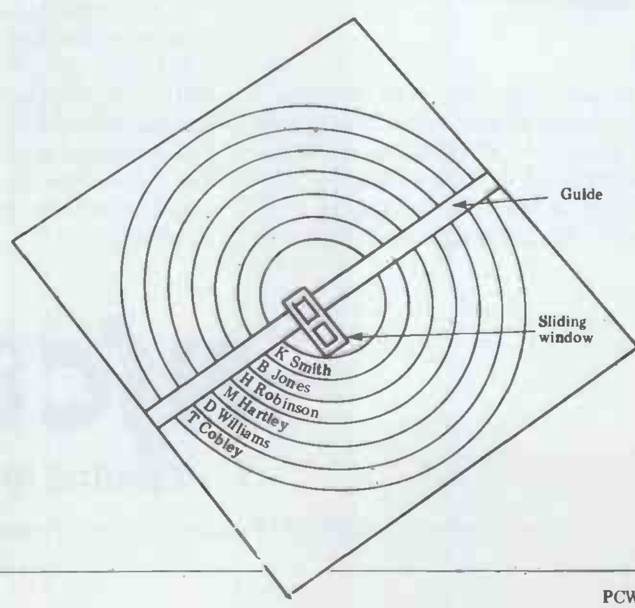

Fig 6

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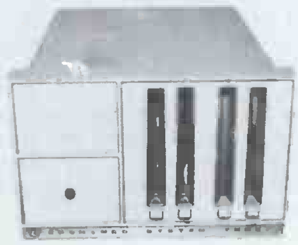

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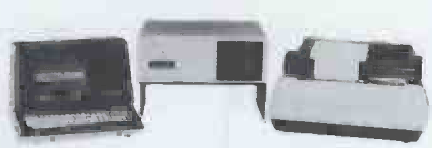

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gadget bashing its image through a ribbon, but upon the arcing of tiny sparks from electrodes to a microscopically-thin aluminium layer on black paper. The spark burns away the aluminium to reveal the black underneath. These printers are very much faster than the other types and, because there are few moving parts, are also cheaper, but of course the paper is more expensive.

However fast they appear to be, printers remain the slowest of peripherals and any computer confined to driving only a printer is grossly underused. the problem of keeping the computer in step with the printer is solved by the latter having memory capability equal to one line-lingth. Some will remember whole pages. The computer is then able to execute other tasks until signalled by the printer that it is ready to accept more data.

Recording data

When the power is switched off, any program stored within most computers is lost. For this reason — as well as for those occasions when the program bombs — all computer users feel the need for some form of long-term storage of programs. Then again, data of all kinds must be stored when it is not actually used by the computer. Three methods are in current use — magnetic tape, paper tape and magnetic disk. All are easy to understand but it is probably best to introduce students to paper tape first as they can see and decode the information stored.

Samples of paper tape are easy to come by from firms using this form of storage, provided that the teacher is able to explain what he or she wants it for and the firm is satisfied that no breach of confidentiality is likely. About 6 — 9ft per pupil is sufficient. Now there are four ways to hold a strip of paper and Murphy's Law ensures that no-one will hold it the right way, so the first exercise must of necessity clear up this point. The sprocket holes are smaller than data holes and are in a continuous line to the right of centre, while the curl of paper will be away from the user. Some manufacturers provide tapes with broad blue arrows printed on them to show the direction of movement and some punches automatically cut the ends of the tape with a vee for the same purpose. Both systems help a great deal.

Have the student draw a pencil line under any selected row of holes and write it on scrap as a binary word. Usually there is no difficulty in getting them to understand that a hole represents a binary 1 and that the absence of a hole represents a binary 0.

Given previous experience of decoding binary to hex and hex to ASCII, most people will be able to decode a few rows before boredom sets in, but nothing more is required for them to have grasped the idea. The keen or fortunate may have come across something intelligible and will pursue it doggedly to the end.

Now that much earlier commercial computer equipment is being disposed of at give-away prices, it would be a good plan for schools to acquire paper-tape punches or readers. The first translate depressions of keys or computer-held data into holes in tape, while the readers accept punched tape and translate it into a stream of data for transmission to the computer.

The cassette tape recorder is a very common piece of equipment nowadays — so common that, in any given class of children, half are likely to own their own. This is fortunate because the cassette is increasingly used for data storage. The system relies upon electronic circuitry that translates binary 1 and 0 into high- and low-pitched tones. The idea is quickly grasped and there is little that one need do to illustrate except put such a data tape into an ordinary machine and allow the class to hear the stream of tones, or if a computer is available, to have it echo onto the VDU screen the data being received from cassette.

One can discuss what is known as the baud rate — the number of binary bits per second that are transmitted. The children will be impressed to learn that the standard for magnetic tape is 300 baud, so that if the tape is travelling at its standard 17/8in per second, 1ft of tape holds 1920 bits of binary. This is impressive, although computer users frequently grumble about how slow it is. I know — I'm one of them. It also means that the average C-60 tape will store some 1,080,000 binary bits, or 135,000 computer words.

Just about the same order of storage is provided by the disk system. This too is familiar in concept but there are a number of important differences between computer disks and the domestic LP. Firstly, it is magnetic, like the tape. Secondly, it spins very much faster and thirdly, it is not sequential. To put that another way, you do not have to play all the recording to get to a bit at the end.

The point can be illustrated by two simple cardboard models from the SMP books, *Man Uses the Computer* and *Computer Bits & Pieces*, (Blackie, 1967). A length of ticker tape is analogous to the cassette tape. Children write a lot of names on it and then feed it through two slits in a piece of card so that only one name can be read at a time. Now to find a particular name, the tape must be fed through from the beginning — perhaps in its entirety. The disk system can be modelled by a disk of card with the names arranged in segments, one name per segment. (See Figures 5 and 6.) The pick-up head is modelled by a small window of card free to slide up and down a fixed guide. To find a particular name with this system, one simply pushes the window up, looking at the first one or two letters of each name, until one finds the one wanted.

For computer users, the difference is one of up to half an hour with tape compared with milliseconds for disk. Not only that, but disk allows the computer to access program and information freely, jumping from one program to another without any human inter-

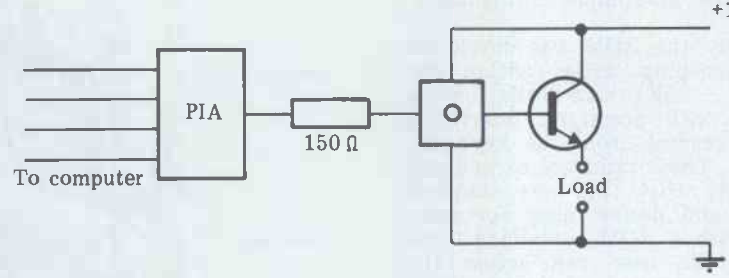

Fig 7

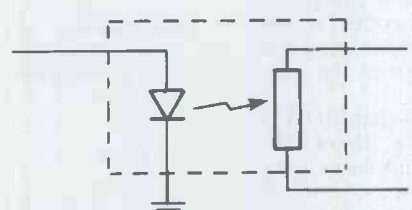

Fig 8

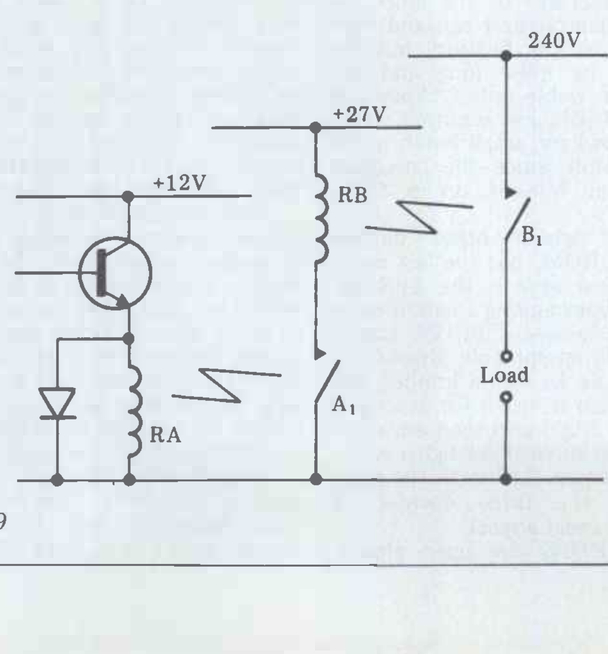

Fig 9

vention — a process known as chaining. A little thought, and you will see that this greatly multiplies the power of even the humblest computer.

In practice, up to four disks can be accessed at once. Moreover, disks are double-sided and/or double density as well, so that the information readily accessible attains astronomical proportions, with yet more available in no more time than it takes to change a disk. Such devices are expensive at the present time, although blank disks are themselves cheap. Since the advent of home computing, smaller devices known as mini-floppies have become available. The disks are flexible, as their name implies, and hold a little under half a million bits per side, although the same remarks about double density apply. The latest developments in this field include Winchester storage and stringy floppies. The Winchester is a more sophisticated disk system with a greater storage capacity and shorter access time, while the stringy floppy is a continuous tape.

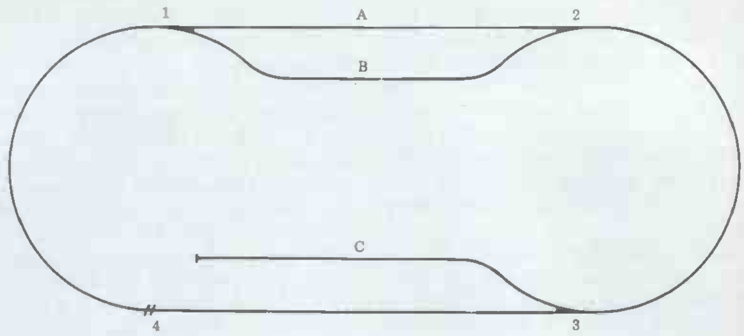

Fig 10

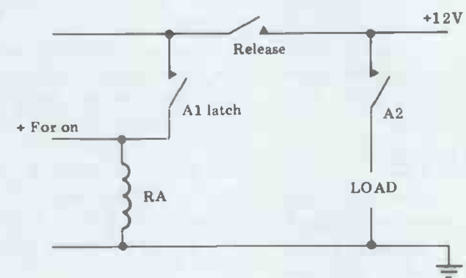

Fig 11

ROM and his relations

Another device for the long-term storage of information is Read-Only Memory (ROM). It is an ordinary integrated circuit in appearance but locked within it is a stack of memory, each with its own address and each with its separate contents in binary. These are, of course, determined during manufacture.

Originally the ROM was developed for housekeeping duties within the computer — all those little chores connected with power-up, interrupts, print-out, reading from the keyboard and so on. These tasks are carried out so regularly that they are standard sequences and perfect meat for automation. With a ROM containing these programs, the user can access the appropriate address and forget about the details of the chore. Examples of this were the BD E1AC and BD E1D1 instructions of machine code, where E1AC is the address appropriate to the task of reading an input from the keyboard.

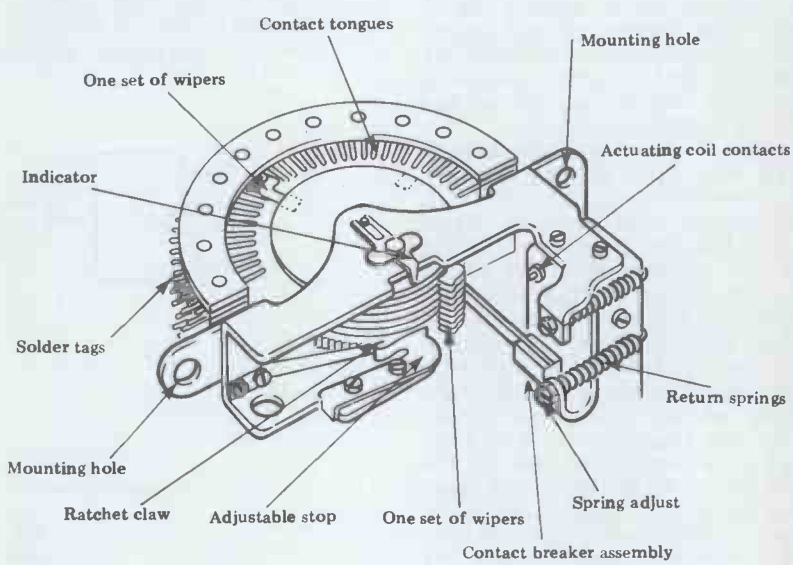

Fig 12

Slightly more expensive than ROM is PROM, or Programmable Read-only Memory, in which the purchaser may encode his own memories and is thereby not confined to those supplied by the manufacturer of the chip. To be sure, the manufacturer can and does supply ROMs to specification, but the lead-time can be quite long and the method is not viable unless thousands of identical ROMs are required. With the PROM, however, small batch quantities are possible since the customer programs them himself on a fairly simple device.

There are several other devices related to the ROM, but the last one I wish to mention here is the EPROM, which finds favour among amateur users and small businesses. EPROM stands for Erasable Programmable Read-Only Memory and, as its name implies, the user can program it, use it for as long as is desired as a ROM and then erase the program (under ultra-violet light) ready to program it again. Although the most expensive of the three devices, it obviously has a great appeal.

Currently, ROMs are used almost exclusively for the storage of programs, but there is no technical reason why they should not also be used for the storage of data in small quantities. Some industrial environments would be totally unsuited to the storage of data on tape. Besides which, tape machines and disk readers are enormously bulky by comparison with the ROM and their costs disproportionate.

Some computer games and television games are already available as ROM and it seems certain that the scope will widen. The more versatile home computers are made with sockets for a plug-in ROM. Manufacturers are beginning to supply the simpler versions of Basic as ROM and it doesn't take much imagination to see that all written or printed matter is capable of being stored for eternity in ROM. I confidently expect a considerable amount of development in this field — perhaps beginning with statistical data. It is only the longer works that need disk or tape storage, although this will become less true as the manufacturer packs more and more into his integrated circuits.

Between them, the three ROM-types cater for all the market requirements. The EPROM provides for one-off applications such as the average home-user might require, the PROM caters for the small business entrepreneur who hopes to sell a few hundred gadgets containing a micro and PROM, while if you are a large manufacturer or governmental agency, the ROM is very cheap.

Perhaps before we leave the ROM family, one further advantage over other forms of data storage ought to be stressed — the data is not degradable under normal storage conditions. Tape and disk-stored data are susceptible to degradation due to magnetic field and dust and indelicate handling. Paper tapes tear, magnetic tapes get fouled up or torn or creased, disks get scratched.

Output switching

The micro is great for switching things: the number of devices that it can switch directly is governed by the length of the computer word, but the practical limit is set by the bulk of the PIA's (Peripheral Interface Adaptors). The average home computer has room inside for about six or eight of these devices, each one addressing up to 16 or 32 separate lines with suitable multiplexing. However, this number can be greatly extended as I will show.

The simplest method is shown in Figure 7. '0' is an opto-isolator inserted to isolate the computer from the circuitry that follows — possibly high-energy circuits that could damage the micro. Figure 8 is a diagram of the working of the opto-isolator. A rise in voltage caused by the presence of a binary 1 causes the LED to glow. Encapsulated with it but electrically separate is a photo-resistor or (sometimes) a phototransistor. Both are encouraged to operate when light falls upon them, so the output is an image of the input, but in the event of something going wrong with later parts of the circuit, no damage can accrue to the micro.

Following the opto-isolator of Figure 7 is a transistor used as a switch. For small-current applications, this is sufficient, but for heavier currents and perhaps alternating current, the transistor switches-in a relay to carry the heavier current. Relays of this type commonly carry a few amps but for even greater currents, the first relay can switch in another, really rugged. This application would be suitable for heavy duty motors or electric heaters. (Figure 9)

A model railway is a small-current application that is both an excellent demonstration piece and a first-class school project. There is no limit to the size and complexity of the layout as far as the computer is concerned, but for a discussion of the general principles involved, I will confine myself to the layout of Figure 10. At the most this would accommodate three locomotives at A, B and C. Three switchpoints at 1, 2 and 3 would energise whichever section of track was open. (See Beale, *Model Railway Encyclopaedia* and other works.) A rail gap at point 4 would isolate the section 3—4 and one or two other gaps might be needed, depending upon the working and number of locos involved. Initially, a loco would be energised (off to full on) by action of the pointswitches but see later for speed and other controls.

Normally, pointswitches are self-holding. That is to say, they remain in whatever condition they are placed without the need for further current applications. Therefore simple control of locos is gained by merely switching over the appropriate pointswitches through circuits as per Figure 7. Signals however are different, whether semaphore or lamp. They need a continual supply of current. It would be uneconomical and perhaps even impossible to devote the computer to the job of continually addressing the signal, so we have recourse to a self-latching circuit as per Figure 11. Here it will be noticed that action of the relay closes a pair of contacts A1 that bypass the energising device, thus the relay remains on after the initialising pulse. When we wish to switch it off, we actuate a release switch that is normally closed, thus breaking the circuit to the relay coil. Spring action pulls it off. The release switch can be another relay or transistor switch, but the relay is better in this case and it could act in a similar capacity for several self-latching devices at once.

Suppose that we build on the system until we have neither the room nor the cash to accommodate enough interfaces and switching circuits? There are several ways out of the dilemma. Electronically, we could multiplex in the manner previously described and it could be made extremely compact and not too expensive. For school use however I recommend the uniselector. It can be obtained very cheaply on the surplus market, it is reliable and above all else, its action is visible to the students. The uniselector is a selective switch with one way in and a choice of routes out. (See Figure 12). It was designed and built for the Post Office for the automatic switching of telephone lines, in which the actuating pulses were provided by the dialling mechanism. The number of pulses determined the route taken. The computer/small relay combination can handle this pulsing very easily from one address out of the PIA, while another signal from the PIA would then be routed as chosen to any one of 25 lines. The scheme is shown in Figure 13.

If that were not enough, there is no reason why, on a super-scale model railway, we could not emulate the Post Office and cascade uniselectors, allowing one to address hundreds of lines from the PIA board.

With the wide range of skills involved, building and running a model

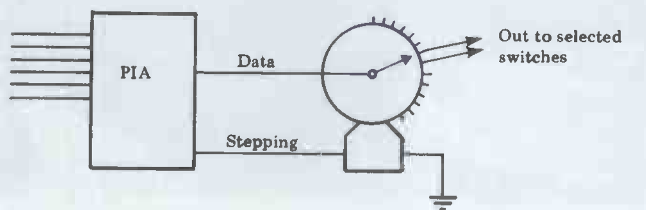

Fig 13 Small relays needed on stepping + data (switching) lines.

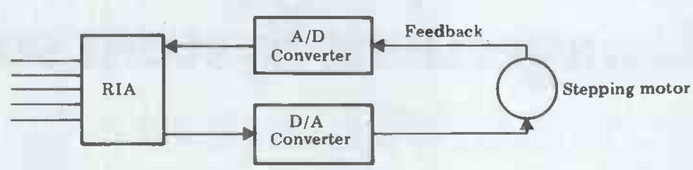

Fig 14 Uniselector

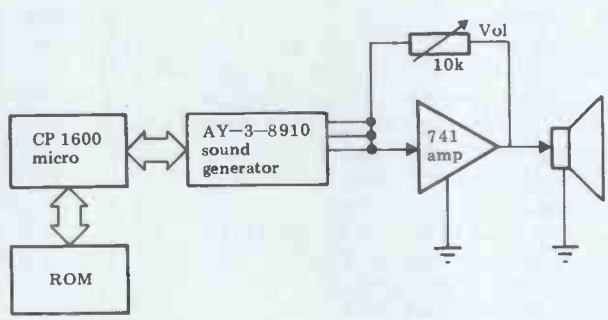

Fig 15

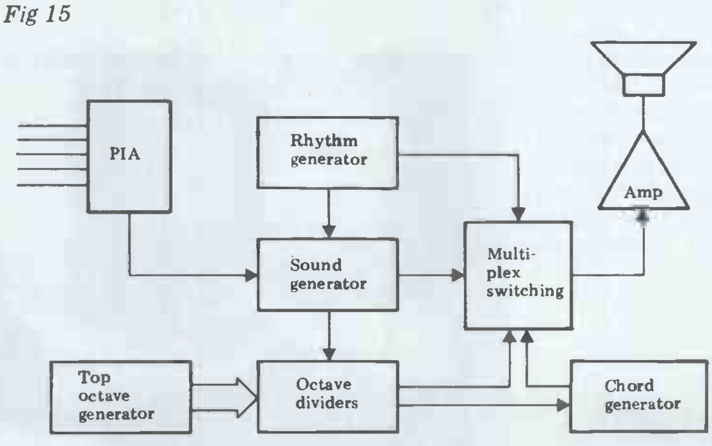

Fig 16 Experimental rig

railway on the above lines would be a most admirable project for a Senior school and I am sure that many such projects will be undertaken, both by schools and solo enthusiasts. For the general reader, the point to be absorbed is that a single micro can and does switch a very large number of electronic and electrical circuits. What one does with the secondary circuits so switched is limited only by the imagination. They range from slot machines to control systems for giant oil tankers.

Every switchable item could be under the control of a micro or fully-fledged computer. Already some enthusiasts in the States have computer-operated lawn mowers, for example, while in this country the notion of computer-controlled central heating has become so commonplace that in computer circles it is a standing joke.

Digital to analogue

The title will not convey much to many readers, so it must be explained that the computer is termed digital because it deals with numbers. However many electronic applications are analogue, which is to say that instead of two states (on or off), there is a whole range of states. A good example familiar to all is the volume control knob. Turning the knob adjusts the output over a wide range and to within close limits. Now by combining voltage-adding and multiplex circuits, we are able to make a digital-to-analogue converter. The simplest modelling of the method is the numbering round the skirt of some control knobs; a numeric input is turned into a sliding scale of output.

If you imagine that users are going to be confined to audio, then your imagination is still in bottom gear. That model railway engine's speed can be controlled, for example, as can any electric motor. Electric heaters can be precisely controlled, as well as a host of other industrial devices. Nevertheless audio applications will probably intrude into our lives first. For example, electronic organs have over the last four or five years shown the most remarkable development, but there is a lot more to come. Synthesisers are prime targets for micro control and with the marriage of the micro-controlled synthesiser and electronic organ, I expect whole orchestras of super-realistic sound to be available to one-finger players within the next decade.

There is also a type of computer termed an analogue computer. We don't hear so much of it these days and its use seems to have been confined to the higher mathematical processes of integration and differentiation and the interaction of constantly-sliding states as in complex mathematical models of systems. Recently, there has been a move to combine digital and analogue computers, but the potential is not clear. It seems likely that the uses of the combination will remain in the sphere of higher mathematics, but, as yet, no one can tell.

Stage lighting has been under computer control for some time now and with the plummeting cost of control devices it is certain that even village hall companies will invest, while less ambitious lighting control devices will begin to creep into the home, with perhaps a dozen or so lamps under the control of a single micro.

It is extremely simple to make an analogue output control physical movement by means of a stepping motor, for example, or some types of plunger — both of which give rise to a number of possibilities, particularly in hazardous industrial applications.

Analogue to digital

The opposite transformation is equally possible and maybe the most familiar application is the joystick control common to many TV games. Here it is worth noticing that a physical movement has been turned to digital data via analogue voltages; a situation ripe with potential. Any physical movement will suffice to feed information to the micro-movement of the head of a bedridden patient, for example, the movement of a steering wheel, the turn of a road wheel, the spin of a wind-speed indicator, the growth of a plant, the opening of a door or the movement of wind and tides.

It will be noted that the A/D converter is essentially an input device for the micro, while a D/A converter is essentially an output. When the two are used together some interesting possibilities arise, especially in the field of motor control. By use of a feed-back loop the motor can, as it were, keep the micro informed as to its current state of position (Figure 14). Perhaps the most spectacular application of this at the present time is the graphic plotter. At first sight this device looks somewhat like a printer, but instead of printing text, the plotter draws pictures. It does this by means of a pen head free to move in an East/West direction under the control of a stepping motor (a special kind of electric motor able to move in small increments.) Another stepping motor controls the movement of the paper in a North/South direction. Combining the two movements backwards and forwards, the result is an impressive drawing based on data accessed by the computer. Currently such plotters are used in drawing weather maps and a wide variety of engineering drawings.

A very good model of the graphic plotter is the child's toy known as Etchasketch, which forms a good teaching aid in classrooms devoted to learning about the future. The Etchasketch control knobs are numbered round the skirt, lending themselves admirably to a written form of program to draw given pictures. If a child was given the task of writing such a program he would learn much — as would any other child that attempted to follow the program later.

A/D converters are, of course, capable of much more than this. By coupling them directly to dedicated micros and/or other circuitry, the retail cost of digital voltmeters and similar test equipment has shown a dramatic fall in recent years. Anyone with an A/D converter and the smallest of computers can, with a minimum of programming effort, provide himself with the facilities of a digital voltmeter, ammeter, ohmmeter, frequency meter, oscilloscope, transistor checker and curvetracer, plus a number of other things — surely a most telling argument for a micro in a school department, regardless of budget.

Sound generators

Manufacturers have produced sound generators by incorporating two or three simple amplifiers, a noise generator, envelope shapers and multiplex switching all within one little package. Waveform envelope shapers give a note to its characteristic timbre and make it possible to distinguish a violin from a shriek, although both may have the same pitch and duration.

A simple application is to couple a micro, a tone generator and some ROM and you have a whole range of noises suitable for fitting inside a child's

GOTO page 144

SOME TRANSDUCERS

Lamp, tungsten	Aerial
Lamp, X-ray	Thermometer
Lamp, arc	Piezo-electric crystal
Pressure gauge	Ohmmeter
Brake meter	Milometer
Decibel meter	Car ignition
Laser beam	Human muscles
Human mouth	Microphone
Heater, electric	Depth gauge
Horn	Bell
Voltmeter	Gas meter
Electricity consumption meter	Petrol gauge
Frequency meter	Frequency generator
Clock, electric	Detonator
Light meter	Colour temperature gauge
Auto pilot (?)	Torch
Gas sensor	Human eye
Human nose	Human skin
Welding arc	Loudspeaker
Motor	TV screen
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Barometer	Human brain
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Human tongue	Joystick

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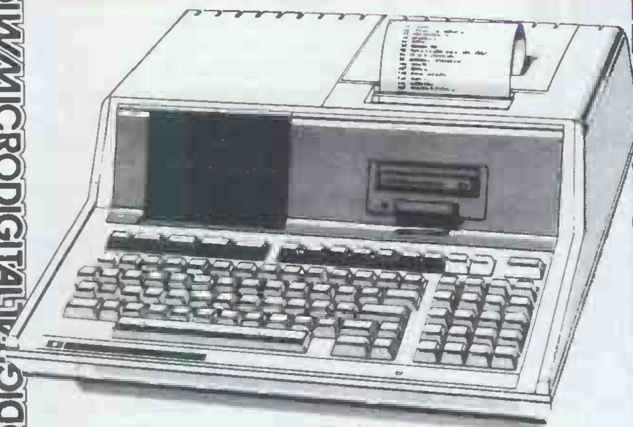

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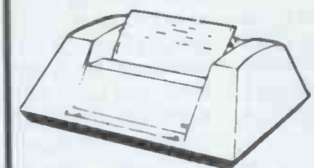

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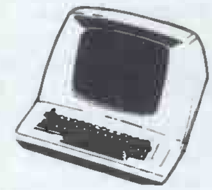

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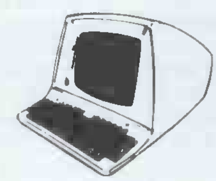

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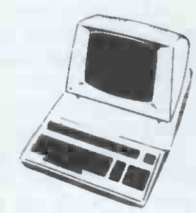

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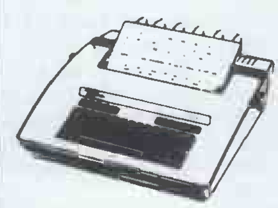

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When loading programs from cassette to microcomputer via the DIN socket on the cassette recorder, the signal level to the computer is a function of the volume control. As the input circuit of the microcomputer which converts the audio analogue signal to a digital signal has a certain threshold and perhaps built in hysteresis, it is necessary to set the audio level above a minimum for the circuit.

The cassette when playing back via the DIN socket also produces an audio signal via the loudspeaker. It is quite useful to hear the audio signal of the cassette recorder when loading programs but the required level for the microcomputer may make the audio level too loud for normal hearing. Another problem may arise when loading a program from a cassette which was recorded on a different machine, with a different audio level. The volume control will have to be adjusted to the optimum level for correct loading.

To overcome these problems, here's an automatic level control (ALC) circuit to fit between the cassette and the microcomputer interface. With this circuit, a constant output voltage is obtained over a wide variation of input voltage. The circuit consists of two dual inline (DIL) modules and several discreet components, the total cost being in the region of £5.

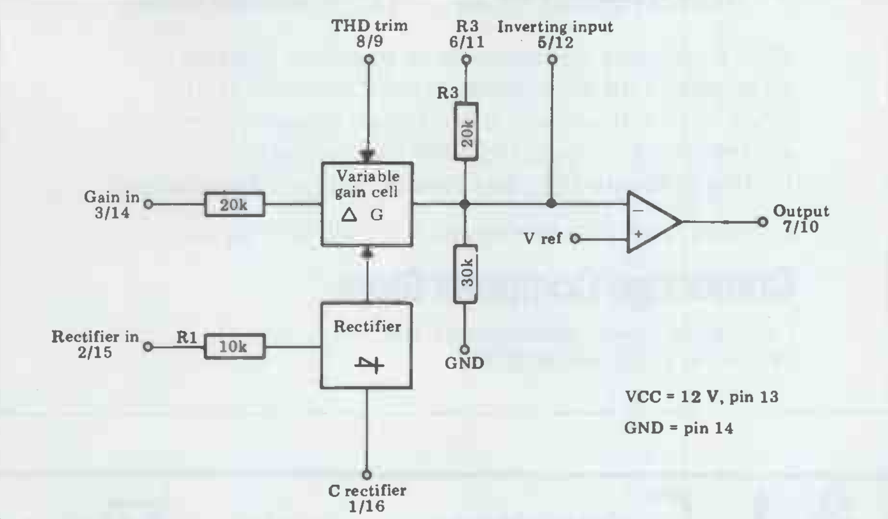

Fig 1 Block diagram of NE570

Principle of operation

The ALC circuit used is a Signetics NE570 Compandor. This circuit was originally designed for telephone network requirements where the audio signal is compressed before transmission over a telephone link and then expanded back to the original dynamic range at the other end. Figure 1 shows the basic block diagram of the NE 570. In fact there are two identical circuits within the module, hence two pin numbers are given for each of the signal lines. The circuit consists of:

— a full wave averaging rectifier, providing gain control current IG;
— a variable gain cell Δ G;
— an operational amplifier.

The NE570, as previously stated, may be wired up as a compandor, expandor or for our case an ALC circuit, as shown in Figure 2. The variable gain cell Δ G is wired in the feedback loop of the operational amplifier. The input signal to the ALC circuit goes to the operational amplifier and the rectifier circuit. When the average input signal varies, the gain control current IG from the rectifier changes the gain of the variable gain circuit in the feedback loop of the operational amplifier. The net result of this is that for a large input variation one obtains a constant output level.

The dynamic range over which a constant output level is obtained can be controlled by resistor RX. Reducing the value of RX reduces the dynamic range. For this application, where the maximum dynamic range is used, an infinite value of RX is used — that is, no resistor at all. Figure 3 shows the response of the ALC circuit for maximum dynamic range. It can be seen that the output voltage remains relatively constant for an input variation of 10 millivolts to 3 V RMS, which is nearly a 50 dB variation of input signal.

ALC circuit

Figure 4 shows the proposed cassette recorder to microcomputer interface circuit. The NE570 wired up as an ALC circuit drives an operational amplifier buffer whose gain can be set to any amount from 0 to +5. The buffer amplifier also avoids overloading the output operational amplifier of the NE570.

As can be seen from the circuit diagram, only a 12V power supply is required. The components' values shown are those which I used, because they were available. The four 0.68 nF coupling capacitors could be any value between 0.47 nF and 1 nF. I used one quarter of an operational amplifier RC 4136, but any 741 type operation amplifier would be suitable.

Setting up and testing

I recommend that the circuit be wired

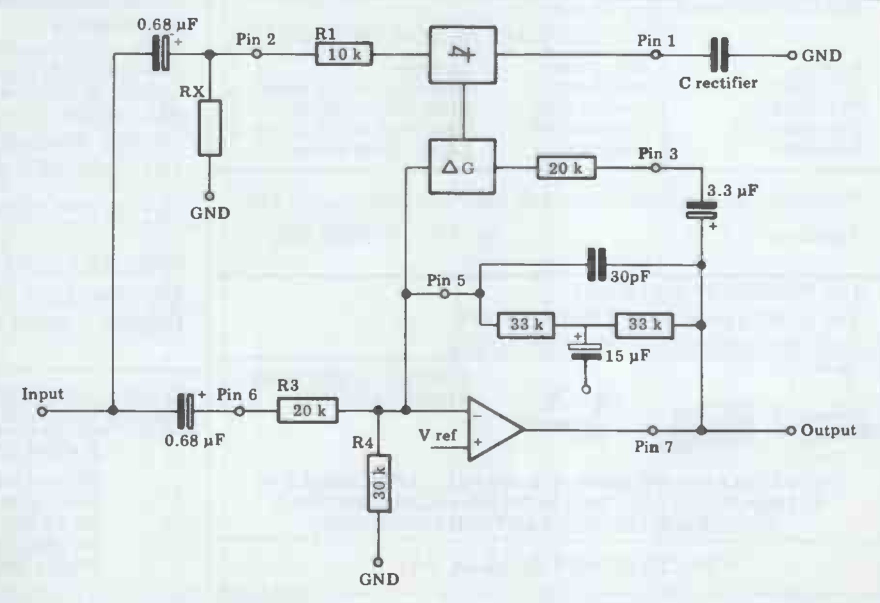

Fig 2 NE570 connected as ALC circuit

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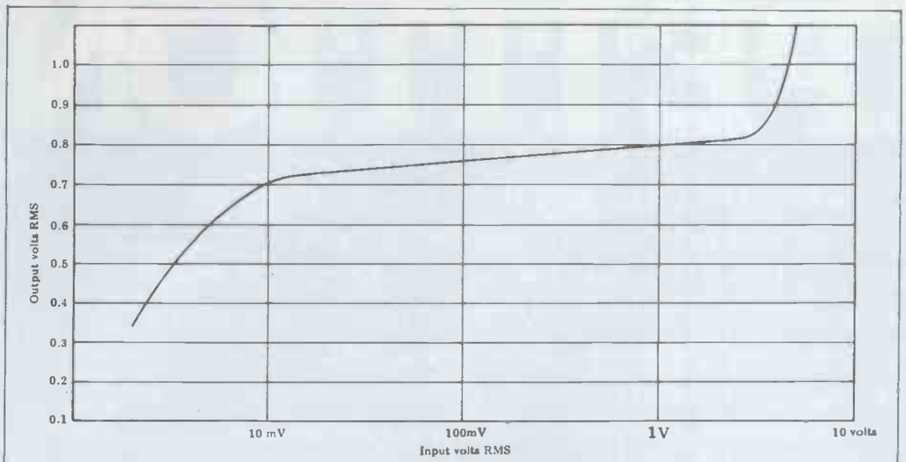

Fig 3 Input/output characteristics of ALC circuit

up using either wire wrap or solder sockets for the two DIL modules.

