Practical Computing

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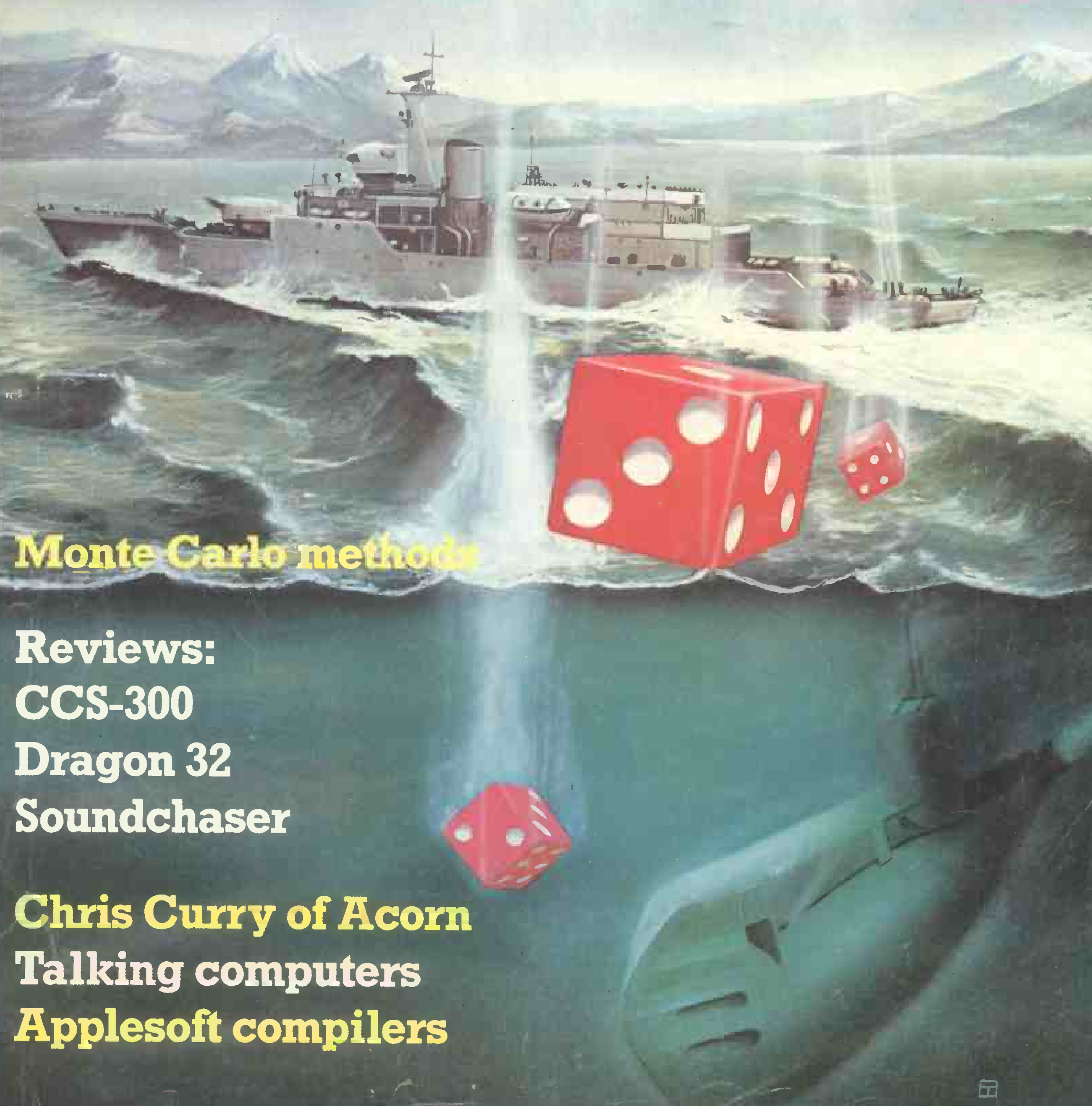
October 1982

Volume 5 Issue 10



Monte Carlo methods

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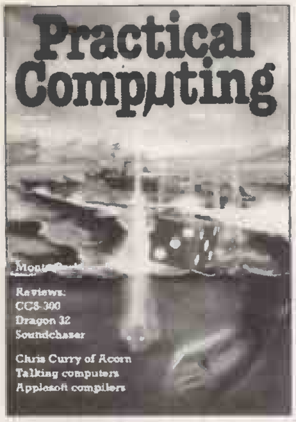

Monte Carlo methods — page 78

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8257A	500
8259	395
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8284	350
8T26A	99
8T27	150
8T28A	120
8T31	350
8T95N	90
8T97N	90
9364AP	550
9602	220
AM26LS31C	125
AM26LS32A	125
AY-3-1015	300
AY-5-1013	300
AY-5-1350	388
AY-5-2376	600
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FD1791	£22
FD1793	£23
FD1795	£28
FD1797	£28
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ZN419CE	190
ZN423E	138
ZN424E	130
ZN425E-8	345
ZN426E-8	300
ZN427E-8	590
ZN428E	410
ZN429E-8	210
ZN459	570
ZN1034E	200
ZN1040E	675
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8205	00
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TMS9928	£30
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Z80A DMA	98

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74S02	32
74S03	32
74S10	40
74S20	40
74S32	70
74S74	75
74S132	110
74S133	60
74S138	125
74S139	150
74S158	195
74S188	210
74S189	158
74S194	320
74S201	350
74S225	525
74S241	390
74S260	50
74S262	850
74S287	300
74S288	210
74S289	290
74S301	000
74S365	000
74S3745	365
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74S475	825
74S571	620
74S08	40
74S27	40
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74S240	390
74S112	90
74S155	39

75 Series

75107/8	95
75110	90
75150	125
75154	125
75182/3	99
75188/9	55
75322	140
75450	86
75451/2	52
75454	70
75491/2	65

TTL74

7400	11
7402	11
7404	13
7410	14
7411	15
7423	18
7414	20
7420	15
7422	20
7427	22
7430	14
7442	32
7447	40
7448	40

7473	24
7474	20
7475	32
7485	60
7486	20
7489	205
7490	20
7491	35
7492	25
7493	25
74100	80
74116	50
74121	25
74125	35
74126	35
74143	210
74148	70
74150	50
74151	40
74153	40
74154	55
74186	470
74188	250
74383	99

74 LS

LS00	11
LS02	11
LS04	12
LS08	12
LS10	13
LS11	13
LS13	20
LS14	30
LS19	58
LS20	13
LS22	12
LS27	12
LS32	13
LS30	12
LS42	28
LS47	35
LS48	55
LS63	120
LS73	18
LS74	18
LS75	20
LS85	48
LS86	16
LS90	24
LS91	60
LS92	32
LS93	23
LS125	24
LS126	25
LS138	28
LS139	28
LS148	85
LS151	40
LS153	40
LS156	36
LS157	30
LS158	30
LS175	50
LS240	55
LS241	55
LS242	55
LS243	55
LS244	60
LS245	70
LS373	60
LS374	55
LS393	42
LS471	629
LS640	180
LS641	180
LS645	180
LS668	125
LS669	120
LS670	150
LS673	550

CMOS

4000	10
4001	10
4002	12
4007	14
4008	32
4009	24
4010	24
4011	10
4012	16
4013	20
4016	20
4017	32
4018	45
4022	40
4023	13
4024	32
4025	13
4026	80
4027	20
4028	39
4029	45
4030	15
4040	40
4041	40
4042	44
4043	40
4044	40
4049	25
4050	25
4051	45
4052	60
4053	50
4060	45
4066	24
4068	14

4069	13
4071	13
4072	13
4075	13
4076	50
4076	50
4077	13
4078	15
4081	13
4082	13
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4094	70
4095	95
4096	70
4097	190
4098	75
4099	75
4160	95

4161	99
4162	99
4163	99
4174	99
4175	105
4411	690
4412	790
4502	60
4503	35
4511	46
4519	30
4533	90
4549	375
4572	36
4583	99
4584	48
4585	99
4597	330

4598	290
4599	290
40100	215
40104	95
40105	115
40106	75
40107	60
40108	450
40109	100
40110	300
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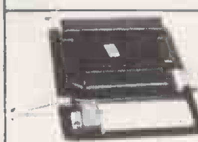

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7 68MHz	200
8 0MHz	150
9 0MHz	200
9 375M	350
10 0MHz	175
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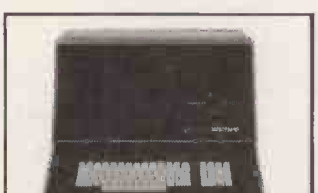
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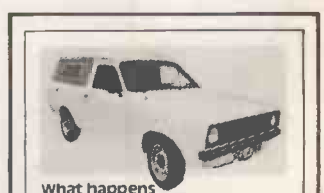

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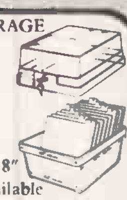

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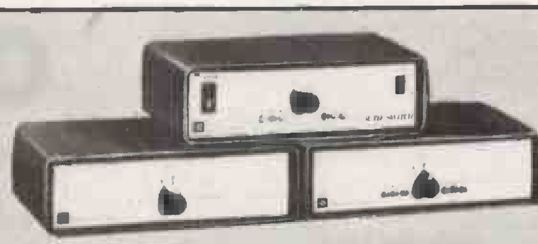

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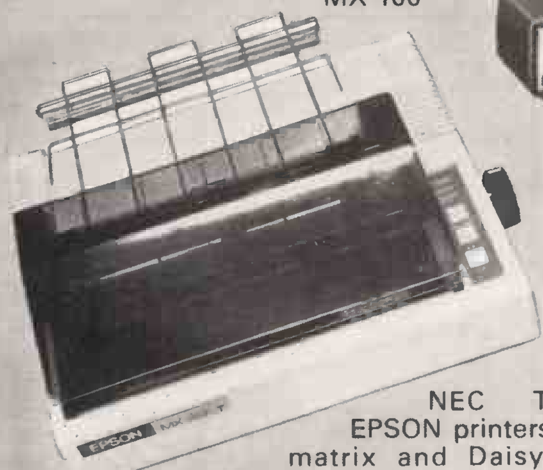

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Six quality products to help you make the most of your Apple

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Copy II Plus gives you the power to make back-up copies of most of the "protected" software packages currently available.

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With Copy II Plus you can protect your valuable software investment. Make back-up copies of Visicalc, DB Master, the Apple Special Delivery range, and many more; keep your originals safely locked away from the wear and tear of everyday use.

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While some software companies offer replacement of expensive damaged diskettes, many do not. With Copy II Plus you eliminate the time, expense, and worry of costly accidental damage to your valuable software.

£50

THE FILER
a new Apple Disk Utility

SAVE TIME
Fed up wasting valuable time waiting for disks to copy? With the FILER's fast and accurate copy program you can make completely reliable back-up copies of your disks in 35 seconds. The FILER is ideal for backing-up your data disks, and for copying all unprotected disks.

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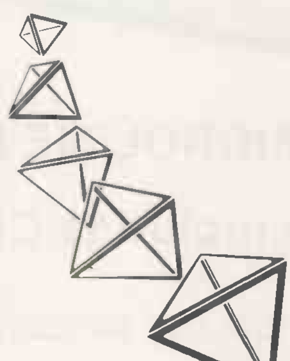
GraFORTH
The Apple Graphics Language



The Apple Graphics language from insoft – specially created to get the most out of the graphics capabilities of your Apple.

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For £89.95 you receive your Jupiter Ace, a mains adaptor, all the leads needed to connect to most cassette recorders and T.V.s (colour or black and white), a software catalogue and a manual.

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The price includes postage packing and V.A.T.

Key Features

- Revolutionary microcomputer language FORTH.
- Full-size moving-key keyboard.
- User-defined high-resolution graphics.
- Programmable sound generator.
- Floating point arithmetic.
- Fast cassette interface.
- Upper and lower case ascii character set.
- 24 x 32 character flicker-free display.

The Jupiter Ace uses FORTH

The Ace is set apart from all other personal computers on the market by its use of a revolutionary language called 'FORTH'. Some computer languages are easy for humans to understand, others are easy for computers; FORTH is most unusual in being both. Its underlying principles are so simple that it takes even a newcomer to computers only a few minutes to learn how to do calculations on the Ace, yet the very same principles are powerful enough to allow you to invent your own extensions to the language itself.

At the same time, the memory-saving coded form used to store your programs inside the Ace allows it to obey them very fast — typically in less than a tenth of the time it would take to do the same thing using a different language. Amongst other things, this makes the Ace ideal for games.

FORTH's unique combination of speed, versatility and ease of programming has already made it a prime choice for professional applications as diverse as pub games and radio telescopes, and gained it an enthusiastic national user group. Now the Jupiter Ace can bring this addictive language into your own home.

Designed by Jupiter Cantab

Leading computer Designers Richard Altwasser and Steven Vickers have a reputation for pushing technology forwards. After playing the major role in creating the ZX Spectrum they formed Jupiter Cantab to develop their latest brainchild the Jupiter Ace.

Technical Specification

Hardware

Processor/Memory
Z80A running at 3.25 MHz. 8K bytes ROM 3K bytes RAM.

Input
40 moving-key keyboard with auto-repeat on every key.

Output
Memory-mapped 32 x 24 character display with high resolution user graphics. Output to drive normal UHF TV set on channel 36.

Sound
Provided by internal loudspeaker.

Cassette
Load Save & Verify at 1500 baud, separate data storage.

Software, FORTH

Data Structures
Integer, Floating point and String data may be held as constants, variables or arrays with multiple dimensions and mixed data types.

Control Stuctures
IF-THEN-ELSE, DO-LOOP, BEGIN-WHILE-REPEAT, BEGIN-UNTIL, all may be mixed and nested to any depth.

Operators
Mathematical +, —, X, ÷.
Logical AND, OR, NOT, XOR.
Comparison <, >, =.

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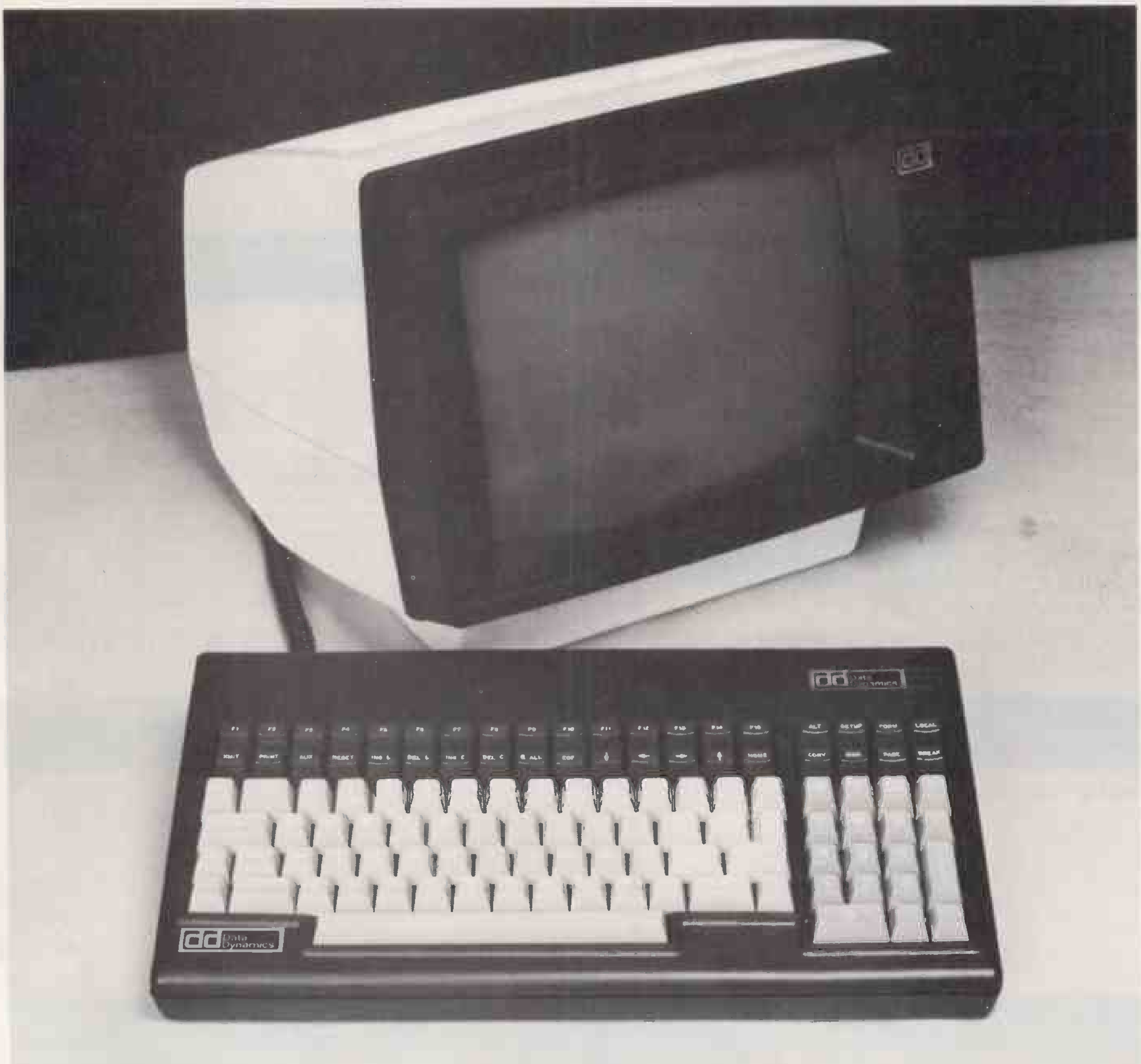

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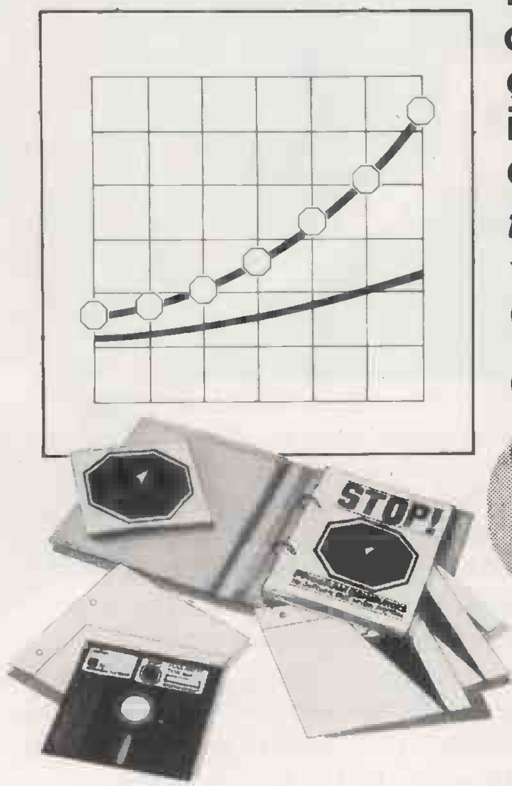

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Which Computer? Magazine

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- **Nationwide dealer network**
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SUPERBRAIN is ideal for both first time buyers needing a general purpose machine, and for users wishing to upgrade from a personal microcomputer system. Its CP/M operating system will handle the most sophisticated programs. Twin Z80 microprocessors and an RS232 communications port make it easy to extend the system in the future.

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★★ SOME POSSIBILITIES ★★

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Once you have designed your file, your report, and stored your records you will be able to 'clone copy' from the master database disk, a task disk whose life purpose will be to produce specific reports without your user-interaction. The task you have specified, begins itself at precisely the moment you have inserted the diskettes in their drives, and closed the doors; you don't have to touch a key or select from a menue.

Imagine building a small library of such 'task' disks from suggestions outlined here, or others you may have around you.

Nominal analysis, stock re-order reporting, stock valuation, sale — analysis, purchase analysis, address mailing, text writing, employees analysis, patient analysis, research analysis, simulations, bureaux personnel analysis, time recording, librarian analysis, budgetting, to name a few.

Here's an arbitrary example to indicate the power of DBMS III.

You have set up a filing system of 20,000 records concerning employees and wish to short-list those who meet certain criteria, then write to them. The records in the file have fifteen fields that look like this.

1 — Record	(33)
2 — Name	(John Smith [Sir])
3 — Addr	(55 Bedford Crt. London)
4 — Age	(40)
5 — Sex	(M)
6 — C.V.	(5 — O levels, 6 — A levels)
7 — Exp	(3 yrs)
8 — Sal	(12,000)
9 — Locn	(London/South)
10 — Type	(Computer analyist)
11 — Sport	(Tennis/golf/riding)
12 — Langu	(English/French/German)
13 — Pr/emp	(Local government)
14 — Status	(married/2 children)
15 — Code [c]	(classified information)

Just one of a thousand selection criteria might take the form:

"Find all persons that are not Esq, who live in London or Surrey or Croydon, in the age range of 30-45 Male, with 6 — A levels, experience less than 5 yrs, prepared for work in London or the South, at computer analysis, whose interests are golf or tennis, speaks German or French, has worked in Local government and is married. Finally matches our own classified code [grade 5]."

Output the short list to a second file for a mail shot.

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CP/M versus Unix

WHENEVER TWO OR THREE micro persons are gathered together, sooner or later the dread question comes up: "Will it be CP/M or Unix?" What "it" might be is never precisely specified, but one supposes it embraces questions like who becomes rich and who goes bust and the meaning of life, the universe, "42" and everything.

As with all interesting questions, there is no real answer. However one can draw up some sort of list of arguments on one side or another. Argument 1 says: Does it matter either way? The difference between microcomputing and big computing is that the customers vote with their wallets for what they want. Ultimately, the winning operating system will be the operating system they buy.

In the micro world, the single most important function of an operating system is to smooth out the differences between otherwise incompatible brands of hardware, so that applications programs will run satisfactorily on them all. The end-users have nothing to do with this process except give thanks, if they are aware of it, when it works and to curse when it does not. Even the applications programmers are unlikely to penetrate to this level because as soon as they do they render their programs machine dependent.

From the customers' point of view it is of no importance at all whether programs and machine run CP/M or Unix so long as the two actually work together. If they have an opinion at all, it would be that CP/M, having been longer adapted to micros and the applications programs they run, might be slightly the better bet because more bugs will have been ironed out. Experience tells us that only time can give some protection against the "My God, why did it do that?" syndrome.

The second function of the operating system is to give the user direct control over files, printers, VDUs, etc. You can copy files, print them out, make the tape reader print to the screen and other delights of this nature. But no applications programmer is going to let the punters get to grips with this stuff, or even assume that they can make head or tail of it. They will be given what is, in effect, a tailored operating system for each applications package that loads the right programs, copies files, sets up printers and all the rest without expecting the least flicker of computer literacy from the user.

From this point of view too it will be of no significance at all whether CP/M or Unix lies beneath the fully interactive, user-sycophantic, parameter-driven marvels of the programmer's trade, because the end-user will never — we hope — be allowed to set eyes on it. So, if the end-user, who is actually paying for it all, does not care which operating system is being used, the decision devolves on the people who sell the kit in the first place.

What arguments might affect them? At the present state of the game, they do not care much what they sell so long as the cheque comes to rest without ricochets. If the customers want CP/M, then CP/M is the thing; if they want Unix, then nothing else is worth consideration. Unfortunately the customers' main interest is in buying a computer with software to solve whatever business problem they can be persuaded they are suffering from. Whichever mix of hardware, software and operating system will do the trick is what will sell, and from this point of view the dealer ought to prefer CP/M just because there is a greater chance of finding something there that will keep the punter quiet.

Proponents of Unix will say that, on the contrary, there is much more and better applications software to run under Unix because it has been around so long on real computers. The snag there is that software for real computers is written to be used by real programmers. Most of it is pretty tough stuff. Very little micro software is truly user-friendly but in comparison with its big-computer counterpart it is as a kitten to a mature and fractious puma.

A more cogent argument says that most of the effort of selling micros to new customers goes in shifting the first machine each customer buys. Repeat orders are easier, and it follows that dealers will prefer to go on selling what their customers have bought already just because it is less trouble. As between CP/M and Unix, this must favour CP/M.

Are there any arguments to be advanced on the merits of the two systems? Since the end-users are unlikely ever to be allowed to see either operating system, we cannot ask them to decide. It must be the applications programmers: Do Unix or CP/M give them the better facilities? In many cases they will organise their menus, file copying, etc. through the high-level language, so they will not care either. Someone who uses direct operating-system facilities might prefer Unix's flexibility, but even here you are only dealing with a front end tacked on to the real operating system. With a little bit of thought CP/M can be made to do very similar things, and indeed a package has already appeared to make it emulate Unix. And conversely, at least one 68000 machine running Unix, the Wicat, has a CP/M emulator.

Like all good theological questions this one too resolves itself into a debate about angels and pins. And anyway, as Adam Osborne recently said, "You don't have to be best. You don't even have to be good. You just have to be first."

Some spiteful words in the August editorial seem to have been undeserved. We were chiding the DoI's revised software-support scheme for favouring the big, established software houses and doing nothing for the small micro people. With the speed of a postman's feet, NCC Director David Fairbairn writes to say that all is not yet lost. Our cry has been heard, and the help which cometh from afar is even yet in the pipeline:

> I read with interest your editorial on the micro industry. I am sure, however, that you will wish to correct the statements that were made in your final paragraphs about support for micro software under the Software Products Scheme. I believe that you will be more than happy to do so given the part that you have played in changing the policy.
>
> You made the case in an editorial a year ago for the right level of support for the micro software industry. The case that you made was echoed elsewhere and given particular attention by the Department of Industry and the NCC. In consequence the substantially enlarged Software Products Scheme announced by the Minister earlier this year reflects the requirement for change.
>
> Although the requirements for substantial software calling for high levels of support and directed at the mainframe industry have not been changed, in the new provisions the rather different requirements of the micro industry are fully acknowledged. Companies looking for a 33⅓ percent grant towards the development of software where the grant sought is around £10,000 or less are not now required to meet these financial requirements.
>
> The assessment will be undertaken strictly on marketing and technical grounds with the only financial requirement being that the proposer must show evidence of ability to meet the financial burden placed by his 66⅔ percent share of the development and marketing cost. There are now proposals in the pipeline of this nature and we are actively seeking proposals for micro software which may be made by the newer and smaller organisations.
>
> Finally, it is a specific requirement of the scheme that no limitations are placed upon the membership status of those submitting proposals. We have always given exactly the same treatment to proposals from non-NCC and non-CSA members as has been accorded to those who belong to either or both of these organisations, and that policy will continue.

Our Feedback columns offer readers the opportunity of bringing their computing experience and problems to the attention of others, as well as to seek our advice or to make suggestions, which we are always happy to receive. Make sure you use Feedback—it is your chance to keep in touch.

A Spectrum for Xmas

"BOOK NOW FOR XMAS" might well be a more realistic phrase than "allow up to 28 days", for those considering purchasing the Sinclair Spectrum.

As a customer who sent off an order, first class, in mid-May and who has been informed quite calmly by Sinclair staff that he might, just might, realistically receive his Spectrum no less than 14 weeks later, I feel that prospective customers should know what they are letting themselves in for. Not only is a long delay likely, but also the receipt of letters saying that all is well. "You will receive your Spectrum within two weeks" is anything other than "consoling". I have received two such letters, one over six weeks ago and another over three weeks ago, but alas no Spectrum.

Surely Clive Sinclair would not end up following the BBC Micro down its troubled road, after all his bitter criticism of it — or would he? With capital-intensive projects in the pipeline and orders rumoured to be running at 1,000 per day, you could be forgiven for thinking that he had realised the entrepreneur's dream of massive interest-free finance.

So if you are after a Spectrum, I am sure it would look nice in your Xmas stocking.

P S White,
Slough,
Berkshire.

False claim

ON PAGE 63 of the July issue Clive Sinclair is quoted at great length while he roundly condemns people who advertise products which they cannot deliver, and who prematurely announce machines which he will have overtaken by the time they are produced.

I ordered my Spectrum just three days after I got the first glossy brochure sent through the post to "established" Sinclair customers. That was in April or May. Nearly three months later I am still waiting. This is despite a letter in June from Sinclair Research promising it in two weeks.

D Simpson,
Rochdale.

In Spectrum's defence

ON READING the review of the new Sinclair Spectrum in *Practical Computing*, July 1982, I was appalled by the biased views expressed in the article.

I have now had a Spectrum for a few weeks, and while on first trying to use the Spectrum keyboard I was frustrated by not knowing where the keywords are and by not being able to type out the keywords, after a short while I was able to enter programs into the Spectrum far more easily and at least as quickly as on a conventional keyboard.

What seems irksome to your reviewer is that the keyboard is not traditional and its layout is unfamiliar to him. In my experience I have yet to find two different makes of terminal with all the keys in the same places not to mention the different combinations for various system control functions.

Why he should find the rubber matt keyboard "aesthetically displeasing" is a mystery to me. It is a very elegant design solution. As for the number of key presses to enter particular keywords your reviewer was not being objective. I write my programs to be readable and hence each keyword has at least one space next to it. Take the case of the infrequently used ATN; this involves four keystrokes, while the same entry on the Spectrum only requires three keystrokes. The shifted keywords are, in the main, the less frequently used words and the single-key entry of the other words more than makes up for the odd occasion when I spend time looking for an unfamiliar keyword.

Wang computers would probably take exception to the statement that "While Sinclair retains single-key entry on his microcomputers they will never be serious tools".

If Caps Shift is pressed firmly, not necessarily heavily then no trouble is experienced on using delete. Beep, while not very flexible and suffering from asymmetry of waveform in the higher frequencies, is rational in its range of frequencies ranging from just over 50Hz to just under 15kHz — well within the range of normal hearing. The internal speaker will not produce the extremes of frequence but routeing the sound through headphones or hi-fi solves this.

While the speed of the Spectrum certainly will not dazzle, I was surprised to find it was as quick overall as the Transam Tuscan but only 63 percent as quick as a Vic-20 and 85 percent as quick as a UK101, 1MHz.

The extra lines on the edge connector at the rear are for video, colours and extra voltage levels, all of which are given in the handbook. The handbook itself is a model of clarity.

The only niggles so far are:

- New and Clear are available at only two key presses; for safety they ought to be on at least one shift level.
- There is no Renumber routine and while line numbers can be edited this takes time.
- The full stop is Symbol-Shift-M.
- Using Draw Over 1;x,y to draw a line and then moving the plot position back to the start of the line and using Draw Over 1;x,y to erase it still leaves the first pixel.
- There are about half a dozen minor obvious printing errors in the section on drawing.
- There are address errors in the given program to Peek the bytes for the program variable and program itself. Actually the addresses given are those for the ZX-81.
- (−X) ↑ Y gives invalid-argument error messages even when Y≥ 1 and it is necessary to use (ABS−X) ↑ Y

These aside, I am pleased with the machine and am eagerly looking forward to the availability of the Microdrives.

D L Buckley,
London W3.

Essential instruction

THE FIGHTER program, BBC Bytes, August 1982, will not run, since an essential instruction was omitted. Before loading press Break and type

PAGE=&DOO

Without this, the model A machine will not have sufficient room to run the program.

Brian Cassidy,
Southport,
Merseyside.

Confused induction

I WOULD HATE to use the word stupid about any article in *Practical Computing*, but Boris Allan's article on program proofs has reached this level.

He makes some very basic errors. He has confused scientific induction with mathematical induction. The former has been thoroughly discredited by Karl Popper. Its proofs usually take the form: the sun has risen every day so far, therefore it will rise tomorrow. Or more erroneously: if I go to sleep at night the sun rises in the morning, therefore if I stay up all night the sun will not rise.

Mathematical induction, on the other hand, is a thoroughly valid method of mathematical proof. There is no question of having played with letters and numbers, the proof is simply the application of the axioms of the system under consideration. In this case an ordered field, for example (a+b)×c=a×c+a×b is axiomatic. Anything proved from axioms is a

(continued on page 37)

(continued from page 35)
theorem of these axioms, a term which the author has confused with theory.

There is no need for goodwill. The whole point of the N in a proof by induction is that it is general. The theorem is proven for N+2 by replacing N by N+1 in the proof. If there were some special value for which the proof were false, this would become apparent in the proof. It matters not whether the value of N is finite or transfinite.

With regard to P2(*) the proof of the statement that ax=ay→x=y, derives from the axiom that for every a in the field except 0 there is y in the field such that ay=1. The proposition as it stands is quite simply wrong, with reference to the axioms of algebra. Deduction from axioms is the only kind of mathematical proof.

Finally I must question his idea of proof of a program's correctness. I would agree that a computer model or simulation may be impossible to prove correct. Such a program is directly analogous to a scientific theory. Both are models of reality and so both must derive their truth value by reference to reality and these can be proven correct. For example I would contend that the Basic program

```
10 A=1
```

is a completely correct program and as the author saw, the counter example, however trivial, is enough to disprove a theory.

Carl Zetie,
Maidenhead,
Berkshire.

Australian connection

HERE IN THE COUNTRY over 400km from Perth we receive most publications two or three months old which makes most correspondence fairly pointless. I find that blatant nationalistic bias in both British and American magazines slightly amusing; it is rather aggressive in the former and more assured in the latter.

I am fairly new to the computing game myself. I have owned an Apple and play occasionally with the Vector graphic at the school where I teach.

Practical Computing I like because of the programs and games featured. I often spend many hours translating from the listed Basic into my own dialect. The notes on the programs are invaluable as sometimes the entire program has to be rewritten in a completely different way, to achieve the same effect. It is particularly annoying when readers supply graphics programs without giving an idea of what the completed picture or diagram is supposed to look like.

One general comment — why do manufacturers still make and presumably sell computers with built-in VDUs? I still do not sit 12in. from the screen to watch TV and I see no reason to glue myself to a monitor when using a computer either. I can read and write programs quite effectively with my monitor some 3ft. away and I am certain it causes far less eye strain.

Inevitably I find I need sheaves of paper in front of me. With only my Silentype printer on top plus the slight groove in the Apple I find most things including *Practical Computing* sit nicely where I can see them and the screen comfortably.

I mainly use the computer for writing and experimenting with games and for processing marks and text for school. In my next computer I shall be looking for considerably more than the present 48K RAM so that I can write comfortably in a more English-looking language than Basic. I shall also require easier to write and better graphics, more in-built user-friendly commands and possibly better control over sound.

All these electronic wizards who write their clever machine-language tricks in computer magazines leave me totally unimpressed. What is the point in having a computer if you have to instruct it in gibberish? Why should you want to compress Space Invaders or the *Oxford Dictionary* into 4K? I want the space to write fully documented programs and give my variables names that explain themselves.

I believe that in four or five years time all this will be available at a competitive price in a micro, but only if consumers demand it. From this point of view, I believe the people who are prepared to write line after line of hexadecimal numbers, along with the soldering iron genii, are doing the rest of us a great disservice.

The big memory chips are already available, as is the technology, so let us — the consumers — start telling manufacturers now what we want before we are swamped with either cheap computers with only 2K machine programmable, or $10,000 machines suitable only for big business, or worse, little terminals all time-sharing the great master computers.

Robert Bannister,
Albany,
Western Australia.

Quick formatter for the Pet

THANK YOU for publishing my article in the August edition of *Practical Computing*, pages 159 and 160. While it must be irksome to receive amendments to programs, I am sure that some readers will point out the limitations imposed by the integer variable used in line 60000. This is easily rectified by replacing

```
Z%=Z1 by Z2=INT(Z1)
```

and the other two references to Z% by Z2 in the complete line which now reads:

```
60000 Z1=INT(ABS(Z)*ZR+.5)/ZR:Z2=INT
  (Z1):ZX$=STR$(INT((Z1-Z2)*ZR+.5)):
  ZT$=STR$(Z2)
```

To type the line into the available space it will be necessary to delete every unnecessary space and to tokenise the two references to STR$ by typing in:

ST_ (S T upper case R).

M C Hart,
Wigston,
Leicestershire.

Book review

WE HAVE just received the August issue of *Practical Computing* in which we were pleased to see a review of *Using Microcomputers in Business*, by Veit.

Unfortunately, the review did not mention that, although the book is published by Hayden Book Company of New Jersey, it is distributed by John Wiley & Sons Ltd and the price is £8.20 or $13.95.

John Wiley & Sons Limited,
Chichester,
Sussex.

Debugged

The letter from A J Macefield, *Practical Computing*, August, reporting a bug in my program Source List, published in June, caused me to take another look at the problems of using Get to read from a text file. The fact that the program worked as published on my equipment was due to the printer control logic. Both our printers apparently add a line feed to Return, but mine ignores Returns if the print head is already at the left-hand side. For the same reason, it may be necessary to adjust the string of L$s on line 120 to give the correct six blank lines.

After further experiments, I have come to the conclusion that the first character printed after any number of Gets from a text file is lost. The problem, about which there has been much correspondence in various magazines, is as simple as that.

Although Source List will work as published or with the August amendment, I can recommend the following changes:

- change all references to line 130 into references to 140
- renumber line 130 as 395
- change line 140 to 140 GET Z$
- change PRINT Y$ to PRINT "X";Y$ in line 160.

This will produce a significant improvement in speed.

Neil Lomas,
Crewe,
Cheshire.

More bugs

IN THE JULY issue a reader's letter reported an unusual bug in Rem statements in the business mode on the Pet 4016.

I have the same problem on my new-ROM Pet 2001, 32K, but it gives the author's line as:

```
5 rem peeky dim. mid$.str$owling
```

The only way to avoid the problem is to write everything inside Rem statements in lower case. As to practical use, the author will just have to change his name by deed poll.

let. mid$.chr$rant,
Bushey Heath,
Hertfordshire.

Its maker claims that this little box will change the way you think about memory. It is the NVR-64, a plug-in, 64K, non-volatile memory module. The unit's dimensions are 4in. by 2in. by 1in. with an industry-standard connector making up one of the sides. The unit can retain data for 10 years, and accepts an unlimited number of read-write cycles. The device needs a 5V power supply and is internally buffered. It can be used as all the memory in an eight-bit system, or can be paged in and out. For more details contact the manufacturer, Greenwich Instruments Ltd, 22 Bardsley Lane, London SE10 9RF telephone: 01-853 0868.

MP/M Basic interpreter

XBASIC IS the first Basic interpreter for Z-80 systems which provides a true MP/M compatibility. The interpreter features a number of facilities not available in other eight-bit interpreters.

The real benefit of XBasic is the ability to write applications which take advantage of MP/M's record locking and test and write facilities. Multiple printer use is also supported. Programs written for multiple-user work will run under CP/M with no changes.

Japanese portable has real staying power

A TRULY PORTABLE A4-sized computer weighing less than 4lb, with a full-size keyboard, built-in display and printer, is being launched in the U.K. by the Japanese company Epson. Priced at under £500, the product is aimed squarely at the business user. It is expected to be available in November, under the name HX-20.

There are no similar machines currently on the market, the closest being the 24lb. mains-powered Osborne 1, or the rather different NewBrain which in its battery-powered version will give little more than four hours continuous operation. The Epson can run independently of mains power for 50 hours using its built-in NiCad cells, requiring about eight hours to then recharge fully.

The whole package is very compact, while the keyboard is of good quality and feel and has the conventional QWERTY typewriter-style layout and key spacing. As well as extra programmable function keys and the usual control keys, a numeric keypad has been provided in a novel and space-saving way. The keys U, I, O, J, K, L, and M, which lie directly under the 7, 8 and 9 keys, operate as number keys 0 to 6 when a special Number Shift key is locked down. A Graphic Shift key provides a further 32 graphic characters.

The screen, or more accurately the liquid-crystal display, is immediately above the keyboard and shows four lines of 20 characters using a five-by-seven dot font, or 120-by-32 dot graphics. It can scroll sideways to show lines up to 255 characters long. The

LCDs used are the very latest from Epson, which is a major LCD supplier to the world market. A knurled wheel at the side of the case allows the viewing angle to be adjusted so that the LCDs are aimed straight at you. The built-in inked-ribbon matrix printer prints graphics and upper- or lower-case characters with descenders on to plain paper rolls. The mechanism is the same as that supplied by Epson for the inexpensive Amber 2400 printer.

The space to the right of the screen can be occupied by either a microcassette drive for program or data storage or a plug-in ROM cartridge. The system comes with 32K of ROM, containing Microsoft Basic and the operating system, and 16K of RAM. An optional expansion unit which clips on the side of the case can hold an extra 16K of RAM and 32K of ROM.

The problem Epson had to solve to get a truly portable machine, independent of mains power, was how to keep the power consumption down. CMOS circuitry is slow, so there is a trade-off between power consumption and processing speed. The HX-20 uses the 6301 processor chip from Hitachi, which is an eight-bit CMOS chip resembling the Motorola 6800, running at a clock rate of 0.6MHz. Epson has attempted to design its way around the speed problem by using two of them, one to look after all I/O and housekeeping tasks, the other for language processing.

The system has a built-in speaker, four-octave sound generator, and a date and time clock. Nevertheless external interfaces assume special importance on any portable machine, and the HX-20 has one RS-232C interface intended for use with a larger printer or Modem. A matching acoustic-coupling Modem will be available along with an official Epson briefcase, so that the micro, together with its Modem and expansion unit, can all be conveniently lugged around the country's telephone boxes.

A second serial interface can be linked to floppy discs, a colour TV, or other computers in a local area network. Floppies for the HX-20 should be available at the time of launch.

A cassette interface is provided so that an ordinary domestic cassette recorder can be used for program or data storage, instead of the optional microcassette drive.

About a dozen applications will be available at the time of launch, including a VisiCalc look-a-like, word processor, mailing list, card-index type Database, Diary, and simple sales and purchase ledgers.

Epson (U.K.), Dorland House, 388 High Road, Wembley, Middlesex HA9 6UH. Telephone: 01-900 0466.

Acorn micros acquire Lisp

A NEW VERSION OF the Lisp programming lanaguage has been developed for the Acorn Atom and the BBC Micro. Developed by Owl computers in conjunction with Acornsoft, the new Lisp interpreters are cassette based and come together with a specially written introduction to the language.

Two books on the language have been written to complement the interpreters, *Lisp theory and practice* and *Lisp on the BBC Micro*. The two books cost £6 and £7.50 respectively.

The Merlin is a new Z-80 based micro capable of running software written for the Tandy TRS-80 or Video Genie. There are a number of useful standard features, including Centronics and remote-control cassette interfaces. The machine comes with 48K of RAM and 14K ROM. CP/M 2.2 is available as an option. The Merlin computer retails at around £1,500. For further details contact C T Maddison Ltd, Eagle Industrial Estate, The Crofts, Witney, Oxford, OX8 7AZ. Telephone: (0993) 73145.

Combined database manager and word processor goes world-wide

IN ITS FIRST full year on the market, Silicon Office has established itself as the premier software package for the Commodore Pet microcomputer. It has achieved this despite its requirements for the expansion board, which gives the 8032 Pet a total of 96K of RAM.

Some 3,000 systems have been sold, about 1,600 of which are now installed in the U.K. The rest are exported, mainly to Australia and New Zealand, where by all accounts, the system is big news. About 800 systems have been sold in North America, proving that high-technology trade is not all in one direction.

The package consists of three integrated elements: a powerful word processor, a flexible database-management system and a communications section. The communications facility is certainly interesting, allowing any two Silicon Office installations to communicate via a telephone link. Such a system is currently used by the Ford Motor Company to communicate between locations at Dagenham and Brest, France.

Silicon Office comes from the Bristol Software Factory, and costs £800. For further details contact The Bristol Software Factory, Kingsons House, Grove Avenue, Queens Square, Bristol. Telephone: (0272) 277135.

Ex-Sinclair designers lead with an Ace

THE JUPITER ACE IS a new microcomputer developed by two of the designers responsible for the ZX Spectrum. The Jupiter costs only £89.95 and uses the Forth programming language. This, the manufacturer claims, makes it "the fastest microcomputer in the universe". Forth has the advantage of being both easy for the machine to understand, and relatively easy for humans to understand, at least when compared to machine code.

The machine itself slightly resembles the ZX-80, in as much as it is in a white case and the keyboard is of a similar style. The processor is the Z-80A running at 3.25MHz, Forth being supplied in a 8K ROM. The user has 3K of RAM to play with, which because of the Forth language will seem larger.

The screen is a memory mapped 32-by-24 character display, with the option of high-resolution graphics. Sound is provided by an internal loudspeaker. The cassette operating system can work at 1,500 baud.

For further details or to order a machine contact Jupiter Cantab, 22 Foxhollow, Bar Hill, Cambridge CB3 8EP.

Coming events

Pascal

The British Apple System users group is running a weekend Pascal course with two tutors from Brunel University, to be held at the Taplow House Hotel, Maidenhead, Berkshire, on 22 to 24 October. The cost is £70, accommodation extra. Priority will be given to BASUG members. Contact R Raikes, BASUG, PO Box 174, Watford WD2 6NF.

Unix and C Courses

Intensive courses are available by leading experts on the features and facilities of Unix and the C programming language. Two days on Unix and three days on C costs £395. The two parts separately are £200 and £250 respectively. For details telephone: 01-828 6661.

Science on a ZX-81

Costing £20 for five evenings from 12 November, the Science on a ZX-81 course deals with processing and tabulation of data, simulation of experiments, interfacing and control. Contact Mid-Kent College, Maidstone, Kent. Telephone: Medway 41001.

Software Expo

A packaged software conference and exhibition will be held at Wembley Conference Centre, London on 8-10 November. For details contact Interco Business Consultants. Telephone: 01-948 3111.

The Northern Computer Fair

Personal computers; home computing, small business systems. Belle Vue, Manchester, November 25-27.

Wider choice for Sirius

ACT SIRIUS USERS can now use the UCSD p-system to gain access to a large base of applications software already written for the Apple, IBM, DEC and other commonly available microcomputers.

On the Sirius, the UCSD Pascal programs will run faster than on eight-bit micros, according to ACT, the importer. Any software will also be able to make use of the larger memory. Also included are Pascal, Fortran and Basic compilers. A special version of the system is available with Turtle Graphics, in addition to all the standard facilities.

The UCSD p-system for the ACT Sirius 1 costs £250 plus VAT from TDI Ltd, 20 Alma Vale Road, Bristol. Telephone: (0272) 742796.

The NEC PC-8000 microcomputer is to be available with a 6Mbyte Winchester disc as an option to the flexible disc drives currently available. The new option will provide the user with 5Mbyte of data storage with an average access time of 70ms. The disc unit is totally compatible with the PC-8000, right down to the colour scheme. It costs £1,995. For details contact NEC, NEC House, 164-166 Drummond Street, London NW1 3HP.

Paragraph grabber

PARAGRAB is a program which can extract key information from files and produce a new document containing those paragraphs in a specific order. It will run on any computer using CP/M or any of its derivatives, and may be used in conjunction with an existing word-processing package.

Files created by Paragrab may be edited prior to printing using the existing word-processing package. The package will be of most use to people who have to produce documents containing a large number of standard paragraphs.

Paragrab costs £95 and is available from Focus Computer Services, 95 Beverly Road, Hull. Telephone: (0482) 27846.

Now CP/M appears on multiprocessor ICL

MICROCOMPUTER USERS wishing to upgrade to a larger system will be interested to hear of the CP/M implementation for the ICL Distributed Resources System, the DRS-20. The DRS-20 series consists of machines that use a number of microprocessors, each one performing a dedicated task.

The entry into the system is pitched low. For example, the model 40 at around £4,000 consists of just the one terminal. It is not much more expensive than many personal computers and can be expanded quickly into a full-blown computer network. The introduction of CP/M also provides a degree of consistency across the ICL range, with programs written for the ICL personal computer being transferable to the larger machine. At the other end of the spectrum, the DRS-20 range can communicate easily with mainframes and other machines in the range.

According to Ninian Eadie, director of ICL's product marketing division, "By adding CP/M to our DRS-20 facilities, we are providing existing users of small micros with a gateway into the ICL networked product line without the need to sacrifice their investment in applications packages. It means that we can offer a single-supplier solution — incorporating both compatible growth paths and communications links to ICL and non-ICL mainframes — to those large organisations whose efficient use of data-processing resources is threatened by the proliferation of incompatible, stand-alone micros in user departments. By replacing individual micros with DRS-20 systems, it will be possible to provide users with both localised personal computing facilities and access to networking operations."

This all means that ICL has, at last, reacted realistically to the microcomputer. There must be a large number of users wanting to upgrade, but frightened of losing their software investment. Also there must be a large number of data-processing professionals who will be relieved that an organisation's processing power can be so readily centralised.

For more details on the DRS-20 system contact ICL, ICL House, Putney, London SW15 1SW. Telephone: 01-788 7272.

Convert analogue to digital and back

A LOW-COST solution to laboratory computing problems is provided by the Series A and Series D interfaces. The Series A range is IEEE-488 compatible, and the Series D range allows connection to any computer with a general-purpose parallel port.

A number of interface applications are available including: A-to-D conversion, with a choice of one, eight and 16 channels at 12-bit resolution, or D-to-A conversion at eight, and 12-bit resolution with four and eight output channels; digital input and output. For details contact Anaspec Limited, Pearl House, Bartholomew Street, Newbury, Berkshire. Telephone: (0635) 44329.

Data display package

GRAPHMAGIC is a new package which can display arithmetic data in a graphics format. The package is menu driven, so it will not daunt the inexperienced user, and comes with a disc of examples. It can be used in conjunction with Visi-Calc or Mathemagic, simply using the data files as sources of data for the graphics.

Graphs can be stored on discs, as can the data, and dumping to the printer is easy for most popular makes. The user has complete control over the graph x- and y-axis labels. There is full screen text editing to add text to the graphics, with high-resolution cursor positioning. Other facilities include overlaying, colour capabilities, and automatic or user-selected axis scaling.

The package retails at £69 plus VAT. For further details contact ISM. Telephone: 01-751 5791.

CALIFORNIA COMPUTER SYSTEMS

A weighty family of micros with ample memory capacity has arrived from Sunnyvale, California. David Watt assesses their features, and sizes them up against competing systems.

STARTING IN January 1979 with a 16K memory board for S-100 systems, California Computer Systems grew to provide a wide range of expansion boards for Apple, Pet, TRS-80 and S-100-based systems. In October 1980 CCS announced the 2210, its first complete system, a Z-80, 64K RAM, S-100 bus system with floppy-disc controller for a price of £1,100 in the U.K. It was closely followed by the announcement of a family of systems designated the 200, 300 and 400 ranges.

All the CCS systems are compatible using a 19-slot S-100 card cage designed to the new IEEE standard. They are differentiated only by the initial size of memory and by the type of mass storage devices used. Memory starts at 32 or 64K and goes up to 512K, while at present either 1.2Mbyte or 2.4Mbyte floppy discs, or 10Mbyte or 20Mbyte Winchester discs may be attached. The standard configurations are shown in table 1.

The evaluation system was the desk-top version of CCS 300-04, which consists of two cream-coloured metal boxes. One contains the S-100 motherboard, Z-80A processor board, 64K dynamic RAM board and floppy-disc controller; the other houses the twin floppy discs, mounted horizontally.

The units are robustly constructed, each designed for mounting in 19in. wide cabinets or as desk-top units. They are converted into desk-top models by fitting metal gloves over the top to cover the sharp edges and screw heads exposed in the rack-mounted version.

One striking feature of the units is their weight. The processor unit alone weighs 60lb. due mostly, it would seem, to a massive 700W power supply which takes up half the space of the cabinet. The processor unit measured 7in. high by 17.5in. wide by 19.7in. deep; the floppy-disc drives measure 5.5in. by 17.5in. by 24in.

At the front of the processor unit, below a black grill, are three lights marked Power On, Power Fail and Halt. A red Reset button is complemented by a key switch to disable the Reset, preventing it being pushed accidentally. At the back are the power switch and socket, twin RS-232C serial ports, one Centronics parallel port, and one disc connector port. There are also slots cut in the

(continued on next page)

System configurations.

	CCS 200	CCS 210	CCS 300	CCS 400
Bus structure	S-100	S-100	S-100	S-100
Memory	32K	64K	64K	64K
Memory speed	200ns.	200ns.	200ns.	200ns.
Hardware-vectored interrupt	yes	yes	yes	yes
Real-time clock	2	2	2	2
Calendar clock	1	1	1	1
Serial channels	2	2	2	2
Parallel channels (Centronics)	1	1	1	1
DMA transfers	std	std	std	std
DMA channel capacity	16	16	16	16
Power-fail detect capability	std	std	std	std
Slots	19	19	19	19
Table-top	yes	yes	yes	yes
Cabinet mountable	yes	yes	yes	yes
Power supply	30A	30A	30A	30A
1.2Mbyte dual floppy subsystem	option	option	std	option
2.4Mbyte dual floppy subsystem	option	option	std	option
10Mbyte disc	option	option	option	std
20Mbyte disc	option	option	option	std
CP/M operating system	std	std	std	std
MP/M operating system	option	option	option	option
CCS Oasis operating system	option	option	option	option

System prices.

CCS 200-02	£1,370
19-slot S-100 motherboard, Z-80A 32K RAM	
CCS 300-02	£3,129
64K RAM, 2 × 0.6Mbyte floppy discs	
CCS 300-04	£3,654
64K RAM, 2 × 1.2Mbyte floppy discs	
CCS 400-02	£4,519
64K RAM, 10Mbyte Winchester	
CCS 400-04	£5,382
64K RAM, 20Mbyte Winchester	
CCS 410-02	£5,549
64K RAM, 10Mbyte, 1.2Mbyte floppy	
CCS 420-02	£6,401
64K RAM, 20Mbyte, 1.2Mbyte floppy	
64K RAM board	£547
Six-channel SIO board	£343
1.2Mbyte floppy-disc system	£1,346
2.4Mbyte floppy-disc system	£1,676
10Mbyte Winchester-disc system	£2,885
20Mbyte Winchester-disc system	£3,283
CP/M	£102
MP/M	£179
Oasis	£330
MOasis	£522
RMCobol (CP/M)	£440
(Oasis	£467
CBasic (CP/M)	£82
	Approximate list price

(continued from previous page)

frame for a further six serial ports, one parallel port and three disc interfaces.

After taking off the outer glove and the top cover, it is possible to see inside the main unit. The front half contains the S-100 motherboard which, in the review machine, had four slots in use. The first contains the Z-80A processor card, incorporating two serial interfaces, a parallel interface and DMA circuitry providing 16 DMA channels with a maximum data rate of 2Mbyte per second. The other three cards are a 64K dynamic RAM card, the floppy-disc controller, and an S-100 terminator board to suppress electrical noise on the motherboard.

The system is able to detect power failures. If power fails for more than 25ms. the Power Fail LED will be activated and a Start routine may be initiated When power returns the LED is activated again until the system Reset button is pressed.