If an oscilloscope is available, play a program cassette tape and measure the output wave from of the NE570 on pin 7; it should be 2 V peak to peak. Vary the volume control of the cassette recorder and the output of the ALC should remain constant. Note that at maximum volume control setting there is considerable signal distortion with the cheaper cassette tape recorder and hence this should be avoided.

Place the oscilloscope on the output of the capacitor from the operational amplifier and vary the potentiometer. The signal should vary from 0V to 10V peak to peak. Connect the output of the circuit to the microcomputer; try loading a program and adjust the potentiometer until the correct output voltage is obtained so that the program is correctly read. It should now be possible to adjust the volume control over a wide range with satisfactory program loading.

ON THE LEVEL

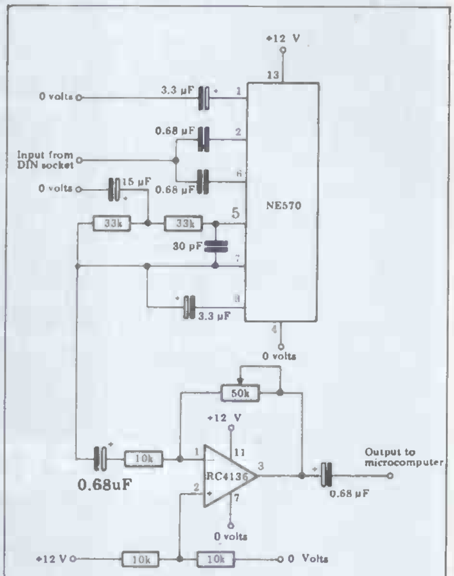

Fig 4 Cassette recorder to microcomputer interface

Component list

1 x NE570
1 x RC4136
4 x 0.68 uF >+15 V working
2 x 3.3uF > +15 V working
1 x 15uF > +15 V working
1 x 30pF capacitor
2 x 33k resistor 5 percent ¼ W
3 x 10k resistor 5 percent ¼ W
1 x 50k pot, ¼W

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.

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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, to arrive not later than 30 April 1981, enclosing a suitable SAE if you would like it returned.

Personal Computer World

1981

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.

WESTMINSTER NEEDS A COMPUTERTOWN

by Ian Lloyd, MP

The articles I have read recently on ComputerTown have encouraged me to think that this concept will be applied throughout the UK as rapidly as it deserves. In recent years I have come to the conclusion that the UK is most proficient at diagnosing the 'British disease' and much less effective at suggesting and taking the proposed action. This is a most heartening exception and I look forward to hearing that the examples of Sutton-in-Ashfield, Street and Eastcote will be widely followed.

There have been several developments at Westminster in recent weeks, even if we do not have our own ComputerTown centre — yet. Perhaps the most significant is the belated appointment of an actual Minister of Information Technology, indicating that the Government has at last recognised the importance of this area. Kenneth Baker will bring energy and enthusiasm to this task, but he will have to be a fast learner and his success will be proportionate to his determination to ensure that Information Technology is appropriately and intensively developed in all govenment departments and not exclusively in or by the Department of Industry.

Within the House of Commons itself two developments deserve a mention. The first is the advent of the 'POLIS' system, which was formally inaugurated on December 15 by Philip Whitehead, Chairman of the Computer Sub-Committee of the Services Committee. This acronym reveals that Parliament has acquired a Parliamentary On-Line Information System. It was supplied by Scicon Computer Services, a BP subsidiary and is intended to meet a requirement by Members and their staff for: 'instant access to up-to-date information on parlamentary papers and proceedings, UK and EEC legislation, current affairs, and other items of specific interest to Parliamentarians.'

The hardware consists of six British-made Cifer 2632s with printers, three Cifer 2684 terminals with printers and magnetic diskettes in Norman Shaw (our annexe). The database, to which the system is linked by private lines with 9600 baud modems, is held on Univac 1100 computers in Milton-Keynes. There is also a 5D11-PDP-11 system with printer and disk storage in Norman Shaw. The software has also been developed by Scicon and is based on the use of a UNIDAS information retrieval system on the mainframe and is transaction oriented, using TIP/CMS. Mr, Chris Baker, of SCICON, will supply either details or explanation on (0908) 565656.

But what does it all do and who can use it?

At present, the only input is Parliamentary Questions. Thousands of these are asked and answered every month that the House is in session and it is important to be able to discover quickly *who* has asked the question, *what* has been asked, what *answer* has been given and by which *minister*. Hitherto the Library and the Table Office (a small department which handles the questions and motions put down by members) have been completely dependant on a manual index. The advantages of rapid search and analysis by computer will need no advocacy, but I think that experience will demonstrate many unsuspected advantages.

The database will eventually be extended to include proceedings, papers, legislation, UK and EEC official publications, international and foreign official publications, press comment and miscellaneous Library material. Even when fully developed it will not be a system to which Members have direct access. But a request to the Library will produce information virtually immediately.

In due course Members (and other users) will be able to provide the Library with an information profile and thus receive a regular printout of any material which has been added to the database within this definition of their interest or interests.

The House of Commons Computer Sub-Committee decided at an early stage that there was likely to be a demand for outside access to this information and that, since most of it was in the public domain, the demand should be met wherever possible without prejudice to the primary objective of providing an improved service to Parliament itself. Organisations outside Westminster may apply to the Library of the House for access to the system on a subscription basis and may install their own terminals.

All this is very heartening, even if the initial system covers only a small segment of the wide spectrum of information which the House of Commons itself generates and requires. When, in due course, answers as well as questions are included, immediate public access to what is undoubtedly one of the most comprehensive databases in the Kingdom — the daily input to Hansard — will be possible. All this information is already available today, unsorted, unclassified, virtually on a random basis. The country, as things are, does not really get value for the money which it spends on the large machines which Whitehall has created to deal with the innumerable questions which MPs ask on their constituents' behalf.

While all this was going on downstairs, a most interesting speech on microelectronics was being given upstairs by the Rt Hon James Prior, who was addressing that august body, the Parlamentary and Scientific Committee. Jim Prior, I am delighted to say, is a recent convert to the significance of microelectronics. As St Paul once said, the late Christian is always more welcome than the early Christian, though it is a sentiment which many find puzzling and paradoxical. The text of his speech deserves much wider circulation than it received, but there is one argument with which I disagree. The Secretary of State for Employment does not believe that the microelectronics revolution is, in fact, a 'revolution' at all. He believes it is similar to the revolution heralded by the discovery of steam, electricity and the internal combustion engine and that 'historical precedent gives us reason to expect that society will take it all slowly and quietly, in its stride.' I believe this to be a profound misjudgement of the difference between all previous technologies which have enhanced the power of human muscle and this unprecedented and novel technology which will enhance, exponentially and with dramatic effect, the power of the human brain.

I do not believe that the effects will be negative or damaging for society as a whole. No system which enables men to eliminate drudgery, danger or monotony from what has hitherto been defined as 'work' can be other than beneficial if wisely and intelligently harnessed to human need. But I have no doubt that the effects will be traumatic for some, difficult if not impossible, to anticipate, and catastrophic where there is mindless resistance and a total lack of imagination. I have written to Jim Prior about this and in my next article will discuss his reply.

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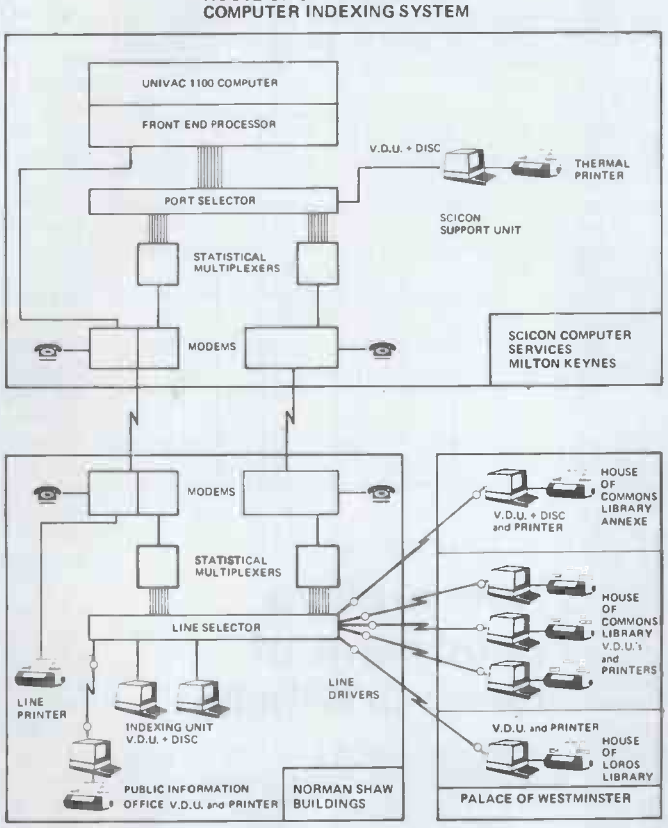

V.D.U. = VISUAL DISPLAY TERMINAL

OTHELLO

David Levy examines the underlying principles of the century-old game of Reversi.

This month we are going to take a look at the game of Reversi (which has recently become known as 'Othello'). This is a superb game simply because the rules can be learned in less than one minute, yet it can take years to master. It is more complex than draughts (checkers) but far less so than chess. And it is great fun to play.

Reversi was invented in England during the early 1880s, and so it should now be celebrating its centenary. The game is played on an 8 x 8 board with discs which are coloured black on one side and white on the other. The players move alternately until the board is full or until neither side may make a move, at which point the player with the most discs on the board is the winner. If a player reaches a position in which he has no moves at his disposal, he must pass, and the right to move is returned to his opponent.

In order to make a legal move, a player must put down a disc with his own colour uppermost, so that the disc being put down and another of his discs which is already on the board contain between them an unbroken line (horizontal, vertical or diagonal) of his opponent's pieces. These pieces showing the opponent's colour are then flipped over and now belong to the player who has just moved, but they may be flipped back later by a move made by the opponent. If the disc being put down forms more than one 'sandwich', all the sandwiched discs are flipped.

The first four moves must all be made in the four central squares of the board, d4, e4, d5 and e5, and herein lies the one and only difference between Reversi and 'Othello'. In Reversi, the two players may choose where they play within these four central squares. Thus, the player who moves second may either force his opponent to make the first two moves in a horizontal or vertical line or offer his opponent the choice between that and a diagonal line. Black moves first and if he decides to put a disc on (say) d4, White could force him to play in a horizontal or vertical line by himself playing on the only diagonal spot, e5. Or White could leave the choice open by playing on e4 or d5.

In Othello, which was 'invented' in Japan during the early 1970s, Black starts the game with discs on d4 and e5, White with discs on e4 and d5. If this really is a new game then I have just invented a wonderful game called David Chess, in which the rules are exactly the same as in normal chess except that White must make his first move on the King's side. (Incidentally, Kevin O'Connell has invented another game, almost as interesting as my own, called Kevin Chess, in which White must make his first move on the Queen's side, and we are both going to patent our games and try to make as much money out of the licensing fee as did the man who 'invented' Othello).

Since the principles of playing Reversi and Othello are identical, we shall now refer to the games under the combined name of Reversi/Othello.

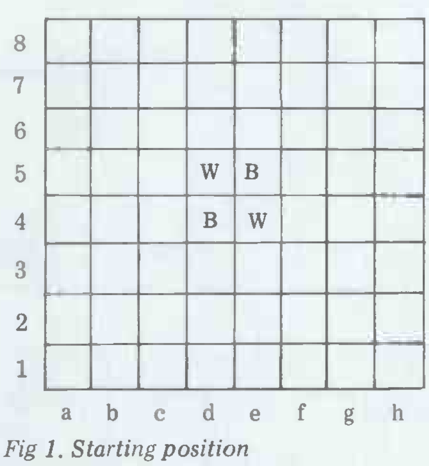

Fig 1. Starting position

How to play a good game of Reversi/Othello

Having explained the rules of the game, we should now examine some of the more important principles or heuristics of good play. Figure 1 shows the initial position of Othello, in which Black may play on d6, c5, d3 or f4. All of these moves are nothing more than reflections of each other, so the decision as to where Black should place his next disc is completely immaterial. I would suggest that your program choose between the four squares at random, so that the human player will be faced with a visually different board position more often.

The first principle of the game is that it is the end result that counts, not who has most discs on the board during the earlier parts of the game. In fact, it is very often the case, particularly in games between beginners and experts, that the beginner has the vast majority of discs until near the end of the game, and he finally loses by an absolutely enormous score. One reason for this is that until the very final stages of the game, material (ie, the relative number of white and black discs on the board) is much less important than structure (where your discs are situated) and mobility (how many moves you have at your disposal). If you have a lot more discs than your opponent, he will tend to have the greater mobility, so it is usually the case that a strong player will try to minimise the number of discs that he turns during the first part of the game. Of course, this strategy can be taken too far. One Othello program which is commercially available recently lost two games in a Pris tournament when it turned so few discs that its opponent scored a clean sweep during the first 20 moves. Such accidents are rare, but your program should prevent them.

Material and mobility are easy to measure, but structure is much more complex. Certain aspects of structure are obvious, and these help us to formulate a sensible strategy. For example, a disc on a corner square can never be captured, so it can form an ever growing base from which its owner can expand outwards unmolested. For this reason, the player who first captures a corner very often wins the game. Since a corner square is so desirable, it is very disadvantageous to place a disc on any of the squares b2, g2, b7 or g7, since this almost always leads to the loss of the adjacent corner, when the opponent gets one of his own men on the long diagonal for just long enough to make a sandwich that includes the b2/g2/b7/g7 square. Similarly, the squares b1, a2, g1, h2, b8, a7, g8 and h7 are undesirable, as they allow an opponent to creep along the edge and finally capture the adjacent corner. On the other hand, since a1 is such a good square and b1, b2 and a2 are so bad, it is obviously desirable to have discs on c1, c3 and a3, so that one day the opponent will be forced to capture these discs, putting his own disc on b1, b2 or a2, and you will be able to recapture, putting your disc on a1.

This analysis of structure can be continued, by placing greater value on the squares d3 and e3 than on c2, d2, e2 and f2, on the grounds that if a player occupies the third rank, when his opponent occupies the second rank, he will be able to make a capture on the edge of the board, and edge squares are worth having. In fact, the value of edge squares is an extremely complex subject, well beyond the scope of this article, but suffice it to say that a lot of erroneous ideas have been expressed about edge squares. Certainly b1 and a2 are bad squares to occupy from the structural point of view, but in fact it is edge formations that are really important, and not individual edge squares.

How the game changes

The nature of the game changes as more and more discs are added to the board. In the early stages (the opening) and the middle-game, structure and mobility are all important, but in the final analysis it is the player with the most discs on the board who wins the game. It is therefore clear that up until a certain point in the game, structure and mobility should be the most heavily-weighted features in the evaluation function, while during the last few moves the evaluation should become more and more oriented towards the number of black and white discs actually on the board. One way in which this might be accomplished is to have an evaluation function of the form:

W_1 x (MOBILITY + k x STRUCTURE) + W_2 x MATERIAL

where $W_1 = e^{-nz}$ and $W_2 = (1 - e^{-nz})$
n=number of discs on the board
k and z are constants

When the number of discs on the board was low, ie during the early stages of the game, W_1 might be just below 1, while near the end of the game, when n approached 64, W_1 approached 0.

Quantifying the features

Mobility is easy to measure, being merely the number of moves available, but in a tree searching program the matter is not so simple. The reason for this is that after a white move, it is possible that White has a very low mobility because he has just made a number of captures (ie flipped a number of black discs), whereas after Black's reply move White might have a much higher mobility because Black has flipped a number of discs back. It is therefore rather meaningless to compare mobility evaluations at odd and even ply, so the tree should be searched to a uniform depth, or at least all terminal nodes should be either at odd or even ply. In this way the program can happily compare its mobility in different positions, whereas were it to compare the mobility after a White move with the mobility after a Black move, the answer would be meaningless.

Material is also easy to measure, being merely the count of how many White and Black discs are on the board. The most difficult problem is how to measure the structural aspects of the position. One obvious method, which has gained wide support, is to weigh the squares of the board in some way that reflects which ones are desirable and which ones should be avoided. A simple weighting map is shown in Figure 2.

All things being equal, which they never are, the above map represents an acceptable valuation of individual squares, but the problem is made more complex by the fact that occupation of one square may well change the desirability of occupying some other square, and this change might have an effect of fatal proportions. A simple example is the question of the b2 square. It is very bad to occupy it, because occupation of b2 might lead to the loss of a1, but if you already occupy a1 then b2 can do you no harm. A map of square values must therefore change dynamically as the game progresses, and your program should be able to cater for these changes.

8	16	−4	4	2	2	4	−4	16
7	−4	−12	−2	−2	−2	−2	−12	−4
6	4	−2	4	2	2	4	−2	4
5	2	−2	2	0	0	2	−2	2
4	2	−2	1	0	0	2	−2	2
3	4	−2	4	2	2	4	−2	4
2	−4	−12	−2	−2	−2	−2	−12	−4
1	16	−4	4	2	2	4	−4	16
	a	b	c	d	e	f	g	h

Fig 2. Possible square weightings to reflect good and bad squares.

The openings

Reversi/Othello is not yet sufficiently well analysed for us to be able to tabulate the best and worst openings, but that is not to say that we cannot make some definite remarks about opening play. Indeed, it is quite possible for your program to build up its own openings library, given one or two elementary principles.

We have already discussed the subject of mobility. Another important aspect of opening play is the apparent undesirability of being the first player to place a disc outside the central 16 squares. The reason for this is rather obvious — if you are the first to place a disc one rank or file away from the edge, your opponent will probably be the first player to place a disc on the edge of the board, and edge squares are important. Therefore, if your program could analyse exhaustively the first 12 moves of the game (remember that there are 4 discs on the board at the start), it could determine which side was ahead in mobility in every variation, and it could also select the move or moves which gave itself the best chance of being the first player to place a disc on the edge of the board. This exhaustive 12-ply search might take a great deal of time, but it would only need to be done once, and the results could be printed so that you would be able to construct an openings book comprising optimal play (at least, optimal in the context of this strategy). Then, even though your program might only be able to perform a 3-ply or 4-ply search during the game, it could play the first few moves on the basis of the exhaustive 12-ply search.

I should perhaps add that it is not yet known the extent to which the 'Sweet 16' strategy is likely to be successful, but that, combined with a mobility feature, should enable your program to write a strong openings book.

The middle game

We have examined the form that a Reversi/Othello evaluation function might take, and it only remains for the reader to select his weightings, which he can perhaps do on a learning basis. The small number of independent parameters (W_1, k and z) makes it relatively easy and quick to play a large number of test games in which one version of the program employs one set of parameters while its opponent uses another set. At the end of a series of such games, the programmer can select optimal weightings. (Once again, let me remind you to ensure that, in its quest for high mobility, your program does not give away all of its discs.)

The end game

Since the total number of discs on the board is the final and absolute criterion for determining the winner, it is clear that your program should, during the last few moves, search the game tree to its very end, and apply only material as its evaluation feature. How far from the end of the game an exhaustive search is possible will depend upon the speed of your processor and the efficiency of your program. For this reason, it is doubly important to have an efficient move generation routine. The advantage of being able to search the whole of the game tree from six or eight moves prior to the end of the game, are rather obvious.

Writing the program

This article contains all that you need to know to be able to devise a suitable evaluation system for the game. Your program will be a traditional tree-searching program, employing the alpha-beta algorithm and all the tricks associated with it (alpha-beta window; killer heuristic; iterative deepening; move sorting; etc). Some of you may have missed my earlier articles in which I went into great detail over these essential elements of game playing programming, and I would strongly urge you to beg, borrow or even buy the back numbers of the magazine so that you will be properly acquainted with all the principles of tree-searching, otherwise most of my articles will be lost on you.

Examples of computer play

Just how strong are the best Othello programs compared to the strongest human players? Since the game is quite complex, and humans have more difficulty envisaging board positions after a number of discs have changed colour and changed back again (and again and again), the relative difference between the best humans and the best programs should be much smaller than is the case in, for example, the game of chess. And that is exactly how things are. The world's strongest human players are not demonstrably better than the best Othello programs and I would guess that within a year or two there are programs which will never, ever lose a game to a human.

In order to test the world's best

human players against good Othello programs, Professor Peter Frey, of Northwestern University, Evanston, Illinois (home of the famed CHESS 4.n programs), organised a man v machine tournament on June 19 1980 at the Northwestern campus. Six Othello programs were pitted against the two top ranking human players in the world, Hiroshi Inouie of Japan (the current World Champion), and Jonathan Cerf of the USA (runner up in the previous World Championship but winner of the title in October 1980.) The result of the tournament was a win for Inouie, but he did lose one game, to a program written in London named The Moor*. Cerf also lost a game, to a program written by Dan and Kathe Spracklen of Sargon fame. Since June the programs have all been debugged to some extent, and I imagine that if the tournament were to be replayed the humans would have more difficulty finishing at the top.

To produce programs that can play this well, normally requires a substantial commitment in man hours. But there is no reason why the readers of this magazine cannot write a program to play at or near expert level. Mike Reeve, who programmed THE MOOR, didn't even know how the pieces moved when he began working on the game, so some advice from a strong player is very useful; you can achieve quite a lot with the information I have given you.

The following games show The Moor in action, and illustrate some of the finer points of Othello/Reversi.

**The Moor was written by Mike Reeve, a postgraduate student at Imperial College, University of London. Expert advice was provided by Michael Stean, a chess Grandmaster who is also a very strong Othello player. The program was written for Philidor Software, a company owned by myself and Kevin O'Connell, and will be available later in 1981 as part of the Scisys range of game playing computers.*

Game

	a	b	c	d	e	f	g	h
8	B	B	B	B	B	B	B	
7	B	B	W	W	W	B	B	B
6	B	B	W	W	B	B	B	B
5	B	B	W	B	B	B	W	B
4	B	W	B	W	B	B	B	B
3	B	B	B	B	W	B	B	B
2			B	B	B	B	B	
1			B	B	B	B	W	

First a position, taken from a game in the third Othello/Reversi tournament for computers organised by the French magazine *L'Ordinateur Individuel*, in May 1980. In this game The Moor, searching to a depth of only 2-ply, had fallen foul of a program looking to 6-ply (The Moor was a development version, written in Pascal). Black, our opponent, had just made a mistake, and I give this position only to illustrate the point that having a large number of discs on the board is not always a good idea, even near the end of the game. Look what happens now, from a position in which Black is 'winning' by 46 discs to 11, with only seven squares left to play on. We begin with White's play at move 58: (White moves are W, Black moves are B)

54 W b1 55 B PASS 56 W h8
57 B PASS 58 W h2 59 B PASS
60 W h1 61 B PASS 62 W b2
63 B a2

and now neither side may move again, so the game ends, with White 39 discs to Black's 24.

The previous episode shows just how easy it is to be deceived into thinking that having a big material advantage is decisive. In the next game, for which you will need an Othello set if you wish to follow it properly, Black gets into serious trouble from early on, and then makes a serious mistake which costs him the first corner. This game was played at the finals of the 1980 British Othello Championships in London, immediately after Neil Cogle won the Championship title. It illustrates my argument that a computer program can already play at the same level as top human players.

Game two

Black: Neil Cogle (1980 British Othello Champion — for humans!)
White: The Moor (4-ply look ahead)

1 B c5 2 W e6 3 B f5
4 W c4 5 B c3 6 W d3
7 B f4 8 W b3 9 B b4
10 W c6 11 B d6 12 W a4

So The Moor has gained the first disc on the edge of the board, and to redress the balance Black takes the dangerous square a2.

13 B a2 14 W f6 15 B e7
16 W f8 17 B b5 18 W e3
19 B f7 20 W a5 21 B a6

Black was already in a bad way, with a disc on a2 and a deficit in mobility, but this move is a fatal mistake which puts his position beyond repair. See if you can spot The Moor's killing reply.

	a	b	c	d	e	f	g	h
8						W		
7					W	B		
6	B		W	W	B	B		
5	W	B	W	W	W	B		
4	W	W	B	W	W	B		
3		B	W	W	W			
2	B							
1								

22 W a3

Now you can see the danger of playing on a2. Black must lose the a1 corner.

23 B d8 24 W b6 25 B c7
26 W a1

Now that The Moor has a corner, it uses it as an impregnable base from which to expand its control of the board.

27 B f3 28 W g3 29 B f2
30 W g4 31 B h5 32 W e2
33 B e1 34 W d2 35 B h4
36 W d7 37 B c8

White can afford to concede virtually every edge square at this stage of the game, in the knowledge that his corner anchor on a1 will eventually allow a clean sweep of the edges.

38 W g1 39 B d1 40 W g6
41 B h6 42 W g5 43 B c2
44 W b1 45 B b2

Now that a1 is already occupied, putting a disc on b2 is relatively unimportant.

46 W a7 47 B g2

There is no way that White can be kept out of h1. If Black plays on f1, White replies on c1 and then Black is forced to play on b7 and g2 within the next few moves.

48 W h1 49 B h2 50 W f1
51 B b7 52 W c1 53 B PASS

Black has no moves, and White continues its march around the edge of the board.

54 W h3 55 B PASS 56 W h7
57 B PASS 58 W g8 59 B g7

Black's problems are aggravated by the fact that by now The Moor is examining the whole of the game tree exhaustively, and is always making the very best move.

61 B PASS 62 W e8 63 B PASS
64 W b8

Neither side may move to a8, so the game comes to an end with The Moor winning by 61 discs to 2, which is rather like being several queens up at the end of a game of chess.

Finally, I shall give without comment the game won by The Moor against World Champion Hiroshi Inoue of Japan, on June 19 1980. The final score in this game was 36-28 in favour of the program, and not 34-30 as reported in the tournament bulletin.

Black: The Moor
White: Hiroshi Inoue

1 B d6 2 W c6 3 B c5
4 W c4 5 B b3 6 W e6
7 B c7 8 W b5 9 B a6
10 W c3 11 B c2 12 W b4
13 B f4 14 W f5 15 B f3
16 W e3 17 B a3 18 W d7
19 B d3 20 W g4 21 B f6
22 W a4 23 B d8 24 W b6
25 B a5 26 W e7 27 B h3
28 W e8 29 B f8 30 W f7
31 B c8 32 W g5 33 B h6
34 W h5 35 B h4 36 W g6
37 B h7 38 W c1 39 B d2
40 W b2 41 B d1 42 W e1
43 B e2 44 W f1 45 B f2
46 W b1 47 B g8 48 W g1
49 B b7 50 W a7 51 B g2
52 W g3 53 B h1 54 W h2
55 B a1 56 W h8 57 B g7
58 W b8 59 B a8 60 W a2

Black wins by 36-28.

To the best of my knowledge, this is the first time that a computer program has ever defeated a human World Champion in a game of pure skill.

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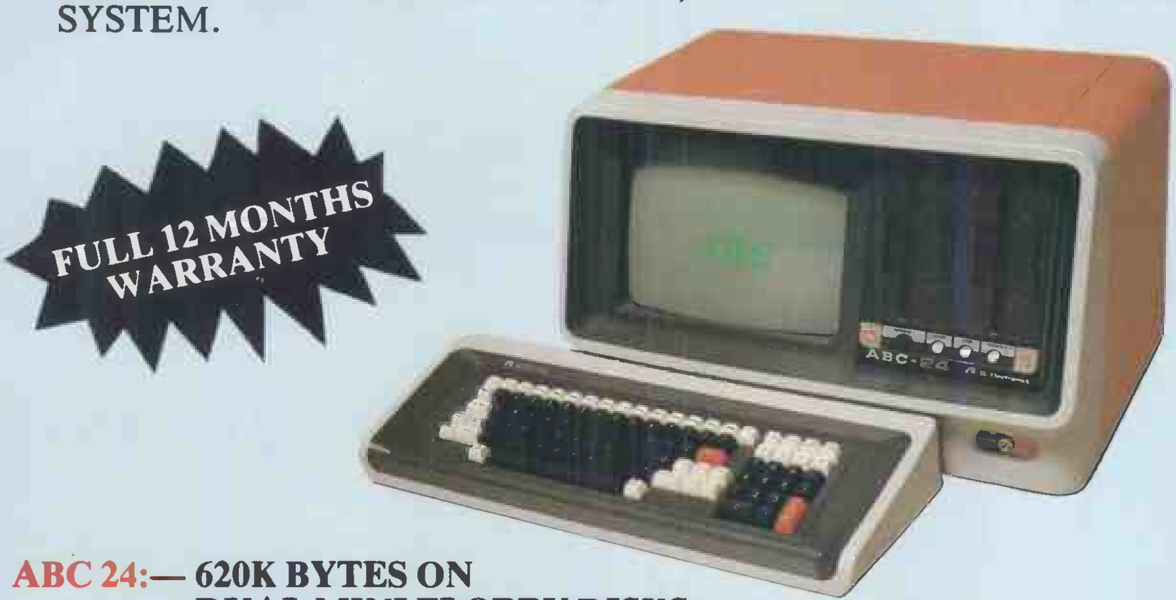

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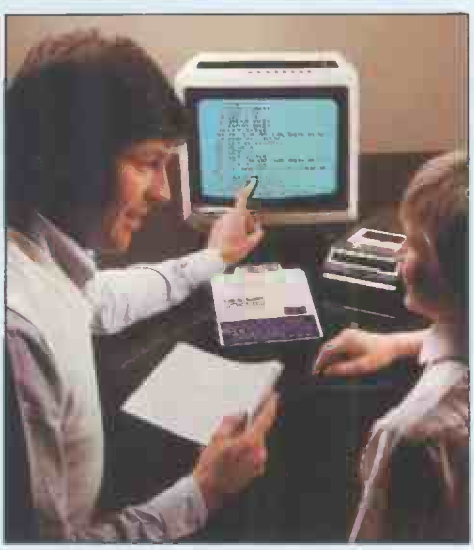

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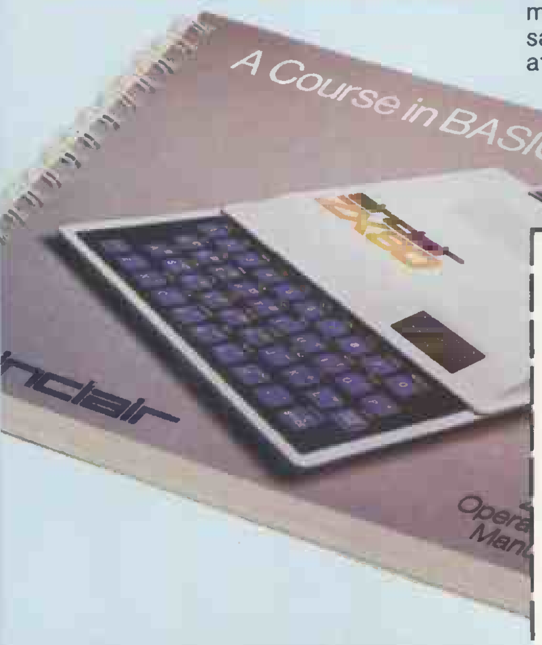

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COMPUTER ANSWERS

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Revas request

Can you tell me where I can get a complete listing of Parkinson's Revas (1.5k Z80 Reverse Assembler)?

One other thing that may be of interest to users of the RML 380Z and an Anadex DP9501 doing HRG hard copy: if you are using a two-wire serial link at highest baud rate and are having extra dots printed, go down to 1200 baud or, better still, parallel mode. This occurred on the program that I have written for Anadex driving and *not* RML's driver program. If anyone would like further details they may contact me directly.
C J Pink, 14 Cowbeck Close, Parkwood, Rainham, Kent.

Thank you for a most useful tip, I know lots of people are working on high resolution graphics hard copy. The information that you want on Parkinson's Revas can be found in *PCW* vol 2 nos 1, 2, 3, 4, 7, 8 and vol 3 no 1.

There was also an offer in vol 2 no 1 which read as follows: 'REVAS on cassette in relocatable form £4, listing of a suitable loader included. You tell the loader where to load REVAS, the REVAS program origin, REVAS workspace origin, the loader does the rest. State CUTS or NASCOM standard. From D W Parkinson, Well Cottage, The Street, Tuddenham, Ipswich IP6 9BT.
SW

Atari answer

I was very interested in your review of the Atari 400 and would like to know whether you recommend it compared with other systems. How much is it going to cost? Are there any drawbacks with the keyboard? What is the actual memory configuration? Will the graphics plot off the screen? Can I use other software than that developed for the Atari 400?
A K Timms

As I had no inside information on the Atari, I sent your letter direct to Ingersoll Electronics, 202 New North Road, London N1 7BL, who kindly replied most promptly with this answer:

'We expect that the suggested retail price of the Atari 400 with 16k RAM will be £395 inc VAT. With the full colour range capability, on-screen editing and all the features described in your excellent original write-up (*PCW*, Oct 80), coupled with consumer end-users' requirements for ease of operation and reliability, the Atari represents a significant advance.

'There are no particular drawbacks with the mono-panel keyboard and it is capable of all the functions of a standard typewriter Qwerty keyboard. It also has the advantage that if liquids are spilt over it, it will not immediately blow up the electronics.

'The Atari 400 has 10k ROM plus 16k RAM plus a ROM cartridge slot, which can hold up to 16k depending on the size of the ROM cartridge pack being used. You will therefore be able to write programs of up to 16 kbytes long. The graphics *do* plot off the screen. The Atari 410 cassette recorder will not accept any other brand of software as they are not written in the same Basic.
Steve Bernard, Ingersoll Electronics Ltd.

It is very hard for me to comment on the above statements as the machine has yet to be released. On paper it certainly looks good value for money, especially at under £400.
SW

Numerial nasty

I have unearthed a peculiar fault in the Nascom Microsoft Basic (8k version 4.7). The following results appear: PRINT 26.53-26 yields the result .529999. On further investigation, I noticed a large number of similar results, and the program 10 A=A+0.01 : PRINT A: GOTO 10 seems okay up to .83 but the next value given is .839999. Is there a problem confined to version 4.7 of Microsoft Basic? Does it appear on all Nascom 2 machines? What is the precise mechanism for the failure? Is there a cure for it?
M D Heden, Ampthill, Bedfordshire

The problem that you have found exists on any system that uses 'pure binary' for its representation of decimal numbers. Certain numbers can be represented exactly in both denary and binary; examples are 0.5 = 0.1 0.25 = 0.01 0.75 = 0.11, etc; however, the majority cannot, eg, 0.2 = 0.0011001100110011 recurring.

Computers have limited storage and therefore numbers have to be represented by a fixed number of bits (binary digits); a common number might be 32 bits of which 24 would be the mantissa and eight the exponent (there are many good books dealing with this and a good one is *Computer Science* by C S French, DP Publications). Using 24 bits, 0.2 is held as 0.19999999881; now as long as the version of Basic only prints six or seven decimal places, the error will not appear until this number has been added up many times, but as soon as this erroneous value has been added up enough times, it will soon appear. This weird effect can also be observed by trying the following program:

```
10  A = 10000001
20  B = 10000000
30  C = 0.0000001
40  PRINT A/C-B/C; (A-B)/C
```

This has serious implications when developing programs, especially in the scientific field, and should always be borne in mind. The cure for it in some applications, such as finance is to work always in pence and not in pounds, dividing by 100 when necessary for display purposes. It is not confined to Nascom or, for that matter, any particular machine, as it is not the fault of the machine but rather of the version of the language implemented.
SW

Text troubles

Soon I will have totted up 50 years of writing. I am getting more and more frustrated with the time taken to type a 'clean' copy so I would like a word processor. I have set a budget of around £1000 and would like your advice. I realise that disk drives are out, but I would like a nice keyboard, a reasonable printer (Centronics 737 or Epsom MX80 will do), use of my own TV, display of 'long' lines, plenty of RAM (would 16k suffice?); and a 'ready-to-go' system.
J H Miskin, London

I am sorry to disappoint you, but I don't really think that you will be able to put a system together for under £1000 that will satisfy a professional such as yourself. I will explain why. Firstly, the printer will cost you around £400 of your budget, leaving £600 for computer and cassette. Although this will enable you to buy a computer, it will inevitably have 16k or perhaps 32k of RAM; if you are going to do without disks then you will need as much memory as you can possibly get.

Assuming each page has 36 lines, and 55 characters per line, that makes approx 2000 ch/page or 2k/page. Therefore ten pages need 20k RAM. You will also have to have a program to perform the word processing which may take anywhere from 8-20k depending on sophistication, making perhaps 30k in all. I don't think it would be practical to type and edit fewer than 20 pages at a time.

Another point is that it will take around four minutes to load 20k of text from cassette; this may not worry you, but you ought really to make regular back-ups of your text each time you edit it. With a disk system I do this about every ten minutes.

You also want a 'turn-key' system, and I know of none for under £1000.

To be more optimistic, there are hopes, for example, the Nascom II with Naspen, which is certainly cheap and good value for money. Look at a stringy floppy system, too, and get a quote for a maintenance contract. An alternative is the PET with a ROM-based word processor, but unfortunately the new 80-column PET is outside your price range at about £825 plus VAT for a 32k system; you would be wisest to try and save up for this version, but I wouldn't be talked into getting anything less than 32k; again, look for a stringy floppy for that.
SW

ZXpansion?

I am considering buying a ZX80. What is the availability of peripherals like. Is it possible to expand it cheaply?
D Bloodworth (and many other users throughout Britain!)

You may find that you obtain better, more up-to-date answers by writing directly to the National ZX80 user group. The address is: Tim Hartnell, ZX80 Users Group, 44-46 Earls Court Road, London W8 6EJ.

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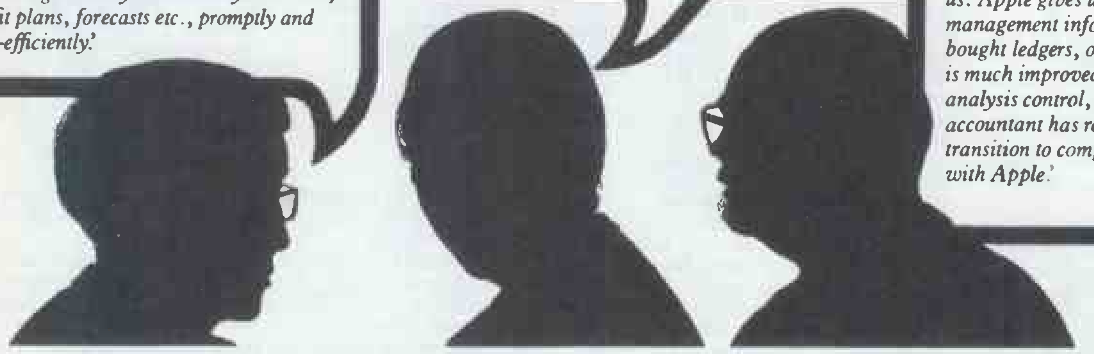

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Interface by sending £7.50 (UK) £9.50 (Europe) or £13.50 (elsewhere) to: National ZX80 Users Club, Unit 3, Woodthorpe Road, Ashford, Middx. TW15 2RP.
SW

Words wanted

Can you tell me where I may get a book on the subject of word processing? Also the following books: *Electronic Logic Circuits* by J R Gibson, published by Arnold and *Systems Design with Microprocessors* by Zissos published by Academic Press?
Name and address supplied

I wonder why you requested to remain anonymous?

You should be able to order the two books mentioned above from any good bookshop — after all, this is their job.

As for books on word processors there is *Wordprocessors Report and Supplement* by Lamsac 1978 at around £4 if you can still get it; also, *Word Processing in the Modern Office* by Paula Cecil, published by Addison Wesley in 1980 for £7 and there is also a magazine called *Which Word Processor?* available from some stationers.
SW

Mathematical micro

Can you give me any problems to work on using my micro. They are best kept to something mathematical, but I would prefer to try something that no-one else has yet solved; are there any such problems?
T Hutchinson, Weybridge, Surrey

Try these:
Has $x^4 + y^4 + z^4 = N$ got any any whole number solutions?
Has $x^4 + x^4 + z^4 = N$ got any whole number solutions, where N is an exact fourth power?

Let's hope they don't keep you awake all night.
SW

Data difficulty

I have an Apple II and recently bought a 6502 manual and assembler with a view to writing subroutines for Basic programs. I cannot see how to pass data and variables (strings in particular) between Basic and assembler.
Miss H Prince, Harrow, Middx

You have hit on one area that is lacking in many micros, the Apple being no exception. However, all is not lost, as page 137 in the Applesoft manual explains all.

Let us consider variables only. Whichever variable is defined *first* in the program can be accessed via locations hex 69 and 6A. However, only the first one can be located in this way. Let us assume that line Ø of our Basic program is Ø MD$ = "Mike Dennis". At locations 69 and 6A will be found two bytes that, together, make up an address where MD$ can be found. This address depends on the size of the program but whatever value this address is, it can be found from these two locations. Let us assume that location 69 holds 9E and 6A holds 35. At address 359E will be found the following data, ASCII M then ASCII D at location 359F. The $ isn't stored. At location 35AØ will be found a byte whose decimal equivalent is the current length of the string (in this instance it will be 11) which explains why strings have a maximum length of 255. The next two bytes hold the address of where the string will actually be found, say 8E98. This address will dynamically change every time A$ is referenced by the program but we can always find this address via 69/A. Try writing simple programs and then looking at the various memory locations either from Basic or alternatively via the monitor.

The next two bytes are set to zero; this is to leave room to store real variables. Other variables can then be found on seven byte increments from the address given at 69/6A but you do have to know in what order your variables appear in the program.
Mike Dennis

APL available

I have just read the letter from L Davies of Cheshunt on the subject of APL on a Tandy TRS-80. You may be pleased to know that there is an APL subset for the TRS-80 called APL80 and this is available in both disk and cassette form from:
Micro Computer Applications, 11 Riverside Court, Caversham, Reading, Berks.
I have a copy of the tape version and am well pleased with it.
P G Hughes, Bracknell, Berks.

This letter needs no answer from me but it does illustrate a good point — that interaction from readers will help make these pages more up-to-date and readable. Thank you Mr Hughes.
SW

TV tips

I am considering buying either a Superboard II or an Ohio Challenger. *PCW*'s review stated that the computer was built for use with a domestic television — does this mean that I will not be able to use a standard monitor with it?
P Beauchamp, Hinckley, Leics

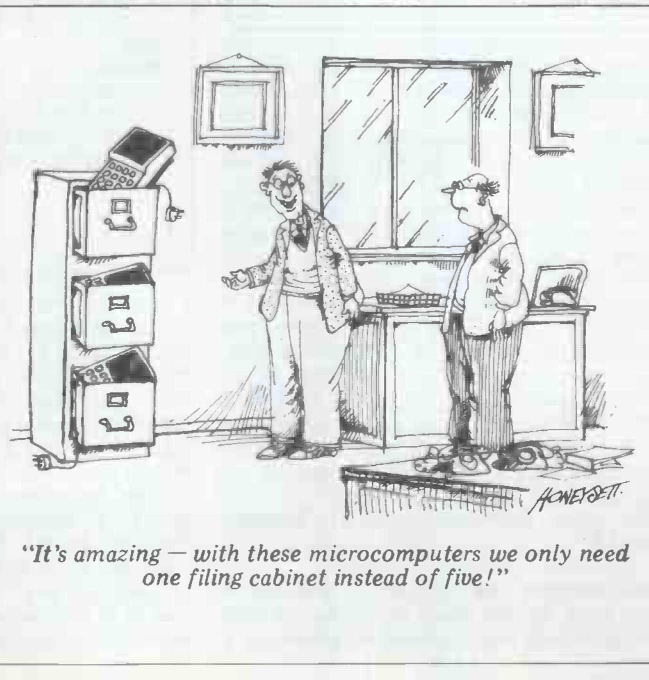
The main difference between a domestic TV and a monitor lies in the manner in which the signal is transferred from the computer to it. The domestic TV expects the signal to be a radio-frequency (or rf) modulated signal. In other words, it expects to see a signal similar to that which crawls out of the end of your TV aerial lead. To this end, many single board computers (including the Superboard and UK101) are fitted with modulators that 'prepare' the computer video signal into a suitable form for the domestic TV, ie they have UHF modulators fitted. A TV monitor, on the other hand, expects a standard unmodulated video signal and this is also provided on the UK 101 at pin 12 on J2, the earth being on pin 11. You should connect your monitor to this point. You may need to adjust contrast and brightness to achieve a decent picture.
Mike Dennis

Speedier shapes

I have a 32k ITT 2020. It is a bit slow, especially when drawing shape tables. Is it possible to speed it up to 2 MHz? Also I am thinking of buying a disk drive from the US. Will it run on my present power supply?
Terence Wong, London

I'm surprised that you think the ITT 2020 slow, particularly as it is virtually identical to the Apple II which has always been considered to have quite respectable Benchmask timings, although I appreciate the fact that they don't test shape tables. Normally, the solution that I would suggest would be to incorporate some assembler subroutines but, as these are extensively used already, there is very little to be gained in that area. If you knew exactly what shapes you wanted and exactly where they were destined to go (and not to move around) then you could POKE directly into the screen memory using machine code for speed. However since this defeats the object of 'drawing' shapes, it's not of much practical use. You can't run the ITT at 2 MHz for many reasons, such as the fact that the screen display is tied into the clock-rate, and so I am afraid that you will have to learn to live with the status quo — after all there are a heck of a lot of dots being plotted which must take some time to plot!

In answer to your second question, there is no problem with buying a disk drive from the States as far as power supplies are concerned since it runs off the DC supplied and not the mains. You may have some difficulty with the slight difference between the clock speeds of the Apple and ITT. They are marginally different and can cause difficulty when, for instance, trying to read on an ITT a disk recorded on an Apple. It all depends on the tolerances of the respective disk drives. If you have access to a disk-speed test disk then one answer (if you are experiencing this problem) is to set the speed to run slightly fast for one machine but slow for the other and so achieve a compromise.
Mike Dennis



"It's amazing — with these microcomputers we only need one filing cabinet instead of five!"

PASCAL READERS WRITE

Chris Sadler presents a selection of reader's letters resulting from the recently proposed Pascal Benchmarks.

As promised, here are the collected timings of the Pascal Benchmarks as sent in by *PCW* readers. Some of the letters we received appear below. First, however, the misprints (p61, *PCW* Dec) — five in all, starting with program VECTOR where the second for-loop should read:

for j:=1 to 10 do

The second error is in program UNEQUALIF where the 'else' line should terminate with a semi-colon. The third is in program VALUE, procedure VALUES, the body of which should read:

i:= 1

Program MATHS was a bit of a mess so I've listed it — see Listing 1. Now for the letters.

```
program maths;
var  k: integer;
     x,y: real;
begin
   writeln ('s');
   for k:= 1 to 1000 do
   begin
     x:= sin(k);
     y:= exp(x);
   end;
   writeln ('e')
end.
```

Listing 1

I have just tried out your Pascal Benchmarks on our Apple II Pascal system but I have made two amendments to the programs. For convenience, I replaced all WRITELN('S') by READLN and all WRITELN('E') by WRITELN(CHR(7)). This meant that programs did not start running until I pressed RETURN and gave an audible bleep at the end, resulting in easier timing. The second — essential — change was in PROGRAM MATHS where you try to take the EXP of K from 1 to 1000. This will, of course, result in a floating point error when you try to calculate EXP(1000)! I also wrote a couple of other test programs which time an iterative and a recursive calculation, as in Listings 2 and 3.

Dr John Rostron, Dept of Biology, NELP

We adopted the 's' and 'e' scheme to conform to the Basic Benchmarks (and because not every computer produces a tone on CHR(7) but the tactile start and audible finish is a good idea which certainly makes timings more convenient. Iteration and recursion are interesting to compare but since both use the same procedure-calling mechanism — although for a different number of calls — they don't distinguish different aspects of the compiler.

```
program iteration;
var i,k: integer;
function ifac (n: integer);
var i,f: integer
begin
   f:= 1
   if n >1 then
     for  i:= 2 to n do f:=f*i;
   ifac:=f
end;
begin
   readln;
   for k:= 1 to 1000 do
     i:= ifac(10)
   writeln (chr(7))
end
```

Listing 2

```
program recursion;
var i,k: integer;
function rfac (n: integer);
begin
   if n >1 then rfac:= n*rfac(n-1)
             else rfac:= 1
end;
begin
   readln;
   for k:= 1 to 1000 do
     i:= rfac(10)
   writeln (chr(7))
end
```

Listing 3

I have just read the Pascal Benchmarks article and found it most helpful. I had been looking for some way of comparing my own Pascal system with others and have now run all the relevant Benchmarks (my system does not yet support REAL arithmetic or reference parameters).

The Pascal system in question is one which I developed myself for the TRS-80 Model I and which is now available from A J Harding (Molimerx). It compiles first into a form of p-code and then translates the p-code into Z80 machine code, hence the rather fast times.

I should like to take this opportunity of thanking you for your coverage of Pascal in PCW. *Please carry on the good work!*

Tim Bourne, Hemel Hempstead

Congratulations on writing your own compiler and I hope you don't mind my naming it as such in the timings table. Please press on with the REAL arithmetic.

You may be interested in the enclosed timings which I ran on our departmental PDP11/04. The system comprises a Unibus PDP11/04 processor, 64k MOS memory, two RK05 disk drives and a bunch of exotic lab peripherals which are irrelevant in the present context.

The Benchmarks were compiled with the OMSI Pascal 1.2 compiler running under RT11 V3B. This compiles Pascal source code into MACRO (PDP11 assembler language) which is then assembled and linked. All Benchmarks were self timing, using the system clock which runs at line frequency (although these times should probably only be considered accurate to 0.1 sec.

As you can see, the execution times are an order of magnitude faster (with the exception of the floating point routines) than the Benchmarks run on the H11A which you reported in December. The slow floating point execution is a consequence of the 11/04 system having no EIS or FPP installed. However, as the 11/04 and LSI 11/2 are roughly comparable in terms of performance, this OMSI Pascal compiler may be of interest since the differences in performance seem to be largely a function of the software, which can be run on any RT11 system with sufficient memory.

Dr J B Brooke, Department of Applied Psychology, UWIST

The OMSI Pascal timings make an interesting comparison with those of our H11A. We seem to benefit from the EIS chip and suffer for the p-machine.

I enclose the Benchmark timings achieved by Pascal-Z version 3.2 on my Midas 3 system, which comprises an S100 system with 4 MHz Z80 and 64k RAM running under CP/M 2.1.

The Pascal-Z times are quite favour-

able except in those areas requiring calculation, as in REALARITHMETIC and REALALGEBRA. The relatively bad timings for calculations are undoubtedly due to some extent to the maths chip used in the H11A, but in view of the low precision used by Pascal-Z (seven to eight decimal digits, with all REAL numbers held as binary in a 32-bit two's complement field where the first eight digits are exponent), I feel that the results are significant.
Mr C J Neville, Welling, Kent

Thank you for your Pascal-Z timings — your floating point software certainly does seem a bit slow.

Enclosed are timings run on a Commodore PET with the TCL Pascal Chip, using the resident compiler. Due to lack of disk space I could only test a few of the Benchmarks with the disk compiler but they came out approximately five percent faster than with the resident compiler.
Mr C Cook, Middlesbrough

It's a pity that the one major Pascal compiler produced in Britain is so slow, even when compared with the Apple II Pascal which uses the same processor and also goes through pseudo-code.

The prospect of the Pascal Benchmarks being used in all future PCW *Benchtests of Pascal systems is so appalling that I must point out the glaring shortcomings of the Benchmarks published before they become any more widely used:*
1. Probably the most important problem is that the short tests, such as memoryaccess, have an inner x10 loop as well as the outer x10,000 loop in order to give a reasonable runtime for stopwatch timing. This means that memoryaccess, for example, executes 110,000 for statements and only 10,000 assignments in its run; thus the time for the statement supposedly being tested is quite swamped and quite misleading times result. Useful results can be extracted by doing the right arithmetic, but what is really required is a set of figures which can be compared directly, which could be achieved if ten assignment statements were written out explicitly, and similarly for most of the other tests.
2. No test is made of operations on character type data; why not?
3. It certainly is worth noting that no account has been taken of the speed of compilation. Again, one can only ask, why not? In practical program development, this factor is at least as important as the execution speed.
4. Some figures on memory usage really should be provided. The size of the compiler at least should be easy to find out. The size of the object code generated could be tested by compiling some standard program of reasonable size, say a standard sort of algorithm, and this would also give a useful test of compilation time, execution speed of a typical mix of statements and show up quirks in the system. Pascal standards are much more widely adhered to than Basic standards, so development of a reasonably large Benchmark program should not present serious problems.
5. Finally, the programs printed contain several errors. As well as the traditional 'misprints', the program statements should be of the form program benchmark(output), to be accepted by a standard compiler.
In conclusion, yes it is a nice idea to have some standard Benchmarks for Pascal but only if they are thorough and informative.
PS — Whatever happened to case statements and function subroutines?
Paul Farrell, Birmingham

To tackle the points in order:
1. I have always claimed that one of Pascal's strengths is its readability. My apologies — we now have positive proof that it cannot be as readable as we thought. How else can one explain the following? Program MEMORYACCESS (and all of the other 'short' tests) has a 10,000 step loop, within which is a ten step loop, contained within which is the assignment statement which we are trying to time. Simple arithmetic dictates therefore that the assignment statement will execute 10 x 10,000 = 100,000 times, once for every iteration of each for-loop. If there were a semicolon between the last 'do' and the '1 := j' (and this is where the readability comes in) then the quoted figures would be correct; but there isn't, so they aren't.
2. This is a good point. Most character handling routines in our *PCW* series performed using library string-handling routines and indeed we published our own emulation of the UCSD string-handling routines in our PCW series 'The Complete Pascal' (which is soon to be published as a book entitled *Pascal for Programmers* published by Springer-Verlag). Since these vary considerably both in form and in scope, there didn't seem any way of comparing them and it never occurred to us to descend to character-handling per se. I accept, however, that some types of programming deal almost exclusively in characters (imagine trying to write an editor?) and we would be pleased to hear from Pascal programmers with this type of experience who can suggest a brief, effective test of these facilities.
3&4. I feel that Sue and I were frank enough about the limitations inherent in the ideas behind our Benchmarks when we wrote the original Benchmark article. These remarks are simply Mr Farrell's own ideas for a different type of Benchmark with a different set of limitations.
5. There are five Pascal compilers (commercially) available for 8-bit microcomputers in this country. At least one of these will flag a compile-time error if the 'standard' syntax is used and the rest will certainly ignore it.
PS The CASE statement is structurally similar to the IF- THEN-ELSE statement and the function-calling mechanism is similar to the standard call-by-reference. It seems unlikely, therefore, that a compiler-writer would be able to find any shortcuts in implementing these and so we could see no point in Benchmarking them.

Finally, we would like to thank everyone who wrote in to us. There are still some gaps in our table which I would be grateful if readers would help us to fill; we need: Pascal/M, Pascal/MT, TCL Pascal under CP/M or resident, Whitesmiths Pascal, UCSD Pascal on a Z80A processor.

PASCAL BENCHMARKS SUMMARY

Benchmark \ System/Software	H11A/ USCD	Pascal Micro-engine/USCD	Apple II/ USCD	Onyx C8002/ USCD	Midas S/ Pascal —Z	PDP 11/04/ OMSI	Tandy TRS-80 Bourne	CBM PET/ Resident TCL
magnifier	3.9	0.8	6.4	0.5	2.4	0.3	2.2	9.5
forloop	42.8	9.5	74.3	6.1	29.3	3.3	26.6	119.0
whileloop	40.1	9.3	70.0	5.9	29.9	2.5	28.6	158.0
repeatloop	35.0	9.1	63.3	5.4	29.3	2.2	26.4	168.0
literalassign	49.9	11.0	88.5	6.7	30.3	3.92	29.5	149.0
memoryaccess	52.0	11.4	91.0	6.9	31.4	4.3	31.2	155.0
realarithmetic	61.7	8.7	93.0	—	192.9	58.0	—	164.0
realalgebra	40.6	6.8	83.4	—	127.9	53.3	—	156.0
vector	102.9	26.4	203.3	22.7	51.6	9.4	72.2	332.0
equalif	66.8	16.0	116.7	9.9	33.9	5.3	46.1	240.0
unequalif	65.8	15.8	115.3	9.9	33.4	5.2	45.9	231.0
noparameters	26.4	4.5	50.2	7.4	13.7	3.0	21.4	66.b
value	29.3	5.0	54.4	8.0	14.2	3.9	21.7	75.0
reference	29.7	5.0	55.3	7.9	15.0	3.9	—	77
maths	25.3	7.0	66.0	—	—	—	—	—

Table 1 Pascal Benchmarks summary. Timings are in seconds, rounded to nearest 0.1 sec

If you have a contribution for Pascal Benchmarks, send it to Chris Sadler, c/o *PCW*, 14 Rathbone Place, London W1P 1DE.

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CALCULATOR CORNER

Dick Pountain tests Hewlett Packard's problem solver.

Introduced to the UK in November 1979, the HP 34C is Hewlett Packard's latest programmable calculator, though inevitably it has been somewhat overshadowed by the remarkable alphanumeric 41C. While the HP 34C is an altogether more modest (and much cheaper) machine, it has some features which will endear it to the mathematically-involved user.

As one would expect, the 34C is very well-made and finished, in a strong ABS case and large, positive, 'click' keys with sloping lower surfaces which bear a second function symbol.

Power is supplied by a battery pack which can be recharged without removal by plugging in the supplied AC adapter. The calculator may be used on AC while recharging. A fully-charged pack allows about three hours of continuous operation.

The suffix C denotes that the 34C has continuous memory, ie, memory contents are retained when switched off. No bulk storage by cassette tape or magnetic card is provided so attention must be given to the state of battery charge, as it must to good documentation of programs. Programs in the calculator are safe for around one month without recharging.

The display, surprisingly, is a traditional red LED 10-digit affair with no frills; a pity that an LCD unit, as on 41C, could not have been adopted to prolong battery life.

Memory

The 34C has its memory allocated as follows: 70 lines of program and 20 data storage registers, plus four stack registers, a 'last x' register and the 'I' register for indirect operations. Program data and I registers are continuous; the others are lost on power off.

More than 70 lines of program memory may be used by repartitioning the memory; this task is handled automatically in a very straightforward fashion. As the seventy-first program line is entered, a data register (R.9 the highest numbered) is converted into seven extra program registers. Data registers are converted as required, from the top, until a maximum of 210 program lines are accommodated, leaving only the I register for data storage.

To check how many data registers are left at any point, one presses the MEM command which displays the highest program line number and highest memory free. Simple, effective and much less confusing than messing around with partitions.

Functions

The 34C has a useful set of scientific functions including trig and their inverses (but no hyberbolics), exponentials, roots, reciprocals, factorials, rectangular to polar, degrees to radians, sexagemisal conversions, FRAC, INT and ABS. In addition to these usual functions are some useful statistical ones; $\Sigma+$, $\Sigma-$, standard deviation, mean, linear estimate and correlation coefficient, and linear regression. The two final *tours de force* are SOLVE and integrate, about which more later.

These functions are accessed by a deceptively simple-looking 30-key board, by making almost all the keys serve no less than four functions. To this end, three shift keys labelled f, g and h are provided.

The display formats are fixed point, scientific and engineering and the display status is in continuous memory.

As expected from HP, the 34C operates in Reverse Polish Notation and the excellent 300 page manual lays heavy stress on the full use of the stack, including the stack-fill technique and Horner's method for reducing polynominals to nested first order expressions.

Programming

All the necessary instructions for full programmability are provided; that is to say, conditional and unconditional branching, register arithmetic (including multiply and divide), six levels of subroutine, loop control and flags and indirect operations. In true HP style, no less than eight conditionals are available: $x \leqslant y$, $x > y$, $x \neq y$, $x = y$, $x < 0$, $x > 0$, $x \neq 0$, $x = 0$. Four flags with set and test are provided.

The destination of jumps is either a numeric label 0—9, or to an absolute address stored in the I register. In addition, two user-defined keys A and B can be used as labels to execute programs from the keyboard. If more than two programs are stored, the remainder are executed by GSB and the numeric label of the start. GTO.nnn sends control to line nnn without executing the program and is useful in editing.

The loop control functions ISG and DSE are of the sophisticated multi argument variety, with start value, test value and increment value, as on the 41C. They work only on the contents of the I register, as do the indirect commands which include STO, RCL, STO + etc., GOTO, and GSB.

Program editing is straightforward with automatic insertion and manual delete. The only gripe here is that both back and forward step are shifted functions requiring two keystrokes. Program steps are well displayed with a three digit line number separated from the instruction code. When keying in, the step just entered is displayed and all instructions are fully merged to occupy one line.

In short, the 34C has features to allow program structures as sophisticated as those of the TI-59, Casio 502 or the HP 41C. The only criticism in this area is the slow speed of execution. For my Benchmark I, the 34C took 67 secs, as opposed to 36 sec for the TI 59 and 7 sec for the Casio.

Solve and integrate

These two special features of the 34C have been widely advertised by Hewlett-Packard and will recommend the machine to mathematicians and engineers.

They are hard wired routines, executable by a single keystroke. SOLVE finds zeros of a function defined in a users subroutine. 'Integrate' evaluates definite integrals of the function by a rather sophisticated numerical method.

To use SOLVE you first write a subroutine which evaluates f(x). Then enter two estimates of x between which you wish to find a root of f(x)=0. Then on pressing f SOLVE, the calculator will search for and evaluate the desired root. If no such root exists in the range, the routine may find a minimum or an asymptote if such exist. In this case, an Error message results and values are left in the X, Y and Z registers, which enable further analysis. SOLVE may be used in a program, in which case it acts as a conditional test causing a branch if x is not a root.

$\int_x^y$ or integrate is used in a similar way, entering the upper and lower limits of integration and pressing f $\int_x^y$. The value of the integral is displayed and its range of uncertainty is stored in the Y-register. This latter is a nice touch which put this routine a cut above the Simpson's Rule programs which are available for other calculators. You can specify the level of accuracy of your function by using FIX n to limit the number of decimal places computed. Integrate will then calculate the integral to this degree of uncertainty, choose its own number of iterations. Obviously a less certain result is more quickly calculated, often remarkably so. Integrate can be used in programs and in a subroutine used by SOLVE, but cannot be used recursively to calculate multiple integrals.

Both these routines are more sophisticated than the usual ones found in calculator program libraries. They are rather slow in operation, often taking several minutes to evaluate an integral to high accuracy. Nevertheless, having them permanently on tap should be attractive to the right sort of user. At around £83, the HP 34C is competing with the TI-38C and the Casio fx-502p, both of which have continuous memory and more of it.

However, particularly among the scientific community, the Hewlett Packard name and quality reputation exact a price premium which overrides such strict value-for-money considerations. With the undoubtedly useful SOLVE and 'integrate' facilities, it will find many users in the laboratory and lecture theatre. I found it a pleasant machine to use, well documented and presented, but rather slow.

Benchmark No.		HP 34C	HP 41C	TI-59	Casio 502
I	(store and recall)	67	31	36	7
II	(multiply)	98	32	54	13
III	(cos)	170	49	76	53
IV	(log)	105	34	51	32

The Benchmarks consist of 100 loops of the function indicated. Times are in seconds.

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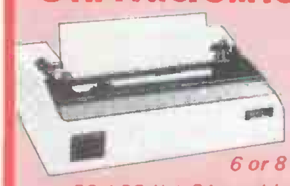

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PATTERNS

Alan Sutcliffe examines the underlying patterns in mathematical pastimes relating to the knight's move.

The moves a knight can make on a chess board are a rich source of mathematical pastimes. In 1512 Guarini put two white knights on the top corner squares of a 3 x 3 chess board and two black knights on the bottom corner squares. He asked what was the smallest number of moves in which the pieces could be interchanged, the black pieces to the top corner squares and the white ones to the bottom corners.

One of the most discussed of all puzzles is the tour of a single knight to every square of the chess board, visiting each square just once and returning to its starting point. Euler was working on this in the 1750s — he is the same man who had figured out the famous problem of the bridges of Konigburg some 20 years earlier.

The puzzle I am going to describe here concerns the shortest path a knight can take from one square to another. What is the smallest number of knight's moves that are needed to get from any square to any other square on a 5 x 5 chess board? Generalising it to boards of different sizes will be left to you.

Figure 1 shows the least number of moves needed by a knight starting from a corner square to reach any other square. There are three squares that cannot be reached in fewer than four moves, all — as it happens — along the diagonal. No square needs more than four moves.

There are five other distinct possible starting points: all others are equivalent to these by rotation and reflection. Similar arrays can easily be made for each of these five cases and Figure 2 shows them in various states of completion. You are invited to fill in the remaining cells. You will find that in no case are more than four moves necessary.

Here is the terminology I shall use in discussing this puzzle:

Board The 5 x 5 board of squares;
Square or cell a single square on this board;
Move a knight's move in chess, one square orthogonally then one square diagonally;
Trip a sequence of one or more moves from one cell to another;
Value (of a cell) the least number of moves to reach the cell from the starting point;
Generation all the cells on a board with the same value; the first generation is all those with value 1, and so on.

The procedure for calculating all the values on a board for a given starting point is straightforward. The first step is to mark with value 1 all those cells which can be reached in one move from the start square, which is marked 0. The second step is to take each of these squares just marked in the first generation and mark with value 2 all those cells which can be reached in one further move, except for those which have already been given a value. This step is then repeated for each succeeding generation until all the squares have been marked. This all seems straightforward and you might think that writing a program to do it was hardly worth talking about. Certainly there are no deep principles or difficult ideas involved. Nevertheless, this innocent puzzle is like a small jewel box: open it, set about solving it by program, and there are all these tiny fascinating questions.

2	3	2	3	4
3	2	3	2	3
2	1	4	3	2
3	4	1	2	3
0	3	2	3	2

Fig 1 Least number of knight's moves needed starting from a corner square.

Notice, for example, that towards the end, for the last one or two generations, it would be more efficient to invert the procedure and look at each remaining cell in turn to see if it could be reached in one move from a cell in the last generation. If you completed the squares in Figure 2, you have made this switch in method without even thinking about it. With only one cell left unmarked you can simply *see* that it can be reached in one more move. No need to look at every cell in the last generation to see where they lead to.

This typifies one of the common problems in programming. A task may be so trivial for a human to perform with pencil and paper that the method used is hardly thought about, while to write a program to do the same thing automatically turns out to be awkward. Turning back now to the main puzzle, there are, as is often the case, items to be selected, moves to be made, or conditions to be met which are easy to do by hand and eye but tricky to turn into code.

The problems here are:
1. Selecting the squares in the generation just produced as the starting points for the next generation. Visually, it is not necessary to inspect each square to see if it is one of those with the right value as the eye picks them out without the need for any apparent thought;
2 To list the squares that can be reached from a given one in a knight's move is trickier by program than it is by hand;
3. Ensuring that the squares that are one move away are within the area of the board may not even be noticed as a problem by a human solver but a program is certain to need to test for this.

I have written two programs to list the number of moves needed to reach any square from a given starting point. The different approaches and methods vary in the quantities of code, storage and processor time they need. This may not matter for these smallish programs but they are often important factors, especially when a small machine is being used. For larger problems they can make the difference between being able to solve it or not on your computer.

There are no best solutions, however.

.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	0	.	.	.

(a)

.	.	.	.	.
.	.	.	.	.
.	1	.	1	.
1	.	.	.	1
.	.	0	.	.

(b)

2	.	2	.	2
1	2	1	.	.
2	.	2	1	2
.	0	.	2	.
.	.	2	1	2

(c)

3	2	3	2	3
.	1	2	1	.
1	2	3	2	1
2	3	0	3	2
1	2	3	2	1

(d)

4	1	2	1	4
1	2	3	2	1
2	3	0	3	2
1	2	3	2	1
4	1	2	1	4

(e)

Fig 2 Partly completed arrays for the other five possible starting squares.

PATTERNS

It all depends on what resource you are most keen to save: programming effort, storage space or running time. And usually there are trade-offs as less use of one resource entails more use of another.

			-2				
	2	-1	2	-1	-1		
	-1	-1	-1	-1	-1		
	-1	1	-1	-1	-1		
	-1	-1	1	-1	-1		
	$\boxed{0}$	-1	-1	-1	-1		
			-2				

Fig 3 Data structure for program A during the second generation.

In program A I have concentrated on simplicity of coding, with liberal use of memory and reasonable but somewhat wasteful effect on run time. The approaches to the three problems stated above are:

A1 For each generation of starting squares, the whole 5 x 5 board is scanned for cells with the right value. Inefficient, but simple to code;

A2 For the knight's moves from a given square, a table of eight pairs of relative coordinates is used. These are added in turn to the position of the base cell to give all those that can be reached from it in one move;

A3 The 5 x 5 board is embedded in a 9 x 9 board so that there is a border of two squares all round. These border squares are initially set to a different value to those in the inner board: this is the simplest way of testing for moves that go off the board.

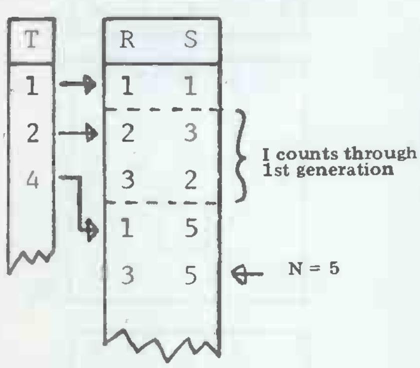

Fig 4 Data structure for program B at the same point.

How this works out in detail can be seen by looking through program A.

In program B the following methods are used for the three problems:

B1 Instead of scanning the 5 x 5 array for cells with the current value, a list is kept of cells in the order in which values are allocated to them and grouped by value. There is a pointer to the first cell with each value;

B2 To generate the knight's moves from a given square, code replaces the list of relative coordinates;

B3 Similarly, to test whether a square is off the board, logic is used rather than the border of squares.

These different approaches can be adopted independently. However, having an array of cells to scan as in A1 works naturally with having border cells as in A3. A mixed method, with a list of cells as in B1 and an array corresponding to the same cells as in A1 but without the border squares, is quite workable. The method of generating the knight's moves does not affect the way the other problems are solved.