The disc controller will handle up to four floppy discs in any combination of 5.25in. or 8in., single or double sided, in single- or double-density formats. It is also compatible with both IBM 3740 and System 34 standards. On switching on or pressing Reset the system automatically loads the operating system from the diskette in drive A, the left-hand drive.

CCS uses either Shugart SA-800 or SA-850, or Siemans 100-8 or 200-8 disc drives, and the controller is also compatible with PerSci-type drives. A hard disc was not supplied with the evaluation system, though they are available in either 10 or 20Mbyte units. The hard-disc cabinet is 7in. by 17.5in. by 24in., the same height as the processor unit and the same depth as the floppy-disc unit. The hard-disc controller will support up to four drives daisy-chained together, for a maximum of 80Mbyte. CCS says it is possible to add an additional controller allowing a maximum of eight Winchester disc drives.

Though CP/M is supplied as the standard operating system, MP/M and Oasis are also available. Languages supplied by CCS are CBasicII, RMCobol and Fortran IV for CP/M or MP/M, and Oasis Basic. Fortran 77, RMCobol or Pascal for Oasis.

Several utilities are available including Sort, and Control, a relational database system for Oasis; Tex, a text-formatting utility, and Despool, a print-spooling utility for CP/M. Some application packages are also available.

The hardware documentation provided by CCS is very good indeed. It consisted of the following documents:

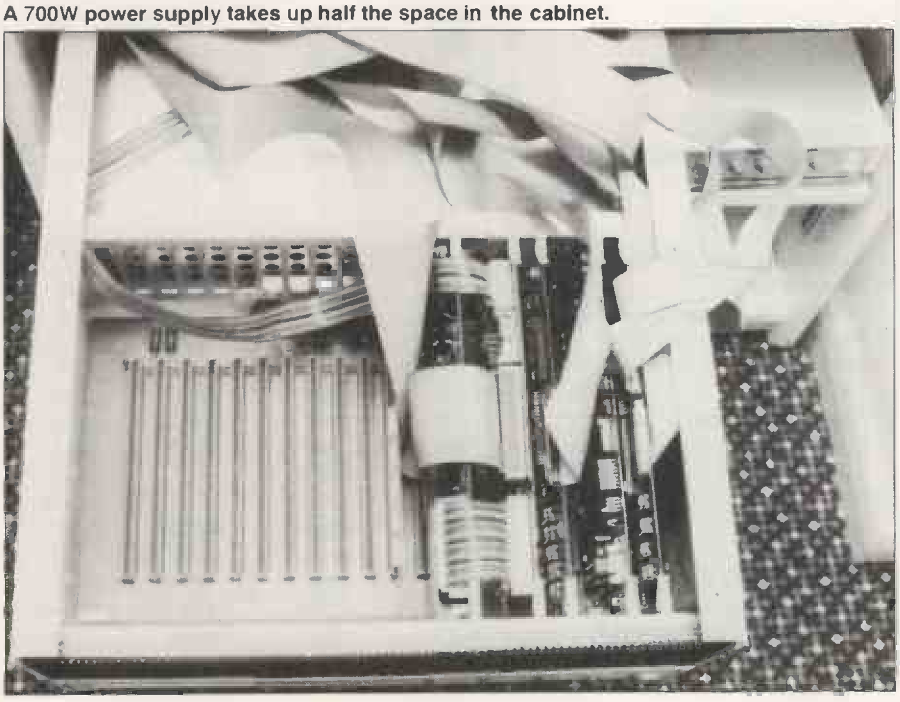
System 200, 300, 400 users' guide
Z-80 family program guide
Individual board manuals:
- the system processor
- 64K static RAM
- floppy-disc controller
- the S-100 mainframe

These manuals cover installation, configuration, hardware descriptions, use and maintenance. In general they are very readable and easy to follow, with only one reservation: the users' guide has excellent instructions on how to format and create a backup system disc under CP/M, but there is only a tiny paragraph covering the creation of Oasis backup diskettes referring you on to the Oasis documentation. It should at least have had its own heading to draw attention to it.

Competing systems.

CCS 410	£7,500
Z-80A, 256K, 10Mbyte disc	
Eight serial ports	
One parallel port	
1.2Mbyte floppy disc	
Onyx C-8001	£9,600
Z-80A, 256K, 10Mbyte disc	
12Mbyte cartridge tape	
five serial ports	
one parallel port	
Rair Black Box 3/10	£7,037
8085, 256K, 5Mbyte disc	
500K, 5.25in. floppy disc	
seven serial ports	

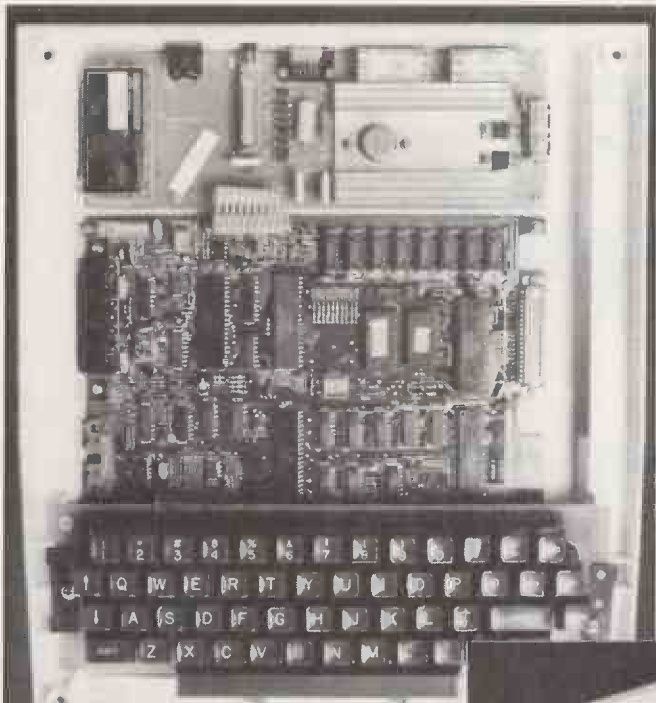
A 700W power supply takes up half the space in the cabinet.



Conclusions

- **The system is well made, robust, with a strong metal chassis, very large power supply and power-fail detector. It is available in desk-top or rack-mountable versions, but in view of its weight the system would be more acceptable mounted in a desk or cabinet. The 2410 system, which has just been announced, weighs only 25lb. and uses a 12-slot motherboard and a 250W power supply.**
- **CCS is well known for providing high-quality work and has a wide range of S-100 and other products available.**
- **Using a S-100 motherboard with 19 slots the system is very easy to expand, four slots are taken up by processor, 64K RAM, disc controller and terminator boards leaving 15 for future expansion. The CCS 400 systems have 14 expansion slots available. A 512K system 410 with eight serial ports and a high-speed arithmetic module would still have five slots free.**
- **The range is very reasonably priced.**
- **Excellent documentation is provided, and Oasis and RMCobol are available, as well as CP/M and MP/M.**
- **CCS computers are available in the U.K. from Wego Computers, 22a High Street, Caterham, Surrey.**

DRAGON 32



Destined to be marketed as a super-toy, the Dragon contains features both attractive and challenging to the serious amateur. Mike Hughes looks at this competitive home computer.

THE DRAGON 32 is a compact home computer aimed at that very competitive High Street market at a price below the magic £200 level. It is assembled in Swansea by Dragon Data, a subsidiary to the Mettoy company, which claims the machine is of British design throughout. However, as is usual, most of the components and the keyboard are of foreign origin. The machine will give anyone familiar with the Tandy Color Computer a strong feeling of deja vu. Not only does the Dragon use the same processor, and the same version of Basic, but games cartridges for the Tandy Color Computer work perfectly well on the Dragon. Moreover, the Dragon is approximately one-third of the price of the Tandy.

The Dragon is designed for high-volume production using flow-soldering techniques, and initial production rates are set for 1,500 per week. The manufacturer has yet to disclose through what channels it will be marketed but, almost certainly, it will be through retailers rather than by mail order. It clearly will be marketed as a super-toy — a type of product for which Mettoy has an established reputation. But do not be deceived: the Dragon 32 is much more than a toy and contains features which will be both attractive and challenging to the more serious amateur user.

The mechanical assembly is most impressive. Although weighing little more than 2kg and housed in an attractive plastic case it is very robust. Inside are to be found two printed-circuit boards. One carries the UHF modulator and voltage regulators, which are amply heat-sinked, while the other carries the rest of the circuitry. The keyboard is a separate assembly using conventional keys which, considering the low price of the unit, have a pleasantly positive feel. The mains transformer is housed in an external plastic case which forms part of the mains cable that is of very generous length.

The system has a considerable amount of I/O hung around the 6809 microprocessor and these are all neatly brought out to substantial sockets on the board's edge. Every input and output, including those for external ROM and the printer, are properly socketed and "bare board" edge connections are not resorted to. Even the push-button power switch and the Reset button have a quality feel to them.

Memory architecture

The 6809 microprocessor is supported by a number of chips from the same family. The memory architecture is made up from dynamic RAM for the bottom 32K, 0000 to 7FFF hex, and two 8K ROM chips from 8000 to BFFF hex, making 16K in all. The remaining 16K of the architecture is left vacant for external ROMs to be plugged in as packs for the preprogrammed commercial games which are planned for the Dragon, although none were sent with the machine for review.

The internal ROM contains an extended Basic by Microsoft. It has obviously been customised with a wealth of special statements to make use of the unique and versatile graphics capabilities of the Dragon 32 as well as its wide range of I/O options.

Some of the unusual statements include: Sound, to output a tone whose pitch and duration can be set by variables or expressions; and Play, which plays a set of tempered scales from strings containing the musical letters A to G. The strings handled by Play can be manipulated by using the normal Basic string-handling routines.

The Draw command allows the letters U, D, L and R as well as four others to draw fine lines over the display in any vertical, horizontal or 45° directions, like Etch-a-Sketch. These letters with corresponding displacement numbers are handled as strings. An extension to the Draw statement allows shapes to be rotated through 90, 180 and 270 degrees on the screen.

The Paint command can be used to fill any bounded area with a selected colour, while Circle allows circles, ellipses and arcs to be drawn. The quality of these figures depends on the screen resolution mode that has been selected.

The Get command takes the picture point data from any specified rectangular area of the high-resolution display and stores it in normal work-area RAM as an array. Put is the counterpart of Get and allows the display, or segment of the display, which has been stored as an array to be placed elsewhere on the screen. The two statements are rather sophisticated to use but will be immensely valuable in computer games. The display operates in two separate modes: Normal Alphanumeric with Pixel Graphics, and High Resolution. Alphanumerics cannot be mixed with high-resolution displays as the data is held in separate areas of memory. It took some considerable time to sort out the memory architecture because, although the Basic manual explains how to use its Peek and Poke statements it does not describe the memory gap. By writing a simple memory dump program in Basic we were able to fathom out the contents of some of the decimal memory locations:

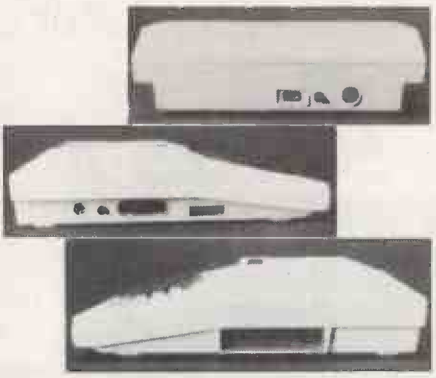
0-1023: System variables and input buffer, etc.
1024-1535: 512 bytes of alphanumeric and pixel display data.
1536-7679: 6,144 bytes of data for high-resolution displays in the "switch-on" default condition of "four pages".
7680-32767: "Switch-on" default Basic text and variable area, allowing 24,871 bytes for program storage.
32768-Top: 16K internal ROM and 16K external ROM.

The 512 bytes of alphanumeric memory always stays at the same location, and the high-resolution memory always starts at 1536. The start of the Basic text area depends on the number of pages that the user selects for high-resolution displays.

There are three degrees of high-resolution. The lowest will fill the screen with one 1,536-byte page giving a display of 128 by 96 picture points, which does not sound very high. Only two colours are available in that mode but the advantage is that the user can have eight pages of data pre-prepared and residing in memory. These can be rapidly switched to the screen using the PMode statement so that smooth, animated effects can be displayed.

Specifications

Dimensions: width 320mm., depth 390mm., height 90mm.
Weight: 2.1kg
Power: External mains transformer, supplied in mains lead
CPU: 6809
Keyboard: Conventional full-size typewriter keys; 53 keys
Video display: Colour-modulated output to domestic colour TV, or video outputs to monitor
Memory:
32K internal dynamic RAM;
16K internal ROM, containing Basic;
16K reserved for external ROM packs for commercial games, etc.
I/O:
Tape input and output at 1,500baud;
Tape-control relay;
Audio output via modulator to TV loudspeaker, tone and duration are software controlled;
Through audio from tape recorder to TV via software switch;
Two joystick inputs via A-to-D converters; the joysticks themselves are not included;
Parallel output to Centronics printer;
Socket for external ROM pack
Display font: Upper-case only ASCII character set, black on green background; letters A to Z available in reversed field
Display resolution:
Normal alphanumeric display: 16 lines of 32 characters per line
Pixel graphics display: 32 rows of 64 columns
High resolution Mode 0: eight pages of 128 by 96, two colours
Mode 1: four pages of 128 by 96, four colours
Mode 2: four pages of 192 by 128, two colours
Mode 3: two pages of 192 by 128, four colours
Mode 4: two pages of 256 by 192, two colours
Software: Resident 16K extended Microsoft Basic
Price: £199.50 including VAT



The power-supply and monitor sockets are at the back of the machine, with the ROM-pack port on the right-hand side, and joystick, tape, UHF and Centronics ports on the left-hand side.

Graphics displays

An alternative mode gives the same resolution with four colour options, but each screenful requires two pages of memory; thus only four different sets of data can co-reside. Medium high-resolution can be obtained giving 192 by 128 picture points in two- or four-colour options, but each screenful requires, respectively, two or four pages of the eight which are available. Very high resolution of 256 by 192 is available in two colours only and a screen requires four pages of memory. Two screens can co-reside in memory at the same time, one being displayed while the other is being prepared or worked on.

When operating in the high-resolution modes the choice of colours is somewhat limited and depends, to some extent, on how mean or generous the user is in eating into the pages available. More spectacular foreground and background colours are available when operating in alphanumeric and pixel mode. There are eight colours in all, including black. Normal default display colours in alphanumeric mode are black letters against a green background.

The tape I/O was tested, and after a few abortive attempts to set the recording and playback levels correctly, was found to work well and very reliably — even while introducing ±5% on the tape's playback speed. The data rate is impressive at 1,500baud and file-search and skip options are available. Very little time is wasted between the motor switch and data transmission. Coupled with the high data rate, this means that it is practical to store several programs or data sets on the front end of a tape without having to wait for a long search to be completed.

The sound mechanical feel to the keyboard tempts the user to try operating at normal high typing speeds. At first it appeared that if you are not quick enough to take your finger off the first key before pressing the next, the second keystroke is still accepted as soon as your finger has come off the first. However, this effect depends on which particular keys are being pressed.

If you press an A and while it is pressed follow it with any letter between B and G in alphabetical order, the second letter is not accepted. If, however, you have pressed A and follow it with H or the following seven letters then the second letter is accepted. This irregularity is clearly a consequence of the way in which the keyboard matrix is decoded by the internal software.

Documentation is in the form of a 162-page A3 booklet which concentrates on guiding the reader through Basic. Perhaps familiarity breeds contempt but its treatment of the more down-to-earth Basic statements seems a little condescending. At the other extreme, the more complex statements, particularly those dealing with graphics mode switching together with the handling of Draw and Play strings and the graphics Put statement, could benefit from the bedside mannerisms found in earlier pages.

In many respects the manual complements the machine — it is ideal for absolute beginners who could, if they wished, be completely oblivious to the sophistication of the high-resolution graphics. Yet there is an incredible latent challenge to the advanced programmer who would like to work out the program for a fast-moving, animated, sound-supported, interactive game.

Conclusions

- **The Dragon 32 is excellent value for money and has an amazing repertoire of potential in its off-the-shelf form. It looks like a toy, comes from a toy company and, no doubt, will be a big seller this Christmas for the kid who has everything.**
- **Yet the Dragon is much more than a toy: it is beautifully designed and built to a high standard, with very good-quality components.**
- **The quality of its internal software and 32K of RAM vie favourably with many other more expensive non-disc professional machines which cost considerably more.**
- **Apart from a minor defect of the keyboard, the hardware is excellent. However, it is poorly documented, and very little is said about the hardware configuration or the addresses of those useful I/O terminations like the Centronics parallel output or the two analogue inputs. Mettoy agrees that extra information is required, and is working to put this right.**

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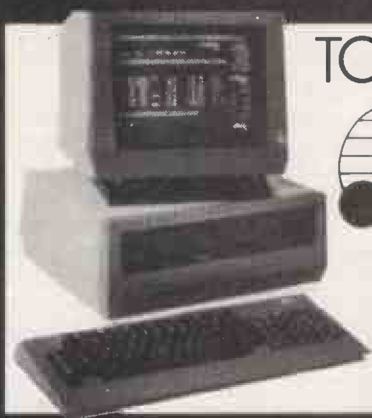

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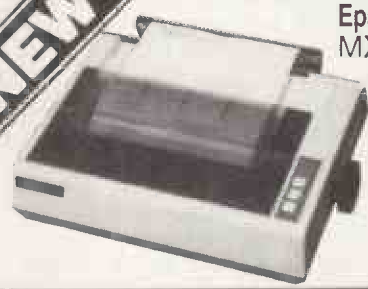

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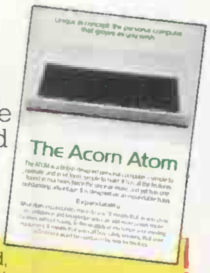

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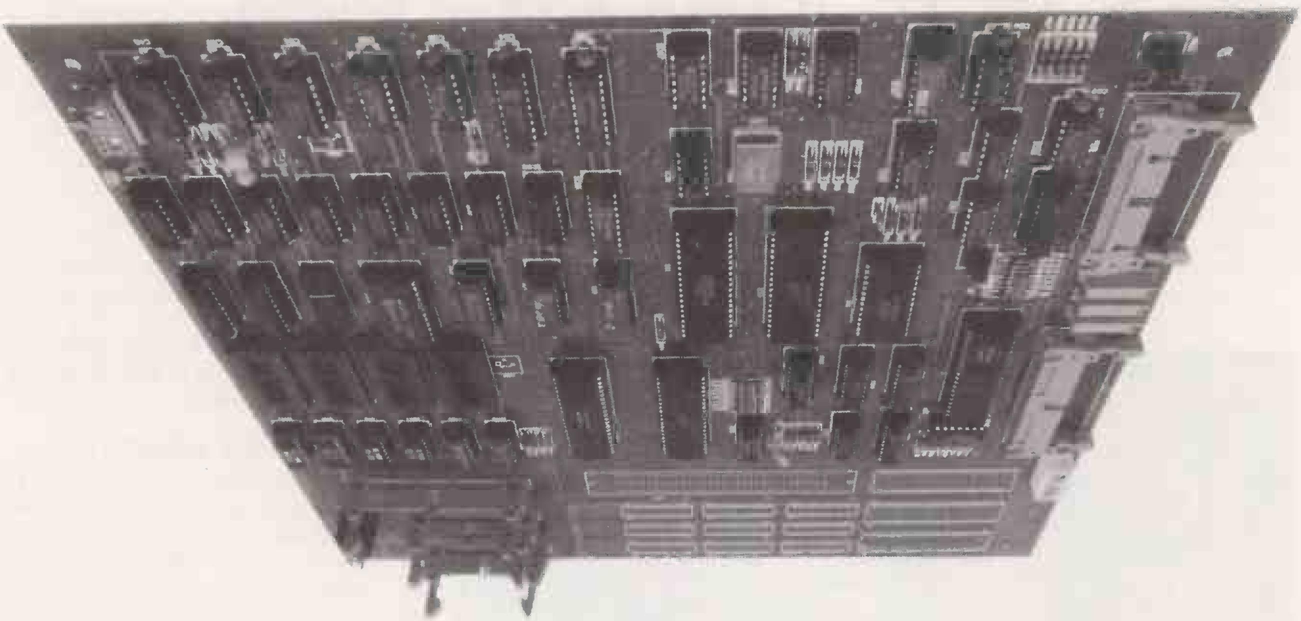

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SOUNDCHASER

Transforming a micro into a full-blown music synthesiser is an obvious goal for budget-minded musicians. David Ellis reports on a package which promises to perform just such a feat.

THE FACT OF LIFE that connects those unlikely bedfellows, piano keyboards and computers, is an all-consuming requirement for data to be inputted in the right place at the right time. Logic circuits have an easy time with the plain and simple on and off of electrical digits, but digits of the flesh-and-blood variety make life a mite more difficult for their owners. It is not so much that muscles become fatigued, joints start aching, and the eyes go bleary with all those dots streaming past them but that, for the average mortal, the fingers are a pretty inefficient interface between creative intent and audible consequences.

There are three ways around these human frailties. You can train the complex collection of motor units which make up the working parts of the upper arm with scales, arpeggios, and sight-reading until they are doing the equivalent of the four-minute mile. Alternatively you can forgo the frustrations of making the fingers do something they are not happy about doing by creating music using a special high-level language entered from the computer keyboard in conjunction with a sound-synthesis program and relevant hardware. Finally you can go for something of a compromise, using the computer to make life on the keyboard a little less painful; this is the approach that Passport Designs has taken with its Soundchaser computer music system.

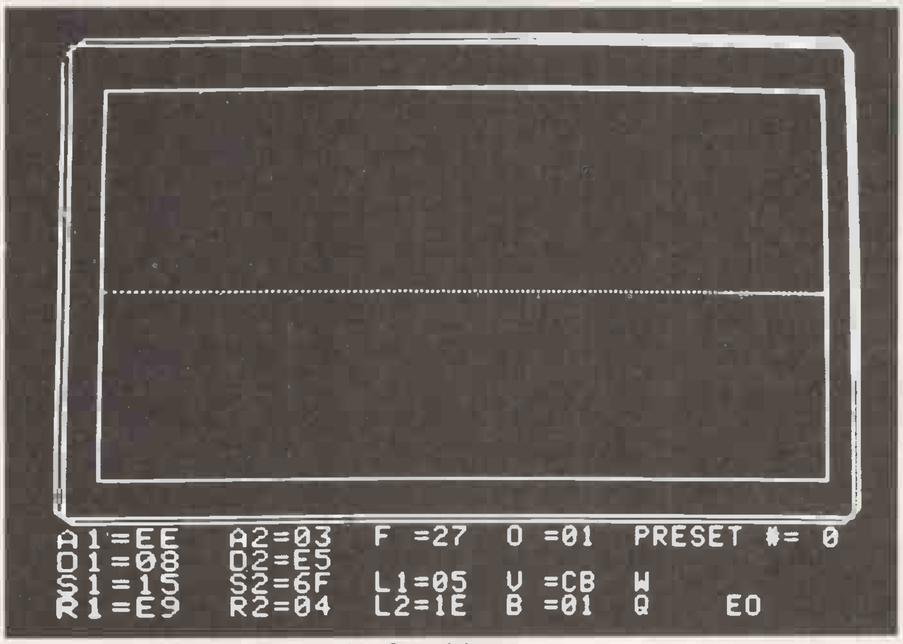


Figure 1. Initial display after booting Soundchaser.

Passport Designs is a Californian company and, like the better-known alphaSyntauri system, Soundchaser has as its basis the ubiquitous 48K Apple II. The single most important advantage of the Apple over other micros in this sort of application is the presence of eight expansion connectors on the motherboard. The Apple will not produce anything that can really be graced with the title of "music" unless some additional hardware is added, and it is here that those expansion sockets prove their worth.

Mountain Computer fortuitously brought out its MusicSystem about two years ago, and both Syntauri and Passport Designs use the MusicSystem hardware for synthesising music. The two boards comprising this clever piece of hardware produce a total of 16 voices individually programmadle for pitch, amplitude and waveform. This ability to output any sort of waveform and, therefore, any flavour of sound, gives this piece of hardware the edge over the PSG chip type of add-on synthesisers produced for just about every available microcomputer.

The Mountain Computer boards have another trick up their silicon sleeve: they are run by direct memory access with an on-board DMA controller stealing every other memory cycle from the 6502 processor. The boards get the DMA treatment from waveform tables in memory 500,000 times a second, and thus each of the 16 digital oscillators is refreshed with a waveform table 32,000 times a second. The digitally synthesised sound is of a thoroughly respectable quality and these boards will produce frequencies from 20Hz to 13.5kHz in 0.5Hz steps — and that is fine for music synthesis.

The hardware that Passport provides is a four-octave keyboard and interface card. The keyboard is scanned by software addressing a multiplexer chip connected to a matrix of the key contacts. Key data is referred to a look-up table for pitch values and the frequency registers of the Mountain Computer boards is updated accordingly.

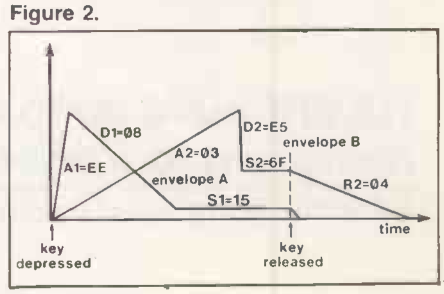
Keyboard capacity

Unlike Syntauri's keyboard, the key data collected by the Soundchaser software does not include the velocity with which the keys are depressed, which is roughly equivalent to the force of one's playing. Frenziedly dynamic playing is transformed only into mechanical noise, worn bearings and heat rather than actually altering the volume of sound synthesised. It is difficult to make a velocity-sensing electronic keyboard behave like a mechanical one such as a piano, and very frustrating if it does not, so Passport is probably wise to have left well alone. All the same, musicians would have been pleased if Passport had incorporated the sustain and portamento pedals, which alphaSyntauri makes such good use of. The Soundchaser keyboard is something of a bare-bones design.

It is in its software that the system really shows its true colours. Passport's current version of its performance software, SEQ.V2, is astoundingly easy of use, and appears to be uncrashable.

To start the ball rolling, you have to boot up with the Soundchaser disc. It takes about 30 seconds and loads 10 instruments or presets automatically into memory. The display that you are greeted with, see figure 1, shows the various parameters that make up each

Figure 2.



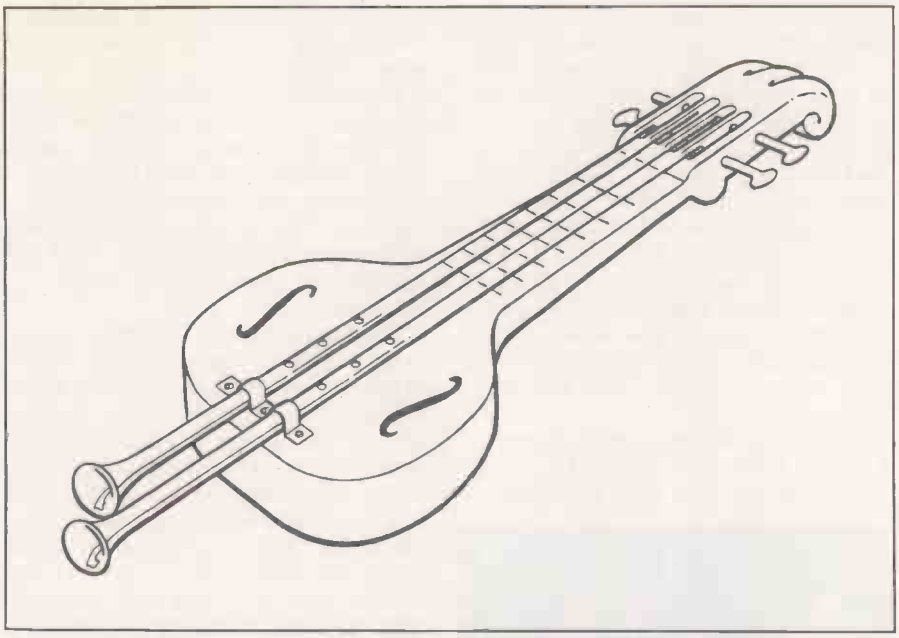


Figure 3. Soundchaser will simulate the "Brute", or any other fanciful instrument.

preset. Firstly, there are two columns of values for the amplitude envelopes applied to the two waveforms that make up each preset. Thus A1, D1, S1 and R1 are the Attack, Decay, Sustain and Release values for the first waveform; A2, D2, S2 and R2 are the corresponding values for the second.

Waveforms

If you play a single note on the keyboard, one left-channel oscillator is fed data corresponding to the first waveform, and the second waveform is directed to one of the right-channel oscillators. There are 16 oscillators available on the Mountain Computer boards, so a grand total of eight notes can be played at once. With two of these oscillators per note you can put different waveforms into the two envelopes. A note may start off with one sound — for example, envelope A in figure 2 — and then change to something completely different with a more or less graceful pan across the stereo field joining the two together. If one's aim in life is to synthesis a hypothetical instrument — the Brute, perhaps — you could put a string-like waveform in envelope A to give a plucked lute sound, and a brass-like waveform in envelope B for a slower-speaking brassy sound.

Synthesised vibrato

One characteristic of natural people playing natural instruments is vibrato, a wobble that is applied to the basic note. Some opera singers produce so much wobble that it is hard to tell what pitch is actually being sung, but generally vibrato breathes life into an otherwise static sound in a way that is pleasing to the ear. The Soundchaser software does this by applying a continuously varying frequency offset to the values being directed to the registers on the Mountain Computer boards.

Frequency offset is provided by a software modulation oscillator or LFO, and any waveform can be used to vibrate the notes into life. A sine wave gives a smooth pitch change, while a square wave inserted into the software LFO makes the pitch jump from one value to another producing, in effect, a trill. The speed of the vibrato is set by the display parameter F.

Musicians do not usually add vibrato until some time after a note has started to sound. The software also allows you to delay the onset of the vibrato by setting different degrees of modulation for the two waveforms making up a note with corresponding values of L1 and L2. Returning to our friendly Brute, a low value for L1, 05 for example, and a value of around 1E for L2 would result in the plucked lute sound having very little wobble and the brassy sound a lot more.

The end product is an instrument that sounds interesting and reasonably natural. The only other parameters that need to be mentioned are O which transposes the keyboard over a five-octave range, and V which sets the volume.

Values of these parameters are changed, by scrolling with the left-arrow and right-arrow keys used in conjunction with the Repeat key. The additional parameter B sets the "bump" value which toggles the scrolling between 01 or 10 increments. All 10 presets can be called up for service by jabbing the appropriate numerical key. The change

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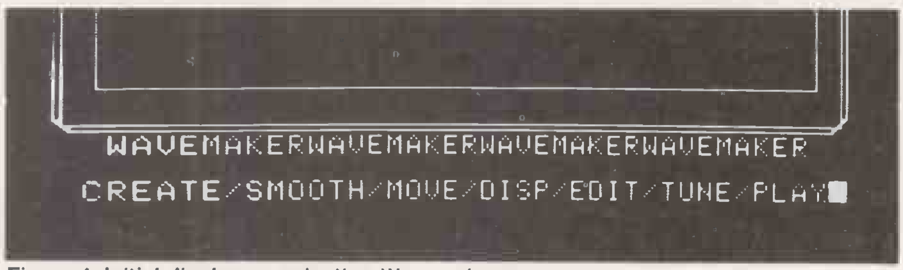
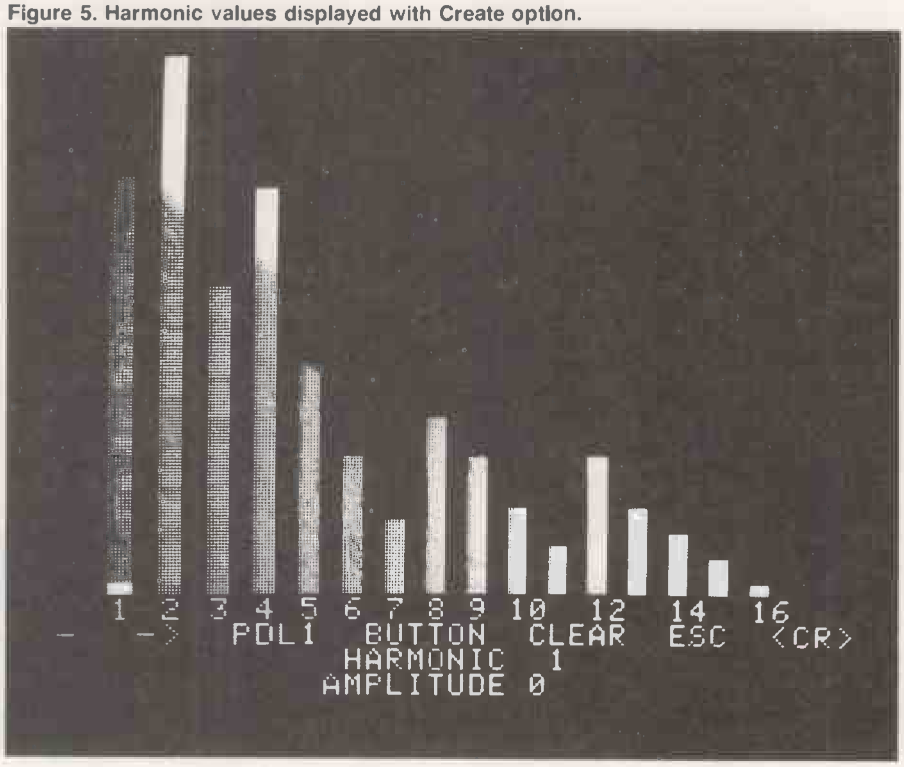


Figure 4. Initial display on selecting Wavemaker.

Figure 5. Harmonic values displayed with Create option.



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from one instrument to another is immediate, and there is no reason why a remote numeric keypad should not be placed on the Soundchaser keyboard to facilitate rapid preset changes during your digital flights of fancy. Any of the preset parameters can be changed while you are playing, simply by scrolling the relevant value. This is particularly useful in the case of the vibrato speed F and the octave transposition O.

Harmonic quality

Anyone used to playing organs or synthesisers will be perfectly happy with the feel of the keyboard. It is just like most other proportional incremental frequency interface annunciators' action: tough going at first. The sound quality is very good, and the only trouble comes when you try playing a sound with lots of high harmonics at the top end of the instrument. Strange digital gurglings result since the high harmonics played on top of a high fundamental pitch fall outside the scope of what the Mountain Computer hardware is designed to pass on into the analogue environment. The Soundchaser avoids this, in part, by using a digital low-pass filter.

The Wavemaker section — see figure 4 — is called up by entering W from the Apple keyboard. Its purpose is to fill up waveform tables with the requisite 256 bytes of waveform data in as quick and straightforward a manner as possible. The fundamental principle behind it is Fourier or additive synthesis.

Waveform tables

The Create option allows the user to build up a bar graph — see figure 5 — of values for the first 16 harmonics with the Apple game paddles; Display then illustrates what your attempt at harmonic composition actually looks like when the resulting 256 waveform table entries are plotted — see figure 6. At any point during your synthetic deliberations, Play can be selected so that the waveform tables can be played with to make sure that you are not heading up a harmonic gum tree.

If you play an A at 880Hz and you have elected to use a waveform with equal levels of the first, second, fourth, eighth and 16th harmonics you will find that the sound has the sonorous complexion of five octaves of A, with the highest harmonic at 14,080Hz, 16 times the frequency of the first. That is just about all right if you stick to playing notes lower than 880Hz on the keyboard, though it is hardly the greatest sound since Mantovani's strings. If you go to higher frequencies you start forcing the boards to synthesise sounds beyond half the rate at which the oscillators are fed data. Once that happens, a phenomenon called aliasing makes itself heard; its digital gurglings are a result of beat frequencies between the oscillator feed rate and the frequency you are trying to output. Low-pass filters on the outputs of the boards are available to remove these spanners in the synthetic works down to about 13.5kHz but if you try to force the system to synthesise harmonics at, say, 20kHz, a 12kHz aliasing gurgle is generated. This is below the operating range of the low-pass filters, and you need to bring the digital filter of the Smooth routine into play. The software filter recalculates the 256 waveform table entries so as to remove the offending harmonics; it puts right the goof you made when adding the harmonics together.

That leaves the three routines Move, Edit and Tune. Move allows you to use any waveform from any of the three

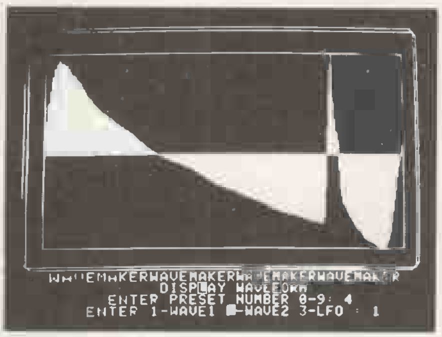

Figure 6. Waveform display.

waveform tables — two oscillators and one LFO — in each of the 10 presets as a starting point for additive synthesis, though in practice it is easier said than done. Edit gives you the alternative option of using the game paddles to draw in a waveform either point by point or in one quick flick of the wrist. It also allows you to do what its name suggests, and edit the parts that you are not happy with in a particular waveform. Tune allows you to tune the keyboard to something other than 440Hz. It will cope with any request from 200Hz to 600Hz, and these tunings can be saved on disc. If one day you have to accompany Uncle Jack who always sings a quarter-tone flat, there is no problem.

Cynics might argue that from what has been demonstrated so far the Soundchaser has not exactly fulfilled promises of the computer making this niche of artistic life easier. The value of computer synthesis really starts to fall into place when you come to the tricky business of ordering lines of music together. With some musical training, good neuromuscular co-ordination, and a piano to hand, it is not really that difficult to play a melody, countermelody and accompaniment all at once.

The piece of music can be made a good deal more interesting if each of these elements is played on different instruments. It is also much safer if each part is recorded in turn and then synchronised together. This technique of multitrack recording is *de rigeur* for the average rock musician but, like all good things, it is expensive.

The Soundchaser's Sequencer section — see Figure 7 — enables you to do both of these things, though recording is into memory rather than on to tape. You first select an instrument out of the 10 presets and enter this for the track you are about to use. Switch the track to record — track number, then R — then press the space bar to start and stop recording. Finally switch the track back to play — track number, then P — and press the space bar to hear the result of your labours.

Overdubbing

The result of the recording procedure is that you have merely loaded into memory the notes — that is the key depressions and durations. You are still free to do whatever you like to the instrument playing the track by pressing Esc to return to the preset display and then scrolling the relevant parameter. You can even allocate an entirely new instrument. And that is for just one of the tracks.

You can do the same with the other three tracks, recording each subsequent track on top of the previous ones. In this way you can build up a multitracked piece of music with different instruments playing different parts and all in perfect synchronisation. You can also play the keyboard on top of the four tracks already recorded so you could, for instance, put down a complex backing of drums, funky bass, chords and twiddly bits, and then play a live lead line over it.

One of the other advantages of this type of digital recording is that it could be child's play to speed up or slow down the music without changing pitch. You can take your time over recording parts then speed up the playback to give you what you really want. In practice the Soundchaser only lets you change the playback tempo in discrete steps of zero, one, two, three and four times the original speed of recording. The zero selection freezes the music on whatever chord is being played when the tempo is brought to a grinding

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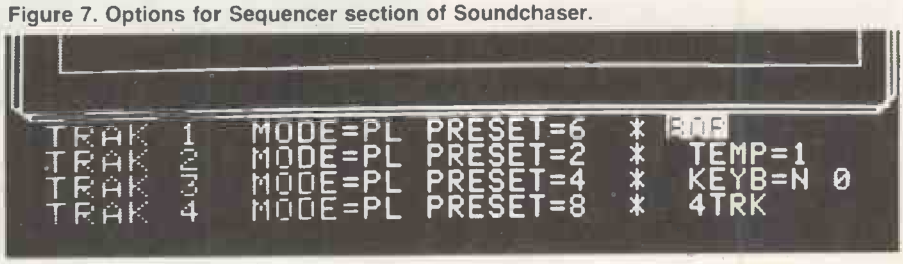
Figure 7. Options for Sequencer section of Soundchaser.



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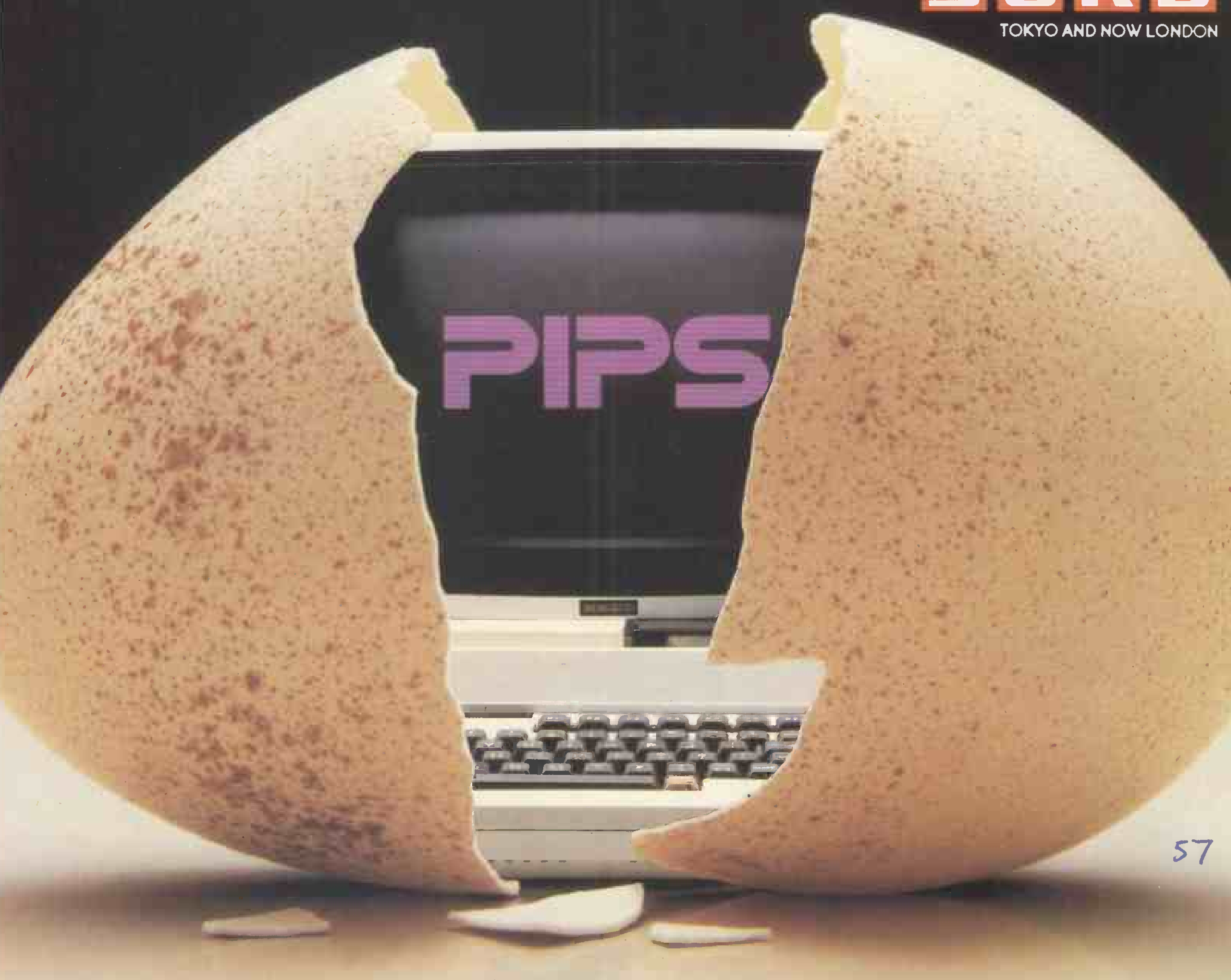

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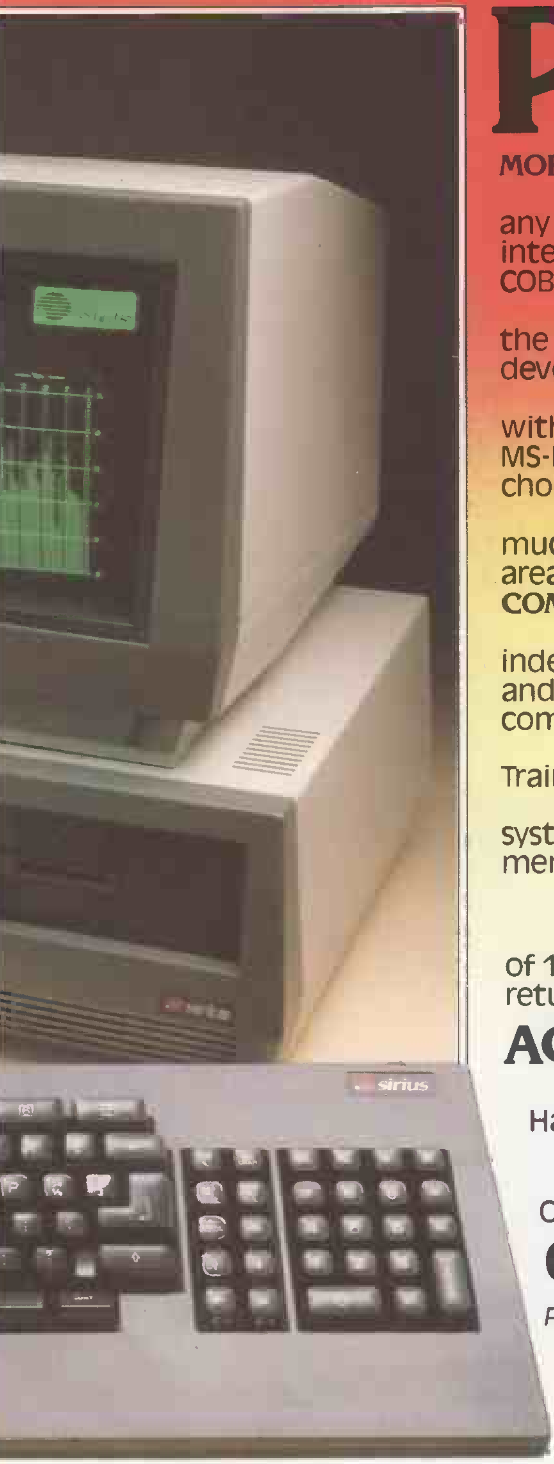

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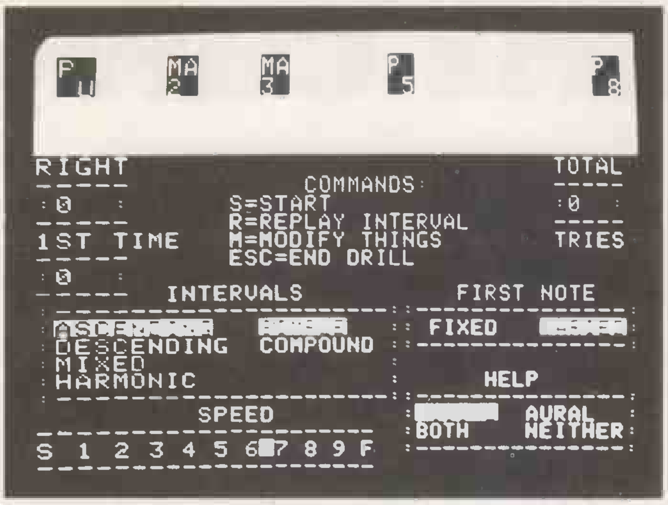


Figure 8. Music Tutor options.

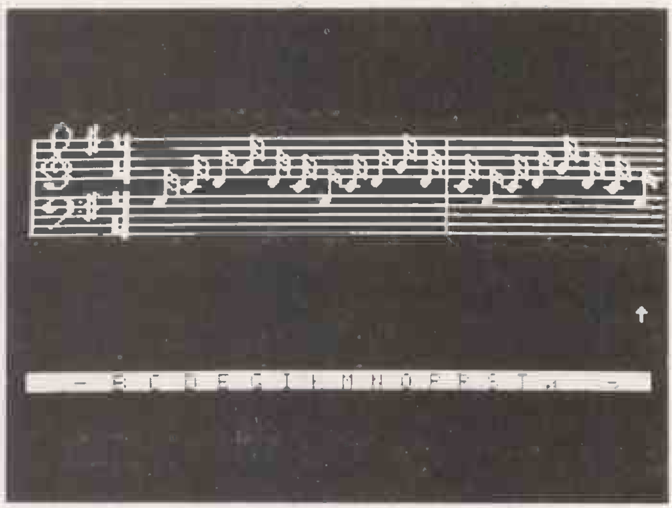


Figure 9. Notewriter display can be output as hard copy.

(continued from page 56)
halt, but speeding-up factors are too extreme to be very useful. Parts appear to spontaneously desynchronise themselves when the tempo is increased but that is the only software bug to have emerged during this review.

At present, the sequencer will store a total of 4,000 notes. The recording can also be configured in an alternative Link mode where all the notes are recorded in one go on a single, extended track made by placing the previous four tracks end to end. A promised software update will expand the number of recordable notes to 12,000 by adding a routine for using a 16K RAM card. The same update will also provide the option of recording on four, eight or 16 tracks, driving drum machines or conventional sequencers with a sync pulse, a more sophisticated means of mixing waveforms together, and some form of waveform table sequencing.

The last addition is the clue to simulating more natural sounds. A single waveform table is just like one frame of a film: a frozen image that might or might not give you the right story line. One way of providing a more accurate idea of the action is to take a number of frames of crucial significance out of the film and then scan through them, and this is the idea behind waveform-table sequencing.

Sonic storyline

Waveform tables are trotted out of memory in order of their significance to the sonic story line and in response to your key depressions. If you go the whole hog by recording on 16 tracks, then each voice cannot be anything other than that from just a single Mountain Computer oscillator. The result is a much thinner sound unless waveform-table sequencing is used.

Passport seems committed to developing the Soundchaser in as many directions as possible, and among the software additions to the system are Music Tutor and Notewriter. Music Tutor sells in the U.S. for $150 and represents an extremely ingenious CAI approach to the thorny problem of musical ear training, an aspect of music that is something of a pain for student and teacher alike. Piano teachers used to rap their students over the knuckles if they did not hit the right notes, and that is not exactly conducive to the learning process.

Tutorial

The three discs of Music Tutor software include an extensive range of drills with superb graphics, a sense of fun, and a terrific manual. This epitome of friendly student-computer interaction here is what it says about the Intervals drill:

> The Intervals software will sharpen your aural (listening) skills and help you to learn to identify the interval between any given notes. These skills are more difficult to learn than the skills of playing Space Invaders, and for two good reasons:
>
> 1. It is more difficult to train your ear bones.
> 2. It requires more patience than saving the Earth from an alien invasion.
>
> Most people feel a deeper sense of satisfaction with finely-tuned aural skills than with 2D video game skills. As you keep reading, you should feel the first waves of satisfaction rolling in shortly.
>
> "The hurrier I go, the behinder you get."
>
> Grandpa Verny

Apart from such friendly encouragement there is chord identification, pitch patching, chord tuning and matching melodic patterns. If these sound boring, it is because they usually are — unless you have something like the Music Tutor to teach you, when it really does become fun. As the software stands at present, it is very much designed for the individual wanting to improve his or her musical skills. For the rigours of classroom use, some sort of unerasable report and statistical analysis of each student's performance is needed, and this is to be added to the next version of the package.

Notewriter, retailing at $99, is a means of transcribing notes played on the keyboard on to a real-time display — see figure 9 — and then printing them out as hard copy. The software will only cope with a monophonic line but once you have entered the music you can then edit it in all manner of ways and play it back before finally committing it to print. Though this sounds all fine and dandy, you may well find yourself having to make so many minor edits to the timing of the notes played that you would save time by copying out the tune by hand. The computer's resolution for musical events tends to be rather too high for human comfort.

Another problem is that notes played very fast sometimes fail to make it into the Notewriter's frame of consciousness, and that again entails tedious editing. Notewriter would make much more sense if the entered line of music could then be used as one track of the Soundchaser sequencer. You could then correct mistakes made in playing the keyboard without having to re-record the entire piece — a very useful piece of computer assistance.

Conclusions

- **The Soundchaser performance software and keyboard transforms the humble Apple II into a thoroughly professional computer music system.**
- **The software is efficient, keyboard commands are kept simple and the sound quality is excellent.**
- **The software expandability of the Soundchaser makes it an extremely attractive propositon for the amateur or professional musician worried by the built-in obsolescence of most conventional synthesisers.**
- **Music Tutor is a fine computer-aided instruction package that should find much application in schools and music colleges.**
- **The projected U.K. price for the Soundchaser is £395. For more details on pricing, availability and performance, contact the Apple Music Synthesis Group on 01-584 5816.**

Chris Curry

Acorn is a company to be reckoned with in computing, yet the forces behind it are not so well known. Ian Stobie meets Chris Curry, one of Acorn's founding fathers.

ACORN COMPUTER, best known as maker of the BBC Micro, is fast becoming a major force in computing. Next year turnover will probably exceed £30 million and the company plans a major assault on the American market.