Now let us turn to some possible refinements. First there is the possibility already mentioned of switching the method of scanning for the last generation or two. This is not relevant to method B1 because the cells to be used are already listed and in any case there is no representation in this method of the cells which have still to be allocated values: they are simply the ones that are not yet on the list.

The point at which it is advantageous to switch to the alternative scan is when there are fewer cells left to be given values than there are in the generation just completed. This is easy enough to test for. A new counter is needed for the number of cells in the current generation while the number of cells remaining is 25—M. These should be compared at the end of each generation, that is after statement 440 in program A. A piece of code is then needed, modelled on statements 320 to 440. The statement corresponding to 340 is altered to test for equality with —1, indicating a square not yet allocated a value. The statement corresponding to 380 is altered to test for equality with N—1, indicating a cell in the last generation. The saving is small, even if a larger board were being dealt with, but it serves to illustrate the kind of refinement possible.

Programs A and B are almost the same length. The main loop in A is only half the length of that in B, including the subroutine but not the print statements. The code in A is easy to follow. In B the code to generate the knight's moves is more opaque — it just happens to work. The main difference between the programs is the way the data is organised — an array in A and a list in B. This is illustrated in Figures 3 and 4 which shows the state of the data at the same point part way through the second generation of cells.

Symmetries

There is another kind of saving that a human might make in solving this problem, by taking advantage of different kinds of symmetry. The 5 x 5 arrays contain two sorts of redundant information. First, some of the arrays have an axis of symmetry. Figure 5 shows these for the six cases of Figures 1 and 2. The array in Figure 1, for example, is symmetrical about the diagonal through the start cell. It is only necessary to compute the values for the cells along the diagonal and on one side of it: those on the other side can simply be copied. They are all needed because a path to a cell on one side of the axis of symmetry may go to a cell on the other side. In Figure 1, for example, the cell value 2 in the middle of the bottom row can only be reached in two moves via the 1 cell in the other half of the array.

In the six arrays there are four different kinds of symmetry, including none in the second array. This is reduced to three kinds as it will be shown in the next section that the sixth array need not be computed. This still leaves code to be written to distinguish the cases, and further code for the

```
100 DIM A(9,9), B(8), C(8)            A is main board, B & C are relative coordinates
110 A = -2                            Set all cells to value for border
120 B(1) = 1                          Set 1st four relative X coordinates
130 B(2) = 2
140 B(3) = 2
150 B(4) = 1
160 C(1) = 2                          Set 1st four relative Y coordinates
170 C(2) = 1
180 C(3) = -1
190 C(4) = -2
200 FOR I = 1TO4                      Copy the 2nd four from the 1st
210 B(I+4) = -B(I)                    for the X coordinates and
220 C(I+4) = -C(I)                    for the Y coordinates
230 NEXT I
240 FOR I = 3TO7                      Set all cells in the 5 x 5 board to -1
250 FOR J = 3TO7                      leaving the border cells at -2
260 A(I,J) = -1
270 NEXT J
280 NEXT I
290 A(3,3) = 0                        Set the start cell to zero
300 M = 1                             Initialise the number of cells set
310 N = 1                             Set the value for the current generation
320 FOR I = 3TO7                      Search the 5 x 5 board for cells
330 FOR J = 3TO7                      with the value of the last generation
340 IF A(I,J) <> N-1 THEN 430         Jump if not correct value
350 FOR K = 1TO8                      Loop for 8 possible Knight's moves
360 X=B (K) + I                       Set absolute X
370 Y=C (K) +J                        and Y coordinates
380 IF A(X,Y) <>-1 THEN 420           Is this cell within the 5 x 5 board & not yet set
390 A(X,Y) = N                        Set it to the value for this generation
400 M=M+1                             Increment the count of cells set
410 IF M=25 THEN 470                  Test if all cells are set
420 NEXT K                            End of loop for 8 Knight's moves
430 NEXT J                            End of loops for search
440 NEXT I                            of 5 x 5 board
450 N=N+1                             Increment generation value
460 GOTO 320                          Return for next generation
470 PRINT "MAX VAL = "; N             Print maximum trip length for this start point
480 PRINT A                           Print all the final values
490 END
```

Program A

```
500 DIM R(25), S(25), T(10)   R & S list cells, T is pointers to R & S
510 L=1                       Set pointer to current position in T
520 N=1                       Index of last entry made in R & S
530 R(1) = 1                  X and
540 S(1) = 1                  Y coordinates of start point
550 T(1) = 1                  Pointer to 1st item in R & S
560 T(2) = 2                  Pointer to start of 1st generation in R & S
570 FOR I=T(L)TOT(L+1)-1      Main loop for a generation: only 1 item 1st time
580 P=1                       Start values for relative X and
590 Q=2                       Y coordinates
600 U=R(I)                    Copy X and
610 V=S(I)                    Y coordinates and base cell
620 FOR J=0TO3                Loop to generate relative coordinates
630 X=U+P                     Set absolute X and
640 Y=V+Q                     Y coordinates
650 GOSUB 800                 Test if this cell is on the board & not yet set
660 X=U-P                     Set 2nd set of
670 Y=V-Q                     absolute coordinates
680 GOSUB 800                 Test these
690 P=P+J-2                   Increment relative X and
700 Q=Q-J                     Y coordinates
710 NEXT J                    End of loop for coordinates
720 NEXT I                    End of main loop
730 L=L+1                     Increment L for next generation
740 T(L+1)=N+1                Enter pointer for start of next generation in
                              R & S
750 GOTO 570                  Return for next generation
800 IF X<1 THEN 920           Subroutine to test cell coordinates
810 IF X>5 THEN 920           Is X coordinate on the board
820 IF Y<1 THEN 920           Same test for the
830 IF Y>5 THEN 920           Y coordinate
840 FOR K=1TON                Loop to test if this cell has already been set
850 IF R(K) <> X THEN 870     If X coordinate is different, next entry
860 IF S(K) =Y THEN 920       If Y coordinate is the same, cell already set
870 NEXT K                    Next item in list
880 N=N+1                     Cell not yet set: increment pointer
890 R(N) = X                  Put new X and
900 S(N) = Y                  Y coordinates in the list
910 IF N=25 THEN 930          If all cells set go to print results.
920 RETURN                    Return to main program
930 PRINT "MAX VAL = "; L
940 PRINT R,S,T
950 END
```

Program B

diagonal and vertical symmetries. A lot of effort for rather small return. On larger boards there will be relatively fewer arrays with symmetry, so that even here the saving will not be great. The second kind of symmetry arises from the fact that in the set of cases for all six starting points, most paths appear twice: once for each end, if the end cells are of different sorts. For example, in Figure 1, to get from a corner square to the centre takes four moves. In Figure 2(e) it takes four moves to get from

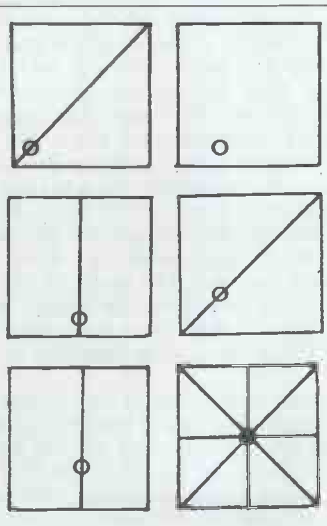

Fig 5 Axes of symmetry for the six arrays of Fig 1 and 2.

the centre of a corner square. The only routes which are not duplicated are those which begin and end on the same kind of square. In Figure 1 again, the route from corner to opposite corner is not repeated elsewhere. To take advantage of this kind of symmetry would

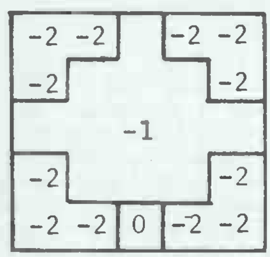

Fig 6 Start points already used set as being off the board.

also need a lot of code, more than the saving would justify unless a very large board is being solved. There is one small easy saving to be made. On the 5 x 5 board, all the routes to the centre square shown in Figure 2(e) have already appeared in earlier arrays. Except, strictly, for the path from the centre square to itself, a route of zero length, requiring 0 moves. Thus there is no need to compute the values for this sixth array.

To implement this saving more generally, the following method might be tried. Each square of a kind that has already been used as a starting cell for an array should be blanked out. In terms of Program A this is achieved simply by setting these cells with value −2 so that they are considered to be off the board. This is shown in Figure 6 for the array corresponding to Figure 2(b). However this method does not work, for a reason similar to that mentioned for the first kind of symmetry. The squares that have been blanked off will be needed as intermediate points on the paths to other squares. It is only when the array is complete that the values in these squares can be discarded. Not much saving in that, but it is the kind of improvement that should be considered even if it is rejected.

Generalisation

It has already been suggested that these programs can be generalised to deal with larger boards. But before that we should put in a loop to set up the different start squares automatically.

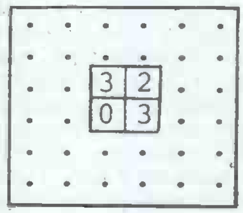

Fig 7 Central squares on a 6x6 board.

This could be done just be setting the coordinates explicitly. In terms of program A this is done in statement 290 A(3,3)=0 then A(4,3)=0, A(5,3)=0 A(4,4)=0 and A(5,4)=0. But since we want to extend this to the general case it is better to generate these values by program:

```
290 FOR G=3TO4
292 FOR H=GTO5
294 A(G.H)=0
.
.
.
482 NEXT H
484 NEXT G
```

This leaves one last awkwardness in generalising to any size of square board. Odd and even sizes differ slightly. With an even-sided board there is no centre square but a set of four central squares, as shown in Figure 7 for a 6 x 6 board. It is not possible to omit the array starting at one of these squares without a bit more thought. Not all the paths from such a square will have been dealt with in earlier arrays. But the only cases not covered are trips from one central square to another. The moves needed are also shown in Figure 7. Let us, for the sake of discussion, not rely on this always being the case. The outer loop for the 6 x 6 board would then be

```
290 FOR G = 3TO5
292 FOR H = GTO5
```

To generalise this further to cope with both odd and even boards, the following code is needed:

```
290  INPUT D                Board size
292  E=INT (D/2)+2          Half board size
                            rounded down +2
294  F=INT (D/2+0.5)+2      Half board size
                            rounded up +2
296  FOR G=3 TO E           The 2 loops
298  FOR H=G TO F           as before.
```

Various statements throughout the program would need to be changed to use D, the length of the side of the board. For example, the test for completion of the array would become

```
410 IF M=D* D THEN 470
```

The dimensions of A would have to be increased to allow for the largest board that was to be solved. Similar amendments would be needed in program B.

GOTO page 146

PACK IT IN

by Roger Morgan, Joan Rosell and John McMullan

Most microcomputers are able to store large volumes of data on magnetic media such as cassettes or floppy disks. Nevertheless, when used for automatic data collection, even the largest cassettes or disks can be too small. This article describes a method for improving the storage capacity for numerical data. The specific examples are intended for the PET but it is easy to adapt them for any Basic-speaking microcomputer.

Numbers are usually stored as strings of numeric characters, which can include the numbers 0 to 9, the sign, the decimal point and the exponent E, and they are terminated by a terminator character, such as a new line. Such storage is provided very simply by the Basic interpreter by means of a statement such as 10 PRINT 1, X. In mathematical terms this is known as counting in base ten.

It is possible to represent numbers by counting in bases other than ten. Computers count in binary or base two, using symbols 0 and 1. Assembler code usually counts in hexadecimal, using 0 to 9 and A to F. In fact, any integer base is permissible provided that one has enough distinctive symbols. The advantage of using a higher base than ten is that it allows one to represent a bigger range of numbers with a given number of characters. To make this clearer, let us consider the problem of representing positive whole numbers. In decimal counting, a two-character number has a maximum value of 99. In binary characters, the maximum is 3 (11). If one goes to a higher base, such as 16, the maximum rises to 255. Generally, the maximum integer which can be represented by C characters when counting in base B is $B^C - 1$.

For the present purpose, the advantage of counting in bases higher than ten is that it allows one to use fewer characters to store numbers of a given range. Once again, let us make this clearer by studying the problem of storing positive whole numbers. Let us imagine that an experiment produces results over the range 0 to 4095, as might result from a 12-bit A/D converter. In decimal notation, this can require up to four characters, plus a terminator character. If instead one chooses to count in base 64, one needs only two characters plus a terminator. Thus the number of characters is reduced from five to three. Indeed, if one decides to insist that all numbers should be two characters long, one can do without the terminator altogether, reducing the character count to two. This last step is almost always beneficial because, though it apparently 'wastes' a character for numbers from 0 to 63, this wasting is not really a waste because one would have needed two characters anyway, the number and the terminator.

As an example of the benefits of such an approach to storing large volumes of data, consider Program 1. A random whole number is generated, with value between 0 and 4095, by line 20. It is then divided up into two parts, the first representing 'sixty-fours' and

```
1 LET Q=32
10 DIM M(1000),C$(1000)
20 LET R=INT(RND(1)*64*64)
30 LET R1=INT(R/64)
40 LET R2=R-(64*R1)
50 PRINT R,R1,R2,
60 LET M(C)=R
100 LET A$=CHR$(R1+Q)
110 LET B$=CHR$(R2+Q)
120 PRINT A$;B$;"  ";
130 LET C$(C)=A$+B$
140 PRINT C$(C)
200 LET C=C+1
220 IF C=1000 GOTO 290
250 GOTO 20
290 PRINT
300 OPEN 1,1,1
310 FOR C=0 TO 999
320 PRINT#1,M(C)
330 PRINT M(C),
340 NEXT C
350 CLOSE 1
355 PRINT
360 OPEN 1,1,1
370 FOR C=0 TO 999
380 PRINT#1,C$(C);
390 PRINT C$(C),
400 LET A$=LEFT$(C$(C),1)
410 LET B$=RIGHT$(C$(C),1)
420 PRINT A$;B$,
430 LET R1=ASC(A$)-Q
440 LET R2=ASC(B$)-Q
450 LET R=(R1*64)+R2
460 PRINT R
470 NEXT C
500 CLOSE 1
600 STOP
```

Program 1

the second representing 'units', by lines 30 and 40, and then for interest and illustration, the original number and its two divided parts are printed out in ordinary decimal notation by line 50. The two parts are now given a character representation and the obvious ones to use are 64 characters of the ASCII set, starting at 0. Unfortunately the characters 0 to 31 are unprintable in the sense that they are control characters rather than screen symbols, so they are somewhat difficult to follow; it makes better sense to use the 64 characters starting at 32 (space) and ending at 96 (backward arrow). All these characters are printable, so it becomes easy to display them for interest and illustration; this is done by line 120. Next comes one of the useful features of Basic character facilities, the ability to add strings to form longer ones. This is done in line 130, forming a string which when printed by line 140, should look identical to the pair of characters printed by line 120.

The above has accomplished the essential encoding of the numbers, and has also stored the results of encoding in the arrays M(C) and C$(C). Lines 300 to 350 record the 1000 numbers on to cassette tape using the conventional decimal system with a newline as the terminator, also displaying the numbers to ensure correct operation. Lines 360 to 500 record the numbers in their encoded two-character form, without a terminator, and also display the two-character string, the two separate single-character parts, and the decimal number equivalent, again to satisfy oneself that the system really is working.

When this program was run on a PET, the recording of the first batch of data, from line 300 to line 350, was found to take 4 min 25 sec, while the second batch in its encoded form, including the time taken to decode for display on the screen, took only 2m 45s. Thus there is an appreciable saving of time in recording. More significantly, when the two batches of data were replayed through an ordinary audio tape recorder, the decimal batch took up 3m 57s of tape, while the encoded batch took only 1m 20s, almost exactly one third of the tape.

```
1 DIM A(1000),D(1000)
2 LET Q=32
10 OPEN 1,1,0
15 PRINT "FOUND DATA"
20 FOR C=0 TO 999
30 INPUT#1,A(C)
40 PRINT A(C),
50 NEXT C
60 CLOSE 1
100 PRINT "TO GO ON PRESS KEY AND RET"
105 INPUT Z$
110 OPEN 1,1,0
115 PRINT "FOUND DATB"
120 FOR C=0 TO 999
130 GET#1,A$
140 GET#1,B$
160 LET R1=ASC(A$)-Q
170 LET R2=ASC(B$)-Q
180 LET D(C)=(R1*64)+R2
190 PRINT D(C),
200 NEXT C
210 CLOSE 1
220 PRINT "TO VERIFY PRESS KEY AND RET"
225 INPUT Z$
230 FOR C=0 TO 999
240 IF A(C)<>D(C) THEN PRINT "ERROR ";C
245 IF A(C)=D(C) THEN PRINT C;" OK"
250 NEXT C
260 PRINT "DONE"
300 STOP
```

Program 2

Having recorded the data, it is necessary to write a decoding program for recalling it — see Program 2, which also checks that the system has worked. Lines 10 to 60 recall the decimal-recorded numbers and put them into array A(C). Lines 110 to 210 recall the encoded numbers, decode them and put the results into array D(C). Finally lines 230 to 260 compare the two arrays and notify any mistakes. When this program was run, the recall of the first batch took 4m 30s, the second batch took 2m 15s and there were no errors. Thus the system saves recalling time as well.

Having succeeded in our initial aim, it is tempting to push the idea as far as it will go, by counting in the highest base available to us. With the PET and most other microcomputers, the maximum number of different characters is 256, so it should be possible to count with this as base. This makes a very useful facility for 8-bit A/D converters, which have a range of positive integer outputs from 0 to 255, allowing each measurement to be stored with only a single character. As mentioned earlier, some of the characters are unprintable, but this does not prevent their use on tape. The program might then be very

```
10 DIM M(1000)
20 LET R=INT(RND(1)*254)
30 PRINT R,
40 LET M(C)=R
50 LET C=C+1
60 IF C=1000 GOTO 90
70 GOTO 20
90 PRINT
100 OPEN 1,1,1,"DATA254"
110 FOR C=0 TO 999
120 PRINT#1,M(C)
130 PRINT M(C),
140 NEXT C
150 CLOSE 1
155 PRINT
160 OPEN 1,1,1,"DATB254"
170 FOR C=0 TO 999
172 IF M(C)<9 THEN J=1
174 IF M(C)>=9 THEN J=2
180 LET A$=CHR$(M(C)+J)
190 PRINT#1,A$;
200 PRINT M(C),
210 NEXT C
220 CLOSE 1
230 STOP
```

Program 3

simple; the main job of encoding would be done by a line such as

1∅ LET A$ = CHRS (X)

Attempts to use such an approach met with some unexpected faults. The symbol corresponding to CHRS (∅), the ASCII character NUL, caused the program to crash during recall, for reasons which are by no means clear. Fortunately, it is easy to avoid the problem by changing the program line to

1∅ LET A$= CHR$ (X+1)

This allows the program to store and recall the number ∅ without crashing, but also restricts the largest number to 254 instead of 255, an acceptable limitation. A further problem produced the rather bizarre effect of missing a number whenever it had the value 9 (corresponding to CHR$ (1∅), the ASCII character LF or line feed). This could have been avoided by adding 10 to every number, but since this would restrict the maximum number to 245 it was felt to be extravagant. Instead, the inelegant procedure was adopted of adding 1 to the number if it was less than 9, and 2 to the number otherwise. This restricts the maximum to 253.

Program 3 generates random numbers from 0 to 253, records them in the usual decimal notation, and then records them again in coded form. When tested on a PET, the recording of the first batch of data took 3m 40s, and the second took 1m 50s. Playing back through an audio tape recorder, the first batch occupied 3m 20 s and the second batch 50s, representing a tape saving of a factor of four. Recalling the numbers using Program 4 took 3m 50s for the first batch and 1m 40s for the second batch, with no errors. Thus this is a very satisfactory system.

Up to now we have dealt with whole numbers only. Some types of data recording systems can produce decimal fractions and it would be useful to devise ways of handling them. The simplest way is probably to multiply them up to a whole number, possibly rounding or truncating where appropriate. Alternatively, it would be possible to encode the figures before the decimal point and after the decimal point as separate entities, imitating what is already done in ordinary decimal

```
10 DIM A(1000),B(1000)
20 OPEN 1,1,0,"DATA254"
30 FOR C=0 TO 999
40 INPUT#1,A(C)
50 PRINT A(C),
60 NEXT C
70 PRINT
90 CLOSE 1
100 PRINT
110 OPEN 1,1,0,"DATB254"
130 FOR C=0 TO 999
140 GET#1,A$
150 LET Z=ASC(A$)
152 IF Z<10 THEN J=1
154 IF Z>=10 THEN J=2
156 LET B(C)=Z-J
160 PRINT B(C),
170 NEXT C
180 PRINT
190 CLOSE 1
200 PRINT
210 FOR C=0 TO 999
220 IF A(C)<>B(C) THEN PRINT "ERROR",C
230 IF A(C)=B(C) THEN PRINT C, "OK"
250 NEXT C
260 PRINT "DONE"
300 STOP
```

Program 4

counting. Indeed, the system can be made as simple or as complicated as the user needs it to be.

The operation has been described entirely in terms of cassette recording. Obviously, however, the system can be adapted to suit floppy disks. In this case, the object is not to save time, since disks are so quick anyway, but rather to improve the storage capacity. The factor of improvement should be roughly in the same proportion as the saving in tape consumption. It is worth remarking, however, that we have not actually tested the system with disks.

Personal Computer World

FEATURE INDEX

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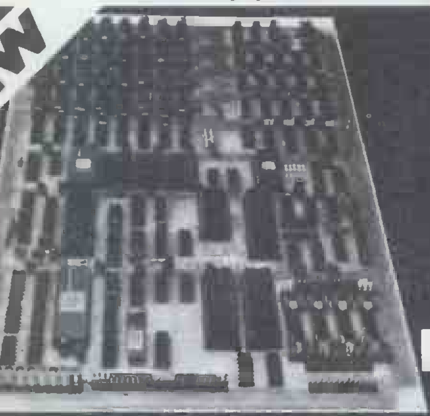

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MICRO CHESS

by Kevin O'Connell

JAWS MK II

Last month I promised to let you know how the Chess Champion Mark V* fared in the Islington tournament. Although it somewhat disappointed its programmer, it still acheived a better performance rating than, to my knowledge, any other chess micro has yet achieved.

In 1979 Sargon 2.5 (as it then was) played in a human tournament in the United States and obtained a rating of 1640. In Islington every one of the Chess Champion's opponents was rated 1700 or over and by scoring 2½ points out of 6 it achieved a rating for itself of 1700, thus proving itself to be a stronger player than 80 percent of all serious human chess players and stronger than more than 99 percent of humans who play chess. It might have done even better but for a bug that caused it to lose its last round game without a real fight.

Chess Champion's best game of the tournament was played in the 4th round, its human opponent having a rating of 1760, placing him comfortably among the top 1% of humans. The game developed as follows:

White: A Bice
Black: Chess Champion Mk V

1	d2-d4	d7-d5 2
2	e2-e3	Ng8-f6
3	Bf1-d3	e7-e6
4	f2-f4	Bc8-d7
5	Ng1-f3	Bf8-b4+
6	c2-c3	Bb4-e7
7	Nb1-d2	0-0 (Ke8-g8)
8	0-0 (Ke1-g1)	Be7-d6
9	Nf3-e5	b7-b6
10	a2-a4	Nb8-c6
11	Qd1-f3	h7-h5?

A weak and rather curious move that surprised the programmer and the onlookers.

12	Qf3-h3	Qd8-e7
13	g2-g4	h5xg4
14	Ne5xg4	g7-g6
15	Ng4-e5	a7-a5
16	Qh3-h6	Ra8-c8

Although Black has developed all of its pieces, White's position is much better. Black has no active plan to use as a counter to the slow build-up of a king-side attack by White. However, computers do not relax, while humans do...

17 Rf1-f2? Bd6xe5!

This wins at least an exchange (rook for knight or bishop). If 18 f4xe5 Nf6-g4 followed by 19. . Ng4xf2

18 Rf2-g2

White thought that he had a very strong attack after this move and it was the best practical chance.

18	...	Be5-d6
19	Bd3xg6	f7xg6
20	Rg2xg6+	

At this point some of the spectators began to laugh at the program's poor play: snatching at material and allowing a mating attack — little did they know...

20	...	Kg8-f7
21	Rg6-g7+	Kf7-e8
22	Rg7xe7+	Ke8xe7
23	Kg1-f1	

Otherwise the black rooks would immediately start an invasion along the open g-file.

23	...	Rf8-g8
24	Nd2-f3	Rc8-f8!

Building up irresistible pressure against the white king.

25	Nf3-g5	Bd7-c8
26	Qh6-h3?	

This hastens the end, but White was already lost.

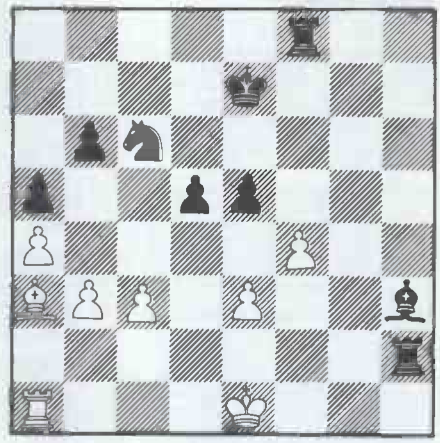
26	...	e6-e5
27	Qh3-g3	Nf6-e4
28	Ng5xe4	

White's best chance was 28 Qg3-h4, hoping that Black would get lost in the complications after 28. . . Ne4xg5. But White was now feeling rather demoralised.

28	...	Rg8xg3
29	Ne4xd6	Bc8-h3+!

There is no rush to recapture the material — that can wait while Black further improves its position.

30	Kf1-e1	Rg3-g1+
31	Ke1-f2	Rg1-g2+
32	Kf2-e1	c7xd6
33	d4xe5	d6xe5
34	b2-b3	Rg2xh2
25	Bc1-a3+	



This was White's very last hope, but it was completely crushed by

35 ... Nc6-b4!!

A beautiful move. If 36 c3xb4 Rf8-g8 37 b4xa5+ Ke7-f7 (or any other white square) and then 38. . .Rg8-g1 will be mate.

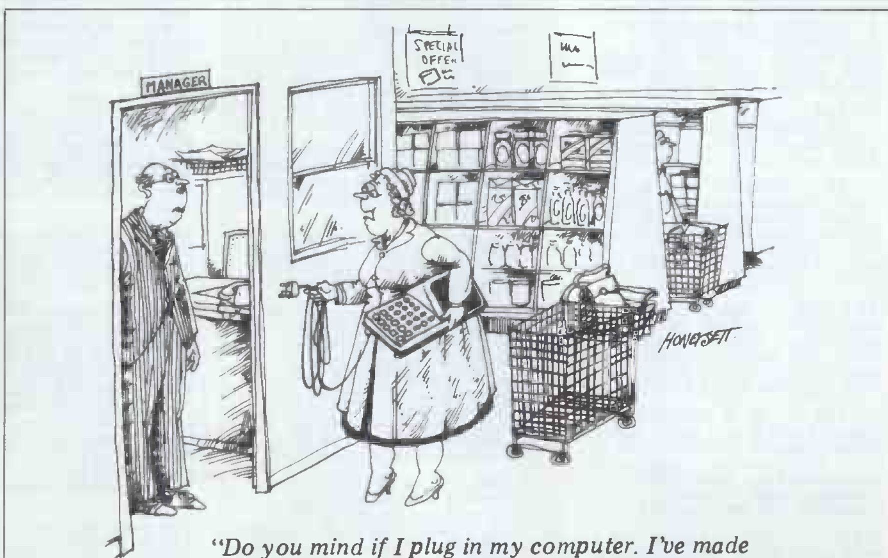
36	Ra1-d1	Rf8-g8
37	White resigned	

It is mate in two (at most).

This game was impressive not so much because the machine beat the human, even though I believe this is the strongest human any micro has ever beaten in open competition, but because of the manner of the program's victory. White made a serious mistake and was then ground relentlessly (and rapidly) into the dust.

If you have a chess program that can play anything like as well as the Chess Champion Mark V then please let me know (send me some games it has played) and I will be delighted to mention it in this column, as well as booking it a place in the next World Microcomputer Chess Championship.

**The Chess Champion Mk V is not commercially available at present.*



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HP41C . . . 41C prog calc with alphanumeric display & permanent memory, complete with manuals, keyboard overlays, case, warranty card & box, made redundant by 32k micro, offers around £140. David Morgan, 5 Ashmole Close, Lichfield, Staffs WS14 9RS, tel Lichfield (05432) 51300.

ZX80 . . . guaranteed as new, complete inc leads, mains adaptor, manual, extra 1k memory etc, cost £137, accept £100. Mr C England, Headlands, Whitley, Dewsbury, W Yorks.

System 68 . . . home built computer, as ETI magazine, in Verocase, inc b/w TV & 2 systems manuals, £300 ono. Also Petsoft soundbox with demo tape & instructions sheet for use on 2nd cass port, £10 ono. Tel Stevenage (0438) 55807 eves.

PET serial interface . . . drives any V24 serial device, eg Qume Sprint 5 printer. Baud rates 110-9600, brand new, complete with manuals, maker's price £147.50, sell for £95. Tel 0353 3205 eves.

Triton . . . with L7 monitor & Basic (Basic not fitted, no montherboard), full doc & plenty of software, full on-board RAM, accept £300 ono the lot. Also 2 Teleprinters type 7, one working, one for spares, with service data, reperforator & tape reader (5 holes), £30 the lot. Geoffrey Hillier, 5a Gregory St, Lenton, Nottingham, tel 0602 783938.

Apple II+ 48k . . . 2 disk drives & controller, 12" monitor, Silentype printer, DOS 3.3, database & w/p software, full doc, as new, £2000 ono (list over £2500). Tel 01-876 4613 eves.

Apple II 48k . . . & twin disk drives, DOS 3.2.1, little used since May, many games & useful s/ware routines, games paddles, manuals & orig packing, £1100. Tel Norwich 810675.

TI59 . . . brand new, complete, bargain at £110 ono. T Lawler, Brywater, Ripple Tewkesbury, tel Upton 2995 eves.

Printer . . . super fast 180 1pm, serial int, £300 ono. Keyboard, TASA solid state, parallel ASCII, £30 ono. Tel Tring 4797 or St Albans 64077.

Sharp TV . . . 4.5" screen with radio & clock, ideal for use as small monitor for micro (RF in only), £50 ono. Tel Robert, Derby (0332) 701964 after 6.

ZX80 . . . with Sinclair mains adaptor, leads & manual, £60. Tel Terry Hoare, Birmingham, 021-444 7320 eves.

PET 2001 16k . . . new keyboard & ROMs, ext cass, lots of s/ware inc 3D Star Trek, Space Invaders, Micro Chess, Breakout, Dissembler, Assembler, several Microsoft progs, also manuals & books inc PET Revealed, Zaks 6502, £600. Tel 01-807 8249 anytime.

ZX80 . . . as new, Sinclair built, with adaptor, leads & manual. £70. Tel Horndean (Hants) 593827.

Teletype . . . terminal, cheap hard copy, £150. Tel Hitchin (0462) 7 730809.

MZ-80K . . . 20k RAM, in maker's box, as new, bought August last year, inc m/c code tape, Crystal Basic tape & manuals, plus Space Invaders, delivery not possible, £500 ono. M Davies, 12 Bishops Ave, Llandaff, Cardiff CF5 2HJ.

Superboard II . . . 4k RAM, 8k Basic, RS232, video & cass int, properly cased & assembled, PSU, UHF modulator, ready to go with all cables, 4 manuals & sample cassettes, £210. Tel Windsor 61258 most days, all eves.

PET 8k . . . as new with large number progs, £350. PET cass machine with built-in Soundbox, £40. Tel High Wycombe 33164.

Complete set . . . PCW mags, May 78-Jan 81 (33 issues), £5; Computing Today complete set Mar 79-Jan 81 (23 issues), £3.50; Practical Computing complete except Sept 78, Oct 78, Dec 79, Nov 80, Nov 78, Jan 81 (24 Issues issues), £3.50; Creative Computing Nov 77-Dec 78 plus June 79, also Byte Dec 79, £2. As sets or £12 the lot, buyer collects. Tel R Wilmot, Horsham (0403) 69835.

Tangerine Micron . . . 8k RAM, 1/case, chunky graphics & ASCII kayboard, some games inc Space Invaders, £320. Tel 01-690 6676.

PET 8k . . . int cass, old ROMs, calc keyboard, upgraded to 32k, £250 no offers. To see & test tel 01-582 7766 any time.

Nascom 1 32k . . . Stuart colour board, NasSys & Nasbug monitors, Verocase, 8k Basic & Zeap assembler on tape, 10 books, loads of progs, good cond, reliable, £240. Tel Fareham 280829, 9am-5pm.

ZX80 . . . fully built inc all leads. manuals & memory exp board with additional 1k RAM, £80. Tel Medway, Kent, 0634 30329 after 7.

HP25C . . . continuous memory, 8 registers, 49 steps, 10-digit accuracy, charger, separate charging cradle, spare batt pack, 2 yrs old but little used & still with orig packing & manuals, owner has bought micro, £50 plus postage. H G Shaw, 2 Cambridge Terrace, Douglas, IoM.

Expandamem . . . board, converts 8k PET to 32k, complete with manual & test tape, £160 ono. Tel 061-654 8983 after 7.

Sorcerer 32k . . . Basic (Microsoft 8k), s/ware manual, h/ware manual, cass recorder, many progs inc 1 Adventure game, £500. Tel Kim Wood, Eris 2399 or 2rite 8 Ash Close, Lakenheath Camp, Brandon, Suffolk.

TRS-80 L2 . . . 4k with VDU, PSU, manual, instruction tapes, 6 monthsl old, £225 ono. Tel Alsager (09363) 3365.

12" monitor . . . new ICL, uncased, boxed with documentation, giveaway at £50 for quick sale as surplus to req, tel 01-950 6936 after 7.

Wanted

Apple II+ . . . with single disk drive, PET, MZ-80K, 32k for preference, cash waiting. Tel Ken, 0632 678828 anytime.

Constructed ZX80 . . . will pay around £60-£70. Contact James Corby, tel Sevenoaks 62620.

Back issues . . . of Microcomputing, March, April, May, August & September. Tel Nottingham (0602) 206573.

HP97 . . . prog printing calc or similar. 21 Leicester Rd, Poole, or tel 0202 761936.

PCW Vol 3 No 1 . . . moderately good cond, tel Whitstable (0227) 272148.

Helping Hand. . . say an hour a week for 2 months, to get going with a ZX80. Location 2 mins Baker St tube. Please tel 01-723 2557 (pm).

ZX80 . . . must be in good working cond, tel Chelmsford (0245) 57350 eves or w/ends.

8" Shugart 800 . . . series disk drives, also VDU Hazeltine type, also Centronics 100 series, also S100 dynamic memory boards. Harold Easton, 7 Ingrebourne House, Broadley St, London NW8, tel 01-723 5822 anytime.

PCW Vol 3 nos 1,4 . . . willing to pay £2.50 for both. Tel Alexander Holt, Plymtree (08847) 423.

SC/MP MK14 . . . any reasonable cond, Mk 5 PCB & RAM I/O if poss, spare parts &/or upgrade per PCW articles to PROM progkammer or intelligent int for TRS-80. Tel Derby (0332) 550408 eves or/w/ends.

Large keyboard PET . . . must have intact expansion port & 4116 sockets. Can collect (50 miles). Tel Sandiway 883436 after 5.

Eight 6550 . . . RAM chips req to help old PET recover its memory. Please send details to Mr D Johnston, 12 Balgillo Rd, Broughty Ferry, Dundee DD5 3L 3LU.

PACKAGES

PCW's 'Packages' section is produced bi-monthly, alternating with our 'In Store' hardware guide. We have confined coverage to business packages which are available and supported at national level and which have been in use for at least six months in a minimum of five sites. Producers of packages which fall within these constraints should send details or updates to: **Packages, *PCW*, 14 Rathbone Place, London W1P 1DE.**

The layout has been designed to allow you to discover which packages are available for the application you have in mind and to show you which packages are available for your computer if you already have a machine. In either case the code enables you to look up the supplier's name and telephone number in the table below.

Code	Company	Telephone
A1	ACT/Petsoft	021-454 5348
A2	Arden Data Processing	0533 22255
B1	B + B Computer Ltd.	0204 26644
B2	Beam Business Centre	01-636 1392
B3	Benchmark Computer Systems	0726 61000
B4	Bristol Software Factory	0272 23430
C1	CAP-CPP Products Ltd.	01-404 0911
C2	Commodore	01-388 5702
C3	Compsoft	0483 39665
C4	Comput-a-crop	01-499 6987
C5	Computastore Ltd.	01-499 6987
C6	Computech	01-794 0202
D1	Data Bank	0509 217671
G1	Graffcom Systems Ltd.	01-734 8862
G2	Grama (Winter) Ltd.	01-636 8210
G3	Great Northern	0532 450667
H1	A.J. Harding	0424 220391
H2	Hartford Software	0606 76265
H3	H.B. Computers	0536 83922
H4	Hipposoft	0332 23127
I1	Intereurope Software Design	0734 786644
I2	Intex Datalog Ltd	0642 781193
J1	T.V. Johnson	0276 62506
K1	Katanna Management Services	0245 76127
K2	Keen Computers	0602 583254
L1	Lifeboat Associates	01-836 4663
L2	Liveport (Exidy Sorcerer Firmware)	0736 798157
L3	Ludhouse (Computing) Ltd.	01-679 4321
M1	Micro Computer Applications Ltd.	0734 470425
P1	Padmede Computer Services	025671 2434
P2	Personal Computers Ltd.	01-626 8121
R1	Rockliff	051-521 5830
S1	SMG Micro Computers	0474 55813
S2	The Softwarehouse	01-637 2108
S3	Stage One Software	0202 23570
S4	Systematics International	0268 284601
S5	Sumlock Bondain	01-250 0505
T1	Tridata Micros Ltd.	021 622 1754
V1	Vlasak Electronics Ltd.	062-84 74789

Applications

Application	Machine	Price	Code
Appointments planner	Commodore/ Computhink	£100	S3
Assembler dev	PET/CBM	£50	L2
Bank accounts	Apple II	£10	D1
	Commodore/ Computhink	£100	S3
	ITT 2020	£10	D1
	PET	£10	D1
Bonds/pension quotations	Commodore/ Computhink	£100	S3
Budgeting package	MCZ Zilog	£500+	I1
Bureau de change	CBM	£8	H3
Cash flow	Apple II	£75	P2
	Apple II	£80	V1
	CP/M	£250	L3
	PET	£8	A1
Cash register	Apple II	£10	D1
	ITT 2020	£10	D1
	PET	£10	D1
CBasic	Tandy Model II	£70	M1
Company secretary	CP/M	£450	C4
Conference organiser	MCZ Zilog	£500+	I1
Contract costing	CP/M	£2000	L3
CP/M & utilities	Tandy Model II	£150	M1
Credit control	Apple II	£98	P2
	PET	£650	B4
Database management/Information retrieval	ACT800	£225	H4
	Apple	£150	A2
	Apple	£150	K2
	Apple	£60-140	S2
	Apple	£150	S5
	Apple II	£98	P2
	Aple II/ITT 2020	£100	S4
	Commodore/ Computhink	£45-250	S3
	CP/M	£150-750	C4
	Cromemco	£250	B3
	North Star Horizon	£250	B3
	PET	£170	C3
	PET	£325	A1
	PET	£225	H4
	PET/CBM	£75	B1
	PET/CBM	£50/150	C2
	PET/CBM	£150	J1
	PET/CBM	£150	G2
	Tandy Model 1	£25-80	M1
	TRS-80	£60	S2
	TRS-80	£150	J1
	TRS-80	£32.50	H1
	8000 Series	POR	C2
Disk operating system	PET/CBM	£150	B1
Estate agent	Apple	£850	A2
	Apple	£850	S5
	Apple	£850	K2
	Apple II	£175	P2
	Apple II/ITT 2020	£750	S4
	CBM	£30	H3
	Commodore/ Computhink	£250	S3
	CP/M	£750	C4
	PCC 2000 Simpelec Triton 3	£350	B3
	PET	£25	A1
Equipment lease/rent/HP	CP/M	£400	G1
Financial modelling	CP/M	£400	G1
Financial planning	Apple II/ITT2020	£250	S4
General ledger/NL	Apple	£300	A2
	Apple	£300	S5
	Apple	£300	K2
	Apple II	£295	P2
	Apple II	£225	V1
	Apple II	£295	C6
	CBM	£200	H3
	Commodore/ Computhink	POR	S3
	CP/M	£500	L3
	CP/M	£500	K1
	CP/M	£375	L1
	CP/M	£500	C4
	CP/M	£400	G1
	Cromemco	£250	B3
	ITT 2020	£295	C6
	ITT 2020/Apple II	£250P	S4
	North Star Horizon	£250	B3
	PCC 2000 Simpelec Triton 3	£350	B2
	PET/CBM	£200	C2
	Tandy Model I	£90	M1
	Tandy Model II	£90	M1
	TRS-80	£225	H1
	TRS-80 I	£225/325	T1
	TRS-80 I	£325	K1
	TRS-80 II	£425	T1
	Vector	£400	C5
	8080/Z80	£357	L1
	8080/Z80	£275	G3
Hire purchase	Cromemco	£400+	B3
Incomplete records	Apple	£250	S2
	Apple	POR	K2
	Apple II	£125	P2
	Commodore/ Computhink	£750	S3
	Tandy Model I	£40	M1
	TRS-80	£40	H1
Individual designed programs	TRS-80 I	£100+	K1
Integrated Accts	Altos (CP/M, MP/M)	£300	B1
	Apple II	£450	P1
	Apple II	£340	P2
	Apple II	£855	V1
	Commodore/ Computhink	POR	S3
	CP/M	£950	L1
	CP/M	£1500	C4
	CP/M	£1100	G1
	Cromemco	£950	B3
	ITT 2020	£450	P1
	MZ-80K	£150	P2
	North Star Horizon	£950	B3
	PET/CBM	£300	B1
	PET/CBM	(£50)	C2
	PET/CBM	£650	J1
	PET/CBM	£650	G2
	Tandy Model I	£350	M1
	Tandy Model II	£350	M1
	TRS-80	£75	J1
	Vector	£1000	C5
	8000 Series	POR	C2
	8080/Z80	£950	L1
	8080/Z80	£995	G3
Investment portfolio	TRS-80	£20	S2
Invoicing	Apple	£295	S2
	Apple II	£300	P1
	Apple II	£125	P2
	Apple II	£140	V1
	Commodore/ Computhink	POR	S3
	CP/M	£500	K1
	CP/M	£325	L1
	CP/M	£150-350	C4
	Cromemco	£100	B3
	North Star Horizon	£100	B3
	PET	£350	A1
	PET/CBM	£25-50	B1
	PET/CBM	POR	J1
	Tandy Model I	£90	M1
	Tandy Model II	£90	M1
	TRS-80	£25	H1
	TRS-80I	£75	T1
	TRS-80I	£75	K1
	TRS-80II	£125	T1
	8080/Z80	£325	L1
	ITT 2020	£300	P1
Job costing	Apple II	£125	P2
	Apple II	£300	P1
	CP/M	£700	C4
	ITT 2020	£300	P1
	Tandy Model I	POR	M1
	Tandy Model II	POR	M1
Job order control	8080/Z80	£275	G3
Leasing	Cromemco	£400+	B3
Legal precedents	CP/M	£1100	C4
Letter writer	Apple II	£80	V1
Lisp	PET/CBM	£75	C2
Lotteries	PET	£45	H2
Mailing list	Altos (CP/M, MP/M)	£75	B1
	Apple	£300	A2
	Apple	£50-150	S2
	Apple	£300	S5
	Apple	£300	K2
	Apple II	£40	P2
	Apple II	£50	D1
	Apple II/ITT 2020	£100	S4
	CBM	£35	H3
	Commodore/ Computhink	£100	S3
	CP/M	£50-150	C4
	CP/M	£250	G1
	ITT 2020	£50	D1
	PET	£45	H2
	PET	£50	D1
	PET	£15	A1
	PET/CBM	£75	B1
	PET/8032	£75/150	S1
	Tandy Model 1	£40	M1
	Tandy Model II	£75	M1
	TRS-80	£50-150	S2
	TRS-80	£25/38/55	H1
Mail shot	Apple	£14	S2
	Apple II	£225	P2
	Commodore/ Computhink	£125	S3
	CP/M	£200-360	C4
	MCZ Zilog	£250	I1
	PCC 2000 Simpelec Triton 3	£450	B2
	Tandy Model II	£75	M1
Membership accting	PET	£85	H2
Order entry/invoicing	CP/M	£350	G1
Order processing	CP/M	£550	L1
	8080/Z80	£550	L1
Office admin	Apple II/ITT 2020	£100	S4
Pad to plotter systems	Apple II	£250	P2
Pascal	PET/CBM	£120	C2
Payroll	Apple	POR	A2
	Apple	£200	S2
	Apple	POR	S5
	Apple	POR	K2
	Apple II	£200	P2
	Apple II	£375	V1
	Apple II	£375	C6
	Apple II	£10	D1
	Apple II/ITT 2022	£250P	S4
	CBM	£10	H3
	CP/M	£450	L3
	CP/M	£500	K1
	CP/M	£475	L1
	CP/M	£495	C4
	CP/M	£500	G1
	Cromemco	£350	B3
	ITT 2020	£375	C6
	ITT 2020	£10	D1
	North Star Horizon	£350	B3
	PET	£200/350	C5
	PET	£50/25/195	A1
	PET	£50/195	I2
	PET	£10	D1
	PET/CBM	£150	G2
	PET/CBM	£150	J1
	PET/CBM	£150	C2
	Sorcerer	£250	L2
	Tandy Model I	£249	M1
	TRS-80	£200	H1
	TRS-801	£218	K1
	TRS-801	£218	T1
	TRS-80II	£375	T1
	8000 Series	£250	C2
	8080/Z80	£475	L1
	8080/Z80	£275	G3
Personnel records	Apple II	£98	P2
	CP/M	£450	C4
	MCZ Zilog	£500+	I1
	PET	£85	H2

PACKAGES

Application	Machine	Price	Code
Petaid report generator	Commodore/Computhink	£125	S3
Petsoft programs	PET/CBM	£160	J1
Planning/Maintenance	PET/8032	£595	S1
Postal advertising response package	Apple	£350	S2
PR/advertising package	Commodore/Computhink	£1000	S3
Price lister	CBM	£12	H3
Printers job control	Commodore/Computhink	£250	S3
Production analysis	Apple II	£75	P2
	CP/M	£700	C4
	PET/CBM	£300	B1
Prof appts groups	8080/Z80	£275	G3
Prof appts Individ	8080/Z80	£220	G3
Prof client billing	8080/Z80	£330	G3
Programming aids	Apple II	£40	P2
Property management	CP/M	£450-1000	C4
Purchase ledger	Apple	£300	A2
	Apple	£300	S5
	Apple	£300	K2
	Apple II	£295	C6
	Apple II	£300	P1
	Apple II	£295	P2
	Apple II	£315	V1
	Apple II/ITT 2020	£250P	S4
	CBM	£350	H3
	Commodore/Computhink	POR	S3
	CP/M	£500	C4
	CP/M	£450	G1
	CP/M	£500	L3
	CP/M	£500	K1
	CP/M	£425	L1
	Cromemco	£250	B3
	ITT 2020	£295	C6
	ITT 2020	£300	P1
	North Star Horizon	£250	B3
	PCC 2000 Simpelec Triton 3	£350	B2
	PET	£300	B4
	PET	£95/120/350	A1
	PET/CBM	£200	C2
	PET/CBM	POR	J1
	PET/8032	£395	S1
	Tandy Model I	£90	M1
	Tandy Model II	£90	M1
	TRS-80	£225	H1
	TRS-801	£225	T1
	TRS-801	£225	K1
	TRS-8011	£375	T1
	Vector	£400	C5
	8000 Series	£250	C2
	8080/Z80	£275	G3
	8080/Z80	£425	L1
Revolving credit	Cromemco	£400+	B3
Sales ledger	Apple	£300	A2
	Apple	£300	S5
	Apple	£300	K2
	Apple II	£295	C6
	Apple II	£300	P1
	Apple II	£295	P2
	Apple II	£315	V1
	Apple II/ITT 2020	£250P	S4
	CBM	£350	H3
	Commodore/Computhink	POR	S3
	CP/M	£500	C4
	CP/M	£450	G1
	CP/M	£500	L3
	CP/M	£500	K1
	CP/M	£425	L1
	Cromemco	£250	B3
	ITT 2020	£295	C6
	ITT 2020	£300	P1
	North Star Horizon	£250	B3
	PCC 2000 Simpelec Triton 3	£350	B2
	PET	£300	B4
	PET	£800	C1
	PET	£95/350	A1
	PET/CBM	POR	J1
	PET/CBM	£200	C2
	PET/8032	£395	S1
	Tandy Model I	£90	M1
	Tandy Model II	£90	M1
	TRS-80	£225	H1
	TRS-801	£225	T1
	TRS-801	£225	K1
	TRS-8011	£375	T1
	Vector	£400	C5
	8000 Series	£250	C2
	8080/Z80	£275	G3
	8080/Z80	£425	L1
Salesman	Apple II	£10	D1
	ITT 2020	£10	D1
	PET	£10	D1
Screen generator	MCZ Zilog	£75+	I1
S/L, P/L & stock control	CP/M	£1000	L3
Solicitor's complete record accounting	Apple	£3000	S2
Solicitor's package	PET/8032	£750	S1

Application	Machine	Price	Code
Statistics	Apple	£150	G3
	Apple II	£100-195	P2
	TRS-80	£45	S2
Stock control/recording	Altos (CP/M, MP/M)	£300	B1
	Apple	POR	A2
	Apple	POR	K2
	Apple	POR	S5
	Apple	£150	G3
	Apple	£80	S2
	Apple II	£35/98	P2
	Apple II	£10	D1
	Apple II	£285	V1
	Apple II	£300	P1
	Apple II/ITT 2020	£500	S4
	CBM	£35/25	H3
	Commodore/Computhink	£100/250	S3
	CP/M	£500	K1
	CP/M	£325	L1
	CP/M	£500-1500	C4
	CP/M	£350	G1
	Cromemco	£450	B3
	ITT 2020	£10	D1
	ITT 2020	£300	P1
	MZ-80K	£150	P2
	North Star Horizon	£450	B3
	PCC 2000 Simpelec Triton 3	£350	B2
	PET	£12/25/350	A1
	PET	£10	D1
	PET	£195	I2
	PET	£300	B4
	PET	£15	A2
	PET/CBM	£300	B1
	PET/CBM	£150	C2
	PET/CBM	£150	J1
	PET/CBM	£150	G2
	PET/Computhink	£250	R1
	PET/8032	£395	S1
	Tandy Model I	£30-50	M1
	Tandy Model II	£300	M1
	TRS-80	£48	S2
	TRS-80	£200	H1
	TRS-80	£115	J1
	TRS-801	£200	K1
	TRS-801	£200	T1
	TRS-8011	£375	T1
	8080/Z80	£275	G3
	8080/Z80	£325	L1
TAP business system	PET	£125	H2
Text file librarian	Apple II/ITT 2020	£125	S4
Time/cost recording	Apple	£450	S2
	Apple II	£300	P1
	Apple II	£125	P2
	Commodore/Computhink	POR	S3
	CP/M	£400	G1
	Cromemco	£250	B3
	ITT 2020	£300	P1
	North Star Horizon	£250	B3
	PCC 2000 Simpelec Triton 3	£350	B2
	PET/CBM	£300	B1
	Tandy Model I	POR	M1
	Tandy Model II	POR	M1
Utilities	Apple II	£20	C6
	ITT 2020	£20	C6
Utility set	CBM	£78	H3
VAT	PET	£17.50	A1
VAT master	CBM	£25	H3
VAT register	TRS-80	£15	H1
Vet package	PET/8032	POR	S1
Video message	Apple	£200	G3
Warehousing	PET/8032	POR	S1
Word processing	ACT 800	£375	H4
	Apple	£60	S2
	Apple	£75	K2
	Apple	£75	S5
	Apple	£75	A2
	Apple II	£150-300	P2
	Apple II	£75	J1
	Apple II	£120	V1
	Apple II	£40	D1
	Apple II/ITT 2020	£180/95	S4
	CBM	£35	H3
	Commodore/Computhink	£120	S3
	CP/M	£500	K1
	CP/M	£150-260	C4
	CP/M	£400	G1
	ITT 2020	£40	D1
	MCZ Zilog	£500+	I1
	PET	£85/65/40/20	H2
	PET	£40	D1
	PET	£375	H4
	PET	£25/325	A1
	PET	£325	C5
	PET/CBM	£75/150	C2
	PET/CBM	£75/150	J1
	PET/CBM	£75/150	G2
	Tandy Model I	£50/75	M1
	Tandy Model II	£175-240	M1
	TRS-80	£30/60/90	S2
	TRS-80	£45/95	J1
	TRS-80	£15	H1
	TRS-801	£70	K1
	Vector	£400	C5
	8000 Series	£250	C2

Machines

Machine	Application	Price	Code
ACT 800	Database management/Word processing	£225	H4
	Word processing	£375	H4
Altos (CP/M, MP/M)	Integrated accts	£300	B1
	Mailing list	£75	B1
	Stock control/recording	£300	B1
Apple	Database management/information retrieval	£150	K2
	Database management/information retrieval	£150	A2
	Database management/information retrieval	£60-140	S2
	Database management/information retrieval	£150	S5
	Estate agent	£850	S5
	Estate agent	£850	A2
	Estate agent	£850	K2
	General ledger/NL	£300	K2
	General ledger/NL	£300	A2
	General ledger/NL	£300	S5
	Incomplete records	POR	K2
	Incomplete records	£250	S2
	Invoicing	£295	S2
	Job costing	£450	S2
	Mailing list	£300	K2
	Mailing list	£300	A2
	Mailing list	£50-150	S2
	Mailing list	£300	S5
	Mail shot	£14	S2
	Payroll	POR	S5
	Payroll	POR	K2
	Payroll	POR	A2
	Payroll	£200	S2
	Postal advertising response package	£350	S2
	Purchase ledger	£300	K2
	Purchase ledger	£300	A2
	Purchase ledger	£300	S5
	Sales ledger	£300	A2
	Sales ledger	£300	K2
	Sales ledger	£300	S5
	Solicitor's complete record accounting	£3000	S2
	Statistics	£150	G3
	Stock control/recording	£150	G3
	Stock control/recording	POR	K2
	Stock control/recording	POR	A2
	Stock control/recording	£80	S2
	Stock control/recording	POR	S5
	Time/cost recording	£450	S2
	Video message	£200	G3
	Word processing	£75	K2
	Word processing	£75	A2
	Word processing	£60	S2
	Word processing	£75	S5
Apple II	Bank account	£10	D1
	Cash flow	£80	V1
	Cash flow	£75	P2
	Cash register	£10	D1
	Credit control	£98	P2
	Database management/information retrieval	£98	P2
	Estate agent	£175	P2
	General ledger/NL	£225	V1
	General ledger/NL	£295	P2
	General ledger/NL	£295	C6
	Incomplete records	£125	P2
	Integrated accts	£855	V1
	Integrated accts	£450	P1
	Integrated accts	£340	P2
	Invoicing	£140	V1
	Invoicing	£300	P1
	Invoicing	£125	P2
	Job costing	£125	P2
	Job costing	£300	P1
	Letter writer	£80	V1
	Mailing list	£50	D1
	Mailing list	£40	P2
	Mail shot	£225	P2
	Pad to plotter system	£250	P2
	Payroll	£375	V1
	Payroll	£200	P2
	Payroll	£375	C6
	Payroll	£10	D1
	Personnel records	£98	P2
	Production analysis	£75	P2
	Programming aids	£40	P2
	Purchase ledger	£315	V1
	Purchase ledger	£300	P1
	Purchase ledger	£295	P2
	Purchase ledger	£295	C6
	Sales ledger	£315	V1
	Sales ledger	£300	P1
	Sales ledger	£295	P2
	Sales ledger	£295	C6
	Salesman	£10	D1
	Statistics	£100-195	P2
	Stock control/recording	£285	V1
	Stock control/recording	£300	P1
	Stock control/recording	£35/98	P2
	Stock control/recording	£10	D1
	Time/cost recording	£300	P1
	Time/cost recording	£125	P2
	Utilities	£20	C6
	Word processing	£120	V1
	Word processing	£150-300	P2
	Word processing	£40	D1
	Word processing	£75	J1
Apple II/ITT 2020	Database management/information retrieval	£100	S4
	Estate agent	£750	S4
	Financial planning	£250	S4
	General ledger/NL	£250P	S4
	Mailing list	£100	S4
	Office admin	£100	S4
	Payroll	£250P	S4
	Purchase ledger	£250P	S4

PACKAGES

Machine	Application	Price	Code
	Sales ledger	£250P	S4
	Stock control/recording	£500	S4
	Text file librarian	£125	S4
	Word processing	£180/95	S4
CBM	Bureau de change	£8	H3
	Estate agent	£30	H3
	General ledger/NL	£200	H3
	Mailing list	£35	H3
	Payroll	£10	H3
	Price lister	£12	H3
	Purchase ledger	£350	H3
	Sales ledger	£350	H3
	Stock control/recording	£35/25	H3
	Utility set	£78	H3
	VAT master	£25	H3
	Word processing	£35	H3
Commodore/ Computhink	Appointments planner	£100	S3
	Bank accounts	£100	S3
	Bonds/pension quotations	£100	S3
	Database management/ Information retrieval	£45-250	S3
	Estate agent	£250	S3
	General ledger/NL	POR	S3
	Incomplete records	£750	S3
	Integrated accts	POR	S3
	Invoicing	POR	S3
	Mailing list	£100	S3
	Mail shot	£125	S3
	Petaid report generator	£125	S3
	PR/advertising package	£1000	S3
	Printers job control	£250	S3
	Purchase ledger	POR	S3
	Sales ledger	POR	S3
	Stock control/recording	£100/250	S3
	Time/cost recording	POR	S3
	Word processing	£120	S3
CP/M	Cash flow	£250	L3
	Company secretary	£450	C4
	Contract costing	£2000	L3
	Database management/ information retrieval	£150-750	C4
	Equipment lease/rent/ HP	£400	G1
	Estate agents	£750	C4
	Financial modelling	£400	G1
	General ledger/NL	£500	L3
	General ledger/NL	£500	C4
	General ledger/NL	£400	G1
	General ledger/NL	£500	K1
	General ledger/NL	£375	L1
	Integrated accts	£1500	C4
	Integrated accts	£1100	G1
	Integrated accts	£950	L1
	Invoicing	£325	L1
	Invoicing	£150-350	C4
	Invoicing	£500	K1
	Job costing	£700	C4
	Legal precedents	£1100	C4
	Mailing list	£50-150	C4
	Mailing list	£250	G1
	Mail shot	£200-360	G4
	Order entry/invoicing	£350	G1
	Order processing	£550	L1
	Payroll	£450	L3
	Payroll	£495	C4
	Payroll	£500	G1
	Payroll	£500	K1
	Payroll	£475	L1
	Personnel records	£450	C4
	Production analysis	£700	C4
	Property management	£450-1000	C4
	Purchase ledger	£500	L3
	Purchase ledger	£450	G1
	Purchase ledger	£500	K1
	Purchase ledger	£425	L1
	Purchase ledger	£500	C4
	Sales ledger	£500	L3
	Sales ledger	£500	C4
	Sales ledger	£450	G1
	Sales ledger	£500	K1
	Sales ledger	£425	L1
	S/L, P/L + stock control	£1000	L3
	Stock control/recording	£325	L1
	Stock control/recording	£500-1500	C4
	Stock control/recording	£350	G1
	Stock control/recording	£500	K1
	Time/cost recording	£400	G1
	Word processing	£500	K1
	Word processing	£400	G1
	Word processing	£150-260	C4
Cromemco	Database management/ information retrieval	£250	B3
	General ledger/NL	£250	B3
	Hire purchase	£400 +	B3
	Integrated accts	£950	B3
	Invoicing	£100	B3
	Leasing	£400 +	B3
	Purchase ledger	£250	B3
	Revolving credit	£400 +	B3
	Sales ledger	£250	B3
	Stock control/recording	£450	B3
	Time/cost recording	£250	B3
ITT 2020	Bank account	£10	D1
	Cash register	£10	D1
	General ledger/NL	£295	C6
	Integrated accts	£450	P1
	Invoicing	£300	P1
	Job costing	£300	P1
	Mailing list	£50	D1
	Payroll	£10	D1
	Payroll	£375	C6
	Purchase ledger	£300	P1
	Purchase ledger	£295	C6
	Sales ledger	£300	P1
	Sales ledger	£295	C6
	Salesman	£10	D1
	Stock control/recording	£10	D1
	Stock control/recording	£300	P1
	Time/cost recording	£300	P1
	Utilities	£20	C6
	Word processing	£40	D1
MCZ Zilog	Budgeting package	£500 +	I1
	Conference organiser	£500 +	I1
	Mail shot	£200	I1
	Personnel records	£500 +	I1
	Screen generator	£75 +	I1
	Word processing	£500 +	I1
MZ-80K	Integrated accounts	£150	P2
	Stock control/recording	£150	P2
North Star Horizon	Database management/ information retrieval	£250	B3
	General ledger/NL	£250	B3
	Integrated accts	£950	B3
	Invoicing	£100	B3
	Payroll	£350	B3
	Purchase ledger	£250	B3
	Sales ledger	£250	B3
	Stock control/recording	£450	B3
	Time/cost recording	£250	B3
PCC 2000 Simpelec Triton 3	Estate Agent	£350	B2
	General ledger/NL	£350	B2
	Mail shot	£450	B2
	Purchase ledger	£350	B2
	Sales ledger	£350	B2
	Stock control/recording	£350	B2
	Time/cost recording	£350	B2
PET	Bank account	£10	D1
	Cash flow	£8	A1
	Cash register	£10	D1
	Credit control	£650	B4
	Database management/ information retrieval	POR	C1
	Database management/ information retrieval	£325	A1
	Database management/ information retrieval	£225	H4
	Database management/ information retrieval	£170	C3
	Estate agent	£25	A1
	General ledger/NL	£1000	C1
	Invoicing	£350	A1
	Invoicing	£400	C1
	Lotteries	£45	H2
	Mailing list	£15	A1
	Mailing list	£50	D1
	Mailing list	£45	H2
	Membership accting	£85	H2
	Payroll	£50/195	I2
	Payroll	£10	D1
	Payroll	£50/25/ 195	A1
	Payroll	POR	C1
	Payroll	£200/350	C5
	Personnel records	£85	H2
	Purchase ledger	£95/120/ 350	A1
	Purchase ledger	£1000	C1
	Purchase ledger	£300	B4
	Sales ledger	£300	B4
	Sales ledger	£800	C1
	Sales ledger	£95/350	A1
	Salesman	£10	D1
	Stock control/recording	£195	I2
	Stock control/recording	£10	D1
	Stock control/recording	£12/25/ 350	A1
	Stock control/recording	£15	A2
	Stock control/recording	£300	B4
	TAP business system	£125	H2
	VAT	£17.50	A1
	Word processing	£40	D1
	Word processing	£85/65/ 40/20	H2
	Word processing	£375	H4
	Word processing	£25/325	A1
	Word processing	325	C5
PET/CBM	Assembler dev	£50	C2
	Database management/ information retrieval	£75	B1
	Database management/ information retrieval	£50/150	C2
	Database management/ information retrieval	£150	G2
	Database management/ information retrieval	£150	J1
	Disk operating system	£150	B1
	General ledger/NL	£200	C2
	Integrated accts	£300	B1
	Integrated accts	£(50)	C2
	Integrated accts	£650	G2
	Integrated accts	£650	J1
	Invoicing	POR	J1
	Invoicing	£25-50	B1
	Lisp	£75	C2
	Mailing list	£75	B1
	Pascal	£120	C2
	Payroll	£150	G2
	Payroll	£150	J1
	Payroll	£150	C2
	Petsoft programs	£160	J1
	Production analysis	£300	B1
	Purchase ledger	£200	C2
	Purchase ledger	POR	J1
	Sales ledger	POR	J1
	Sales ledger	£200	J1
	Stock control/recording	£150	C2
	Stock control/recording	£300	B1
	Stock control/recording	£150	G2
	Stock control/recording	£150	J1
	Time/cost recording	£300	B1
	Word processing	£75/150	J1
	Word processing	£75/150	G2
	Word processing	£75/150	C2
PET/ Computhink	Stock control/recording	£250	R1
PET/8032	Mailing list	£75/150	S1
	Planning maintenance	£595	S1
	Purchase ledger	£395	S1
	Sales ledger	£395	S1
	Solicitor's package	£750	S1
	Stock control/recording	£395	S1
	Vet package	POR	S1
	Warehousing	POR	S1
Sorcerer	Payroll	£250	L2
Tandy Model I	Database management/ information retrieval	£25-80	M1
	General ledger/NL	£90	M1
	Incomplete records	£40	M1
	Integrated accts	£350	M1
	Invoicing	£90	M1
	Job costing	POR	M1
	Mailing list	£40	M1
	Payroll	£249	M1
	Purchase ledger	£90	M1
	Sales ledger	£90	M1
	Stock control/recording	£30-50	M1
	Time/cost recording	POR	M1
	Word processing	£50/75	M1
Tandy Model II	CBasic	£70	M1
	CP/M + utilities	£150	M1
	General ledger/NL	£90	M1
	Integrated accts	£350	M1
	Invoicing	£90	M1
	Job costing	POR	M1
	Mailing list	£75	M1
	Mail shot	£75	M1
	Purchase ledger	£90	M1
	Sales ledger	£90	M1
	Stock control/recording	£300	M1
	Time/cost recording	POR	M1
	Word processing	£175-240	M1
TRS-80	Database management/ information retrieval	£60	S2
	Database management/ information retrieval	£32.50	H1
	Database management/ information retrieval	£150	J1
	General ledger/NL	£225	H1
	Incomplete records	£40	H1
	Integrated accts	£75	J1
	Investment portfolio	£20	S2
	Invoicing	£25	H1
	Mailing list	£25/38/ 55	H1
	Mailing list	£50-150	S2
	Payroll	£200	H1
	Purchase ledger	£225	H1
	Sales ledger	£225	H1
	Statistics	£45	S2
	Stock control/recording	£200	H1
	Stock control/recording	£48	S2
	Stock control/recording	£115	J1
	VAT register	£15	H1
	Word processing	£45/95	J1
	Word processing	£15	H1
	Word processing	£30/60/ 90	S2
TRS-80I	General ledger/NL	£225/325	T1
	General ledger/NL	£325	K1
	Individual designed programs	£100 up	K1
	Invoicing	£75	K1
	Invoicing	£75	T1
	Payroll	£218	T1
	Payroll	£218	K1
	Purchase ledger	£225	K1
	Purchase ledger	£225	T1
	Sales ledger	£225	T1
	Sales ledger	£225	K1
	Stock control/recording	£200	K1
	Stock control/recording	£200	T1
	Word processing	£70	K1
TRS-80II	General ledger/NL	£425	T1
	Invoicing	£125	T1
	Payroll	£375	T1
	Purchase ledger	£375	T1
	Sales ledger	£375	T1
	Stock control/recording	£375	T1
Vector	General ledger/NL	£400	C5
	Integrated accts	£1000	C5
	Purchase ledger	£400	C5
	Sales ledger	£400	C5
	Word processing	£40	C5
8000 Series	Database management/ information retrieval	POR	C2
	Integrated accts	POR	C2
	Payroll	£250	C2
	Purchase ledger	£250	C2
	Sales ledger	£250	C2
	Word processing	£250	C2
8080/Z80	General ledger/NL	£275	G3
	General ledger/NL	£375	L1
	Integrated accts	£950	L1
	Integrated accts	£995	G3
	Invoicing	£325	L1
	Job order control	£257	G3
	Order processing	£550	L1
	Payroll	£475	L1
	Payroll	£275	G3
	Prof appts groups	£275	G3
	Prof appts individ	£220	G3
	Prof client billing	£330	G3
	Purchase ledger	£425	L1
	Purchase ledger	£275	G3
	Sales ledger	£275	G3
	Sales ledger	£425	L1
	Stock control/recording	£325	L1
	Stock control/recording	£275	G3

USER GROUPS INDEX

Here are the details of additions and changes recently notified. If we have failed to include YOUR group (or have published incorrect information) either here or in the complete listing, then please address changes/additions to: PCW *(User Groups Index), 14 Rathbone Place, London W1P 1DE. Finally, the next complete listing will appear in our May issue.*

INTERNATIONAL

Sym-1 Users' Group. Publishes a quarterly newsletter *Sym-physis*. Annual sub $13.50 (airmail). Contact Sym-1 Users' Group, PO Box 315, Chico, CA95927, USA.

NATIONAL

British Amateur Robotics Association. Recently formed for anyone interested in robotics. Membership free but small production charge for newsletter. Contact: D Stocqueler, 66 Waterloo Rd, Penylan, Cardiff, S Glam.

UK Pilot User Group. Send an A4-size SAE for fact sheet on various Pilot versions available. Common Pilot Reference Manual available for £5. Versions of Pilot available for different machines. Contact: Alec Wood, Wirral Grammer School for boys, Cross Lane, Bebington, Wirral, Merseyside L63 3AQ.

ZX80 Users Club. Bi-monthly newsletter, software bank, technical support. Annual membership £6 (UK) or £10 (overseas). Contact: ZX80 Users Club, PO Box 159, Kingston-upon-Thames, Surrey KT2 5U2.

BUCKS/BERKS

Anyone interested in joining an Apple Users Group in the Bucks/Berks should contact: S F Proffitt on Marlow 73074 (evenings) or 01-750 7298 (day).

DERBYSHIRE

Derby & District branch of IPUG meets second Thursday each month. Contact: Raymond Davies Davies, 105 Normanton Rd, Derby DE1 2GG.

EAST MIDLANDS

The East Midlands Independent TRS-80 Users Group now has to charge for its newsletter. Send 50p for Issue 4 (balance credited to your account). Contact: Mike Costello, 17 Langbank Avenue, Rise Park, Nottingham NG5 5BU.

LONDON

East London Computer Club. Meets every Friday at 7.30 in term at North East London Polytechnic, Romford Rd Precinct, Stratford E15. Contact John Grieve, 01-533 4761.