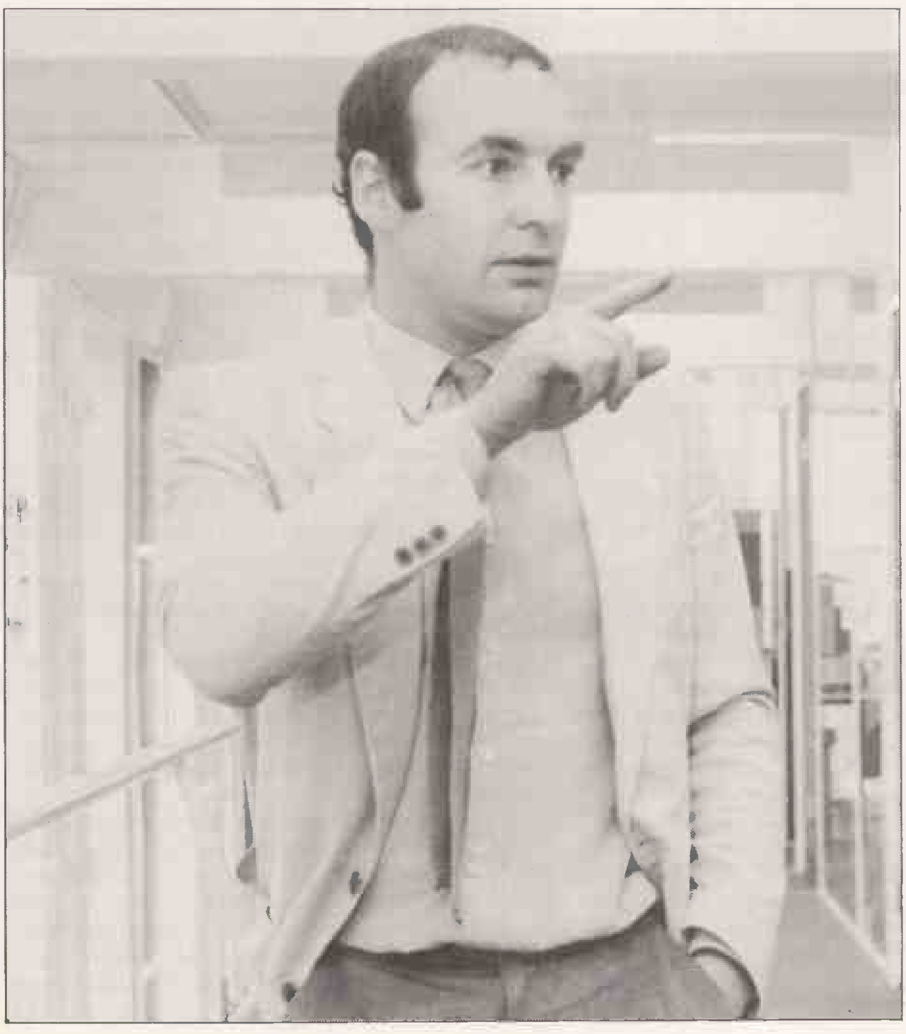
Compared to its Cambridge-based rival Sinclair Research, Acorn does not generate the same almost fawning coverage in the computing and general press, and the personalities behind the company are certainly less well known. Chris Curry, who with Hermann Hauser founded Acorn Computer, does not find this at all surprising.

"Apple is much more our competitor than Sinclair. We have a fairly wide base compared with Sinclair's monolithic, product-based approach, so we will never make such dramatic impacts. Clive brings out one product and pushes that straight towards whatever sector of the market is appropriate. Generally speaking for him it is the consumer market. Whereas ours is a company with diverse interests, having customers in the consumer, development, education and office sectors."

Chris Curry worked for Clive Sinclair for 13 years, first in hi-fi at Sinclair Radionics, then calculators, and finally computers at Science of Cambridge, which Chris Curry set up for Sinclair. "To start with I was the only person there. We were producing a little gadget, a wrist calculator, a ghastly thing. I used to do everything: placing the ads; packing kits; taking them to the post office; mending some of them; answering technical queries; absolutely everything. Later on there was a secretary, then more and more people were involved. By the time the MK14 came out I think there were about five or six people there."

The MK14 was one of the very first cheap computers. It cost £39.95 in kit form and came with 256 bytes of RAM, a hex keypad, an eight-digit display, and was based around the National Semiconductors four-bit SC/MP chip.

"It was quite a successful computer. The next step was obviously a version that ran Basic instead of just machine code. That was where our ways separated, because Clive didn't want to do it and I did. So I set up Acorn Computer with Hermann Hauser."



Their first product was the Acorn System One, which came out in January 1978. "We chose the word Acorn because it was going to be an expanding and growth-oriented system." The System One was a semi-professional 6502 development system aimed at engineering and laboratory users, but priced low enough, at around £80, to appeal also to the more serious enthusiast.

One thing that stands out about Acorn is how consistently the company has stuck with the philosophy that the design must generally take into account future developments. By the same token a new Acorn product usually has some continuity with its predecessors.

"We still use parts of what you could call the System One, the Eurocard system, as our rack-mounted file server for Econet systems. The Basic that went into the Atom was a slight variation of the Basic that was written for the System One, a fast, control-oriented Basic." The System One established the 6502 as Acorn's standard processor, to be used later in the Atom and BBC machine, and the Torch and Electron.

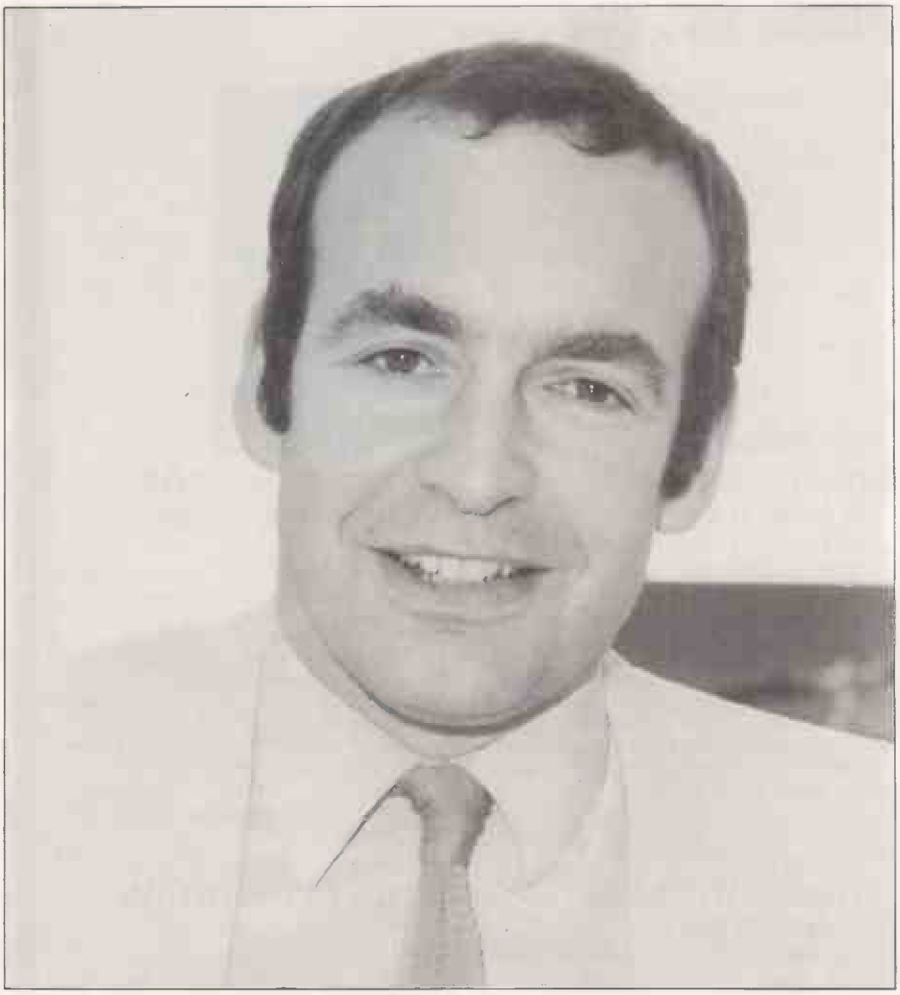
Hermann Hauser and Chris Curry met through Cambridge University while Curry was still at Science of Cambridge, and the university connection has been very valuable to Acorn.

Glittering prizes

"We are in Cambridge because the university processor group, or its computer lab, has maintained Cambridge as one of the leading universities in computer science. So there is a good supply of bright people to go into the industry. One of our directors is a lecturer at the computer lab, and he is on the watch for good people about to leave that might want to work for us. And of course an awful lot of hobbyists come out with software that they have written in their spare time to sell us, and we make contact that way. Cambridge is a fairly small town; people know each other. There are lots of small software houses, all closely interlinked with the university, and we all talk to each other. To move out of this area would be a major disadvantage."

Acorn's current products are: the Atom; the BBC Microcomputer model A

# of Acorn



and B; and Econet, Acorn's low-cost networking system. A division of Acorn called Orbis deals with the high-performance networking system, the Cambridge Ring. In addition Acorn supplies Torch Computers with boards to go in the office-oriented Torch machine. Acorn helped set up Torch, and Chris Curry was a director, but this link has now been severed and Torch is supplied on a straightforward OEM basis.

A new version of the rack-mounted development system, called the System Five, is due soon, continuing the System One tradition. But the major new products from Acorn are the consumer-oriented low-cost Electron, and the top-end add-on processor system, the Gluon.

"The Electron is designed to compete with the Spectrum. The idea is to get the starting price very low, but not preclude expansion in the long term. It runs the same Basic as the BBC machine. We anticipate it having just an extension bus, and the extension bus will have modules plugged into it to give you whatever interfaces you want. So an Econet interface would be a plug-in module, a printer interface would be a plug-in module." The Electron is due out in the late autumn. The price is not yet announced but it will probably be under £200 to compete with the Vic and Dragon, as well as the Sinclair Spectrum.

Chris Curry clearly thinks that BBC Basic has a good chance of becoming a world standard. "An awful lot of work has gone into that language, almost to the extent of having committees deciding things. The Electron will be very useful for people to get in at a lower cost level, and gradually more and more people will adopt our language."

Acorn plans to start a major assault on overseas markets with the Electron and BBC machines. "We are actually doing very little exporting at the moment because of the backlog on the domestic market. Our production levels are very high indeed, and when we have cleared it we will be producing far more than we are selling in the U.K., so we will be making a very heavy push overseas. There will be very heavy advertising in America in the Autumn when the Electron comes out. The English-speaking countries, Australia, New Zealand, South Africa, are our best bets as all the course material and software is immediately appropriate. But I have no intention of just limiting it to those markets. We have already made arrangements with people to translate all our documentation into Italian and Spanish."

The Acorn philosophy is to look well ahead, but not lightly to throw away tried and tested systems. So it comes as no surprise that Chris Curry intends the Atom to have a continued life even when the Electron becomes available.

"The beauty of the Atom is that you can get inside it, you can tack bits on to it, you can use it as part of another, larger, piece of kit. The Electron will be a fairly finite system, and because it will have, like the BBC machines, ULAs and so on, it will be very closed to an electronics engineer who might want to use it. The Atom is still a fine machine for tampering with hardware."

Long-term strategy

The Gluon is an interesting system as it uses the 32-bit processor chip from National Semiconductors, the 16032. Superficially this looks like an aggressive attempt by Acorn to leapfrog the competition, who are mostly migrating from eight-bit processors to 16-bit chips, principally the Motorola 68000. But Chris Curry's explanation shows that the usual long-term and even slightly defensive Acorn strategy is being followed in this case as well.

"We chose to go with National Semiconductors, who we have been working with very closely, rather than with the 68000, Z-8000 or 8086, some time ago. I think we have made quite a good choice, because there are already many people on the bandwagon who we could be competing with if we went towards the 68000 or one of the others. But we are in with a head start with the 16032, which happens to outperform the others pretty heavily anyway. National Semiconductors have set up a package deal called the EP^2 scheme, which ties in a lot of suppliers of software and hardware to provide the chip with the support it needs. At the end of this year we will be able to offer a whole range of languages and programming tools, all that you need to start developing systems."

The Gluon comes in two versions, one intended as an add-on box for the BBC machine, the second as an add-on for the popular commonly available, eight-bit microcomputers. The BBC Gluon comes with 0.25Mbyte of RAM and the 16032 processor. It sits in a box beside the BBC machine connected by the Tube, the very high speed data highway used in the BBC machine which gives the system much of its long-term expandability. In effect the

(continued on page 69)

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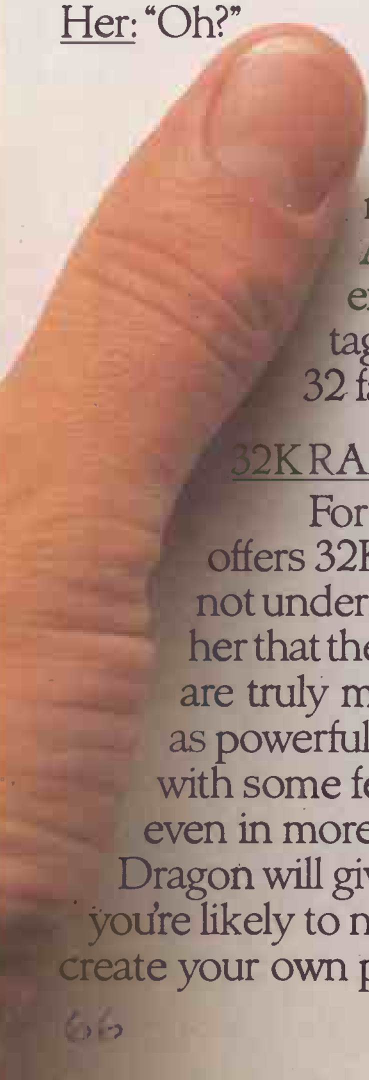

You: "Darling, I've decided to buy a computer."

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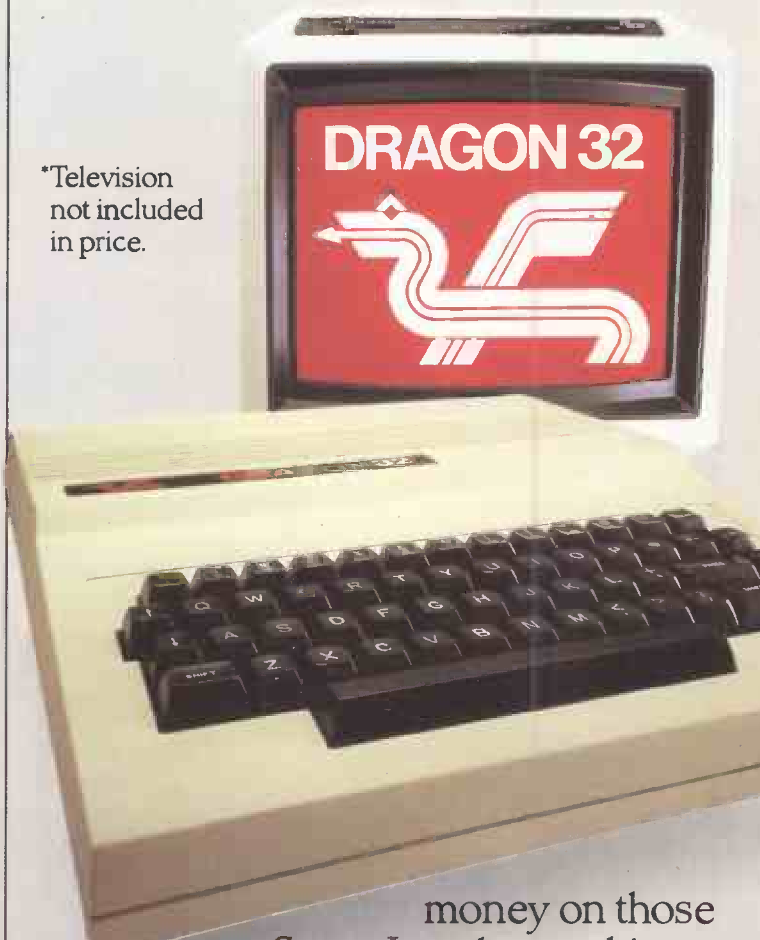

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SPECIFICATIONS
6809E MICROPROCESSOR. Pet, Apple, Atari 400, BBC Micro, and VIC 20 still have the less powerful 6502.
32K RAM (as standard). At least twice the power of similarly priced machines. Expandable to 64K RAM.
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(continued from page 63)

6502 in the BBC machine becomes a front-end I/O processor and all the language processing is done in the 16032.

Version two, the Universal Gluon, cannot use the Tube because it is unique to the BBC machine, but will connect via some serial or parallel interface, probably

initially the RS-232. It will be a bigger package, comprising a 16032, up to 1Mbyte of RAM, and 1-, 2- or 5Mbyte Winchester hard-disc drives. It comes with terminal emulation software, so in effect your Apple, Tandy or Pet becomes just a terminal connected to the Gluon 32-bit computer, where the real action is.

The Gluon will be making its appearance, vaguely scheduled for the end of this year, at the same time as major computer companies such as DEC and IBM enter the U.K. microcomputer market. Part of the appeal is the very high standard of the display and keyboard, and this may well encourage the raising of ergonomic standards generally.

The Gluon, using say a Tandy or an Apple as a terminal, will have imposed on it the ergonic limitations of the older machine. But Chris Curry does not think this will limit the Gluon's appeal.

"Apple and Tandy owners want to maintain the usefulness of their equipment, they don't necessarily want to change over completely to a 32-bit computer. Remember that a very large proportion of the existing installed user base of things like Apples are in the hands of home users, and those people don't want to lash out enormously on a completely new system."

This version of Gluon is best understood as a migration tool, intended to pick people up from other manufacturers' existing user base and move them on to Acorn kit. The price has not been announced yet, but it is clearly crucial to the success of the strategy.

Acorn will be offering two different operating systems for the Gluon; its own very minimal operating system, and a version of Unix. "We always see ourselves as supplying development-hardware for people in the systems house business, and that is what these small operating systems are for. It also gives us an intimacy with the product that a lot of other people who buy in system software do not have. To do serious commercial applications software people can go for the more expensive option — Unix."

Many of the new 16-bit machines from other manufacturers run Unix, which has a good chance of becoming the standard 16-bit operating system in the same way CP/M has become the eight-bit standard. To the computer user, and more so to the programmer, the operating system defines a computer system, usually much more strongly than any hardware feature. So the Gluon will be another Unix system as far as the potential buyer is concerned, and probably one of the cheapest.

What price performance?

Chris Curry believes Acorn has another advantage. "There have already been some 68000 add-ons provided for the Apple so we know we are competing with people using the other 16-bit processors. But because we know that our one, with the 16032, outperforms them, we feel that we have got a fairly clear technical edge."

Practical Computing has been a bastion of scepticism as to how far the performance of the chip at the heart of a system actually concerns the end-user, once all

the other hardware and software factors have been taken into account. Systems are rarely CPU-bound. So how far does Chris Curry think the fact that the 16032 outperforms the 68000 really matter?

"Probably not as much as one can imply. It is a matter of presentation, advertising. You can say this will run three times as fast as a 68000. Now whether or not that is desperately important in real terms I don't know, I am not a user myself. I know that if I went up to the labs and asked someone that they'd say of course the speed of operation is vitally important. It means you can do things which you wouldn't be able to do otherwise. This certainly is the case when it is part of a total system, with its own screen, doing its own graphics. Where it is on the end of an RS-232 perhaps it is a little less important. Nevertheless, I think it appeals to people, that they are getting the latest, in that terrible phrase, 'State of the Art'."

Both versions of the Gluon, and the Electron, which is really a cut down BBC machine priced to appeal to the consumer market, demonstrates the flexibility Acorn's systems approach gives them. "Because of the way we have designed things it is particularly easy for us to bring out a machine for a particular market. We can both spread them out and add more facilities, or we can prune them down dramatically to produce a much cheaper machine."

It is one reason why Chris Curry does not fear a price war, which seems more and more likely as new companies enter the increasingly defined market and production capacity builds up. "If we need to go to a lower price we bring out a new product that costs us less, we don't cut prices."

One of the most successful recent computers is the Osborne 1, a cheap portable computer with everything, including screen and discs, in a single carrying-case. Given its flexibility, why had Acorn not done it first?

"We thought about it, and always considered that the sort of small screen that you could put in the thing was not really practical. What we did not really expect was that the very notion of a complete box with everything in it would be so attractive. And it obviously has been because it seems to be very successful. Mind you we are aware of its success and there are products in the pipeline."

Take-away Electron

The likely date for Acorn to bring out its first portable machine is June 1983. "It won't look much like an Osborne but it will be a machine that includes its own display facilities. Because it will have limited interfaces and it must be as small as possible, it will be based on the Electron rather than the BBC machine. It will have a very strong emphasis on communications. If it is used in an office it will expect to see a local file station acting as its storage. It will have an Econet local area network interface and Modems for the British Telecom network."

Success brings with it new problems. Apple's success has made it the target for piracy, in the form of cheap imitation machines which pass themselves off as

Apples, and legitimate competition from manufacturers of plug-compatible machines such as the Dutch Pearcom and German Basis 108. They are intended to be sufficiently similar to the Apple to accept all hardware and software add-ons yet use different circuit boards and have

(continued on page 71)

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(continued from page 69)
some significant additional features.

The BBC machine would seem a tempting target for copiers if it proves as successful as Chris Curry hopes. "You would have a job to do it with the BBC machine because it uses ULAs, and these are not so easy to copy. If you have a

design the main blueprint of which is the printed-circuit board, then this gives the circuit away and there is no way of protecting it. The point about the Apple is that it is all standard components on the PCB so it is a prime opportunity for somebody to copy."

The circuit is burned into ULAs late in the production process and cannot be discovered by physical examination. The functions of the circuit would need to be analysed and a similar circuit designed to carry them out — a lengthy process. "That is why Sinclair can be relatively safe with the ZX-81. It is the perfect thing to copy in Taiwan, but for the fact it has ULAs in it."

Acorn has been expanding fast. "We don't make the sort of profits that Sinclair makes but we are putting a lot more back into the company." With expansion has come reorganisation. "We started out with a lot of bright young chaps up at university doing design work, and found that we were, as we always intended to be, heavily research and design oriented. But with substantial production we have found that there is quite a lot of management to be done. So quite recently we have installed a financial controller, a software manager, and a chap in charge of Orbis Computers to look after networking.

"One of the things that we have to expand enormously is our marketing ability. The Sinclair type of marketing approach is almost entirely mail order, plus one mass merchandiser. It is very simple to organise with a minimum of staff. We are now going to go into having mail order, mass merchandisers, dealerships, and direct institutional sales on quite a large scale. So our marketing side is being expanded very dramatically."

By the meagre standards of a high-technology computer company Acorn is becoming a major employer. Most of this is in design, marketing and administration. "Out of our total workforce of about 75 people only about eight or nine are actively putting things together. We do not do any assembly work ourselves except the final configuration of systems. There are four production lines making products for us in the U.K.: ICL at Kidsgrove; Race Electronics and AB Electronics in South Wales; and RH Electronics in Cambridge — about another 220 people."

Dangerous business

Acorn also has a Hong Kong supplier. "They make 50 percent of the Atoms that we build at the moment, and they are also a source of components from the Far East. We have known them a long time and can trust them not to go into Taiwan for any of those awful copies they make. We have to provide detailed listings of the operating system software to our subcontractors to enable them to do testing properly, and that is a fairly dangerous business, especially if it is going overseas."

The main reason for assembly in Hong Kong is to supply the Far East market. "The cost of shipping becomes a very

significant factor. Completed units are fairly bulky, which is why we are not desparately opposed in the long term to local assembly overseas where it is desirable on political grounds. If we can get just casing and final packaging done overseas, and ship tested boards in bulk packs, that would mean the majority of the work, in value terms, is done in the U.K."

Acorn does come up against barriers abroad. "There is a strong requirement for local assembly in an awful lot of countries; certainly in America. We have not started marketing in North America yet, but when we do we will find that in a very short time it will be in our interests to do at least some local assembly and deal very closely with an American company. In South America it is very largely required that local, or at least part local, assembly is done. Europe is OK. France is of course extremely partisan; it is difficult to sell anything into France, at least in the education field."

On the other hand Acorn has been the beneficiary of U.K. government policy, in particular the Department of Industry scheme to put one micro in every primary school. The machine had to be British. Chris Curry does not think this has helped Acorn much: "I am a free market person and absolutely against all forms of protectionism. The Americans practise it against U.K. products, incidentally, so I suppose it is only fair that there is a little bit done here. But is it beneficial? The education market for us has been quite a small proportion of our business; so far it hasn't made a lot of difference to Acorn."

The market Acorn is in would be a difficult one for an entrepreneur in any country. It is changing rapidly, with very large companies moving into it with new products and attempting to force the market towards paths that suit them. As the market stabilises around a predictable range of defined products the massive electronics production facilities in the Far East can be brought to bear on particular, attractive market segments.

Not like calculators

"If the consumer end of the personal-computer market ends up like the calculator market then I don't suppose we would bother to be in it, because there won't be any reward. I am not sure whether it will, because the software aspect of personal computers does protect it from the Far East onslaught to quite a large extent."

Apple has been making predictions of a major crisis in 1984, when all the curves on its graphs lead to an expectation of massive overproduction. Only five or six companies are expected to survive with any appreciable market presence.

Acorn emerged in the early days of small computers, the days of a general excess of demand over supply. It was a period typified by tiny companies, long waiting lists for products and forgiving, enthusiastic consumers. Chris Curry's

strategy for Acorn in the coming brave new world of computing is to concentrate on building an organisation sufficiently large and sufficiently flexible to survive.

"For the next year we will grow as much as our profits will allow us to grow — wide growth in all directions that we are technically capable of going into. Then we will select whatever sphere of operation is the best bet for us. I don't think just one, but we will select perhaps three areas to concentrate on. We will survive by having lots of strings to our bow."