NORTH-EAST

North-East RML 380Z Users' Group. Meets monthly at Micro-Electronics Education Centre, The Polytechnic, Newcastle upon Tyne. Contact: M Hatfield or R Reed, Computer Unit, Northumberland Building, The Polytechnic, Newcastle-upon-Tyne NE1 8ST, tel: 26002 ext. 268 (office hours).

SCOTLAND

Central Scotland Computer Club. Meets twice monthly in Falkirk College of Technology, Grangemouth Rd, Falkirk. Contact: Jam James Lyon, 78 Slamannan Rd, Falkirk FK1 5NF, tel (0324) 22430.

Computer-Town Centres

EASTCOTE: Meets 1st & 3rd Tuesdays monthly in Eastcote Library from 6—8pm. Contact: CTUK! Eastcote, 7 Collins Drive, Eastcote, Middx HA4 9EL.

GATESHEAD: Meets on Saturdays (except last Sat in month) from 10am to 4pm at 22 Durham Rd, Gateshead, Tyne & Wear. Contact: John Bone, 2 Claremont Place, Gateshead, Tyne & Wear NE8 1TL.

SUTTON-IN-ASHFIELD: Group has a computer permanently available to the public in Sutton-in-Ashfield library, The Precinct, Sutton-in-Ashfield. Contact: Deric Ellerby, tel (0380) 75376.

DIARY DATA

Bilbao, Spain	Electrical & Electronic Equip Exbn — ELA Contact ECL Ltd, 01-486 1951.	2 — 8 Mar
London, England	(Wembley Conf C) Microsystems '81 Exbn. Contact: IPC Exbns Ltd, 01-837 3636	11 — 13 Mar
Glasgow, Scotland	(Albany Hotel) Computermarket. Contact: Couchmead Ltd., 42 Gt Windmill Street, London W1. 01-437 4187	17 — 19 Mar
Malmo, Sweden	Computer Exbn — DATAKRAFT. Contact: ECL Ltd, 01-486 1951	23 — 27 Mar
Manchester, England	(New Cent. Hotel) Computermarket. Contact: Couchmead Ltd., 01-437 4187	24 — 26 Mar
Dublin, Eire	Int Computing Exbn — COMPUTEX. Contact: SDL Exbns Ltd, Dublin 763871	24-27 Mar
London, England	(Wembley Conf Centre) Numerical Control Equip Exbn & Conf. Contact: British Numerical Control Socy, 01-579 9411	30 Mar — 1 Apr
Birmingham, England	(Albany Hotel) Computermarket. Contact: Couchmead Ltd, 01-437 4187	31 Mar — 2 Apr
London, England	(West Centre Hotel) Peripherals '81 Exbn. Contact: IPC Exbns Ltd, 01-837 3636	1 — 3 Apr
London, England	(West Centre Hotel) Computermarket. Contact: Couchmead Ltd, 01-437 4187	7 — 9 Apr
Paris, France	Int Exbn of Electronic Components. Contact: French Trade Centre, 01-439 3964	7 — 11 Apr
Kenilworth, England	(Nat. Agric. Centre) Computer Numerical Control Equip, Machine & Services Exbn & Conf. Contact: Corinthian Exbns, 01-681 7055	12 — 14 Apr
London, England	(Grosvenor House) All Electronics Show. Contact: All Electronics Show, (0799) 22612	22 — 24 Apr

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 (all in Microsoft Basic).

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).

PCW SUBSET

Sub Set is not confined to Z80 routines; by sheer coincidence the original contributors were Z80 users, but contributions, documented as shown here, are most welcome from users of other processors. Send your subroutines to:
PCW Sub Set, *PCW*, 14 Rathbone Place, London W1P 1DE

Block move

The first Datasheet this month, HEXMV, is a collection of routines from Paul Zarucki of Solihull. These translate a block of binary data to ASCII-hexadecimal characters, which are stored at a specified location with a checksum appended.

HEXMV is used to prepare for the serial transmission of ASCII data from one micro to another. Several systems put data to backing storage in this form. Storing data in ASCII-hexadecimal has the advantages of allowing for the 176 possible non-ASCII bytes to be used for control purposes or for redundant bits to be used in the detection and correction of transmission errors. It has the disadvantages of occupying twice as much space as the original data and therefore taking twice as long to transmit and allowing twice as many opportunities for errors in transmission to occur.

There are other situations, apart from data storage, where it is useful to convert and hold data in ASCII-hexadecimal, in order to distinguish it from control information. Write in and tell us of any you have found.

Just as we received these routines, Nigel Stephens of Wembley wrote to tell us how neatly Intel's MDS monitor converts a binary to an ASCII-hexadecimal digit and pointed out that the technique could be adapted to any machine with a DAA (decimal adjust) instruction, such as the M6800. So, in place of Paul's original HEXASC routine, we have borrowed the Intel technique Nigel wrote in about.

Motorola

HEXMV is our first Datasheet for the Motorola M6800 processor, which has two 8-bit accumulators, A and B, a condition codes register and a 16-bit index register, stack pointer and program counter. Don't skip this Datasheet, you Z80 owners, but enjoy the simple directness of the M6800 instruction set, with addresses the right way round, superb indexed addressing facilities and BSR (a relative call), then consider how you would do the job with the Z80's abundance of 16-bit registers and its digit rotating instructions. See Figure 1 for the appearance of the stack while HEXMV is being executed.

Datasheet

```
;= HEXMV — Block move.
;/ CLASS: 1
;/ TIME CRITICAL ?: No.
;/ DESCRIPTION: Takes a block of data up to 256 bytes long,
;/              translates it into ASCII-hexadecimal and
;/              deposits the result in a destination table with
;/              a one-byte (two ASCII-hex digits) checksum
;/              appended.
;/ ACTION: 1. Initialise checksum to zero.
;/         2. Subtract 2 from destination address.
;/         3. Read byte pointed to by source address.
;/         4. Unpack low & high nibbles and add both to checksum.
;/         5. Convert to 2 ASCII-hexadecimal digits.
;/         6. Increment source address by 1.
;/         7. Increment destination address by 2.
;/         8. Store MS-digit of ASCII-hex at dest. address
;/            and LS-digit at Dest. address + 1.
;/         9. Decrement byte count and so to step 3 if not zero.
;/        10. Read checksum then repeat steps 4 thru 8.
;/        11. Return to calling program.
;/ SUBr DEPENDENCE: None.
;/ INTERFACES: None.
;/ INPUT: Parameters supplied on stack by calling program:
;/        SOURCE ADDRESS at SP+1 and SP+2
;/        DESTINATION ADDRESS at SP+3 and SP+4
;/        BYTE COUNT at SP+5
;/ OUTPUT: 2n+2 (where n = byte count) bytes of ASCII-hex data
```

```
;/              (including checksum) stored at destination.
;/              Parameters still on stack:
;/                      SOURCE ADDRESS = input value + n
;/              DESTINATION ADDRESS = input value + 2n
;/                                      (points to checksum)
;/                              BYTE COUNT = zero
;/ REGs USED: XR, ACCA, ACCB and CONDITION CODES
;/ STACK USE: 8
;/ LENGTH: 89
;/ PROCESSOR: M6800
HEXMV:  CLR  A            ; initialise checksum           4F
        PSH  A            ; and put on stack.             36
        TSX               ; point XR to stack workspace.  30
        LDA  A 6,X        ; initialise                    A6 06
        SUB  A #2         ; destination                   80 02
        STA  A 6,X        ; pointer to                    A7 06
        BCC    A7         ; DEST-2 for                    24 02
        DEC    5,X        ; pre-incrementing.             6A 05
A7:     LDX    3,X        ; fetch next byte XR←(XR+3—4)   EE 03
        LDA  A 0,X        ; of binary source.             A6 00
        TSX               ; convert to ASCII, store       30
        BSR  HEXMV1       ; at dest. and update           8D 0B
        TSX               ; pointers & checksum.          30
        DEC    7,X        ; decrement byte count &        6A 07
        BNE    A7         ; repeat until zero.            26 F4
        LDA  A 0,X        ; append checksum               A6 00
        BSR    HEXMV1     ; to ASCII data.                8D 02
        PUL  A            ; clear stack of checksum.      32
        RTS               ; return.                       39
; convert byte from binary to hex, move it to
; destination and update pointers and checksum.
HEXMV1: BSR    BINASC     ; convert byte to ASCII-hex     8D 19
        INC    4,X        ; update                        6C 04
        BNE    A8         ; source                        26 02
        INC    3,X        ; pointer                       6C 03
A8:     INC    6,X        ; update                        6C 06
        BNE    B8         ; destination                   26 02
        INC    5,X        ; pointer.                      6C 05
B8:     INC    6,X        ;                               6C 06
        BNE    C8         ;                               26 02
        INC    5,X        ;                               6C 05
C8:     LDX    5,X        ; XR←(XR+5—6)                   EE 05
        STA  A 0,X        ; store ASCII at                A7 00
        STA  B 1,X        ; destination.                  E7 01
        RTS                                               39
; convert byte to two ASCII-hex bytes in A & B
; and update checksum.
BINASC: TAB               ; B←A.                          16
        AND  A #0FH       ; separate byte into two        84 0F
        AND  B #F0H       ; hex. digits in A and B.       C4 F0
        LSR  B            ; logical shift 1 bit right.    54
        LSR  B            ;                               54
        LSR  B            ;                               54
        LSR  B            ;                               54
        PSH  A            ; save A.                       36
        ADD  A 0,X        ; add checksum to A.            AB 00
        ABA               ; add B to A.                   1B
        STA  A 0,X        ; put updated checksum on stk.  A7 00
        PUL  A            ; restore A.                    32
        BSR    HEXASC     ; convert hex digit to ASCII.   8D 06
        PSH  A            ; save A.                       36
        TBA               ; A — B.                        17
        BSR    HEXASC     ; convert hex digit.            8D 02
        PUL  B            ; restore A to B.               33
        RTS                                               39
; hexadecimal to ASCII conversion subroutine.
HEXASC: ADD  A 90H        ; so A—F will give carry on     8B 90
        DAA               ; decimal adjust.               19
        ADC  A 40H        ; add any carry & 40H.          89 40
        DAA               ; decimal adjust.               19
        RTS                                               39
```

Dave Barrow who, in last month's HLFHL, gave the shortest solution to HL = HL/2, when HL contains four BCD digits, has now sent the fastest solution so far received. It takes 82 — 93 T states and 23 bytes. He has also given this version of HLFA, eight bytes shorter than that printed in February:

```
HFA:  JR   NC,LB1    ; skip if no cy.
      ADD  A,A0H     ; make cy. worth 10.
LB1:  RRA            ; divide by 2.
      BIT  3,A       ; cy. into units?
      JR   Z,LB2     ; skip if not.
      DEC  A         ; else convert
      DEC  A         ; carried 8
      DEC  A         ; into 5.
LB2   RET
```

32-bit binary

You don't often see routines to do calculations on 32-bit binary numbers, not even in expensive books on microprocessor programming. This probably has something to do with the fact that they are not all that easy to handle with the limited number of registers in the popular microprocessors. Even the Z80 could do with more registers when it comes to manipulating 32-bit numbers.

Paul Jenner of Southampton is the first contributor to brave your scrutiny of a 4-byte integer divide in our second Datasheet, DIV4. In the true spirit of this series, Paul will be interested to see any better attempts and so will we.

Datasheet

```
;= DIV4 — 4-byte integer divide.
;/ CLASS: 1
;/ TIME CRITICAL ? No.
;/ DESCRIPTION:  Divides one 4-byte unsigned integer by another.
;/               Returns quotient and remainder. Checks for
;/               divide by zero.
;/ ACTION: Long division by shift-and-subtract, using HL
;/         and (SP) as an extended accumulator.
;/ SUBr DEPENDENCE: None.
;/ INTERFACES: None.
;/ INPUT:  Dividend in IX,IY
;/         Divisor in BC,DE
;/ OUTPUT: Carry set, arguments unchanged if BCDE = 0 on entry.
;/         A is always set to zero.
;/         Quotient in IX,IY.
;/         Reminder in BC,DE.
;/ REGs USED:  All normal and index registers (not alternate
;/             registers).
;/ STACK USE: 2
;/ LENGTH: 54
;/ PROCESSOR: Z80.

DIV4:   LD    A,B        ; if all                    78
        OR    C          ; BC                        B1
        OR    D          ; DE                        B2
        OR    E          ; are zero                  B3
        SCF              ; set carry                 37
        RET   Z          ; and return.               C8
        LD    A,32D      ; set bit count.            3E 20
        LD    HL,0000H   ; set accumulator           21 00 00
        PUSH  HL         ; and extend to stack.      E5
TOP:    ADD   IY,IY      ; shift left IY.            FD 29
        EX    (SP),IX    ; get IX                    DD E3
        EX    (SP),HL    ; into HL                   E3
        ADC   HL,HL      ; shift it left (with carry) ED 6A
        EX    (SP),HL    ; and return                E3
        EX    (SP),IX    ; it to IX.                 DD E3
        ADC   HL,HL      ; shift HL left (with carry). ED 6A
        EX    (SP),HL    ; get (SP) into HL          E3
        ADC   HL,HL      ; shift it left (with carry) ED 6A
        EX    (SP),HL    ; and return it to (SP).    E3
        OR    A          ; clear carry.              B7
        SBC   HL,DE      ; subtract                  ED 52
        EX    (SP),HL    ; BC,                       E3
        SBC   HL,BC      ; DE                        ED 42
        EX    (SP),HL    ; from (SP),HL.             E3
        INC   IY         ; set result bit.           FD 23
        JR    NC,WENT    ; jump if                   30 09
        JR    Z,WENT     ; subtraction went.         28 07
        ADD   HL,DE      ; else                      19
        EX    (SP),HL    ; add                       E3
        ADC   HL,BC      ; back                      ED 4A
        EX    (SP),HL    ; divisor                   E3
        DEC   IY         ; and reset result.         FD 2B
WENT:   DEC   A          ; repeat                    3D
        JR    NZ,TOP     ; 32 times.                 20 D9
        EX    DE,HL      ; put remainder from        EB
        POP   BC         ; (SP),HL to BC,DE.         C1
        RET                                          C9
```

LEISURE LINES

The check digit problem set in puzzle number 16 proved to be a little tougher than usual, and only about 30 entries were received.

In inverse proportion to the number of entries were the cries of 'too easy' — this time only two correspondents complained — although one reader pointed out that there was no need to give the information about successive primes and another said that there was no need to specify the modulo.

I'm not sure about that last comment but anyway the solution was as follows:

Weights 1-82
2-86
3-94
4-53
5-59
6-61

And the required checksum (not check

digit — someone else picked me up about that!) was 51.

The winner by random selection was again from overseas — Brussels to be exact — Mr Hans Van Leeuwen.

Congratulations — your prize is on its way from Angleterre (or should we say Engeland?).

Quickie

Sorry quickie addicts, nothing this month since you got two last month.

Prize puzzle

This month's prize puzzle will probably eliminate all those readers who don't have alpha facilities on their calculators. But necessity is the mother of invention, so perhaps they'll find some other means of cracking this problem.

1 The 49 letters shown in the grid can be formed into seven by seven-letter words and the initial letters of each of the seven words will form an eighth word which is the answer to the puzzle.

2 Alongside each letter is also a number in the range 1-6. This indicates the number of squares that must be traversed to reach the next square.

3 Starting with the letter D in the centre of the grid move the number of squares specified (in this case six) East, West, North or South (assuming North is at the top of the grid) and you will arrive at another square.

4 If any move takes you beyond the edge of the grid, you should assume that the grid 'wraps round'. Thus, if a Northerly move takes you to the top of the grid, the count of squares should continue from the foot of the same column.

T_4	R_6	E_3	S_6	T_5	S_6	O_5
U_2	Y_3	L_4	S_2	O_5	N_2	A_3
R_5	B_3	S_1	E_2	E_1	R_2	N_5
Y_6	L_5	R_2	D_6	N_3	D_2	I_1
E_5	A_4	T_6	S_1	B_3	N_5	G_5
A_3	E_2	E_5	A_2	T_3	G_4	R_6
Y_2	A_1	T_1	T_3	R_3	N_1	I_6

5 Hence, from the start point, a move of six squares East will take you to the right hand edge after three squares and the fourth, fifth and sixth squares should be made from the left-hand edge of the same row to bring you to the letter R2.

6 In this way the initial move can take you to either the R2, E2, N3 or S1 squares immediately adjacent to the start letter.

7 No square may be landed on more than once. Diagonal moves are not permitted.

8 A correct series of moves throughout the grid will yield seven consecutive seven-letter English words, the initial letters of which, taken in order, will then give the required solution.

One word only required.

Answers on a postcard please, to Puzzle number 19, *PCW*, 14 Rathbone Place, London, W1P 1DE, to arrive no later than March 31. The prize is the usual book token.

PROGRAMS

TRS-80 Show Jumping

by Roy Bowden

This must be the best TRS-80 program we've ever received! It is a game for one to four players each of whom must make their way round the course using the arrow keys. Start by positioning your horse under the START hitting S when you reach the right position. Press R to start your round. As you reach each jump a picture of it will appear and a square will appear in the top centre of the screen. You then have two seconds to put in your figures relating to the height and the spread of the jump. Low height is represented by number keys 1, 2 and 3, medium by 4, 5 and 6 and high by 7, 8 and 9. Spread is dictated by which of the keys in the group is chosen. 1, 4 and 7 represent no spread and 3, 6 and 9 represent maximum spread. The only other point worth making is that the vertical arrow comes out on the listing as a square bracket. Good luck!

```
70 CLEAR 2000:RANDOM:DEFINT A,B,J,K,N,V-Y
80 DIM R$(4),H$(4),JP$(2,15),JP(15),FA(4),CL(4)
90 CLS:PRINTCHR$(23)
100 PRINT@338,"SHOW  JUMPING"
110 PRINT@402,"*************"
120 FOR K=1 TO 750:NEXT K
160 CLS
170 INPUT"HOW MANY COMPETITORS (1-4) ";N
180 IF N<1 OR N>4 THEN 170
190 PRINT
200 FOR C=1 TO N:PRINT"COMPETITOR NUMBER";C
210 INPUT"NAME OF RIDER, HORSE.";R$(C),H$(C)
220 NEXT C
230 PRINT:PRINT"PLEASE WAIT WHILE THE JUMPS ARE CHECKED."
250 C=0:JN=0:J=0
260 JP(1)=1:JP$(1,1)="H5-1"
270 GOSUB 600
280 IF P=1 THEN JP(2)=1:JP$(1,2)="H5-1"
290 IF P=2 THEN JP(2)=4:JP$(1,2)="H5-4"
300 IF P=3 THEN JP(2)=7:JP$(1,2)="H5-7"
310 GOSUB 600
320 IF P=1 THEN JP(3)=2:JP$(1,3)="S5-0":JP$(2,3)="H5-1"
330 IF P=2 THEN JP(3)=5:JP$(1,3)="S5-0":JP$(2,3)="H5-4"
340 IF P=3 THEN JP(3)=8:JP$(1,3)="S5-0":JP$(2,3)="H5-7"
350 GOSUB 600
360 IF P=1 THEN JP(4)=1:JP$(1,4)="H5-1"
370 IF P=2 THEN JP(4)=4:JP$(1,4)="H5-4"
380 IF P=3 THEN JP(4)=7:JP$(1,4)="H5-7"
390 JP(5)=4:JP$(1,5)="H5-4"
400 JP(6)=7:JP$(1,6)="H5-7"
410 JP(7)=4:JP$(1,7)="H5-4"
420 GOSUB 600
430 IF P=1 THEN JP(8)=1:JP$(1,8)="H5-1"
```

PROGRAMS

```
440 IF P=2 THEN JP(8)=4:JP$(1,8)="H5-4"
450 IF P=3 THEN JP(8)=7:JP$(1,8)="H5-7"
460 JP(9)=6:JP$(1,9)="S16-0"
470 GOSUB 600
480 IF P=1 THEN JP(10)=1:JP$(1,10)="H5-1"
490 IF P=2 THEN JP(10)=4:JP$(1,10)="H5-4"
500 IF P=3 THEN JP(10)=7:JP$(1,10)="H5-7"
510 GOSUB 600
520 IF P=1 THEN JP(11)=2:JP$(1,11)="S5-3":JP$(2,11)="H5-1"
530 IF P=2 THEN JP(11)=5:JP$(1,11)="S5-3":JP$(2,11)="H5-4"
540 IF P=3 THEN JP(11)=8:JP$(1,11)="S5-3":JP$(2,11)="H5-7"
550 JP(12)=7:JP$(1,12)="H5-7"
560 JP(13)=5:JP$(1,13)="S5-5":JP$(2,13)="H5-4"
570 JP(14)=1:JP$(1,14)="H5-1"
580 JP(15)=7:JP$(1,15)="H6-7"
590 GOTO 660
600 P=RND(3):RETURN
660 PA$=CHR$(191):PB$=CHR$(131):PC$=CHR$(92):PD$=CHR$(93)
670 PE$=CHR$(140):PF$=CHR$(143):PG$=STRING$(4,131)
680 P1$=PA$+PG$+PB$+PC$+PG$+PD$+PG$+PB$+PD$+PG$+PD$+PG$+JP$(1,7)+JP$(1,5)+PG$+PB
$+PB$+JP$(1,5)+STRING$(3,131)+JP$(1,4)+STRING$(11,131)+PA$+PA$+"      "+PC$+"
    "+PC$+"    "+PD$+"    "
690 P1$=P1$+PD$+"  "+PB$+PA$+PB$+" "+PB$+PA$+PB$+"       "+PB$+PA$+PB$+"     "+PB$
+PA$+PB$+"      "+PD$+"      "+PA$
700 P2$=PA$+"    "+PA$+STRING$(3,140)+PA$+STRING$(13,32)+"[      "+PE$+PF$+PE$+" "
+PE$+PF$+PE$+"       "+PE$+PF$+PE$+"     "+PE$+PF$+PE$+"      [     "+PA$+PA$+"
"+JP$(1,12)+" 11     "
710 P2$=P2$+PC$+STRING$(12,32)+"6 DBL        5       4      "+JP$(2,3)+"     "+PA$
720 P3$=PA$+"    "+JP$(1,13)+"   T             [   "+PD$+"    "+PD$+"     "+PD$+STRING
$(18,32)+"3"+PA$+STRING$(3,143)+PA$+"    "+PA$+PA$+"    "+PA$+STRING$(3,188)+PA$+"
 B   "+PA$+STRING$(3,140)
730 P3$=P3$+PA$+"7"+STRING$(15,32)+"["+STRING$(19,32)+JP$(1,3)+"     "+PA$
740 P4$=PA$+"    "+JP$(2,13)+"  L    "+JP$(1,8)+STRING$(15,32)+JP$(2,11)+STRING$(2
6,32)+PA$+PA$+"    "+PA$+STRING$(3,140)+PA$+STRING$(22,32)+"10"+PA$+STRING$(3,143
)+PA$+STRING$(16,32)+"2"+PA$+STRING$(3,140)+PA$+"    "+PA$
750 P5$=PA$+"    "+JP$(1,14)+"        "+PA$+STRING$(3,188)+PA$+"8"+STRING$(13,32)+J
P$(1,11)+STRING$(18,32)+JP$(1,2)+"      "+PA$+PA$+STRING$(13,32)+"WATER"+STRING$(4
4,32)+PA$
760 P6$=PA$+STRING$(13,32)+JP$(1,9)+STRING$(35,32)+"1"+PA$+STRING$(3,140)+PA$+"
  "+PA$+PA$+"    "+PA$+STRING$(3,140)+PA$+"12"+STRING$(21,32)+"9"+PA$+STRING$(3,1
40)+PA$+STRING$(17,32)+JP$(1,1)+"     "+PA$
770 P7$=PA$+"    "+JP$(1,15)
780 P8$=PA$+"* FINISH *
790 P9$=STRING$(21,32)+STRING$(42,176)
800 PRINT"THE COURSE IS NEARLY READY."
820 PO$=STRING$(6,179)+STRING$(6,191)
830 PO$=PO$+PO$+PO$
840 G1$=STRING$(36,188)
850 G2$=PA$+STRING$(5,32)
860 G3$=STRING$(4,32)+PA$+PA$+STRING$(4,32)
870 G2$=G2$+G2$+PA$+G3$+G2$+G2$+PA$
880 M1$=STRING$(11,191)
890 M1$=M1$+PB$+M1$+PB$+M1$
900 M2$=STRING$(7,131)+PA$
910 M2$=M2$+M2$+M2$+M2$+STRING$(3,131)
920 M3$=PA$+STRING$(7,131)
930 M3$=STRING$(3,131)+M3$+M3$+M3$+M3$
940 T1$=CHR$(184)+PA$+STRING$(9,188)+PA$+CHR$(180)
950 T2$=CHR$(160)+CHR$(190)+STRING$(13,191)+CHR$(189)+CHR$(144)
960 T3$=CHR$(184)+CHR$(140)+CHR$(180)+STRING$(13,176)+CHR$(184)+CHR$(140)+CHR$(1
80)
970 T4$=CHR$(160)+CHR$(190)+PA$+CHR$(136)+CHR$(157)+STRING$(13,140)+CHR$(174)+CH
R$(132)+PA$+CHR$(189)+CHR$(144)
980 T5$=CHR$(170)+PA$+PA$+CHR$(179)+CHR$(183)+STRING$(13,179)+CHR$(187)+CHR$(179
)+PA$+PA$+CHR$(149)
990 O1$=CHR$(184)+CHR$(180)+STRING$(12,176)+CHR$(184)+CHR$(180)
1000 O2$=CHR$(160)+CHR$(190)+PA$+CHR$(157)+STRING$(12,140)+CHR$(174)+PA$+CHR$(18
9)+CHR$(144)
1010 O3$=CHR$(184)+STRING$(20,191)+CHR$(180)
1020 S1$=PA$+PB$+PA$
1030 S2$=PA$+PB$+PB$+PA$
1040 S3$=PA$+PB$+PB$+PB$+PA$
1050 S4$=PA$+PG$+PA$
1060 S5$=PA$+PG$+PB$+PA$
1070 S6$=PA$+PG$+PB$+PB$+PA$
1080 S7$=PA$+PG$+PB$+PB$+PB$+PA$
1090 S8$=PA$+PG$+PG$+PA$
1100 PH$=STRING$(4,32):PI$=STRING$(5,32)
1110 J1$=PA$+PG$+PA$
1120 J2$=STRING$(2,191)+PH$+PA$
1130 J3$=STRING$(3,191)+PH$+PA$
1140 J4$=STRING$(4,191)+CHR$(32)+CHR$(32)+CHR$(136)+STRING$(2,191)
1150 J5$=STRING$(5,191)+PH$+PA$
1160 J6$=STRING$(5,191)+CHR$(136)+STRING$(4,191)
1170 J7$=STRING$(5,191)+STRING$(4,143)+PA$
1180 J8$=STRING$(5,191)+PI$
1190 K1$=J1$
1200 K2$=PA$+PH$+STRING$(2,191)
1210 K3$=PA$+PH$+STRING$(3,191)
1220 K4$=STRING$(2,191)+CHR$(132)+CHR$(32)+CHR$(32)+STRING$(4,191)
1230 K5$=PA$+PH$+STRING$(5,191)
1240 K6$=STRING$(4,191)+CHR$(132)+STRING$(5,191)
1250 K7$=PA$+STRING$(4,188)+STRING$(5,191)
1260 K8$=PI$+STRING$(5,191)
1270 W1$=CHR$(176)+CHR$(188)+PA$+CHR$(188)+CHR$(176)
1280 W2$=PA$+PG$+PB$+PA$
1290 W3$=PA$+PI$+PA$
1300 W4$=W2$
1310 W5$=W3$
1320 W6$=W2$
1330 W7$=W3$
1340 W8$=W2$
1350 W9$=W3$
1360 F1$=CHR$(188)+STRING$(43,140)+CHR$(188)
1370 F2$=PA$+CHR$(32)+PA$+PA$+STRING$(5,131)+CHR$(32)+PB$+PA$+PA$+PB$+CHR$(32)+P
A$+PA$+CHR$(188)+CHR$(176)+CHR$(32)+PA$+PA$+CHR$(32)+PB$+PA$+PA$+PB$+CHR$(32)+CH
R$(188)
1380 F2$=F2$+PA$+PB$+PB$+PB$+CHR$(143)+CHR$(140)+CHR$(32)+PA$+PA$+STRING$(3,32)+
PA$+PA$+CHR$(32)+PA$
1385 PRINT"NOT LONG NOW,...."
1390 F3$=PA$+CHR$(32)+PA$+PA$+STRING$(3,131)+STRING$(4,32)+PA$+PA$+STRING$(2,32)
+PA$+PA$+CHR$(131)+CHR$(143)+STRING$(3,191)+STRING$(2,32)+PA$+PA$+STRING$(2,32)+
CHR$(176)+CHR$(179)
1400 F3$=F3$+STRING$(3,131)+PA$+CHR$(188)+CHR$(32)+PA$+PA$+STRING$(3,131)+PA$+PA
$+CHR$(32)+PA$
1410 F4$=PA$+CHR$(176)+STRING$(2,179)+STRING$(6,176)+STRING$(4,179)+CHR$(176)+ST
RING$(2,179)+STRING$(3,176)+STRING$(2,179)+CHR$(176)+STRING$(4,179)+STRING$(2,17
6)+STRING$(5,179)+STRING$(2,176)+STRING$(2,179)
1420 F4$=F4$+STRING$(3,176)+STRING$(2,179)+CHR$(176)+PA$
1430 GOTO 2110
1440 GOSUB 2030
1450 PRINTSTRING$(11,32);S1$;STRING$(36,32);S1$
1460 PRINTSTRING$(10,32);S2$;PO$;S2$
1470 PRINTSTRING$(9,32);S3$;STRING$(36,32);S3$
1480 PRINTSTRING$(8,32);S4$;PO$;S4$
1490 PRINTSTRING$(7,32);S5$;G1$;S5$
1500 PRINTSTRING$(6,32);S6$;G2$;S6$
```

```
ETIRED.";GOTO 4220
4210 PRINT:PRINTFA(V);"FAULTS IN ";:PRINTUSING CL$;CL(V)
4220 FOR K=1 TO 2000:NEXT K
4230 GOTO 2110
4250 CLS:PRINTCHR$(23)
4260 PRINT@320,"WINNER OF THIS COMPETITION"
4270 PRINT"*****************************":PRINT
4280 IF FA(V)=100 THEN PRINT"DISQUALIFIED OR RETIRED-":PRINT"NO WINNER.":GOTO 43
20
4290 PRINTR$(V);" RIDING "
4300 PRINTH$(V);" :-":PRINT"FAULTS :";FA(V);".    ";
4310 PRINT"TIME : ";USING CL$;CL(V)
4320 PRINT:PRINT:PRINT"WOULD YOU LIKE"
4330 PRINT"ANOTHER COURSE ? (Y/N)"
4340 I$=INKEY$:IF I$="" THEN 4340
4350 IF I$="Y" THEN RUN
4360 IF I$<>"N" THEN 4320
4370 END
```

Listing courtesy of London Computer Centre

PET Grand Prix

by Michael Matar

This runs on a new ROM PET. You have to steer your car around a convoluted race track, competing against a PET-driven rival.

```
1 REM GRAND PRIX BY MICHAEL MATAN
2 CLR:GOTO9000
5 Q=102:PRINT"J":R2=42:R3=144:R5=0:Q2=32
6 V2=1:V3=1
10 FORA=1TO80
20 W=32767+A:A2=33687+A
30 POKEW,Q:POKEA2,Q
38 NEXT
39 IFT$="M"THEN50
40 IFT$="E"THENPOKE33348,Q:GOTO50
41 POKE33350,Q:POKE33390,Q
42 POKE33094,Q:POKE33095,Q
43 POKE32895,Q:POKE32975,Q:POKE33015,Q
44 POKE33018,Q:POKE32898,Q:IF T$<>"H"THEN50
45 FORA3=1TO8
46 A2=32822+(40*A3)
47 POKEA2,Q
48 NEXT
50 FORA3=1TO25
60 A4=(A3*40)+32808:A5=(A3*40)+32847
70 POKEA4,Q:POKEA5,Q
71 NEXT
79 IFT$="M"THEN90
80 IFT$="E"THEN90
81 POKE33398,Q:POKE33399,Q:POKE33400,Q:POKE33438,Q:POKE33439,Q:POKE33440,Q
82 POKE33438,Q:POKE33467,Q:POKE33518,Q:POKE33507,Q
83 POKE33671,Q:POKE33631,Q:POKE33591,Q
90 FORA6=1TO20
100 A7=33216+A6:A8=33256+A6:A9=33296+A6
110 POKEA7,Q:POKEA8,Q:POKEA9,Q
111 NEXT
120 IFT$="E"THEN130
121 POKE33338,Q:POKE33378,Q
122 POKE33418,Q:POKE33419,Q
130 FORB=1TO5
140 W2=(B*40)+32827:B2=(B*40)+32991:B3=(B*40)+32979
141 A=32989+B:A2=33276+B
142 H=33036+B
143 POKEH,Q:POKE33255,Q:POKE33213,Q:IFT$="E"THEN150
144 POKE33105,Q:POKE33106,Q:POKE33107,Q:POKE33147,Q
150 POKEW2,Q:POKEB2,Q:POKEB3,Q:POKEA2,Q
155 NEXT
156 POKE32942,32
160 FORW3=1TO3
170 B4=33095+W3:B5=33210+(W3*40)
180 POKEB4,Q:POKEB5,Q
185 NEXT
186 PRINT"  LAPS-YOU";R4;"PET";K
190 FORB6=1TO4
200 B7=(B6*40)+33465
210 POKEB7,Q
215 NEXT
216 POKE33585,32
220 POKE33284,Q:POKE33425,Q:POKE33535,Q
230 IFD=5THEN2400
231 FORP=1TO9
240 P2=(40*P)+33315:A=33314+(P*40):A2=33313+(P*40)
250 POKEP2,86:POKEA,90 :POKEA2,90
254 NEXT
255 IFR5=1THEN310
256 IFR5=2THEN2400
260 X=33395:J=33475:D=0:R=-1:K=0:R4=0:A4=33182:A3=-1:B5=0
265 POKEX,42:POKEJ,144
266 POKE33469,Q
270 FORI3=1TO300
280 NEXT
300 C=PEEK(166)
301 A=A-1:IFA=22THEN2600
302 IFX<33268THEN310
303 IFX>33287THEN310
304 H=7: R5=1:GOTO230
310 IFC=10THEND=-1:GOTO360
320 IFC=1 THEND=1:GOTO360
330 IFC=80THEND=-40:GOTO11000
340 IFC=32THEND=40:GOTO360
350 D=0
360 N=X:X=X+D
370 GOSUB1000
371 IFA=23THEN390
380 POKEN,Q2:POKEX,R2
390 GOSUB2000
410 GOTO300
600 B6=RND(1):Q2=32
```

```
605 B9=B9+1:IFB9=1THENPRINT"YOU ARE OUT OF CONTROL":V8=1
610 X=N:POKEX,170:IFB6<.26THENX=X-1:GOTO650
620 IFB6<.51THENX=X+1:GOTO650
630 IFB6<.76THENX=X+40:GOTO650
640 X=X-40
650 IFPEEK(X)=QTHENB5=0:GOTO1020
652 B5=B5-1
655 IFB5=0THENPRINT"":GOTO700
660 RETURN
700 PRINT" LAPS-YOU";R4;"PET";K
701 GOTO660
1000 K5=PEEK(X):IFK5=127THENB9=0:B5=B5+5
1001 IFB5>0THENGOSUB600
1002 IFK5=32THENRETURN
1003 IFK5=QTHENB$="A WALL":I9=2:GOTO1020
1004 IFK5=144THENB$="PET":GOTO1020
1010 RETURN
1020 PRINT"YOU HAVE HIT ";B$;
1021 IFI9=2THENPRINT""
1025 FORA=1TO5
1026 POKEN,170
1030 GOSUB2000
1031 POKEN,42
1035 NEXT
1036 A=23:Q3=Q3+1:IFQ3>1THENQ2=127
1037 X=N
1040 RETURN
1500 IFRND(1)<.5THENQ4=1:GOTO1520
1510 R=40:GOTO2400
1520 R=-40:GOTO2400
1530 IFJ=33430THENR=-1:GOTO2400
1540 IFJ=33386THENR=-1:GOTO2400
1550 IFJ=33460THENR=-1:GOTO2400
1560 IFJ=33380THENR=40:GOTO2400
1570 IFJ=33546THENR=-1:GOTO2400
1580 IFJ=33540THENR=-40:GOTO2400
1590 IFJ=33426THEN1610
1600 GOTO2400
1610 IFRND(1)<.5THENR=-40:GOTO2400
1620 R=-40:GOTO2400
1700 IFRND(1)<.5THENR=40
1710 GOTO2400
2000 IFJ=33176THENR=-1:GOTO2400
2001 IFJ=33456THENQ4=0:R=-40:GOTO2400
2005 IFQ4=1THEN1530
2010 IFJ=33173THENR=-40:GOTO2400
2011 IFJ>33400THEN2080
2012 IFJ>33000THEN2072
2015 IFJ=32952THEN1700
2020 IFJ=32933THENR=1:GOTO2400
2030 IFJ=32945THENR=40:GOTO2400
2060 IFJ=32949THENR=1:GOTO2400
2070 IFJ=32966THENR=40:GOTO2400
2071 GOTO2400
2072 IFJ=33123THENR=40:GOTO2400
2073 IFJ=33065THENR=1:GOTO2400
2074 IFJ=33069THENR=-40:GOTO2400
2075 IFJ=33112THENR=1:GOTO2400
2079 GOTO2400
2080 IFJ=33486THENR=-1:GOTO2400
2085 IFJ=33483THENR=-1:GOTO2400
2092 IFJ=33475THENR5=2:GOTO230
2093 IFJ=33470THEN1500
2094 IFJ=33590THENR=-1:GOTO2400
2095 IFJ=33580THENR=-40:GOTO2400
2096 IFJ=33460THENR=-1:GOTO2400
2100 GOTO2400
2400 J3=J
2410 J=J+R
2415 IFJ=33475THEN2500
2420 IFD=5THENRETURN
2431 GOTO3000
2434 IFJ3=33475THENJ3=33767
2435 POKEJ,144:POKEJ3,32
2440 RETURN
2500 K=K+1:PRINT" LAPS-YOU";R4;"PET";K
2510 GOTO2420
2600 PRINT""
2605 PRINT" LAPS-YOU";R4;"PET";K;"":S9=0
2610 GOTO302
3000 IFH<>7THEN3030
3010 IFPEEK(X-1 )=86THENR4=R4+1:H=0:PRINT" LAPS-YOU";R4;"PET";K
3020 IFR4=3THEN3050
3030 IFK=3THEN3070
3035 GOTO2434
3050 IFR4=K-1THEN3080
3060 PRINT"YOU HAVE BEATEN PET":GOTO3100
3070 PRINT"PET HAS BEATEN YOU":GOTO3100
3080 PRINT"YOU AND PET  HAVE DRAWN":GOTO3100
3100 IFR4=K-1THEN4000
3110 IFR4=3THEN3140
3120 GOTO4000
3140 D=5:GOSUB2000
3150 V7=V7+1
3160 IFK<3THEN3140
3170 GOTO3910
3910 PRINT""
3915 PRINT"YOU FINISHED ";V7;" PLACES AHEAD OF PET"
4000 PRINT"PRESS SPACE FOR NEXT GO"
4001 CLR
4002 IFPEEK(166)<>6THEN4002
4010 GOTO5000
5000 CLR
5010 PRINT"IF YOU WANT ANOTHER LOOK AT THE RULES   THEN PRESS(R),OTHERWISE";
5020 PRINT"PRESS(N)"
5021 PRINT"IF YOU DO NOT WANT ANOTHER GO THEN PRESS RETURN";
5030 N8=PEEK(166):IFN8=22THEN10145
5035 IFN8=27THEN20000
5037 IFN8=6THEN5030
5040 IFN8=255THEN5030
9000 PRINT""
9001 PRINT"****************************************"
9002 PRINT"                 GRAND PRIX"
9003 PRINT"****************************************"
10000 PRINT" YOU CAN CONTROL YOUR CAR WITH THE   CONTROLS INDICATED BELOW"
10010 PRINT"                |"
```

PROGRAMS

```
1510 PRINTSTRING$(5,32);S7$;G2$;S7$
1520 PRINTSTRING$(4,32);S8$;G2$;S8$;:RETURN
1530 GOSUB 2040
1540 PRINTSTRING$(8,32);W1$;STRING$(37,32);W1$
1550 PRINTSTRING$(7,32);W2$;STRING$(35,32);W2$
1560 PRINTSTRING$(7,32);W3$;M1$;W3$
1570 PRINTSTRING$(7,32);W4$;M2$;W4$
1580 PRINTSTRING$(7,32);W5$;M3$;W5$
1590 PRINTSTRING$(7,32);W6$;M2$;W6$
1600 PRINTSTRING$(7,32);W7$;M3$;W7$
1610 PRINTSTRING$(7,32);W8$;M2$;W8$
1620 PRINTSTRING$(7,32);W9$;M3$;W9$;:RETURN
1630 GOSUB 2030
1640 PRINTSTRING$(8,32);J1$;STRING$(36,32);K1$
1650 PRINTSTRING$(7,32);J2$;PO$;K2$
1660 PRINTSTRING$(6,32);J3$;STRING$(36,32);K3$
1670 PRINTSTRING$(5,32);J4$;PO$;K4$
1680 PRINTSTRING$(4,32);J5$;STRING$(36,32);K5$
1690 PRINTSTRING$(4,32);J6$;PO$;K6$
1700 PRINTSTRING$(4,32);J7$;G1$;K7$
1710 PRINTSTRING$(4,32);J8$;G2$;K8$;:RETURN
1720 GOSUB 2030
1730 PRINTSTRING$(11,32);S1$;STRING$(36,32);S1$
1740 PRINTSTRING$(10,32);S2$;STRING$(6,32);CHR$(176);CHR$(188);CHR$(143);STRING$
(18,131);CHR$(143);CHR$(188);CHR$(176);STRING$(6,32);S2$
1750 PRINTSTRING$(9,32);S3$;STRING$(3,32);CHR$(176);CHR$(188);CHR$(143);CHR$(131
);STRING$(22,32);CHR$(131);CHR$(143);CHR$(188);CHR$(176);STRING$(3,32);S3$
1760 PRINTSTRING$(8,32);S4$;CHR$(176);CHR$(188);CHR$(143);CHR$(131);STRING$(28,3
2);CHR$(131);CHR$(143);CHR$(188);CHR$(176);S4$
1770 PRINTSTRING$(7,32);S5$;PO$;S5$
1780 PRINTSTRING$(6,32);S6$;G1$;S6$

1790 PRINTSTRING$(5,32);S7$;G2$;S7$
1800 PRINTSTRING$(4,32);S8$;G2$;S8$;
1810 PRINT@671,"...,:::,...";
1820 PRINT@724,".....:::::,......";:RETURN
1830 GOSUB 2050
1840 PRINTSTRING$(24,32);O1$
1850 PRINTSTRING$(22,32);O2$
1860 PRINTSTRING$(21,32);O3$
1870 PRINT:GOSUB 1450
1880 RETURN
1890 PRINT:PRINT
1900 PRINTSTRING$(25,32);T1$
1910 PRINTSTRING$(23,32);T2$
1920 PRINTSTRING$(22,32);T3$
1930 PRINTSTRING$(20,32);T4$
1940 PRINTSTRING$(20,32);T5$
1950 GOSUB 1540
1960 RETURN
1970 GOSUB 2050
1980 PRINTSTRING$(24,32);O1$
1990 PRINTSTRING$(22,32);O2$
2000 PRINTSTRING$(21,32);O3$
2010 PRINT:GOSUB 1640
2020 RETURN
2030 PRINT:PRINT:PRINT:PRINT:PRINT:PRINT:PRINT:PRINT:RETURN
2040 PRINT:PRINT:PRINT:PRINT:PRINT:PRINT:PRINT:RETURN
2050 PRINT:PRINT:PRINT:PRINT:RETURN
2110 C=C+1:JN=0
2120 CLS:PRINTCHR$(23):PRINT
2130 PRINT"COMPETITOR NUMBER";C
2140 PRINT:PRINTR$(C):PRINT"RIDING ";H$(C)
2150 FOR K=1 TO 1400:NEXT K:GOSUB 2170:GOTO 2270
2170 CLS
2180 PRINTP1$;:PRINTP2$;:PRINTP3$;
2190 PRINTP4$;:PRINTP5$;:PRINTP6$;
2200 PRINTP7$;
2210 PRINT@784,PC$;:PRINT@801,JP$(1,10);:PRINT@831,PA$;
2220 PRINTP8$;:PRINT@885,"* START *";:PRINT@895,PA$;
2230 PRINTPA$;:PRINT@912,CHR$(94);:PRINT@922,CHR$(94);
2240 PRINT@931,"[";:PRINT@959,PA$;
2250 PRINTP9$;:POKE 16383,191:RETURN
2270 X=64:Y=45
2280 SET(X,Y):FOR K=1 TO 50:NEXT K
2290 RESET(X,Y):FOR K=1 TO 50:NEXT K
2300 I$=INKEY$:IF I$="" THEN 2280
2310 SET(X,Y)
2320 GOTO 2410
2330 ON I GOSUB 2430,2440,2450,2460
2340 RESET(X1,Y1):IF POINT(X,Y)=0 THEN 2380
2350 X=X1:Y=Y1
2360 ON I GOSUB 2440,2430,2460,2450
2370 GOTO 2340
2380 SET(X,Y):FOR K=1 TO 25:NEXT K
2390 I$=INKEY$:IF I$="" THEN 2330
2400 IF I$="S" THEN 2470
2410 I=(ASC(I$)AND 3)+1
2420 GOTO 2330
2430 X1=X:Y1=Y:X=X-2:RETURN
2440 X1=X:Y1=Y:X=X+2:RETURN
2450 X1=X:Y1=Y:Y=Y+1:RETURN
2460 X1=X:Y1=Y:Y=Y-1:RETURN
2470 I$=INKEY$:IF I$="" THEN 2470
2480 IF I$="R" THEN I=4:GOTO 2510
2490 GOTO 2410
2510 IF(X<112 OR X>117) OR Y<41 THEN 2720
2520 IF(X>111 AND X<118) AND Y>41 THEN GOSUB 2460
2530 SET(X,Y):RESET(X1,Y1):FOR K=1 TO 25:NEXT K
2540 IF Y>41 THEN 2520
2550 IF Y=41 THEN CLS:PRINTCHR$(23)
2560 PRINT@406,"*********"
2570 PRINT@470,"* START *"
2580 PRINT@534,"*********":FOR K=1 TO 750:NEXT K
2590 C1=0:C2=.00:FA=0:CLS
2600 GOSUB 2170
2610 CL$="£.££"
2620 IF C2>=.59 THEN C1=C1+1:C2=.00
2630 CL=C1+C2
2640 PRINT@960,"FAULTS:";FA;
2650 PRINT@970,"CLOCK:";
2660 PRINTUSING CL$;CL;
2670 GOSUB 2460:SET(X,Y):RESET(X1,Y1):FOR K=1 TO 25:NEXT K
2680 C2=C2+.01
2690 IF Y=32 AND(X>111 AND X<118) THEN JS=1:GOTO 2820
2700 GOTO 2620
2720 CLS:PRINTCHR$(23)
2730 PRINT@84,"***********"
2740 PRINT@148,"* WARNING *"
2750 PRINT@212,"***********"
2760 PRINT@456,"YOU ARE NOT APPROACHING"
2770 PRINT@524,"THE START CORRECTLY."
2780 PRINT@660,"WAIT PLEASE."
2790 FOR K=1 TO 1200:NEXT K
2800 GOSUB 2170:GOTO 2310
2820 CLS:J=JS
2830 IF JS>=7 THEN J=JS-1
2840 IF JS=13 THEN J=JS-2
```

```
2850 IF JS>13 THEN J=JS-3
2860 IF JS=1 OR JS=2 OR JS=4 OR JS=7 OR JS=8 OR JS=10 OR JS=14  THEN GOSUB 1440
2870 IF JS=3 OR JS=11 THEN GOSUB 1630
2880 IF JS=5 OR JS=15 THEN GOSUB 1530
2890 IF JS=6 THEN GOSUB 1830
2900 IF JS=9 THEN GOSUB 1720
2910 IF JS=12 THEN GOSUB 1890
2920 IF JS=13 THEN GOSUB 1970
2930 N1$=CHR$(188)+STRING$(4,140)+CHR$(188)
2940 N2$=PA$+PH$+PA$
2950 N3$=PB$+PG$+PB$
2960 PRINT@0,N1$;
2970 PRINT@64,N2$;
2980 PRINT@128,N3$;
2990 PRINT@65,J;
3000 GOSUB 3490
3020 JN=JN+1:IF JS<>JN THEN 3710
3030 GOTO 3070
3050 IF JN=15 THEN 3880 ELSE 3360
3070 R=RND(15):F=RND(15)
3080 RF=INT((R+F)/2)
3090 IF RF<>JS THEN 3150
3100 FA=FA+3
3110 ON I GOSUB 2440,2430,2460,2450:GOSUB 3490:GOSUB 3490
3120 ON I GOSUB 2440,2430,2460,2450:GOSUB 3490:GOSUB 3490
3130 JN=JN-1:CLS:PRINTCHR$(23)
3135 PRINT@384,"YOUR HORSE JUST REFUSED."
3140 FOR K=1 TO 750:NEXT K:GOTO 3790
3150 FOR A=60 TO 65
3160 FOR B=0 TO 2
3170 SET(A,B)
3180 NEXT B,A
3190 FOR K=1 TO 50
3200 II$=INKEY$:IF II$="" THEN 3220
3210 GOTO 3250
3220 NEXT K
3230 GOTO 3300
3250 II=VAL(II$)
3260 IF II=JP(JS) THEN R=RND(10)-1 ELSE 3300
3270 IF R=9 THEN R=1 ELSE R=0
3280 J=JP(JS)+R:IF II=J THEN 3050
3300 FA=FA+4:CLS:PRINTCHR$(23)
3310 PRINT@384,"YOU DID NOT CLEAR"
3320 PRINT"THE JUMP."
3330 FOR K=1 TO 500:NEXT K
3340 GOTO 3790
3360 ON I GOSUB 2430,2440,2450,2460
3370 ON I GOSUB 2430,2440,2450,2460
3380 GOSUB 3490:GOSUB 2170:GOSUB 3510
3390 I$=INKEY$:IF I$="" THEN GOSUB 3490:GOSUB 3510:GOTO 3420
3400 SET(X,Y)
3410 I=(ASC(I$)AND 3)+1
3420 ON I GOSUB 2430,2440,2450,2460
3440 RESET(X1,Y1):IF POINT(X,Y)=0 THEN 3480
3450 X=X1:Y=Y1
3460 ON I GOSUB 2440,2430,2460,2450
3470 GOTO 3440
3480 SET(X,Y):GOTO 3525
3490 C2=C2+.01:IF C2>=.59 THEN C1=C1+1:C2=.00
3500 CL=C1+C2:RETURN
3510 PRINT@960,"FAULTS:";FA;

3520 PRINT@970,"CLOCK:";:PRINTUSING"##.##";CL:RETURN
3525 IF Y=32 AND (X>111 AND X<118) THEN JS=1:GOTO 2820
3530 IF Y=23 AND (X>111 AND X<118) THEN JS=2:GOTO 2820
3540 IF Y=14 AND (X>111 AND X<118) THEN JS=3:GOTO 2820
3550 IF X=100 AND (Y>3 AND Y<7) THEN JS=4:GOTO 2820
3560 IF X=86 AND (Y>3 AND Y<7) THEN JS=5:GOTO 2820
3570 IF X=68 AND (Y>3 AND Y<7) THEN JS=6:GOTO 2820
3580 IF X=60 AND (Y>3 AND Y<7) THEN JS=7:GOTO 2820
3590 IF Y=15 AND (X>29 AND X<36) THEN JS=8:GOTO 2820
3600 IF Y=24 AND (X>29 AND X<36) THEN JS=9:GOTO 2820
3610 IF Y=35 AND (X>67 AND X<74) THEN JS=10:GOTO 2820
3620 IF Y=23 AND (X>67 AND X<74) THEN JS=11:GOTO 2820
3630 IF Y=6 AND (X>9 AND X<16) THEN JS=12:GOTO 2820
3640 IF Y=15 AND (X>9 AND X<16) THEN JS=13:GOTO 2820
3650 IF Y=21 AND (X>9 AND X<16) THEN JS=14:GOTO 2820
3660 IF Y=33 AND (X>9 AND X<16) THEN JS=15:GOTO 2820
3670 GOSUB 3490:GOSUB 3510:I$=INKEY$:IF I$="" THEN 3420
3690 GOTO 3410
3710 CLS:PRINTCHR$(23)
3720 PRINT:PRINT:PRINT"YOU HAVE BEEN"
3730 PRINT:PRINT"DISQUALIFIED"
3740 PRINT"*************"
3750 PRINT:PRINT"FOR TAKING A JUMP"
3760 PRINT"OUT OF ORDER."
3765 FOR K=1 TO 1000:NEXT K
3770 GOTO 4030
3790 CLS:PRINTCHR$(23)
3800 PRINT:PRINT:PRINT"YOU HAVE JUST COLLECTED"
3810 PRINT"SOME FAULTS."
3820 PRINT:PRINT:PRINT"DO YOU WANT TO"
3830 INPUT"RETIRE (Y/N) ";RT$
3840 IF RT$="Y" THEN 3960
3850 IF RT$="N" THEN 3050
3860 GOTO 3820
3880 CLS
3890 PRINT@393,F1$
3900 PRINT@457,F2$
3910 PRINT@521,F3$
3920 PRINT@585,F4$
3930 FOR K=1 TO 1000:NEXT K
3940 GOTO 4030
3960 CLS:PRINTCHR$(23)
3970 PRINT@394,"YOU HAVE"
3980 PRINT@458,"SIGNALLED"
3990 PRINT@522,"YOUR RETIREMENT"
4000 PRINT@586,"****************"
4010 FOR K=1 TO 750:NEXT K
4030 CLS:PRINTCHR$(23)
4040 PRINT@322,"RESULT FOR"
4050 PRINT" ";H$(C):PRINT" RIDDEN BY":PRINT" ";R$(C):PRINT
4060 IF RT$="Y" THEN PRINT" RETIRED":FA=100:GOTO 4090
4070 IF JS<>JN THEN PRINT" DISQUALIFIED":FA=100:GOTO 4090
4080 PRINTFA;"FAULTS.    TIME";CL
4090 FOR K=1 TO 2000:NEXT K
4100 RT$=""
4110 V=1
4120 FA(C)=FA:CL(C)=CL
4130 FOR K=1 TO C
4140 IF FA(V)=FA(K) THEN IF CL(V)>CL(K) THEN V=K
4150 IF FA(V)>FA(K) THEN V=K
4160 NEXT K
4170 IF C=N THEN 4250
4190 CLS:PRINTCHR$(23)
4200 PRINT@322,"BEST RESULT SO FAR:-":IF FA(V)=100 THEN PRINT" DISQUALIFIED OR R
```

```
10020 PRINT"!                    |"
10021 PRINT"                     |"
10025 PRINT"UP                   |"
10030 FORA=1TO4
10040 PRINT"                     |"
10050 NEXT
10060 PRINT" Z                   | 0          ="
10070 PRINT"DOWN                 |LEFT       RIGHT"
10071 PRINT
10080 PRINT"PET WILL CONTROL HIS OWN CAR.YOU CANNOT HIT ANY WALLS(####)";
10090 PRINT"IF YOU DO,PET WILL   ADVANCE 5  PLACES.YOU HAVE 3 LAPS TO DO ";
10100 PRINT"YOU START AND FINISH ON THIS LINE (XXXX) .DO NOT MOVE RIGHT ON ";
10110 PRINT"THESE LINES(♦♦♦♦)";
10120 PRINT"YOUR CAR IS(*),AND PETS IS (P)";
10130 GOTO10200
10145 PRINT"]WHAT STANDARD OF TRACK DO YOU WANT?,HARD(H),MEDIUM(M),OR EASY(E)?"
10147 GETT$
10148 IFT$="H"THEN5
10149 IFT$="M"THEN5
10150 IFT$="E"THEN5
10170 GOTO10147
10200 PRINT"FOR MORE  RULES PRESS SPACE";
10201 IFPEEK(166)=255THEN10201
10210 PRINT"]IF YOU HIT THE WALLS MORE THAN TWICE";
10220 PRINT",    THEN YOU WILL LEAVE AN OIL  TRAIL BEHIND";
10230 PRINT"IF YOU HIT THIS TRAIL THEN YOU WILL LOSE";
10240 PRINT"CONTROL OF YOUR VEHICLE FOR 5"
10250 PRINT"MOVES"
10880 PRINT"TO START PRESS RETURN";
10890 IFPEEK(166)<>27THEN10890
10900 GOTO10145
11000 IFX<33322THEN360
11010 IFX>33326THEN360
11020 D=0:GOTO360
20000 END
```

Listing courtesy of Eurocalc Ltd

PET Aircraft Landing

by K Bywater

This program is for either new or old ROM PETs and will fit into 8k. You have to fly the aircraft down the glide-slope, adjusting its speed and height to avoid stalling, landing too soon or over-shooting.

```
5 UF=0:U=1:ZZ=0:Z=1:M=20
10 A$="SQQQQQQQQQQQQQQQQQQQDDDDDDDDDDDDDDDD!"
15 DN$="SQQQQQQQQQQQQQQQQQQQ":CL$="      ||||||!"
20 D1$=DN$+"XQQQQQQ"
25 B$=A$+"||||||||||||||||QQ"
30 SQ(0)=108:SQ(1)=120:SQ(2)=124:SQ(3)=126:IFQT=1THEN50
35 PRINT"]QQQQPRESS  *  FOR INSTRUCTIONS. IF NOT, THENQQPRESS ANY OTHER KEY."
40 GETR$:IFR$=""THEN40
45 IFR$="*"THENGOSUB10000
50 PRINT"]N-
55 PRINT"  -
60 PRINT"   -
65 PRINT"    -
70 PRINT"     -
75 PRINT"      --
80 PRINT"        --
85 PRINT"          --
90 PRINT"            --
100 PRINT"              ---
110 PRINT"                 ---
120 PRINT"                    -----
130 PRINT" Q.............................................↑.......Q"
135 PRINT" ________________________________________________";
140 PRINT"Q* * * * * INSTRUMENT   PANEL * * * * *■";
145 PRINT"Q________________________________________________■"
200 FA=0:H=1900:AS=150:AG=0:EF=1:EP=3000
220 GOSUB5000
240 GOSUB2000:AG=AG+AF
241 IFSA=1THENXD=XD+1:IFXD<7THEN243
242 IFAS>120ANDSA=1THENSA=0:XD=0
243 IFSA=1THENPRINTD1$"YOU ARE Q STALLING ■]"
245 EP=EP+(EF*341):IFEP>10000THENEP=10000
246 IFEP<0THENEP=0
247 IFUF=1ANDSA=1THENUF=0:Z2=1
248 IFZZ=1ANDSA=1THENZZ=0:Z1=1
249 TF=1.5*((EP*2)/AS-20+(UF=1)*20+(ZZ=1)*175-(FA*3)-19*SIN(AG*π/180)*M)
250 IFZ2=1THENUF=1:Z2=0
251 IFZ1=1THENZZ=1:Z1=0
252 AS=AS+INT(10*TF/M)/10
253 IFAS<=1THENH=H-(T*22):AS=1:SA=1
260 HD=HD+INT(COS(AG*π/180)*AS+.5)
280 IFABS(AG)>9THENL=(1/(ABS(AG)-9)):GOTO302
285 IFSA=1THENAS=AS+INT(10*TF/M)/10:GOTO302
300 L=1-(COS(AG*π/6))*AS/150
302 IFAS<92THENSA=1:GOTO325
304 IFAS<110AND(FA=0ORU=1)THENSA=1
320 IFAS>185ANDFA>0ANDAS<210THENPRINTD1$"SPEED TO GREAT FOR FLAPS!]"
322 IFAS>177ANDFA>0ANDW<>1THENL=L*(FA*2)
325 IFC=1ORC=2THENFORI=33649TO33664:POKEI,32:NEXT
326 IFC=2THEN360
335 IFAS>210ANDFA>0THENC=1
340 IFC=1THENPRINTD1$"FLAPS & WINGS TORN OFF!               ]":W=1
360 IFC=1ORC=2THENAG=AG-5
365 IFSA=1THENGOSUB6000:GOTO400
380 L=L+(SIN(FA*π/180))*(45*(1-SIN(AS*π/180)))
400 H=H+INT((AS*SIN(AG*π/180)+L*COS(AG*π/180)))
420 GOSUB5200
425 IFH>1900THENPOKEPV,32:GOTO644
430 IFHD>33970THEN7105
440 X=HD/900:Y=((1950-H)/150)
460 IFINT(X)=INT(X+.5)THENX=INT(X):GOTO500
480 X=INT(X)+.5
500 IFINT(Y)=INT(Y+.5)THENY=INT(Y):GOTO540
520 Y=INT(Y)+.5
540 QS=0:IFX=INT(X)THENQS=QS+1
```

```
560 IFY=INT(Y)THENQS=QS+2
580 POKEPV,RC
600 PV=32768+(INT(X))+INT(Y)*40
620 RC=PEEK(PV)
625 IFH<=0THEN6100
640 POKEPV,SQ(QS)
644 IFUF=0THENU=1:POKE33715,32:POKE33717,32:POKE33719,32
645 IFUF=1THENU=-1:POKE33715,81:POKE33717,81:POKE33719,81
650 IFZZ=0THENZ=1:POKE33723,32
651 IFZZ=1THENZ=-1:POKE33723,42
652 IFAS>250THENW=1:PRINTD1$"PLANE HAS JUST LOST WINGS!!":C=2
653 IFAS>225ANDAS<250THENPRINTD1$"DANGER!! AIR SPEED TO HIGH."
660 GOTO240
2000 REM******INPUTS********
2010 GETR$:IFR$=""THENRETURN
2020 IFR$=">"THENEF=1
2025 IFR$="↑"THENEF=0
2030 IFR$="<"THENEF=-1
2050 IFR$="U"THENUF=UF+U
2060 IFASC(R$)<56ANDASC(R$)>47THENFA=5*VAL(R$)
2065 IFR$="-"THENAF=-1
2070 IFR$="+"THENAF=1
2075 IFR$="="THENAF=0
2076 IFR$="A"THENZZ=ZZ+Z
2080 RETURN
5000 PRINT"┌──────────────────┐END OF"
5010 PRINT"|AIR SPEED         RUN. DIST.   HEIGHT"
5020 PRINT"├──────────────────┤"
5030 PRINT"|ANGLE             |"
5040 PRINT"├──────────────────┤"
5050 PRINT"|ENG. REVS         |  FLAPS U/CARR. A/B. "
5060 PRINT"└──────────────────┘"
5100 RETURN
5200 AS=INT(AS+.5)
5201 IFH<6ANDH>-10THENH=0
5202 PRINTDN$:PRINTTAB(11)CL$AS
5205 PRINTTAB(20)"        "33965-HDTAB(32)CL$H
5210 PRINTTAB(11)"        "CL$AG+1
5215 IFC=1ORC=2THENPRINT" NO ENGINES!!!! ":GOTO5230
5220 PRINT""TAB(11)"        "EP
5230 PRINTTAB(21)CL$FA
5235 FORI=33728TO33768:POKEI,32:NEXT
5250 RETURN
6000 AG=AG-3-AF
6002 IFAG>0THENAG=INT(AG/(XD+1))
6005 H=INT(H+AS*(SIN(AG*π/180))-9.5)
6010 AS=AS+((AG<0)*3)
6030 RETURN
6100 IFW=1THEN7100
6110 IFHD<=30000ANDHD>19000THEN7110
6120 IFHD<=19000ANDAS>200THEN7120
6125 IFHD<=19000THEN7125
6130 IFAS>150ANDHD>30000ANDHD<33965ANDFA>=15ANDU=-1ANDAG>=-1ANDAG<=4THEN7130
6135 IFAS<150ANDHD>30000ANDHD<33965ANDFA>=15ANDU=-1ANDAG>=-1ANDAG<=4THEN7135
6140 IFHD>30000ANDHD<33965ANDU=1THEN7140
6150 GOSUB8000:PRINT"I THINK YOU COULD DO BETTER - TRY AGAIN!":GOTO13000
7000 R=RND(TI):IFR>.5THEN7103
7100 GOSUB8000:PRINT"NEWS HEADLINES: SUICIDAL PILOT HEADS"
7102 PRINT"TO THE CENTRE OF THE EARTH!":GOTO13000
7103 GOSUB8000:PRINT"NEWS HEADLINES: SUICIDAL MANIAC TRIES"
7104 PRINT"TO COPY METEORITE!!":GOTO13000
7105 GOSUB8000:PRINT"YOU'VE OVERSHOT THE RUNWAY AND YOU'RE"
7106 PRINT"FLIGHT CREW WISH TO RESIGN.":GOTO13000
7110 GOSUB8000:PRINT"SO SORRY! I DID'NT KNOW YOU WAS BLIND!":GOTO13000
7120 GOSUB8000:PRINT"DIGGING FOR OIL ARE WE???":GOTO13000
7125 GOSUB8000:PRINT"I SUPPOSE YOU THINK THAT'S A VERY"
7126 PRINT"CUTE LANDING IN THE MIDDLE OF NOWHERE!":GOTO13000
7130 GOSUB8000:PRINT"IT'S A GOOD JOB THAT THE TOWER WAS IN"
7131 PRINT"THE WAY TO SLOW YOU DOWN--YOU CAME IN"
7132 PRINT"AT"AS"MILES PER HOUR!":GOTO13000
7135 GOSUB8000:PRINT"            CONGRATULATIONS         "
7136 PRINT"YOU MADE IT! (JUST).":GOTO13000
7140 GOSUB8000:PRINT"THANK YOU FOR SAVING THE USE OF THE"
7141 PRINT"UNDERCARRIAGE, BUT THE BOTTOM HALF OF"
7142 PRINT"OF THE PLANE SEEMS TO BE MISSING!!":GOTO13000
8000 PRINT"                ";:FORI=1TO400:PRINT" ";:NEXT
8001 PRINT"                ";:RETURN
10000 GOSUB12000
10005 PRINT"       BY ... YWATER AND ... AI."
10015 PRINT"    IN THIS GAME YOU HAVE TO LAND AN"
10020 PRINT"AEROPLANE WHICH YOU CONTROL FROM THE"
10025 PRINT"GROUND."
10030 PRINT"    YOU CAN SEE THE PLANE ON A RADAR"
10035 PRINT"SCREEN WHICH HAS A PATH PLOTTED ON IT."
10040 PRINT"THE NECESSARY INSTRUMENTS WILL APPEAR"
10045 PRINT"ON THE BOTTOM HALF OF THE SCREEN."
10050 GOSUB11000
10060 PRINT"     ┌ ┬/┴┐└●"
10065 PRINT"     ──────────"
10070 PRINT"THE '+' KEY INCREASES RATE OF CLIMB."
10075 PRINT"THE '-' KEY DECREASES RATE OF CLIMB."
10080 PRINT"THE '=' KEY MAINTAINS THE RATE OF CLIMB."
10085 PRINT"THE '>' KEY INCREASES THE ENGINE REVS."
10090 PRINT"THE '<' KEY DECREASES THE ENGINE REVS."
10095 PRINT"THE '↑' KEY MAINTAINS THE SAME ENGINE   REVS."
10100 GOSUB11000
10110 PRINT"     THE '/' KEY LOWERS & RAISES THE      UNDERCARRIAGE."
10115 PRINT"     THE '♠' KEY OPERATES THE AIR BRAKES."
10117 PRINT"     THE KEYS '0,1,2,3,4,5,6,7' OPERATES"
10118 PRINT"THE FLAPS AT FIVE DEGREE INTERVALS."
10120 GOSUB11000
10290 PRINT"     ┐/┌─♠└ ╲/┬┌─♠|╲┌/"
10295 PRINT"     ────────────────"
10300 PRINT"     TO PLAY THIS GAME IT WOULD BE BEST IF";
10305 PRINT"YOU KNOW THAT TO LAND THE AEROPLANE AT"
10310 PRINT"LEAST 15 DEGREES OF FLAP SHOULD BE ON"
10315 PRINT"AT TOUCHDOWN. DO NOT PUT ANY FLAPS ON"
10320 PRINT"IF YOU ARE DOING MORE THAN 185MPH."
10321 PRINT"    LANDING SPEED IS A MAXIMUM OF 150 MPH"
10325 PRINT"    STALLING SPEEDS, THAT'S WHEN YOU FALL";
10326 PRINT"OUT OF THE SKY, ARE 92 MPH WITH FLAPS &"
10330 PRINT"LANDING GEAR DOWN, OTHERWISE STALLING"
10335 PRINT"SPEED IS 110 MPH."
10350 GOSUB11000
10380 PRINT"     IF YOU WANT TO GO OVER THESE"
10382 FORI=1TO11:GETR$:NEXT
10385 PRINT"  INSTRUCTIONS AGAIN THEN PRESS '♠', IF"
10386 PRINT"  NOT THEN PRESS ANY OTHER KEY."
10390 PRINT"                              |♠┐┐|└♠/╲/|●!":FORI=1TO500:GETR$:NEXT
```

```
10391 GETR$:IFR$=""THEN10391
10392 IFR$="A"THEN10000
10395 PRINT"":POKE59468,12:RETURN
11000 PRINT"                                "
11005 FORI=1TO1000:GETR$:NEXT
11010 WAIT59410,4,4
12000 POKE59468,14:PRINT"                          "
12005 PRINT"                      "
12010 PRINT"                      "
12015 RETURN
13000 FORI=1TO2000:NEXT:GOSUB8000:PRINT"PRESS SPACE-BAR TO CONTINUE."
13010 WAIT59410,4,4
13015 FORI=1TO10:GETR$:NEXT
13020 CLR:QT=1:GOTO5
```

Listing courtesy of Eurocalc Ltd

PET Bouncy

by Jeff Aughton

This will run on any PET and even has sound effects, if you've a Soundbox. You have to hit targets with a ball, whose direction can be altered by inserting paddles in its path.

```
10 REM BOUNCY-JEFF AUGHTON
20 GOSUB600:PRINT""
30 A=32768:T=1:P=40:Y=100:Z=101
40 FORI=1TO38:A=A+T:POKEA,Y:NEXT
50 A=A+T
60 FORI=1TO23:A=A+P:POKEA,Z:NEXT
70 A=A+P:IFT<0THEN90
80 T=-1:P=-40:Y=99:Z=103:GOTO40
90 S=59464:POKES+3,16:POKES+2,15:POKES,0
100 L=32970:C=0:B=1:P=0:T=0:Y=176:X=TI
110 Z=INT(900*RND(1))+A+40
120 IF(Z=L-B)OR(PEEK(Z)<>32)THEN110
130 Y=Y+1:POKEZ,Y
140 REM START LOOP
150 GETA$:IFA$="M"ORA$="Z"THEN300
170 K=PEEK(L+B):IFK>32THEN200
180 POKEL,32
190 L=L+B:POKEL,81:GOTO150
200 IFTI-X>3600THEN840
205 IFK>78THEN250
210 C=SGN(B)*(41-ABS(B))
220 Z=87:IFK=78THENC=-C:Z=43
230 GOSUB830:IFPEEK(L+B+C)<>32THEN180
240 POKEL,32:L=L+B:B=C:GOTO190
250 IFK=YTHEN270
260 B=-B:Z=61:GOSUB830:GOTO180
270 Z=225:FORJ=1TO9:Z=390-Z:GOSUB830:NEXT
280 T=T+1:GOTO110
300 C=SGN(B)*(41-ABS(B))
310 Z=78:IFA$="Z"THENC=-C:Z=38
320 IFPEEK(L+C)<>32THEN180
330 POKEL,78+(A$="M"):GOSUB830
340 P=P+1:B=C:GOTO190
600 PRINT""TAB(16)"BOUNCY
610 GOSUB970
620 PRINT"          THE ULTIMATE GAME OF SKILL
630 GOSUB970
640 PRINT"BOUNCY GIVES YOU 1 MINUTE TO HIT AS MANY "
650 PRINT"TARGETS AS YOU CAN.YOU MUST HIT THEM IN  "
660 PRINT"ORDER STARTING WITH 1 BY PLACING PADDLES"
670 PRINT"IN THE PATH OF THE BALL.
680 PRINT"      PRESSING  Z  GIVES YOU A  /
690 PRINT"      PRESSING  M  GIVES YOU A  \
700 PRINT"OTHER KEYS HAVE NO EFFECT.HOWEVER,IF YOU "
710 PRINT"USE TOO MANY PADDLES YOU WON'T BE ABLE  "
720 PRINT"TO REACH THE TARGETS AND YOUR SCORE WILL "
730 PRINT"BE REDUCED.    PRESS SPACE
740 GOSUB980
750 PRINT"BOUNCY WILL NOT LET YOU HIT THINGS FROM "
760 PRINT"VERY CLOSE RANGE (FAIR ENOUGH) AND MAY, "
770 PRINT"IF NECESSARY ERASE UNWANTED PADDLES."
780 PRINT"CONNECT A SOUNDBOX TO THE USER PORT FOR "
790 PRINT"IRRITATING BLEEPING NOISES.
800 PRINT"     PRESS SPACE TO PLAY BOUNCY
810 GOSUB980:RETURN
830 POKES,Z:FORI=0TO11:NEXT:POKES,0:RETURN
840 FORZ=250TO4STEP-3:GOSUB830:NEXT
850 PRINT"              "
860 PRINT" GAME OVER "
870 PRINT"              ":GOSUB970
880 PRINT" YOU HIT";T,"TARGETS
890 PRINT" YOU USED";P;"PADDLES
900 PRINT" BOUNCY GIVES YOU A SCORE OF";INT(8000*T/(P+70))/10;"%
905 FORI=0TO9:GETA$:NEXT
910 PRINT" ANOTHER GAME";:INPUTA$
920 IFLEFT$(A$,1)<>"Y"THENPOKES+3,0:END
930 PRINT"":GOTO30
970 FORI=1TO2000:NEXT:RETURN
980 GETA$:IFA$<>" "THEN980
990 RETURN
```

Listing courtesy of Eurocalc Ltd

GATEWAYS TO LOGIC

Continued from page 99

toy (Figure 17). Merely by altering the ROM, different sounds can result — anything from a rumbling bomb blast to a high pitched ricochet.