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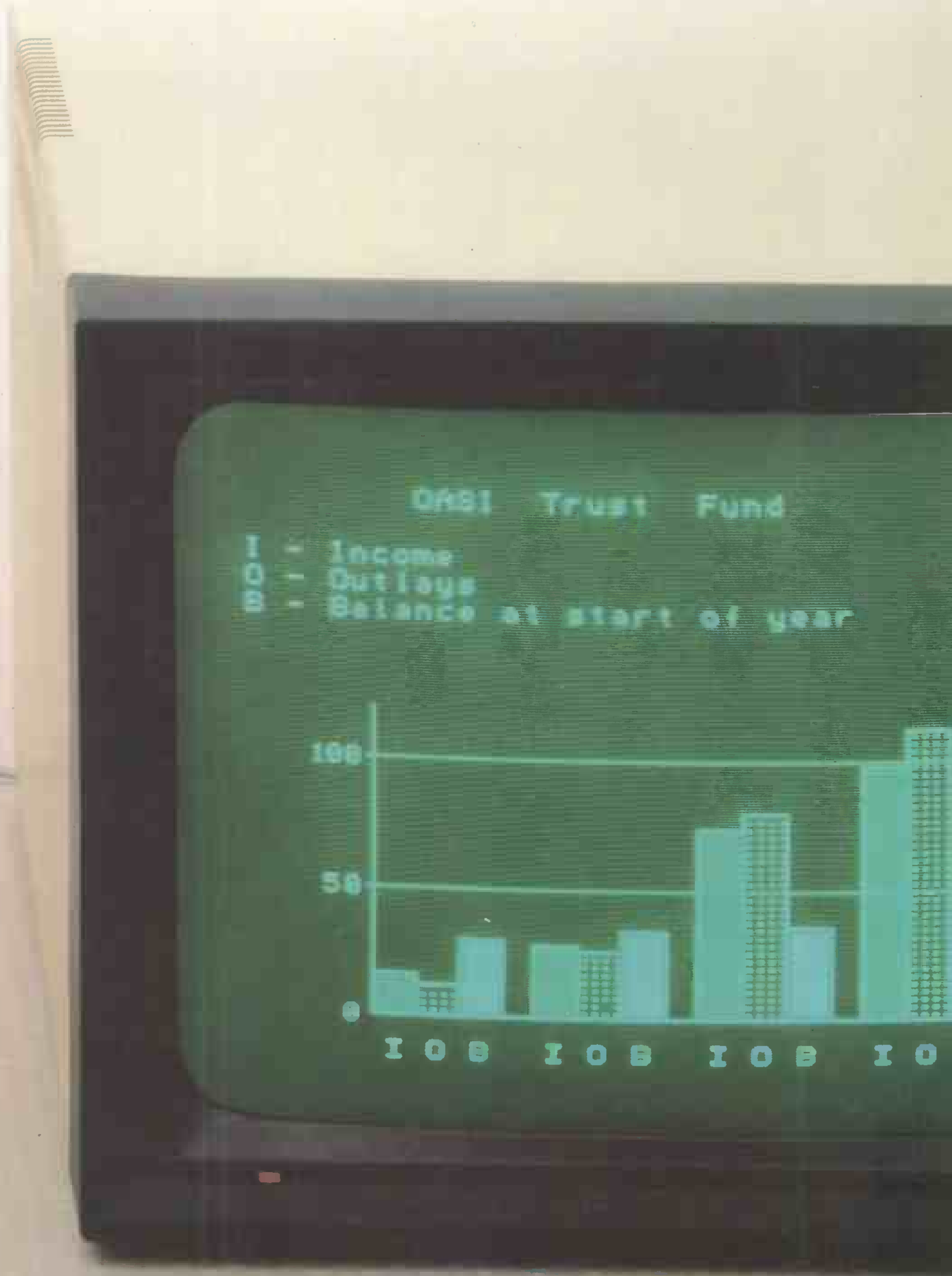

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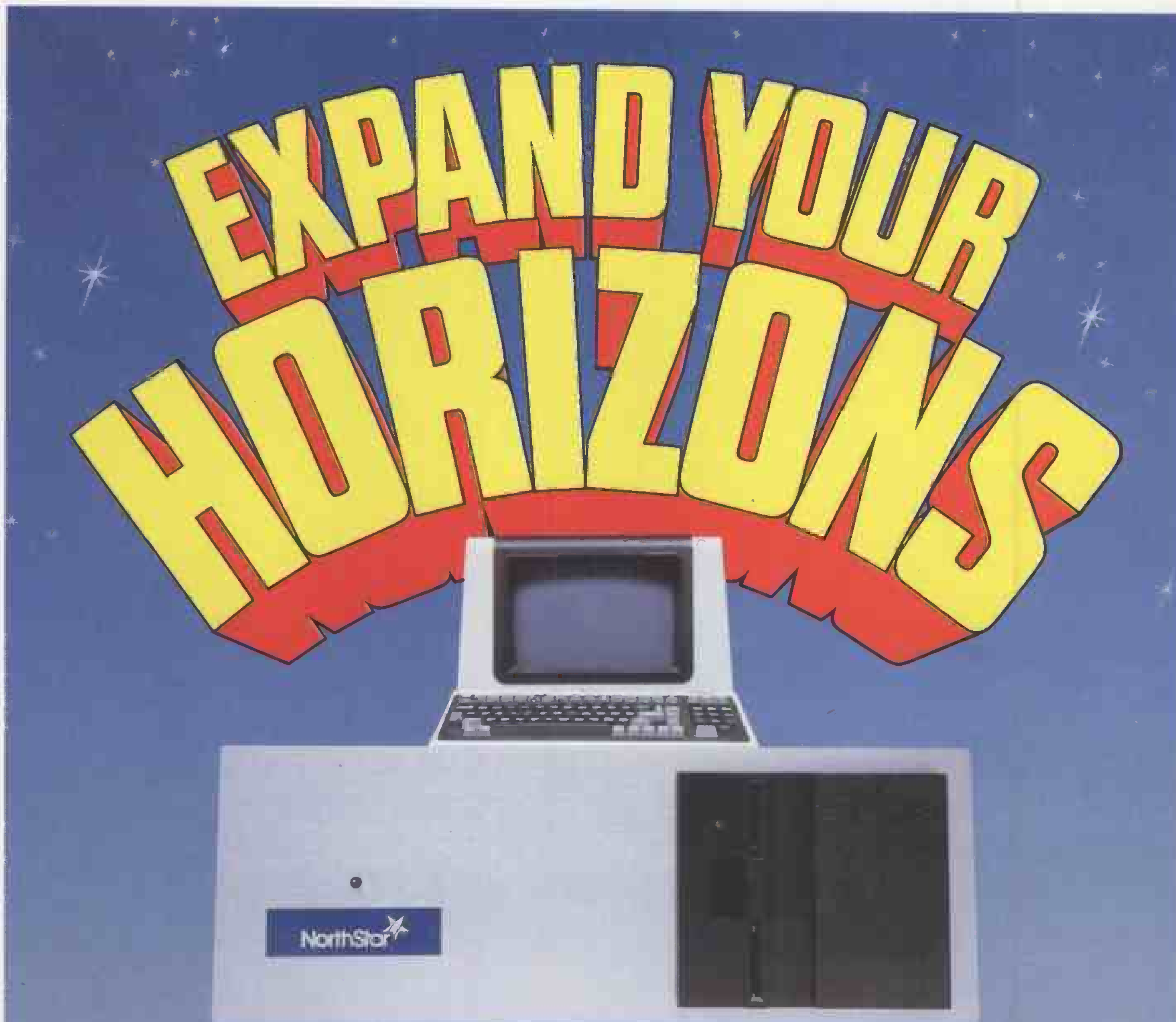

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Precise answers from random numbers

— a beginners' guide to Monte Carlo methods

Listing 1. Applesoft example program.

```
10    HOME
20    PRINT "PROGRAM TO EVALUATE THE
      DEFINITE INTEGRAL OF A FUNCTION,
      USING RANDOM NUMBERS": PRINT
30    PRINT "ENTER THE FUNCTION AS
      LINE 40 USING DEF FN F(X)= ":PRINT
40    DEF FN F(X) = EXP (X)
50    PRINT "ENTER THE LOWER LIMIT OF
      INTEGRATION" : INPUT A: PRINT
60    PRINT "ENTER THE UPPER LIMIT OF
      INTEGRATION" : INPUT B: PRINT
70    PRINT "ENTER THE LOWER VALUE FOR THE
      BOX" : INPUT C :PRINT
80    PRINT "ENTER THE UPPER VALUE FOR THE
      BOX" : INPUT D : PRINT
90    PRINT "ENTER THE NUMBER OF POINTS
      REQUIRED" : INPUT N: PRINT
100   E=0
110   FOR K=1 TO N
120   X=(B-A) * RND (1) + A
130   Y=(D-C) * RND (1) + C
140   IF Y< = FN F(X) THEN E = E + 1
150   NEXT K
160   I=(B-A) * (D-C) * E/N + C * (B-A)
170   PRINT "APPROX VALUE OF INTEGRAL =";I
      :PRINT
180   INPUT "TRY A DIFFERENT VALUE FOR
      N ?";A$
190   IF LEFT$(A$,1) = "Y" THEN GOTO 90
200   END
```

HELPING YOU to plan your summer holidays is not what this article is about. It is, in fact, an introduction to some of the numerical techniques commonly known as Monte Caro methods which use random numbers — hence the connection with the famous gambling centre of Monte Carlo.

Mathematicians have experimented with random-number techniques for several centuries. The advent of the digital computer, with its high calculating speed, meant that simulations of numerical techniques requiring vast quantities of random numbers and calculations became a practical proposition.

A project manager can, for example, estimate the likely completion time of a project containing thousands of different activities, or can gauge when a machine should be repaired, in order to keep a production line running smoothly. A nuclear engineer can use a Monte Carlo simulation to estimate the scatter of a beam of neutrons as it passes through matter.

Mathematicians later realised that Monte Carlo methods could be used to solve complex deterministic problems — meaning those which are exact, and not governed by the laws of probability. In particular, it could be useful in evaluating integrals in several dimensions, where the deterministic methods are far more complicated and require large amounts of computer memory and time.

To keep things simple, look at the evaluation of a one-dimensional definite integral of the form:

$$I = \int_a^b f(x)\,dx$$

where a and b are the lower and upper limits of integration, and f(x) is any function of the independent variable x. The problem is thus to find the area between the x-axis and the curve of the function between the limits a and b.

To evaluate I, use the simplest Monte Carlo technique, known as the "hit-or-miss" method. Plot f(x) between the upper and lower limits of integration and then box-in the curve, as shown in figure 1. Then randomly generate a series of points which must fall somewhere inside the rectangular box. The probability P of a point falling below the curve of f(x) is given by:

$$P = \frac{\text{number of points in shaded area}}{\text{total number of points in box}}$$

If the points are truly random, then P is also equal to the ratio of the shaded area to the total box area, so that

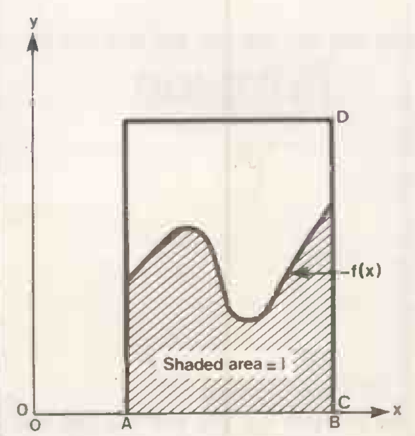
$$\frac{I}{\text{total box area}} = \frac{\text{number of points in shaded area}}{\text{total number of points in box}}$$

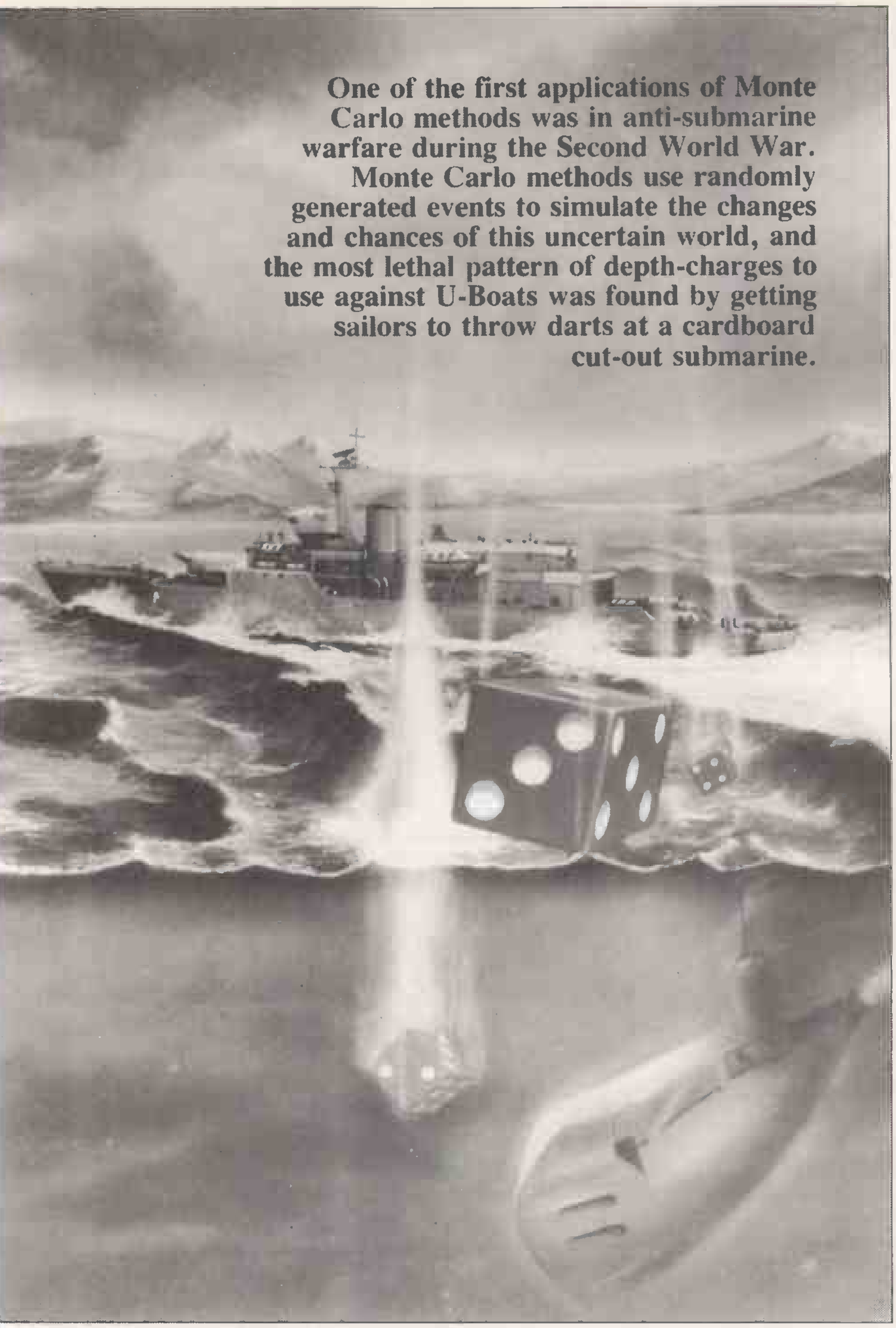
and thus

$$I = \frac{\text{total box area} \times \text{points in shaded area}}{\text{total number of points in box}}$$

A tutorial program in Applesoft Basic is shown in listing 1, and is easily adaptable for use on most machines. First define the function you wish to integrate, and this should be entered as line 40,

Figure 1.





One of the first applications of Monte Carlo methods was in anti-submarine warfare during the Second World War. Monte Carlo methods use randomly generated events to simulate the changes and chances of this uncertain world, and the most lethal pattern of depth-charges to use against U-Boats was found by getting sailors to throw darts at a cardboard cut-out submarine.

Where brute-force methods fail, an apparently unpromising approach based on random numbers is sometimes effective. William Hill shows how Monte Carlo methods can be used to solve integrals in several dimensions on a micro.

using the Basic DefFN F(X). In listing 1,

FN F(X) = EXP(X)

is used as an example.

When the program is run, it will require specification of the dimensions of the box by giving the lower and upper limits of integration, and the bottom, C, and top, D, values of the box. The program allows the extension of the box below the x-axis so that you can evaluate the integral of a function that becomes negative — a sine wave, for example. Then specify the number of points (N) that you wish to randomly generate. The For-Next loop does this and counts how many fall below the curve. The integral is then evaluated in line 160, which also subtracts any additional area below the x axis if you have specified a negative value for C.

The larger the value of N, the more accurate your estimate of I, so experiment with increasing values of N until the calculated value of I is fairly close in each case. Because random numbers are used, even if there is no change to N or the box size, slightly different values for I will occur every time the program is run. A large increase in N will only make a small improvement in the accuracy of the calculated value of I.

An alternative approach is to increase the probability P by reducing the enclosed area above the curve; thus the box shown in figure 2a should give a better estimate of I than the box shown in figure 2b for the same value of N. D can only be reduced until it either touches the curve at x=b, as in figure 2c, or touches a maximum, as in figure 2d. It means that if the area above the curve is still a significant proportion of the box area, then I will still be difficult to evaluate accurately unless N is very large. One way to reduce this problem is to subdivide the curve and integrate over several smaller intervals using different-sized boxes, as shown in figure 2e.

The estimate $\hat{P}$ of the ratio of areas P has a variance given by:

$$S^2 = \frac{P(1-P)}{N}$$

For a fixed value of N this is graphically shown as a parabolic function in figure 3.

Therefore, for a fixed value of N, if the area below the function curve is less than half of the box area, for example if $\hat{P}$=a on the graph, then the accuracy of $\hat{P}$ will be improved either by making P less than a or greater than b by changing the box shape. It is because either way you are reducing the variance in $\hat{P}$ and hence increasing your confidence in the estimate. Thus accuracy can be improved by either reducing or increasing P sufficiently, but it is often easier to increase P. Always be sure to move P, that is, I÷box area, nearer the centre of the parabola. It will usually be obvious from inspection; the box should not be defined

(continued on next page)

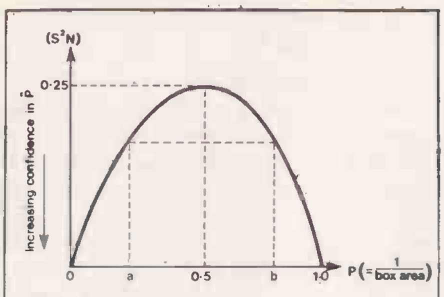


Figure 1.

(continued from previous page)
so that the function curve splits the box into two roughly equal areas.

As a specific example take the integral of exp(x) between the limits x=0 and x=1. Although the integral can be evaluated analytically, it serves well as a demonstration. The program produces typical results, shown in figure 4.

The Monte Carlo method can easily be extended for two-dimensional integrals of the form:

$$I = \int_e^f \int_a^b f(x,y)\, dx.dy$$

In this case, the box becomes three-dimensional, and the randomly generated points now have three co-ordinates instead of two. Listing 1 may be modified to do this.

Evaluating pi

The value of π may be evaluated by finding the area of a given circle and using

$$\pi = \text{area} \div \text{radius}^2$$

In fact, you can use a quadrant of radius 1, and define the box as a square with sides of length 1. If the program is run using the equation for a circle of radius 1 with centre at the origin, then

$$f(x) = (1 - x^2)$$

and the area I of the quadrant can be determined. Since

$$\pi = 4I \div r^2$$

then π=4I. The program gives typical estimates for π, shown in figure 5.

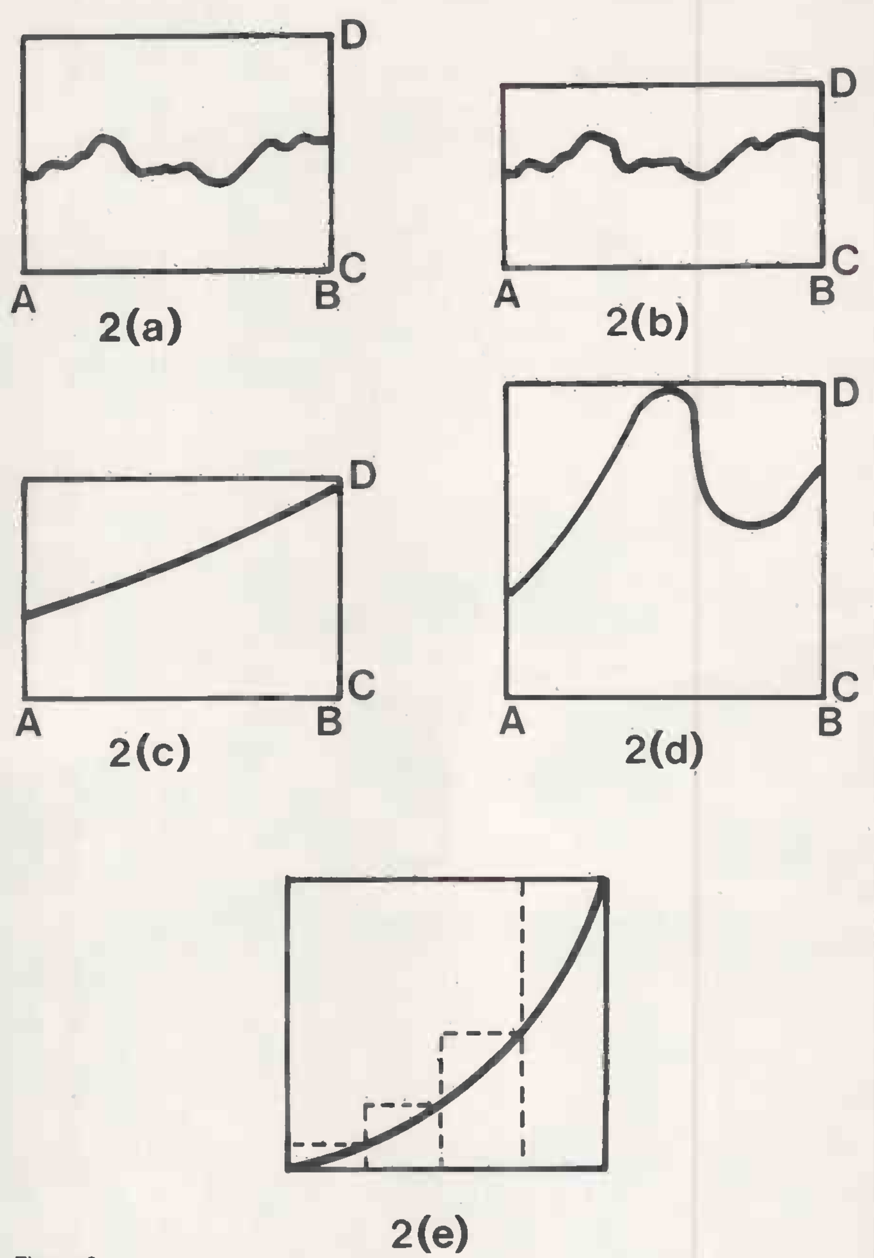


Figure 2.

Figure 4.
Box: A = 0, B = 1, C = 0, D = 3

N	I	Approximate time taken (s.)
10	1.20	1
100	1.86	5
500	1.716	26
1,000	1.704	53
10,000	1.7325	526

For comparison, the actual value of this integral is 1.7183 to four decimal places.

Figure 5.

N	π
10	3.2
100	3.16
500	3.232
1,000	3.088
10,000	3.1632
50,0000	3.1412

For comparison, the actual value of π is 3.1416 to four decimal places. The routine took 11 hours to complete.

The time taken by the Applesoft interpreter for an accurate Monte Carlo evaluation of an integral is too long for serious use. A large saving could be made by using machine code, a compiling language such as Fortran, or by using a powerful mainframe computer.

If these facilities are available, then millions of random numbers can be generated very quickly, and complex multi-dimensional integrals can be evaluated accurately. A routine for determining the box size, by finding the maxima and minima of the function, and its values at x=a and x=b, can also be added to improve the program.

Further reading

Numerical Analysis by A M Cohen, McGraw-Hill (1973)

Monte Carlo Methods by J M Hammersley and D C Handscomb, Methuen (1964)

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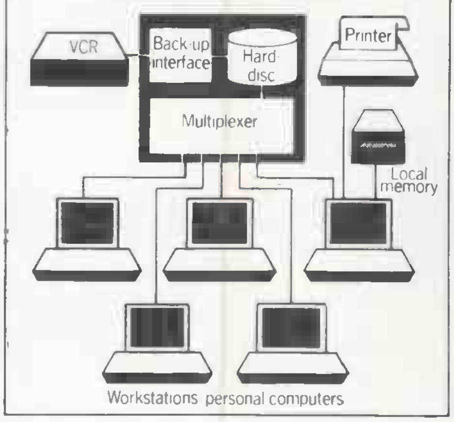

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Compiled or interpreted Applesoft?

Basic has traditionally been an interpreter-based language. It is stored more or less as it is written: the interpreter must seek the required Basic command and initiate the machine-language operation. A compiler can convert the program operations into machine code, so that when the program is called it will be executed much faster. Roger Hill compares two Apple compilers.

A CONVENTIONAL Apple II computer has within its ROM a Basic interpreter which converts Basic instructions into the machine-language operations necessary to produce the desired operations within the 6502 microprocessor. Since Basic was introduced in the 1960s to make computer power available to the programming novice it has been increased in power, and in the Apple II the extended form of Basic known as Applesoft is used.

Lines of code

Applesoft Basic provides a relatively sophisticated capability for manipulating data coming into the computer, generating information displays, and moving data with the help of the disc-operating system to and from disc drives or peripheral devices such as printers. Basic has traditionally been an interpreter-based language. When a program is typed into the computer it is then stored in RAM. From there it can be dumped on a cassette of magnetic tape or on magnetic disc for long-term storage. In both cases it is stored more or less as written, and a List command passes the program characters back to the monitor for display. When the program is run the interpreter looks at each line of Basic code and decides what has to be done.

For instance, say the program has a command

```
150 PRINT M
```

The value of M may have been evaluated earlier in the program, and a numerical value may be stored in memory. The Basic interpreter has to look along the line until it finds the word Print, decide that this is a Basic command and then initiate the machine-language operation which takes the numerical value of M and causes it to be printed on the monitor screen.

If the command is of the form

```
200 PRINT "NUMBER OF PEOPLE=";M
```

then the interpreter has to recognise that the characters between the quotation marks have to be transferred directly to the monitor screen. The semicolon tells the interpreter to print the value of M directly after the character string so that if M is equal to 150

```
NUMBER OF PEOPLE = 150
```

appears on the monitor screen.

A compiler works in a different way: it operates on the Basic program source code to do part of the work of interpretation before use, converting the program operations into machine code. When the compiled program is BRun or Called at a later date the machine code is already prepared and the program is executed much faster.

A machine-code program produced from Basic without the effort of undertaking assembly-language programming clearly has considerable attractions, but compilers can have certain drawbacks too. With this in mind two commercially available compilers were examined: the Hayden Applesoft Compiler and the Speedstar Compiler by Southwestern Data Systems.

The first advantage of any compiler is an increase in the speed of program execution. Though this may be desirable you have first to be sure that faster execution is what you need. Increasing the operating speed of a video game written in Basic may have the effect of making it so fast that it is impossible to play. Compiler manuals state that speed increases of from two times to 20 times are possible, depending on the type of program in use.

Program code is much more secure when it is compiled into machine code, which may be important if you have sensitive data in the computer such as pay rates or personal information. Compiled information cannot easily be listed and examined.

The two compilers were tested using Brian's Theme, a graphics demonstration program supplied with the Apple II. Speedstar produced a compiled code which was a little longer, \$1D88, than the Hayden's compiled code, \$153D. Both produced a speed increase of about 1.8 times, though both manuals claim the minimum speed increase to be two times.

One of the disadvantages of compilers is that the code becomes not more compact, as you might expect, but less compact. The memory requirement of the compiled code is generally twice that of the uncompiled code, which may or may not offset the advantages provided by the speed increase. Though this may not be particularly important for small programs, it can be critical for larger ones.

If Speedstar runs out of memory during compilation an option can be invoked which sends compiled code straight to disc and then reloads it when compilation is complete. In this way the Basic source code can be overwritten and memory space conserved. Another Speedstar option uses a segmented version of the compiler which is loaded in sections so that less compiler resides in memory at any one time. The Hayden compiler solves this problem by loading the compiler into the space normally occupied by the disc-operating system.

Modular solution

If space remains a problem the user must break down the source code into modules and each module must be compiled separately with calls between modules. Of course, complete compilation of the source code may not be necessary. The desired speed increase might be obtained by compiling a particular algorithm within the source program, and both compilers provide this option. In this case the compiled code would need to be BLoaded and then Called from within the uncompiled Basic main program.

Applesoft statements not supported.

Hayden:	Speedstar:
Lomem	Resume
Trace	List
NoTrace	Load
Store	Cont
Recall	Store
ShLoad	Save
	Del
	Recall

The Hayden compiler is supplied in a large A4 folder with two copies of the compiler disc, one intended for back-up. The 26-page manual provides an adequate explanation of how to run the compiler. The disc is copy protected, and because the compiler is loaded into the space normally occupied by Dos, the disc-operating system must, presumably, be truncated.