It so happens that the human voice is composed of noise and musical pitch so that more and more products are making their appearance that actually talk to the user and the vocabulary is limited only by the size of memory store. Texas instruments has produced a gadget that looks like a large calculator, which ASKS the child to spell. As the child taps out the spelling the device repeats the name of the letter and finally tells the child either that the spelling is wrong, or compliments him and gives the next word.

Again, the applications are enormous. One begins to approach the dreams of the science fiction writers. Imagine your cooker TELLING you when the roast begins to burn!

In the shorter term, a sound generator chip will provide students with many happy hours of experimentation to produce an enormous range of sounds. Adding on a few more bits and pieces opens up a veritable gold-mine for experimentation. Here are a few chips already available in addition to the sound generator — (1) an organ masteroscillator chip that produces the 12 semitones of the chromatic scale, at a very high frequency or pitch; (2) divider chips that reproduce any input tone at successively lower pitches, commonly up to eight; (3) the chord generator chip that produces a minor or major chord from any keynote input and (4) a rhythm generator chip able to trigger up to 12 instruments at once in any one of a number of named rhythms (see Figure 18).

In the longer term the voice-reproducing capability of the sound generator chip has enormous potential in the education of the slow reader, the blind, or the child not yet able to read.

Since a microphone is an analogue device, it is clear that coupling it to a computer through an A/D converter opens up some interesting possibilities and already circuits are available that allow the human user to instruct his computer through voice alone. Couple that with the previous device and you have a fully-interactive situation with the computer and user talking to each other in the most literal sense. As yet the vocabulary that the computer understands is generally limited to Basic commands, but with careful programming, more can be added. That class exercise with a child playing the role of Fred becomes more important with every passing day.

Transducers

According to my Penguin Electronics Dictionary, a transducer is any device for changing energy in one wave-form to energy in another wave-form, taking 'wave' in its widest possible sense. Now wave-form energy at its lowest possible frequency is undiscernible movement. As frequency increases it goes on to visible movement, sound, heat, infra-red, visible light, ultra-violet, X-rays, radio and electricity. Therefore, a transducer is a device for changing any of these to any other — including any that I may have missed out. The transducers with which we are most concerned at the moment are those that effect changes to or from electricity, such as a microphone or loudspeaker. It would be a good idea to have older students write down as many transducers as they can think of in a given time — say 15 minutes. Table 3 is the result of my attempt at this exercise. It is of course by no means exhaustive and readers are invited to add to it.

The point to ponder is that the electrical side of any transducer can and probably will be connected to a micro or computer. Dwell on it for a while. Muse on it while waiting for a bus, or in the bath. Pick one or two at random and think of the possibilities, the implications and the problems. It can almost be guaranteed that no matter how way-out your ideas, someone will have thought of them before you and will be working to make them practical and commercial propositions.

Some combinations with the computer at first glance seem to be absurd. Connect an aerial to a computer? Whatever for? Yet for some years now the BBC have broadcast extremely accurate time information from their transmitter at Rugby. So, couple a micro to an aerial and your home computer has access to real-time information. Then there are the Viewdata systems — pages and pages of information receivable on any TV set with suitable modifications. Several manufacturers retail their home computers with an added board to receive Viewdata. These computers not only receive the news but are able to do something about it! Then in that home of popular computing — California — there is already at least one radio station dedicated to micros, transmitting information to be received and stored by home computers.

Look for the unusual. Television cameras are dirt cheap compared to what they were ten years ago, but the amateur has so far hardly used them at all. Even commercial and industrial users seem to confine their use to the reduction of pilfering. Yet even as I write, the Japanese are working on what is essentially a battery-powered TV camera in which the 'film' is a computer memory. Plug it into the TV when you get home.

SECRETS OF SYSTEMS ANALYSIS

PART 7: THE FIRST STAGE IN SPECIFYING A PROGRAM

Continued from page 67

sprocket holes and perforations. Many printers cannot deal with the type of multipart stationery that is commonly used in offices. Of course, you bore these limitations in mind when chosing your printer and discussed them with your stationer.

Typewriters have another useful facility which does not occur on a standard printer: the margin release. If you have an 80-column printer, you are stuck with 80 columns and cannot go any nearer to the edge of the page than that. There may well be a standard page length, too, so that you cannot go right to the top or bottom of the page. Your supplier will have the exact figures.

It is very helpful to the operator — and saves a lot of wasted paper — if you make sure that the programmer builds in a halt before starting on a bit of printing, or even prints a dummy line first, so that the paper alignment can be checked.

Next month

So far, I have tried to cover all those parts of the program specification that refer to what goes on outside the machine. If you can think of anything else that is going to be happening on your machine in terms of input or output, make sure that your programmer knows about it. In a large mainframe computer set-up, this would have to be done formally, but better results can be achieved in the micro situation by user and programmer chatting about them, but more of that anon. Next month I shall continue with those parts of the program specification that refer to things going on inside the machine — Processes and Files.

PATTERNS

Continued from page 123

I hope you will implement this generalised program on your own machine. It will probably be easier with program A, but either of mine or a new version of your own may be used. This will allow you to solve the following puzzle that I will leave with you till next month.

The largest number of moves needed to get from any square to any other on a 4 x 5 board is four. What is the smallest square board on which five moves are needed to get from any square to any other? And then the same problem for six moves, and for as many more cases as you and your computer care to run.

Next month I shall be writing about a game that is a cross between chess and battleships. Each player moves a Queen (or other chess piece) round a board that the other player cannot see, trying to land on or at least pass through the square that the opponent's piece is on. Without further information that would be blind man's buff. But you are told where the other player was before the last move, as well as when a hit or a pass has been made. Try it.

MICRO MUSIC MAKING

Continued from page 89

mind and the eyes rebel after a while. Nascom's mode of entering maching code, where you can just enter one byte after another without having to step the cursor in eight places for each new line, is much easier.

The start of the toccata is a fast, rising octave scale in D major. With an instrument such as a harpsichord, the decay of each note continues after the next one has been struck, so I arranged to 'strike' each of the first four notes using voices one to four in mode one in turn, sustaining the ones that had been sounded. I had to come back to voice one after this and repeat the technique, but the effect of sustaining over four notes was quite pleasing. I used mode two to get a louder note at the bar line, and mode three to get a still louder effect for the next section, again with good effect.

I have not been able to try out as many things as I would like, owing to editorial deadlines, but have done enough to convince myself that the MTU software provides a very powerful and versatile system, marred slightly by noise and limited frequency range in the sound, and by the complexity of writing a musical score in hex code. I look forward to the human interface which will overcome the last. Musicians would, of course, prefer to use a conventional piano keyboard for entry, but this would add considerably to the cost. And, a practical point, couldn't the booklet be decently bound with a spiral, instead of being stapled at one corner and punched with three holes for which you can't get an American ring binder?

Acknowledgements to the City University Microprocessor Laboratory, for the loan of a PET 3032.

TAKING THE LID OFF UNIX

Continued from page 63

but we have tried to look at Unix from the points of view of several sorts of users. At system programmer level the Unix system is wide-open, having been written in C and having commands and system calls which make accessible most of the system information and operations. This provides a particularly hospitable working environment for system programmers and, in consequence, it is probably within this group that Unix finds its most ardent admirers.

For the applications programmer, Unix provides a flexible and efficient interface to its development tools although the commands are a bit curt for many tastes. On a busy system where many users are making demands on the system resources (although not necessarily simultaneously) some sort of housekeeping routines, as well as good accounting and rationing procedures, would have to be developed. On an educational system where new programmers are being introduced to programming and don't need to be confused by having to learn the operating system as well, a subset of the commands with some more obvious names would probably be an advantage. However, as the students gained familiarity with the system, Unix may become vulnerable to the 'malicious junkie' syndrome sooner than other, more restricitve operating systems might. Finally, for the commercial systems developer, Unix affords a straightforward mechanism for implementing a reliable, multi-user turnkey system.

BLUDNERS

Last month's 'Greenfingers' program has been causing consternation among PET aficionados. Rumour has it that POKEing 59458 causes an internal conflict in PET resulting (sometimes) in chip damage. We spoke to the program's writer who tells us that he uses it without problems. He also tells us that Commodore used to market the program on his behalf. You have been warned.

Sheridan Williams mentioned that to convert from an old ROM to new ROM involves the substitution of a single chip. In fact, depending on your precise model, four or seven chips are involved. Hence the price of £38 plus VAT.

Last month we announced the winners of a 'Printer Survey' — it should, of course, have been Reader Survey.

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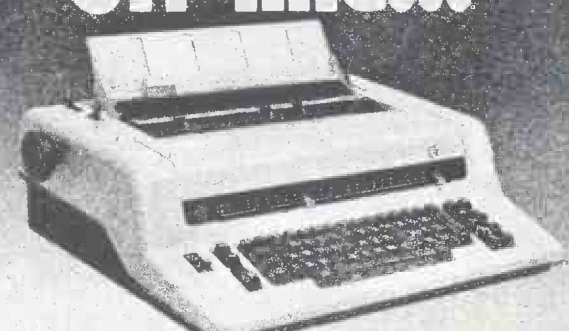

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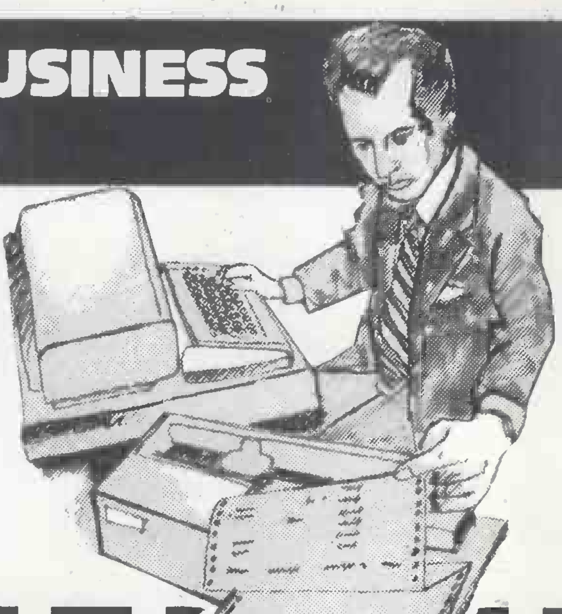

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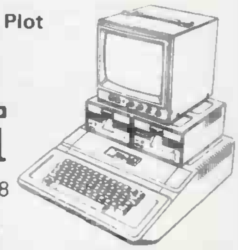

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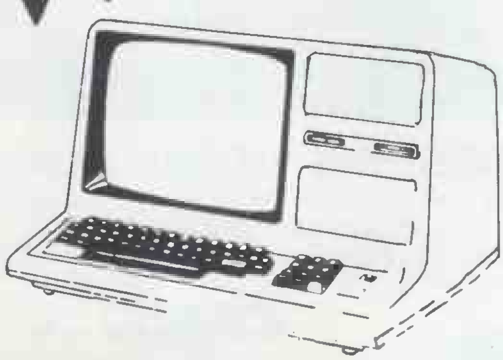

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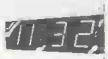

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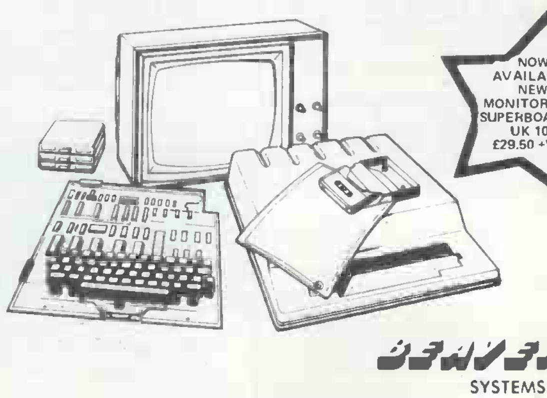

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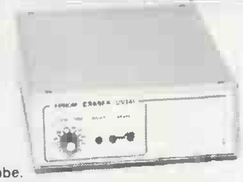

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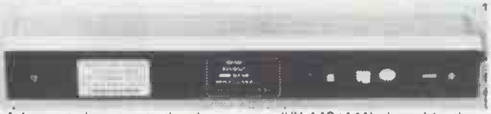

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4027	50p	4071	25p	40192	£2.41	4514	£2.65	4572	40p
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4029	99p	4073	25p	40194	£3.27	4516	£1.10	4581	£2.62
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4039	£2.78	4089	£2.91	4194	£1.16	4528	£1.20		
4040	£1.00	4093	80p	4408	£9.37	4529	£1.30		
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74C

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74C08	28p	74C93	89p	74C192	£1.15	74C909	£1.69		
74C10	28p	74C95	£1.08	74C193	£1.15	74C910	£7.45	80C95	85p
74C14	90p	74C107	£1.27	74C195	£1.08	74C911	£7.39	80C96	92p
74C20	28p	74C150	£3.81	74C200	£7.46	74C912	£7.39	80C97	85p
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74LS02	16p	74LS74	41p	74LS155	96p	74LS248	£1.90	74LS378	£1.84
74LS03	16p	74LS75	48p	74LS156	96p	74LS249	£1.90	74LS379	£2.15
74LS04	16p	74LS76	48p	74LS157	76p	74LS251	£1.34	74LS384	86p
74LS05	20p	74LS78	40p	74LS158	96p	74LS253	£1.46	74LS386	86p
74LS08	22p	74LS83	£1.15	74LS160	£1.28	74LS257	£1.10	74L'390	£2.30
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FLOPPY DISK CONTROLLER BOARD

This is used in conjunction with 'Kemitron' Z80 boards to interface to twin single density S/S 8" floppy disks. It is not available as a bare board, but only built and tested. Regrettably Kemitron do not supply circuit diagram £165.00

To run CP/M on the system a serial interface (e.g. S10 board) to some sort of VDU or terminal is required and 48K of RAM (e.g. three MXD-2 boards). The MZB-3 board has facilities for 'power on jump' and a 'boot prom' to load the CP/M operating system from the disk

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This is an assembled P.C.B. size 130 x 190mm, which you add to your own 12"/14" black and white C.R.T. (90 degree, 20mm dia. neck), to obtain a T.V. monitor at modest cost. (Regrettably we cannot supply the C.R.T. at present.)

Preset controls, contrast, brightness, etc., are included, and the only inputs needed are 15 Volts ± 10% AC at 1.5 Amps and 1 Volt pk-pk composite video input
Supplied with circuit diagram £33.50

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This is about the same price as for example the Nascom Imp, but has many features only previously found in models costing hundreds of pounds more:
Standard interfaces (not 'extras') RS-232, 20mA, IEE 488, Centronics I/O, 15 baud rates to 9600, 100 characters per second, 64, 72, 80, 96, 120 or 132 characters per line, rear, bottom or front paper loading, friction or tractor feed, can accept user defined characters, can also print graphics under program control, has 'self-test' facility. Supplied with mains cable and full operator's manual.
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6522	£6.96
6532	£8.26

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Z80A-PIO	£6.76
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(Add £1 for the 4MHz version of any of the above 3 chips.)

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SC/MP II (4MHz)	£10
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(Descriptive leaflet available on above. Ref SW4, 5)

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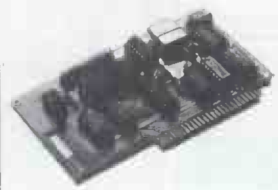

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VIDEO GENIE PROGRAM

At last, a program for the Video Genie owner, which not only explains the many things not covered by the instruction manuals but also shatters those many 'trade secrets', showing what to do to allow you to use the Genie to its full potential:

Speeding up — which tells you how to speed up your Basic programs and at the same time save space. Machine language — explains what you need to get into machine language and its benefits. Abbreviations — a list of all the 'shorthand' you can use on the Genie which is not shown in the manual. Memory size — obvious to the Tandy user, but not so to the Genie owner, this explains it all. InkeyS — is just not explained in the manual, yet a very useful command as you will find out. Programs — tells you exactly why some TRS-80 programs are just not compatible.

Then comes the information concerning the hardware of the Genie:

Loading problems — the bugbear of all the micros. This will help considerably. Second Cassette — gives details of exactly what you can do with it to your advantage. Getting sound — easily, without the need of a sound box either. Converting television — get rid of the wobbles, use it as a monitor instead. Screen adjustment — no more losing either the top or the bottom line. Gain adjustment — will sort out the loading difficulties for once and for all. Azimuth adjustment — will show you how to check, and even adjust, the azimuth of your tape head. Modifications — explains all the mods which can be undertaken. Peripherals — and what you can hang on to the Genie. Dismantling — diminishes the fear of getting inside, which is very easy indeed. And finally, there's an adjustment program included.

Written by a qualified engineer and authorised Genie dealer, this program really does explain everything. No Genie owner should be without it.

It's from Kansas—and only from Kansas—

which means it's good and at a sensible price £9.50.

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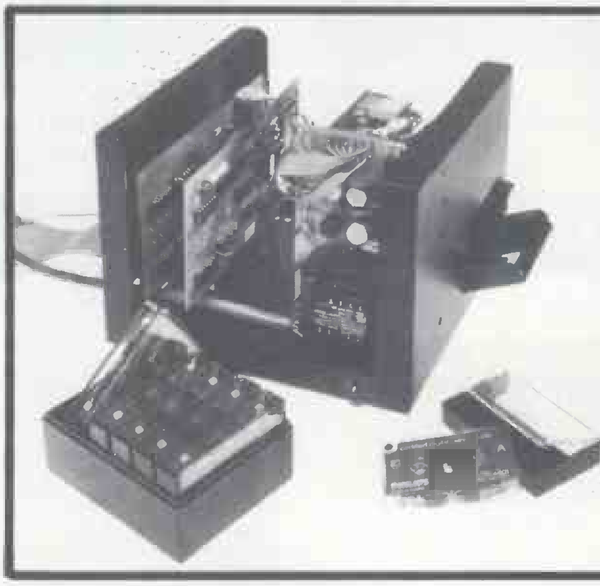

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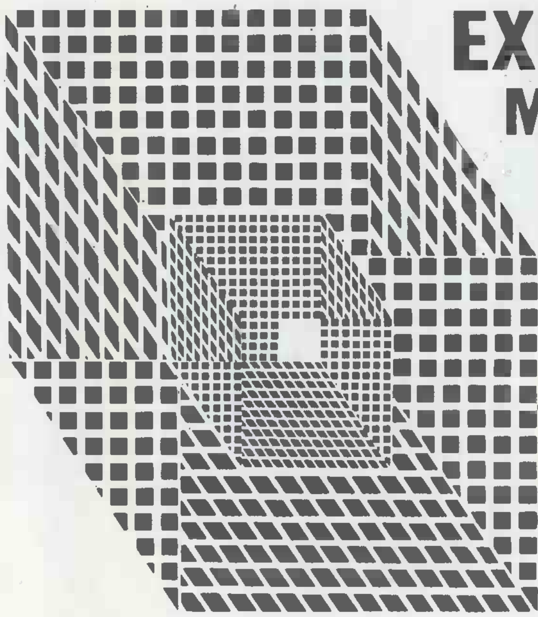

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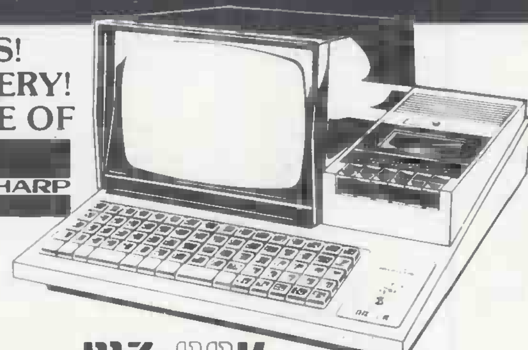

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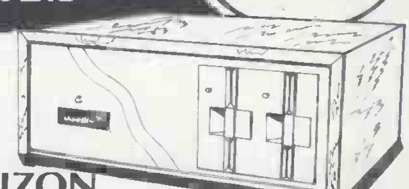

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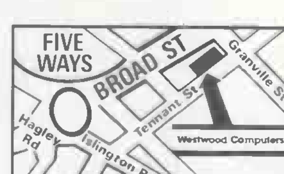

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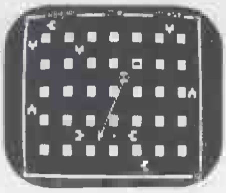

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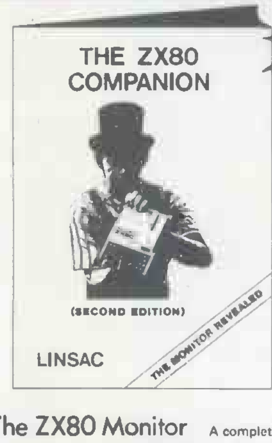

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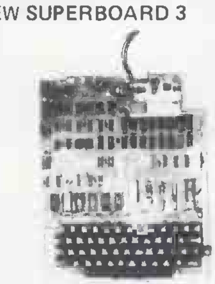
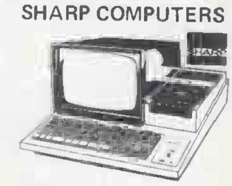


The special offer of the century (only Swanley could do it!):- For just £159 we will supply Superboard 3 witn a free power supply and modulator kit and our free quard bank kit (A brilliant break through in itself for this kit extends the display to 32 x 32, allows 1200 as well as 300 Baud tape speeds, increases the computing speed by 50% and coverts the display to 50Hz for flicker free viewing). 4K extra ram £16.95. Case £27. Cassette recorder £16. Cegmon improved monitor £29.50. Assembler/Editor £25. Word processor £10. Guard band kit also supplied separately £10. 30 lines x 54 character display expansion kit for Superboard 2 (not 3) £20.

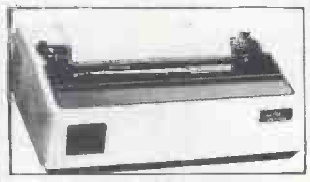
Cheapo memory expansion offer:- Buy a 610 expansion board with 8K ram on board and space for another 16K for £159 and get a free 5V 4A power kit and any extra ram you want for £3k. Buy a minifloppy + case + power supply + 2 copies of DOS for £275 and we will do the extra ram for £2/K (Max 16K).

SHARP COMPUTERS



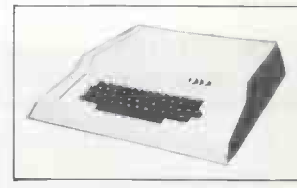
Sharp MZ80K Computer with Basic tape and a free tape of approx 50 programs:- 20K version £415, 35K £437, 48K £459. MZ80 I/O £83. MZ80P3 £499. MZ80FD £772. PC1211 £83. CE121 £12.

PRINTERS



Buy any of the below and get a free interface kit and word porcessor program for UK101 or Superboard 2:- OKI Microline 80 (Illustrated) £349. Base 2 800 MST £299. Seikosha GP80 £250.

THE NEW OHIO SERIES 2 CHALLENGER C1P



Cheap, beautiful and powerful! Suddenly Ohio sales have gone through the roof and everybode is screaming for the new Challenger. Program selectable 24 x 24 or 12 x 48 displays. Sound, music and voice output. 8K ram expandable to 32K. 8K basic. Cheapo version (Made in Swanleyland) £219. Official version (Illustrated) £259.

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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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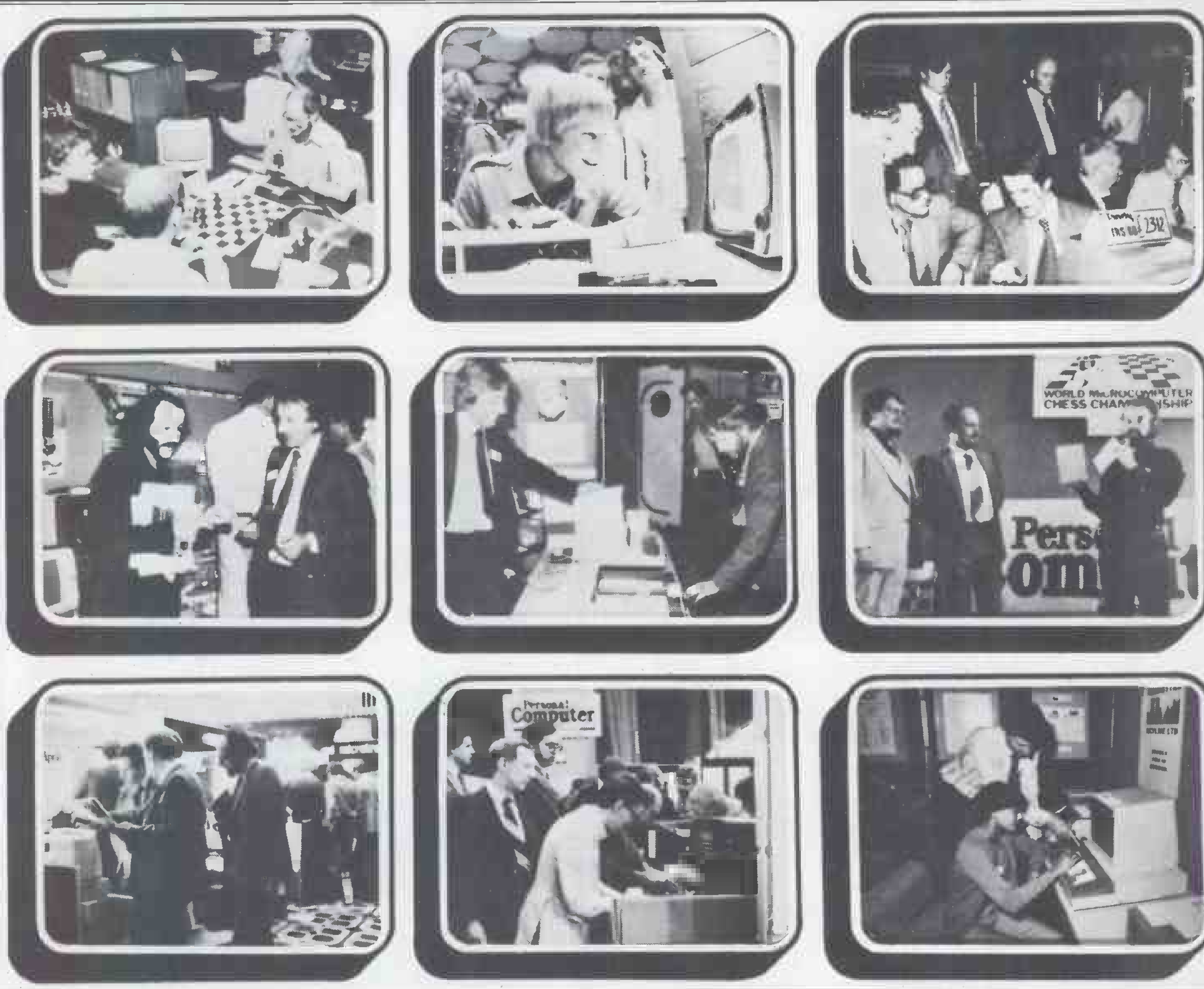
The 4th Personal Computer World Show

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

The Job is a police magazine and guess who appeared in it recently? — Rupert Allason, brother of 'Squire' Julian, no less. It seems that while on holiday in the Bahamas, he hired a glass-bottomed boat and hurtled off to 400-yard long Stocking Island for a sunbathe. Imagine his amazement then when an aeroplane decided to crash there. The two very dazed occupants run for the ferry which was just leaving, shouting to Rupert, 'The plane's yours, you can keep it.' Rupert, suspecting a crime, went to investigate what appeared to be hay bales but which turned out to be bales of marijuana. Rupert whizzed off in the glass-bottomed boat, managing to head off the ferry, and on arrival back to Stocking Island he whipped out his police warrant and arrested the criminals for illegal entry to the Bahamas. Back on patrol as a 'special' he was looking forward to a return visit as a witness in the court case when he heard a rumour that the evidence had disappeared, 'just as if it had gone up in smoke,' one Bahamian is rumoured to have said. . . Latest gleeful discovery of software vendors is that their business is akin to running a bordello — you sell it and you've still got it. Nigel Coster of London Computer Centre asked us not to mention his name as the source of this epigram, by the way. . . Rumour has it that PET buyers are in the very best of company (kneel, kneel, curtsey, curtsey) — Buckingham Palace bought one from Ron and Derek Bailey of Birmingham's Camden Electronics. . . Remember our January cover? — it was the one with the salesman and the customer on it. A lot of people rang to ask which article it referred to — and we thought the word 'Secrets' was a dead give-away. . . Another person who rang to complain was the artist, Colin Hadley. You may have noticed that the 'bar code' on the cover actually gave Colin's name and, even worse, his phone number. Imagine how he felt early on Boxing day morning when some nerd rang to say, 'I've cracked the code — do I win a prize?'!!! . . . Computer Genius Leads Britain's Brains.' So ran a press release from British Mensa, announcing the appointment of its new chairman — none other than Clive Sinclair. . . While on the subject, 'Uncle' Clive was seen recently at the Consumer Electronics Show in Las Vegas. Well seen *at* the show isn't quite true, he was more often lying on the grass outside the Hilton Rotunda. Since Las Vegas is in the desert, the grass has to be kept permanently watered so we presume that a at the end of each day's sunbathing there was a Clive-shaped patch of desert in the middle of the lawn. . . We must have had printer surveys on the brain last month — we even announced winners for one!! It should have read *Reader* Survey. Our apologies to the 26 readers who thought they'd turned into printers. . . We suspect (but can't prove it) that Malcolm Peltu is really Milton Friedman in disguise. See the cover of the new *Free to Choose* paperback and then look at Malcolm. . . A certain magazine which we lovingly call *Toady* is about to launch a low-'Budgett' version of Chip Chat. Or so we hear. . .

If you've got a PET and you've POKEd 59458, then turn immediately to Bludners. . . Finally, this is your *last chance* to take advantage of our West Coast Faire offer on page 46. Whether you're a dealer or just plain interested, this is the only exclusively micro show in the USA. Covering two floors it's got everything on display, from stands you couldn't swing a cat in, displaying new products which may one day become big, to enormous stands put up by the microcomputing 'establishment'. Being in San Francisco, it's well placed at the top end of 'Silicon Valley for visits to manufacturers and software houses. If you don't fancy that, San Francisco ain't too bad, either.

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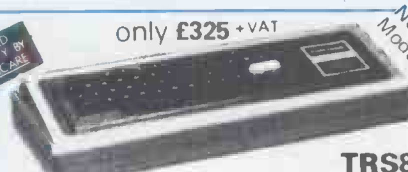

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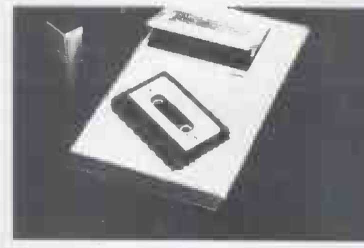

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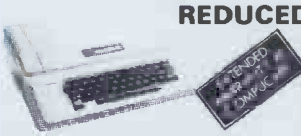

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