The compiler auto-runs at switch-on or following a Dos boot, displaying a request for the file name and the source program slot, disc drive and volume. The compiler then sets about its task of com-

(continued on next page)

Listing 1.

```
10  REM  STRING MANIPULATION TEST
20  HOME
30  INPUT "HIT A RETURN TO BEGIN TEST";X$
105 TEST$ = "A"
140  FOR COUNT = 0 TO 250
150 X$ = X$ + "*"
160 Y$ = Y$ + "*"
170 Z$ = Z$ + "*"
180  NEXT COUNT
201  VTAB 12: HTAB 15: PRINT "                    ";
205 TEST$ = "B"
210  DIM X$(20),Y$(20),Z$(20)
220  FOR COUNT = 0 TO 19
230 X$(COUNT) = X$
240 Y$(COUNT) = Y$
250 Z$(COUNT) = Z$
255  GOSUB 2000
260  NEXT COUNT
301  VTAB 12: HTAB 15: PRINT "                    ";
305 TEST$ = "C"
307  FOR COUNT = 1 TO  LEN (X$) - 1
310 X$ =  LEFT$ (X$, LEN (X$) - 1)
320 Y$ =  LEFT$ (Y$, LEN (Y$) - 1)
330 Z$ =  LEFT$ (Z$, LEN (Z$) - 1)
335  GOSUB 2000
340  NEXT COUNT
1000  PRINT "TEST COMPLETE"
1010  END
2000  REM  ROUTINE TO DISPLAY CURRENT TEST AND COUNT
2010  VTAB 12: HTAB 15
2020  PRINT TEST$,COUNT;
2030  RETURN
3000  REM
3010  PR# 1
3020  LIST
3030  LIST
3050  PR# 0
3060  END
```

(continued from previous page)
pilation. Messages are displayed intermittently to say what operation is under way, involving some interaction between computer and disc drive. When the compilation is complete the binary file can be BSaved on the appropriate disc.

The Speedstar compiler disc is supplied in a 54-page A5 folder together with a data key. The Speedstar disc is not copy protected, which is reassuring, but Speedstar cannot be run unless the data key is inserted in the game-paddle socket. Though data keys can be a nuisance, this one takes only a few seconds to instal and is then transparent to the user. Nevertheless it would be a bind if data keys proliferated with software packages, each one different.

Speedstar will run by a Dos boot or using BRun Speedstar. The compiler loads below Dos in memory and moves Himem down. The appropriate program can be loaded and a series of commands following an & will initiate a compilation. When compilation is finished the compiled code has to be BSaved.

The compilers were tested on a longer program which uses disc I/O as well as string manipulation. Computer memory is critical, but the Hayden compiler was able to compile in place. The Speedstar compiler did not have sufficient memory available, though compilation was successful when a Compile to Disc option was invoked. On another occasion Speedstar ran short of memory while doing a Compile to Disc but the compilation was successful when the compilation was done using the segmented version of Speedstar.

When the compiled code was run, both programs failed, possibly as a result of the use of Onerr statements. The Hayden compiler produced three operational errors in the compiled code compared to one for Speedstar.

Having compiled a longer program, it is clear that for longer programs the compilers must be regarded as tools to be used during program development, as the source code may need to be tailored to the compiler performance. You cannot expect to take a large fully developed software package and speed its operation with a compiler. A long program may be too long to compile in one piece in any case, and if it will compile it may still fail to run properly. If you want to compile developed source code you must be prepared to modify the code, in which case you need to know something of how it operates.

Some speed improvement is possible for sections of all programs but disc I/O tasks are not speeded significantly. Any program doing a large amount of disc I/O operations, such as a database-management program, will not benefit significantly from compilation. Programs using output to the monitor do not significantly increase in speed.

Two specific test programs were run using the compilers, the first of which was a concatenation program — see listing 1. Using the Hayden compiler the program compiled but gave an out of memory message when BRun, and despite various changes the program never executed successfully.

Speedstar compiled and executed successfully with a compiled code of 2.5 K from an original program code length of 1,580 bytes. Execution time for the Speedstar compilation was reduced from 19 seconds to 14 seconds. The concatenation operated without printout of strings and it appears that time saving on string manipulation is not large.

A short sine-wave generation program, listing 2, with and without data being printed to the monitor, was used to assess the compilers' number-crunching abilities. With data printed to the monitor, Speedstar reduces the execution time from 87 to 62 seconds. Without data going to the monitor, execution time drops from 58 to 32 seconds, and a source code of 1,400 bytes becomes 2,300 bytes. The Hayden compiler performs well on this test, with identical execution times to Speedstar and compiled code 100 bytes shorter.

Compilers appear useful utilities to back up the process of program development, providing a degree of protection

Listing 2.

```
20  FOR N = 1 TO 1000
30 X =  SIN (2 * 3.14159 * N / 1000)
40  PRINT X
50  NEXT
60  PRINT "FINISHED"
70  END
100  REM
105  PR# 1
110  LIST
120  LIST
130  LIST
135  PR# 0
140  END
```

for machine-language software. They will provide some reduction in execution time for most programs, but their impact on programs with heavy disc I/O operations is small, and the concatenation process is not speeded up to any large extent. Significant speed increases can be achieved with other calculation operations; complex array manipulations may yield greater speed increases.

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LEN K + LIST SCREEN $
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ENTER
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The ZX Printer – available now

Designed exclusively for use with the Sinclair ZX range of computers, the printer offers ZX Spectrum owners the full ASCII character set – including lower-case characters and high-resolution graphics.

A special feature is COPY which prints out exactly what is on the whole TV screen without the need for further instructions. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your ZX Spectrum. A roll of paper (65ft long and 4in wide) is supplied, along with full instructions. Further supplies of paper are available in packs of five rolls.

The ZX Microdrive – coming soon

The new Microdrives, designed especially for the ZX Spectrum, are set to change the face of personal computing.

Each Microdrive is capable of holding up to 100K bytes using a single interchangeable microfloppy.

The transfer rate is 16K bytes per second, with average access time of 3.5 seconds. And you'll be able to connect up to 8 ZX Microdrives to your ZX Spectrum.

All the BASIC commands required for the Microdrives are included on the Spectrum.

A remarkable breakthrough at a remarkable price. The Microdrives are available later this year, for around £50.

RS232/network interface board

This interface, available later this year, will enable you to connect your ZX Spectrum to a whole host of printers, terminals and other computers.

The potential is enormous. And the astonishingly low price of only £20 is possible only because the operating systems are already designed into the ROM.

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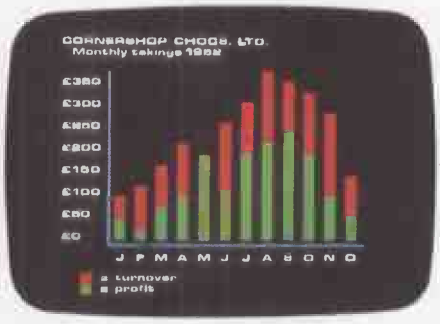
ZX Spectrum software: how good and how soon?

The ZX Spectrum uses an enhanced version of Sinclair BASIC, fast becoming a world standard, and unlikely to be superseded. Unique features, such as one-touch keyword entry and syntax check and report, are increasingly attracting software originators.

Building the software library is already far advanced, and a complete catalogue will be available in the next few months. Subjects will include sophisticated games, education, 'housekeeping', and business management. The more complex packages can, of course, be used to their best advantage with the full 48K RAM version of the ZX Spectrum.

The Sinclair ZX Spectrum can handle sophisticated games programs with high-resolution colour graphics and sound.

This major advance in computer technology maintains Britain's world-beating position in the field of personal computers.



A range of business software will soon be available, covering both specific applications (eg stock-control and payroll) and general business management systems (eg matrix models).

This second generation of Sinclair personal computers demonstrates continuing commitment. Advanced technology made the ZX80/81 family a price breakthrough: advanced technology makes the ZX Spectrum a breakthrough in price and performance.

Elegant, effective, unique—the ZX Spectrum design.

'Less than half the price of its nearest competitor – and more powerful.'

'These two pictures show how it's done. On the right is the PCB from the BBC Model A Microcomputer. On the left is the PCB from the ZX Spectrum.

'It's obvious at a glance that the design of the Spectrum is more elegant. What may not be so obvious is that it also provides more power.

'The ZX Spectrum has more usable RAM, and higher maximum RAM.

'It offers twice as many colours on the screen at any one time, plus a colour brightness control. It also offers user-definable graphics.

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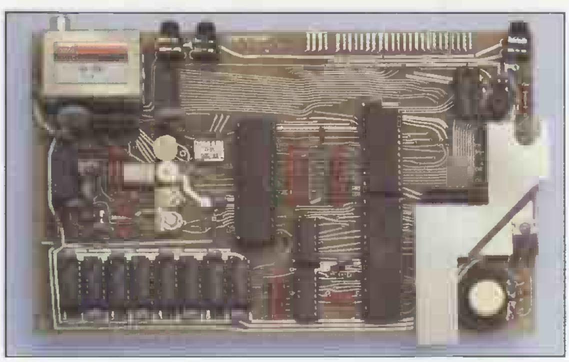

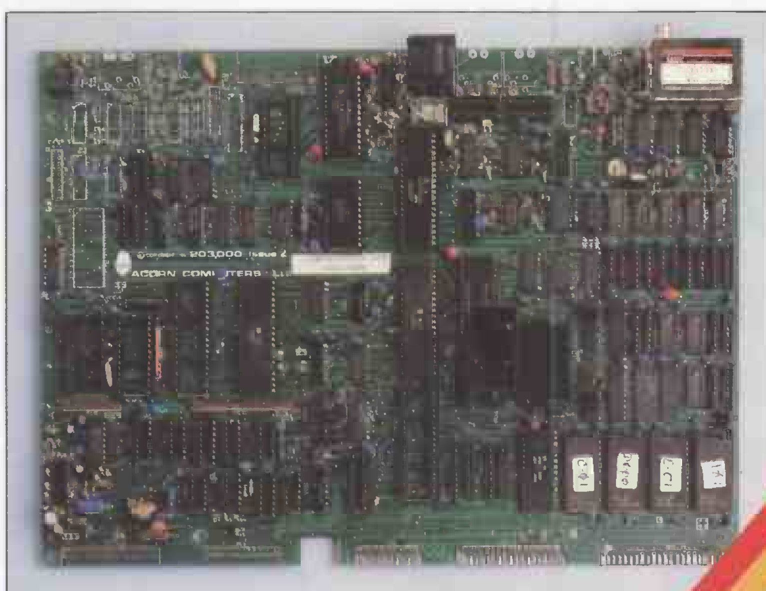

Above left: internal layout of Sinclair ZX Spectrum.

Right: Internal layout of BBC Micro Model A.

The illustrations are to the same scale, and demonstrate the rate of advance in microcomputer design. The ZX Spectrum uses just 14 chips to provide more power and more user-available RAM.

sinclair ZX Spectrum

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BBC Microcomputer achieves complex graphics

Although it is not at first apparent, the BBC Microcomputer has graphics facilities that lend themselves to paging. T K Cowell shows that, with the right information, complex images can be turned on or off or interchanged instantaneously. The commands Write, Display and Erase are capable, with special treatment, of setting up pages.

GRAPHICS PAGING is the name given to a technique in which two or more images are stored in graphics memory and manipulated so that they can be displayed or modified independently of one another. By this means, complex images can be turned on or off or interchanged instantaneously to provide a rapid change of displayed information, or to simulate movement.

The BBC Microcomputer's graphics facilities are very flexible, and readily enable paging, although the graphics commands required may not be particularly obvious. The paucity of information in the provisional handbook and the publication elsewhere of erroneous information does not help matters.

Essential conditions

A prerequisite for paging is that there is more than one bit available to define each graphics element or pixel, so modes 1, 2 and 5 are the only ones suitable for paging. Moreover, paging uses the pixel bits in such a way that the normal range of colours available is reduced for a particular mode.

In paged graphics, the three distinct operations of Write, Display and Erase each require a somewhat different treatment to that in simple graphics. To write an image to a particular page requires that one specific bit in each pixel involved in the image be set. In mode 1 or mode 5 there are two bits per pixel, so two pages are available. Table 1 shows the pixel bit

Colour	Colour number	bits set
Black	0	00
Red	1	01
Yellow	2	10
White	3	11

Table 1. Foreground colour bit patterns in mode 1 and mode 5.

patterns corresponding to the default colours for mode 1, showing that the only combinations available for paging are colours 1 and 2.

It is convenient to think of these logical colours as corresponding to pages 1 and 2. In practice, each of these logical colours can be related to an actual colour via the VDU 19 statement so that, for example, when they are displayed they each produce a white image.

The required page-write operation is effected by the process of logically Oring new data with that which may already exist in the pixels written to, due to an image on the other page. Thus the statement

GCOL1,2

followed by the necessary plotting commands would write to page 2 — logical colour 2 — without affecting bits stored in page 1.

Figure 1 illustrates the process, showing the pixel bit patterns for a small part of screen memory containing lines on each page which cross one another. If

GCOLO,2

had been used, the whole of each pixel written to would be redefined, resulting in loss of any page 1 points sharing the page two pixels.

Once a page is written, it can be either displayed or hidden by making use of the logical/actual colour relation control via the VDU 19 driver statement. Thus, to display page 1 only, use

VDU 19,1,7;0; (setting page 1 to white)
VDU 19,2,0;0; (setting page 2 to background)

Actually this would not be quite enough, since those pixels containing bits set for both pages would not be displayed unless logical colour 3 were also set to foreground with

VDU 19,3,7;0;0;

However, since this is the default assignment, it would normally occur automatically. With images written to both pages, use of appropriate logical/actual colour definitions can produce displays corresponding to the combination of the two images, or of only their common points. For example, assuming that colours 1 and 2 had been set to background by VDU 19 statements,

VDU 19,3,7;0;

will display only those pixels common to both images, whereas

VDU 19,1,7;0;19,2,7;0;

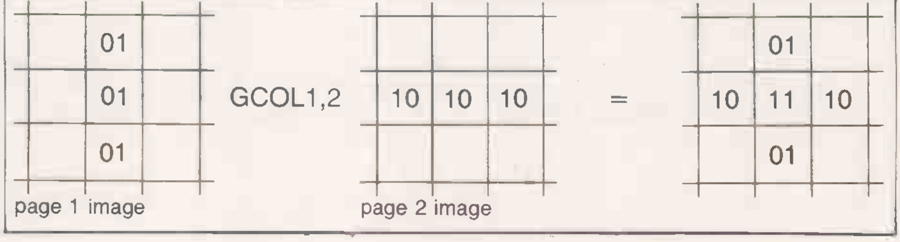
will superimpose the two images except where they coincide, unless

VDU 19,3,7;0;

is effective.

(continued on next page)

Figure 1. Oring a second image into the display.



Program 1.

```
10 REM SIMPLE MOVING SHAPE
20 MODE 1
30 A=1:B=2:P=4
40 VDU 19,A,0;0;
50
60 REPEAT
70   REM DRAW IMAGE
80   GCOL 1,A
90   PROCDRAW(P)
100
110   REM CHANGE DISPLAYED PAGE
120   VDU 19,A,7;0;
130   VDU 19,B,0;0;
140
150   REM ERASE IMAGE
160   GCOL 2,A
170   PROCDRAW(P-4)
180
190   C=A:A=B:B=C
200   P=P+4
210   UNTIL P>1055
220 END
230
240 DEF PROCDRAW(Q)
250 MOVE Q,Q
260 PLOT 0,150,0
270 PLOT 81,-70,-50
280 ENDPROC
```

Program 2.

```
10 REM 3DHOUSE
20 *FX11,0
30 DIM T(119,1),Q(50,2,2)
40 MODE1:VDU29,640;512;
50
60 REM LOOK-UP TABLE FOR SINE & COS
70 FOR I=0 TO 119:T(I,0)=SINRAD(I*3)
80   T(I,1)=COSRAD(I*3)
90   NEXT I
100
110 ALWAYS=TRUE:C=2:D=1
120 GOSUB 710
130
140 REPEAT
150   REM READ CONTROL KEYS
160   V=VAL(INKEY$(1))
170   ON V+1 GOSUB 570,560,590,620,630,
      650,660,680,690,710
180
190   REM COMPUTE IMAGE DATA
200   GOSUB 360
210
220   REM DRAW IMAGE
230   GCOL 1,D
240   PROCDRAW(D)
250
260   REM CHANGE DISPLAYED PAGE
270   VDU 19,D,7;0;19,C,0;0;19,3,7;0;
280
290   REM ERASE IMAGE
300   GCOL 2,D
310   PROCDRAW(C)
320
330   E=C:C=D:D=E
340   UNTIL ALWAYS=FALSE
350
360 REM COMPUTE & STORE IMAGE DATA
370 FOR I=1 TO 36
380   READ Q(I,0,D),X,Y,Z
390   P=(ZO+S*(X*T(NR,0)-Z*T(NR,1)))/S2
400   Q(I,1,D)=(X*T(NR,1)+Z*T(NR,0))/P
410   Q(I,2,D)=Y/P
420   NEXT I
430 RESTORE
440 RETURN
450
460 DEF PROCDRAW(H)
470 REM DRAW IMAGES
480 FOR I=1 TO 36
490   PLOT Q(I,0,H),Q(I,1,H),Q(I,2,H)
500   NEXT I
510 ENDPROC
520
530 REM SUBROUTINES TO MODIFY IMAGE
540 REM SIZE, ORIENTATION, ETC.
550
560 NR=NR-1:IF NR<0 THEN NR=120+NR
570 RETURN
580
590 NR=NR+1:IF NR>119 THEN NR=NR-120
600 RETURN
610
620 ZO=ZO*.95:RETURN
630 ZO=ZO/.95:RETURN
```

(listing continued on page 101)

(continued from previous page)

Erasing a page is perhaps not quite so straightforward as you might expect, since the clear graphics command is effective on all graphics data, and cannot be specific to one colour only. The problem is overcome by rewriting the image to be erased to the other page, Anding it with the existing graphics data. Thus

GCOL2,2

followed by the plotting statements corresponding to the page 1 image will result in the elimination of all page 1 bits, a process shown diagrammatically in figure 2.

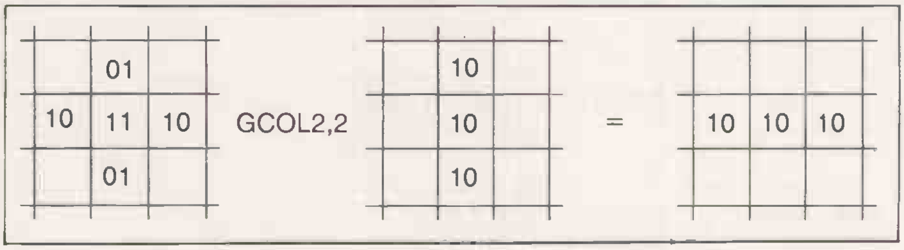
The separate processes are brought together in program 1, which demonstrates the simulation of movement. A small triangular shape is generated by ProcDraw, its position on the screen set by the value of P via Procedure parameter Q.

Initially, with P=4, A=1, the first image is drawn bottom left on page 1 in background, then displayed. On the first pass, the Erase function is redundant, and execution passes to an interchange of A, B page values and an increment to P. The process then repeats, with new images drawn on alternate pages and each previous image erased.

With such a simple image, no computation is involved other than incrementing the position co-ordinates. For more complex moving images — for example a wire-frame representation of a three-dimensional object — all the image points have to be computed each time an image plot is carried out. This would necessitate separate Erase and Write computations for each image display, and would be unnecessarily time consuming.

Instead, the computed image data may be stored in an array, which is then used to generate and subsequently erase images. The array needs to be three dimensional to hold the two pages, each of which contains a set of co-ordinate data for every point of the stored image.

Figure 2. Logical Anding to erase an image.



Program 2 provides a paged display of a simple outline representation of a house, with facilities to zoom, rotate about a vertical axis and change perspective. Operation of the program is similar in principle to the previous one, with some extra facilities added. Initially a look-up table of sines and cosines is generated and stored in array T. Then, with all variables set to initial values execution passes to checking the value of any control key that may be pressed.

Final displays

Assuming no key is pressed on this first pass, the Repeat-Until loop generates the paged displays much as in the previous example, but in this case the images for the two pages are produced using the subroutine and ProcDraw for generating and plotting the image data stored in its raw state in the data statements, processed to take account of rotation.

Execution continues around the loop, when if keys 1 or 2 are pressed subsequent images are rotated about a vertical axis in 3° increments. Keys 3 and 4 produce a zoom effect, changing both the size and perspective of the image, and keys 5 and 6 modify the perspective without changing the size of the image. Keys 7 and 8 turn perspective off and on, and the

(continued on page 101)

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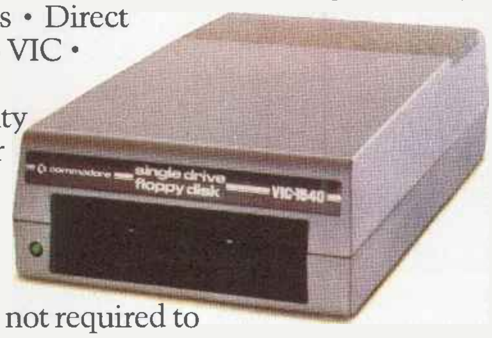

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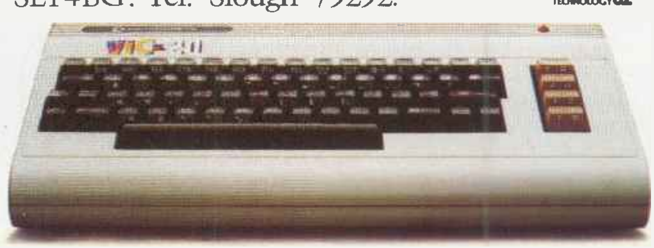

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(listing continued from page 94)

```
 640
 650  S=S*.7:RETURN
 660  S=S/.7:RETURN
 670
 680  S=0:RETURN
 690  S=1:RETURN
 700
 710  Z0=20:NR=0:S=1:S2=5000
 720  RETURN
 730
 740  REM DATA FOR IMAGE POINTS
 750
 760  REM WALLS
 770  DATA 4,1,1,1,5,1,-1,1,5,-1,-1,1
 780  DATA 5,-1,1,1,4,1,1,-1,5,1,-1,-1
 790  DATA 5,-1,-1,-1,5,-1,1,-1
 800  DATA 4,1,-1,-1,5,1,-1,1
 810  DATA 4,-1,-1,-1,5,-1,-1,1
 820
 830  REM DOOR
 840  DATA 4,-.2,-1,1,5,-.2,0,1
 850  DATA 5,.2,0,1,5,.2,-1,1
 860  DATA 69,-.15,-.5,1
 870
 880  REM ROOF
 890  DATA 4,-1.1,1,1.1,5,1.1,1,1.1
 900  DATA 5,1.1,1,-1.1,5,-1.1,1,-1.1
 910  DATA 5,-1.1,1,1.1,5,-.8,1.5,0
 920  DATA 5,.8,1.5,0,5,1.1,1,1.1
 930  DATA 4,-.8,1.5,0,5,-1.1,1,-1.1
 940  DATA 4,.8,1.5,0,5,1.1,1,-1.1
 950
 960  REM WINDOW
 970  DATA 4,1,0,.5,5,1,.5,.5
 980  DATA 5,1,.5,-.5,5,1,0,-.5
 990  DATA 5,1,0,.5,4,1,0,0
1000  DATA 5,1,.5,0
```

Program 3.

```
 10 REM SPINNING PROPELLER
 20 MODE 2
 30 DIM A(3,5):VDU29,640;511;
 40
 50 PROCSETWHITE
 60 PROCCALC
 70 PROCDRAW
 80
 90 REM TURN ON EACH PAGE IN TURN
100 REM VARY SPEED WITH KEYS 1-8
110 REM KEY 9 TO END
120 REPEAT
130   FOR I=0 TO 3
140     VDU 19,A(I,3),7;0;
150     VDU 19,A(I,2),0;0;
160     TIME=0
170     DELAY=VAL(INKEY$(1))*5
180     REPEAT UNTIL TIME>DELAY
190     NEXT I
200   UNTIL DELAY>40
210 END
220
230 DEF PROCCALC
240 FOR I= 0 TO 3
250   A(I,0)=500*COS(PI*I/8+PI/32)
260   A(I,1)=500*SIN(PI*I/8+PI/32)
270   A(I,4)=500*COS(PI*I/8-PI/32)
280   A(I,5)=500*SIN(PI*I/8-PI/32)
290   NEXT
300 ENDPROC
310
320 DEF PROCDRAW
330 FOR I=0 TO 3
340   VDU19,A(I,3),0;0;
350   GCOL1,A(I,3)
360   MOVE-A(I,0),-A(I,1)
370   DRAW-A(I,4),-A(I,5)
380   PLOT 85,0,0
390   MOVE A(I,4),A(I,5)
400   PLOT 85,A(I,0),A(I,1)
410   MOVE-A(I,1),A(I,0)
420   DRAW-A(I,5),A(I,4)
430   PLOT 85,0,0
440   DRAW A(I,5),-A(I,4)
450   PLOT 85,A(I,1),-A(I,0)
460   VDU19,A(I,2),0;0;
470   NEXT I
480 ENDPROC
490
500 DEF PROCSETWHITE
510 FOR I=0 TO 3
520   READ A(I,2),A(I,3)
530   NEXT
540 ENDPROC
550
560 DATA 8,1,1,2,2,4,4,8
```

(continued from page 94)

image is reset to initial conditions if key 9 is pressed.

Extra controls could be added to this program, say to produce additional image rotation or translation, but would increase computation time and therefore the time between displaying of successive images. In the previous example, the speed with which the display can be paged is restricted by the time taken to compute the co-ordinates of every point of the image each time a page is drafted. This is necessary because the user could specify variations of orientation, perspective, etc., giving rise to a virtually indefinite number of image possibilities.

Spectacular speed

If the number can be limited to the number of pages available, no inter-page computation need be involved, and quite spectacular speed of movement can be simulated. The effect is demonstrated in this example, where mode 2 is used to provide the four independent pages — 1,2,4 and 8 — available from its 16-colour capability, albeit at reduced resolution compared with mode 1.

In program 3, ProcSetWhite defines each logical colour as white. ProcCalc then generates a set of co-ordinates which, associated with page numbers derived from the data statement, are stored in array A. ProcDraw uses this information to draft a four-blade propeller shape on four pages, successive images being rotated by 22·5°. The main segment of the program then loops around the Repeat-Until loop, turning each page on for a time determined by the numeric key pressed, thus varying the apparent speed of the propeller.

Colour number	Bits set
0	0000
1 page 1	0001
2 page 2	0010
3	0011
4 page 3	0100
5	0101
6	0110
7	0111
8 page 4	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111

Table 2. Foreground colour-bit patterns in mode 2.

Using similar methods, quite complex images can be changed very rapidly. As in the case for two pages, it is necessary to account for shared pixels if there are not to be odd effects in the images where more than one page shares the pixel. Inspection of the bit patterns shows that in four-page mode each page has a further seven logical colours associated with it if all intersections are to be allowed for.

Mixed text and graphics

In the propeller program the only intersections are at the centre, where it is not a problem, but other applications might require an appropriate set of VDU 19 statements. For the four-page mode, the pixel bit patterns are listed in table 2, from which it can be seen for example, that page 1 requires colours 3, 5, 7, 9, 11, 13 and 15 to be set to foreground, whereas the fourth page, logical colour 8, also requires colours 9 to 15 to be set.

The display technique used in these examples is also applicable to text or mixed text and graphics displays. Routines similar to program 2, where appreciable inter-page computation is involved, are probably the most useful; they can be substantially speeded up by the use of integer arithmetic. In the example, by appropriate rescaling of the image computations, the trigonometric tables could be held in integer form. Some assembly-language programming would help even more, particularly if 16-bit integer arithmetic were invoked in place of the interpreter's 32-bit manipulations.

DECIS

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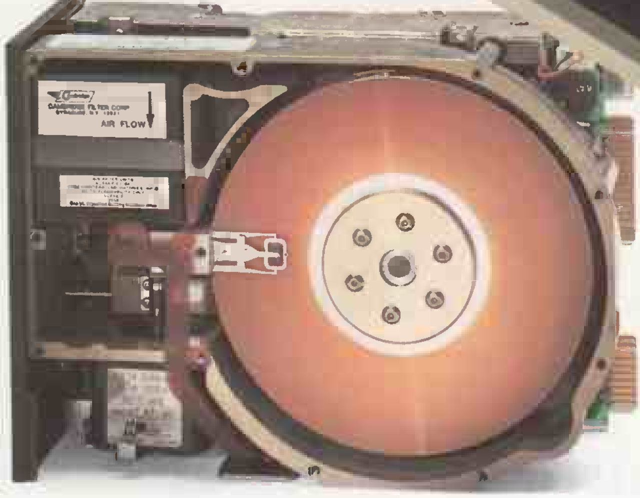

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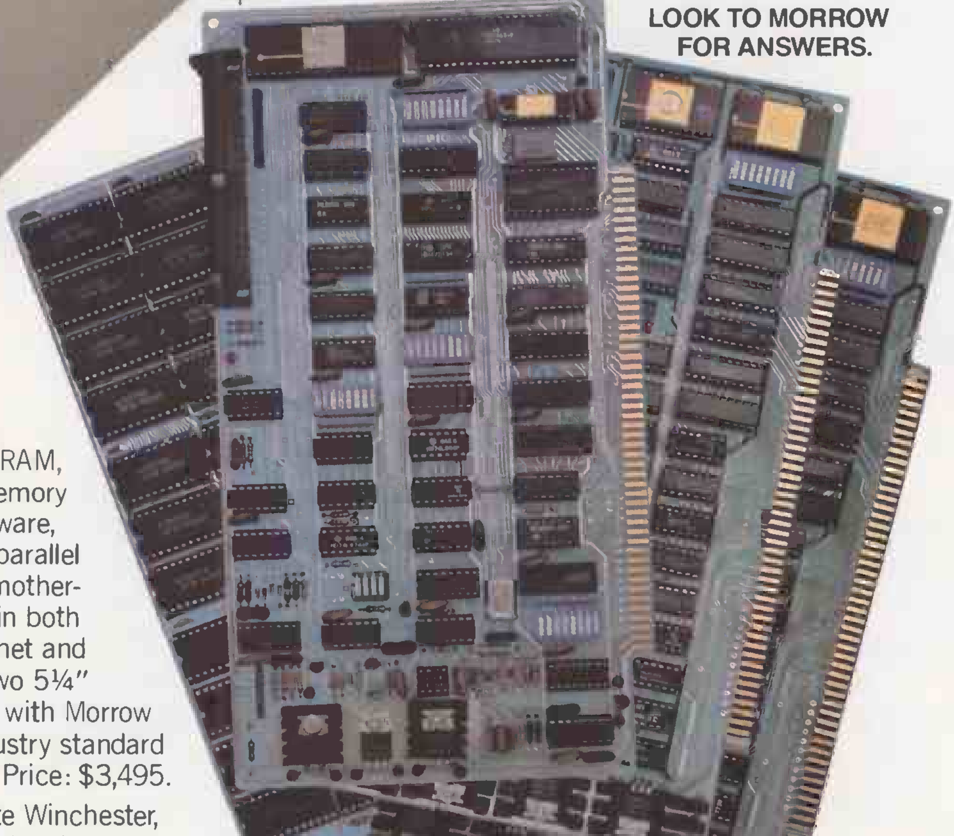

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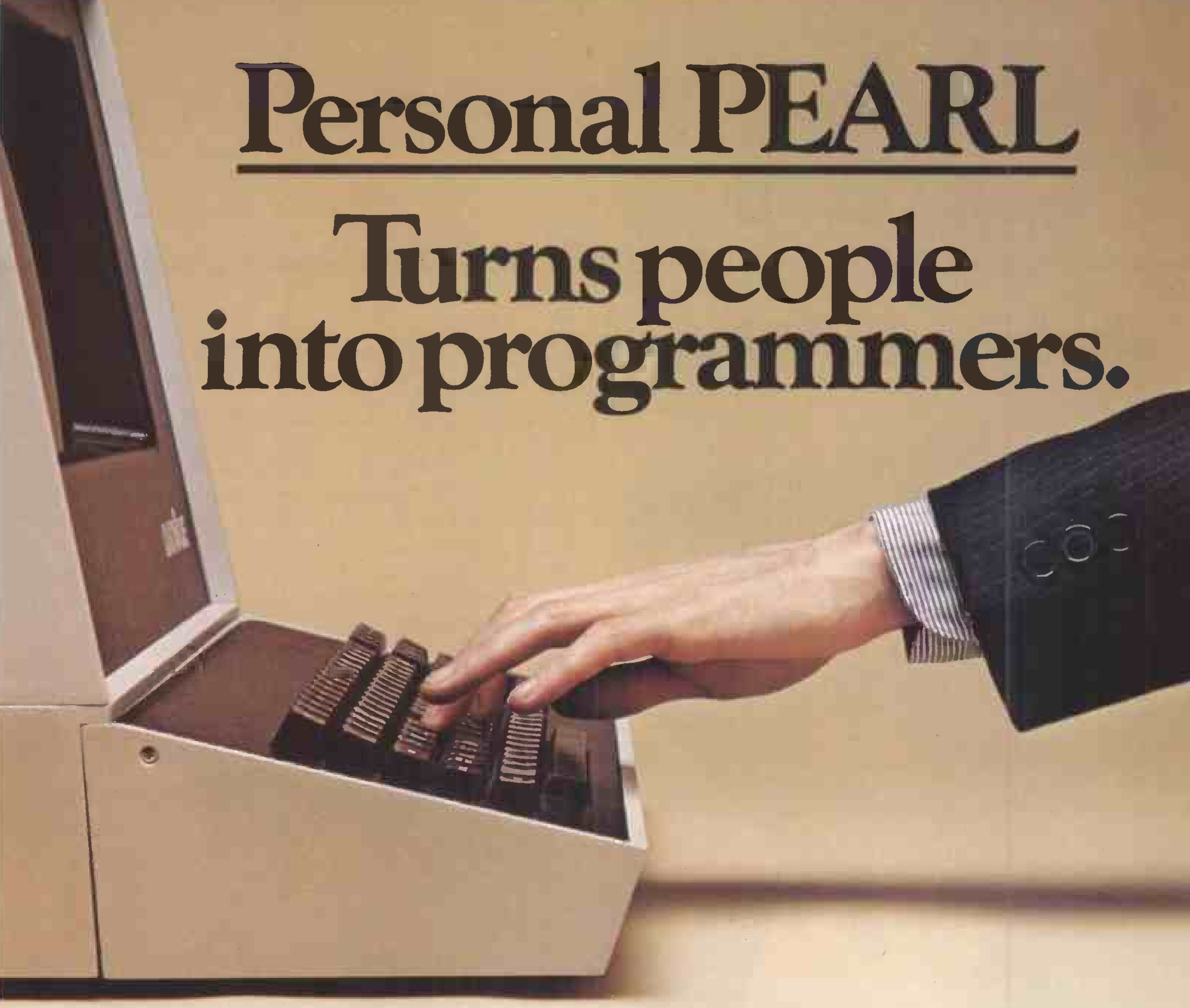

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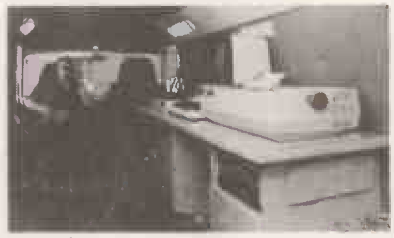

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Clive Sinclair's oft-quoted jibe that the Spectrum ought to be called "Not the BBC Micro" has prompted P K Chilvers to make a point-by-point comparison of the rival machines. Beneath the surface he finds two distinct design philosophies at work.

Certainly not the BBC Micro

CLAIMS ARE MADE that the Spectrum has the same specification, is more powerful, is more advanced, is better than and exceeds the specification of the BBC model A, but my initiation to the world of the BBC Micro has proved a delight, often provoking the confession: "You know I'm concerned that the BBC will not . . ." followed by, "You remember I said the BBC will not ...? Well it will, you do it this way and isn't that amazing."

Sinclair has 256 by 192 or about 50,000 pixels arranged on 32-by-24 character blocks. The Colours, Flash and Bright attributes are set for each character block so that although all attributes are possible on the screen at one time each character block can have only two colours. Consequently for high-resolution graphics it is best to keep to two colours.

By this means Sinclair requires only 7K for the screen. The advert says teletext mode is available — but does this need extra software? In comparison the commands VDU, @% and Print provide tremendous power and flexibility on the BBC. For ease of use many of the VDU commands are given their own Basic words. Four modes are available. Mode 4 gives the highest resolution on the model A: 320 by 256 or about 82,000 pixels using 10K; of the total 13K, some 3K is scratch pad, defined graphics and static variables. Any two of the 16 colours — that is eight steady and eight flashing against inverse — can be chosen.

Mode 5 uses larger characters, each of 20 by 32 characters, and 160 by 256 resolution. Any four colours can be chosen from the 16. Text foreground and background colours can be specified in the same was as on the Spectrum, but only from the four chosen colours.

Colour logic

The 10K of memory and fewer colours are necessary as each of the pixels, not character blocks, has its own attribute so graphics displays do not have the checkered effect of the Spectrum. New plotting on the BBC can have the colour Anded, Ored, EOred or Inverted with respect to the current colour. Eor enables "foreground-background-moving character between" animations.

Mode 6, requiring 8K, is for text only: there are fewer lines of text, 40 by 25 pixels, because of forced black lines between, making it easier to read. These lines stay black when the two-colour text has colours altered.

Mode 7, the default mode, is standard teletext with colour, six-pixel graphics, double-height characters and only 1K.

Text and graphic cursors may be linked, so all commands for one apply to the other. Hence letters can be printed anywhere, from top left to any of the 81,920 pixels, enabling powers, subscripts, and plotting of special graphics characters.

The text may also have attributes Anded, Ored, EOred or Inverted with what is already present. Unfortunately, a sacrifice must be made: the screen does not scroll but wraps round, and printing is slower.

Windows can be defined for text and graphics independently. Anything already outside the window remains unchanged, and the text scrolls only inside its window. For example, it permits pupil inputs to scroll while the teacher's text is static. More crudely Width X restricts overall page width to X characters. Paging for the scroll is either continuous, or three-quarters of the text at a time, thereby permitting information on the page boundary to be viewed sensibly.

Plot on the BBC can move the cursor, draw a point, line or dotted line, or fill a triangle, either relative to previous points, as in the Spectrum, or absolute — that is relative to the origin which can be redefined, with or without the final point. The Spectrum does not have Fill but does have commands to draw arcs and circles. The Spectrum has 16 predefined graphics characters, but will define 21. Outside mode 7 the BBC has no predefined characters, however all but 33 can be redefined; memory is already set aside for 32 of these. Pixels can be set using hex or decimal compared to Binary used on the Spectrum.

For Printing, the Spectrum has set a good precedent with the words Ink, Paper and Border while the BBC border is always black. It also has a better arrangement for including colours in Print displays. The BBC includes variable @% for specifying print format, which is of a high standard.

For sound output, the Spectrum provides a piezo speaker for one channel of sound where the pitch is based on musical notes, but all frequencies are available in 10 octaves and the duration can be specified. If the Spectrum wins a few points on display, fewer are won here. The BBC has a real loudspeaker with four channels of sound. Channel 0 gives continuous and periodic. Channel 1 controls pitch and may also be used as an ordinary channel similar to channels 2 and 3.

These numbers can be adjusted to coordinate the starts and ends of notes for chords, or to flush the queue of waiting notes. The 6502 processor can carry on with its own business as the sounds are made. Volume as well as duration and pitch can be specified in one-eighth tone increments covering five octaves. If that is not enough the volume can be replaced by a request for a sound envelope which requires 13 parameters specifying attack, decay, sustain, release rates and timing, and also three pitch changes if required.

The data-transmission rate of the Spectrum is 1,500baud; the BBC has a rate of 1,200baud, as well as 300baud available for those needing extra reliability.

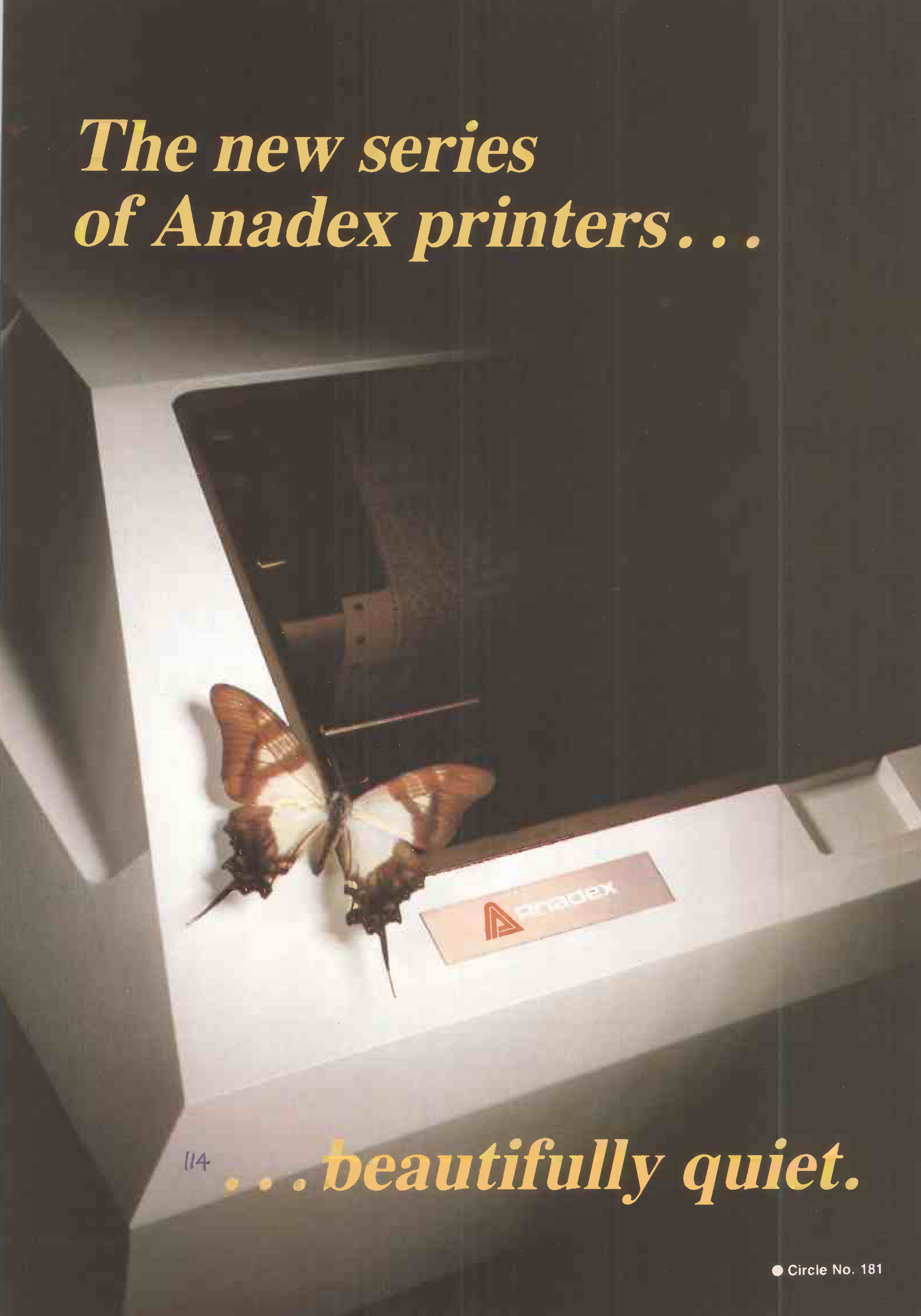
The Spectrum's Basic could be thought of as being standard and modern with some nice extras. LPrint and LList are effected on the BBC using the VDU driver's printer on-off instruction. Line lengths on the BBC can be up to 240 characters. Does the Spectrum take 22 screen lines, equivalent to 704 characters? Upper and lower case are distinguished, upper case being necessary for Basic words. Variable names can be any length, and keywords are forbidden in upper case at the start of the name; effectively spaces are possible as the underscore is accepted in names.

Keyword entry

The cost is that names need to be followed by a symbol or space, and variables must be assigned a value or initialised before being used in an expression. Mathematical operations are extended to include integer Division, Modulo, Radian-Degree conversion. The Spectrum does not distinguish upper and lower case, but the keyword entry solves the embedding problem and allows spaces in names.

For strings the BBC uses the more traditional Left$, Right$, Mid$ compared to A$ (X to Y) on the Spectrum. Both have expression evaluators Eval or Val$. BBC adds String$ (X,A$) to produce X repeats of A$, while Instr searches one string for another. For inputting from the keyboard the Spectrum has Input and

(continued on page 115)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(continued from page 111)

Inkey$. The BBC has many options: Get looks at the keyboard, waits until a key is pressed and takes the ASCII value of that key; Get$ takes the character itself. Inkey( ) and Inkey$( ) are similar, allowing timed delays which can easily be speeded up in program development. Input is equipped with multiple inputting with interspersed prompts printed as instructed; to return after no input does not crash the program.

Structured programs

Facilities for structuring programs are excellent on the BBC. The Spectrum has single-line numeric and string functions, and Gosub with calculated line numbers. The BBC has three and more, permitting functions to be multilined — functions are best for retiming a single value into the main program. Multilined procedures are available, and would tend to be used for doing more complex activities not just returning one value.

Both are called by name, easing the memory, and both can have variables extra to their arguments, defined as Local. It enables program blocks to be written by separate people without risk of one upsetting the other in the final program. Gosub has On-Gosub extra. Both machines have If-Then with the BBC adding the Else option. The BBC also has Repeat-Until. For logic the BBC has Exclusive Or and tokens for True and False as extra.

The BBC has one of the fastest interpreted Basics around. Using the many facilities, available memory is saved and speed is increased by suitable choice of instruction. The interpreter and operating system is allowed to do the work on those large, time-consuming routines needed in robust programs. This is further aided by OnErrorGoto.

Time waster

The interpreter and operating system must check everything anyway, so why make Basic waste more time on error trapping? This facility can interrupt the machine's error message, enabling errors to be dealt with in Basic only after they occur. The Spectrum could be programmed to match many of the BBC's facilities, but how much of its 16 or 48K will be gobbled up, and how much more slowly will the Basic then run?

For program development and control the BBC is well endowed. With the exception of Continue, there are all the usual toolkit instructions: Renumber, Delete, Auto line number, Indented For-Next, right-justified line numbers, Trace up to a line and error facilities.

As well as OnErrorGoto it is possible for the error's code — there are 44 of them — or line number to be printed. *Key can be used in programs for redefining the red keys, and they may be used when programming to get listing, default screen settings, etc. by a single keystroke. The pre-spelled single-key entry of the Spectrum will be a help to children.

Once a program is running there are three ways to abort it. Escape is the most gentle, preserving the program and variable values. Break sends the machine more or less back to power-up, but the memory is still powered so that *Key and character definitions are preserved, as are the static variables @% and A% to Z%. These are not even cleared by Run, making it easy to pass values between Chained programs. The command Old recovers the program after Break, as well as after an unintended New. The on-off switch clears all definitions, programs, etc.

Built-in assembler

Some assembler facilities are available in BBC Basic. Peek and Poke are replaced by the indirections ? for single bytes, ! for quadruple bytes and $ for strings. The operator & causes a number to be read in hex; while ~ causes a number to be printed in hex; for example.

```
?&7000=33:P.~?&7000
```

sets contents of location 7000hex to decimal value 33, and prints these new contents in the hex format. Labels can be set for Calling machine code or operating-system routines.

Memory can be set aside by moving memory-map boundaries Page, Top, Lomem, Himem, or by using a Dim statement without brackets. Assembly language goes in square brackets; it can be in multiple mnemonic lines similar to Basic, but the brackets have to be closed and reopened round every Remark note. The Opt command permits errors and listing to be suppressed. The static variables, A%, C%, X% and Y% hold the contents of the acumulator, status register and index registers. The Spectrum has In and Out for control which is not available in the BBC model A. Both machines have instructions in the operating system and interpreter which will cope with any expansions that may be introduced.

The BBC does cause some concern: take the model B with 32K operating system and interpreter, use 20K high-resolution graphics, 4K network and system workspace, 1·5K new characters, 2·5K disc workspace and not much is left of 64K. The BBC machine seems to have two philosophies. One is to provide a computer for teaching various aspects of computing — text, graphics, control high-level and low-level programming — for which a small memory is adequate. The other function is a very powerful and versatile input-output device for connecting to another processor, Prestel, or network, etc. with the ability to adopt future development. With discs, paged ROMs and a small memory, a "half-way house" is also possible.

Artificial speech all too often sounds like an American Dalek with a cold, says Paul Marsden, but the SC-01 chip of Mutek's Voxbox is flexible enough to let non-technical users develop natural-sounding utterances. Here he presents some of the software which enables the micro to speak its mind.

A voice emerges from the wilderness

AN ELECTRONIC back-seat driver would be an unwelcome addition to most cars, although it might be a major contribution to road-safety, but the thought of a Dalek-like voice giving a running commentary on one's driving is unbearable. However, the idea of talking computers is very exciting to teachers of handicapped kids.

Speech output could give blind, partially sighted and mentally handicapped kids their first taste of computer-assisted learning. It could open up new areas of the curriculum in which printed displays are inappropriate, for instance spelling. It could also clean up the displays in many programs by taking routine instructions off the screen. Above all, it could provide artificial voices for people without speech; the educational implications of that possibility are staggering.

At the moment the speech-synthesis stakes is a one-horse race, at least for special education. There is only one system which can meet the needs of teachers at reasonable cost, and it is probably the only one which would satisfy most hobbyists.

Most synthesisers, for example Texas Instruments' Speak 'n' Spell and National Semiconductors' Digitalker, store digitised words, and therefore have limited vocabularies. One British designer, Tim Orr, and one American firm, Votrax, have opted for phoneme synthesis, building up words from a library of individual sounds. Orr's Micro Speech 2, at almost £1,000, is beyond the reach of most amateurs and educators alike, but Votrax offers a single chip which can produce over 60 phonetic building blocks. This chip, the SC-01, powered, interfaced to the computer via a parallel port and coupled to a small audio amplifier and loudspeaker, can produce an unlimited vocabulary. It is available in the U.K. from Intelligent Artefacts at £50 plus VAT.

Votrax offers a complete synthesiser, the Type 'n' Talk, with software to translate ASCII-coded English from the computer directly into speech. Unfortunately English spelling is complex, and the results are unsatisfactory when the program hits an irregular spelling.

Two British firms, Mutek and Wideband, have gone for a simpler approach which gives the user complete control over the chip, and a far cheaper product. Mutek's Voxbox is impressive and cheap, at around £60. Mutek's own software, supplied on cassette, will not run on a 4032 Pet. However, the listings supplied with it do work, and using these and some SC-01 data it is quite easy to develop both utilities and applications programs.

Digitisation

Speech can be represented very precisely as a graph of amplitude against time — a waveform — and waveforms can be converted into digital form. Digitised waveforms can be stored in a computer's memory, reconstituted by a digital-to-analogue converter, and fed to an amplifier and loudspeaker to reproduce the original sound perfectly, as demonstrated in digital music recordings.

This approach will fill your computer's entire memory with a few seconds of speech, but thankfully there is a high degree of redundancy in speech waveforms. You can discard a great deal of data before the speech begins to sound unnatural, and a vast amount more before it becomes unintelligible.

Stored phrases

Speak 'n' Spell and Digitalker use this approach to store whole words or phrases. The result is clear speech, though one reviewer described it as sounding like an American Dalek with a cold. The drawback is that flexibility is limited because the vocabulary must be established in advance and committed to ROM.

Votrax's chip stores phonemes instead of words and phrases, and is designed in such a way that they are easily combined to form words and phrases. This leaves the users to do the hard work, but they gain full control over the chip's facilities, and are not stuck with someone else's vocabulary and idea of what sounds right.

The SC-01 chip offers 24 consonants, 37 vowels and three pauses. The consonants are:

F, G, K, S, T, V, Z, B, D, J, P, H, M, N, L, R, W, TH, SH, CH, NG, DT, THV, ZH.

The system of vowels is more complicated:

A, AH, AE, AW, E, EH, I, O, OO, U, UH, Y.

all come in two or more variations indicated by subscripts — EH, EH_1, EH_2 and EH_3, for example — which indicate durations of 185, 120, 71 and 59 milliseconds in the case of the EH family. There are also ER, AY and IU diphthongs. Finally, PA_0 and PA_1 provide pauses of 47 and

Suppliers.

Mutek, Quarry Hill, Box, Corsham, Wiltshire SN14 9HT. Telephone: Bath 743289. Manufacturer of Voxbox.

Wideband Products, Cambridge Road, Orwell, Royston, Hertfordshire. Telephone: 0223 208017. Manufacturer of Speakeasy.

Intelligent Artefacts, Cambridge Road, Orwell, Royston, Hertfordshire. Telephone: 0223 207689. U.K. stockist of SC-01 chip.

Votrax, 500 Stephenson Highway, Troy, Michigan 48084, U.S.A. Manufacturer of SC-01 chip.

Figure 1. SC-01 chip connections and schematic configuration.

+7 - 14V	Vp	AO	Audio out (.26 × Vp)
Inflexion MSB	I2	AF	Audio feedback input
Inflexion LSB	I1	CB	Current output—Class B
	nc	nc	
Normally 10nF to GND	TP3	VG	0V
Not connected normally	TP2	TP1	Not connected normally
Latch phoneme code	STB	MCRC	Time constant for clock
Acknowledge/request	A/R	MCX	External clock input
Phoneme code MSB	P5	P0	Phoneme code LSB
Phoneme code	P4	P1	Phoneme code
Phoneme code	P3	P2	Phoneme code

Table 1. Assembler memories for example words and phrases.

Assistance	UH_3 S I_2 S T UH_3 N S	Good morning	G OO_1 D M AW_1 N I_3 NG
Brookside School	B R OO_1 K S AH_2 Y_1 D S K U L	Goodnight	G OO_1 D N AH_2 Y_1 T
Carl Smith	K AH L S M I TH	Goodbye	G OO_1 D B AH_1 Y
Communication	K UH_3 M Y U_1 N I_3 K EH_1 I_2 SH UH_3 N	He	H E
Computer	K UH_3 M P Y U_1 T ER	Hello	H UH_3 L O_1 W
Control	K UH_3 N T R O_1 U_1 L	Help	H EH_1 L P
Darren Whitehead	D AE_1 R UH_3 N W AH_2 Y_1 T H EH D	Hers	H R R Z
Data file	D A_1 AY T UH_3 F AH_2 I_3 L	His	H I_1 Z
Disabled	D I_3 S A AY B UH_3 L D	I	AH_1 Y_1
Eight	A_1 AY T	It	I_3 T
Fantastic	F AE_1 N T AE S T I_3 K	John Sedgwick	D J AW_2 UH_3 N S EH D J W I_2 K
Five	F AH_1 Y_1 V	Karl Allison	K AH L AE L I_3 S UH_3 N
Four	F O O_1	Language	L AE_1 NG G W I_3 D J
Good afternoon	G OO_1 D AH_1 F T UH_3 N U U_1 N	Lee Young	L E Y UH NG
Good evening	G OO_1 D E V N I_3 NG		

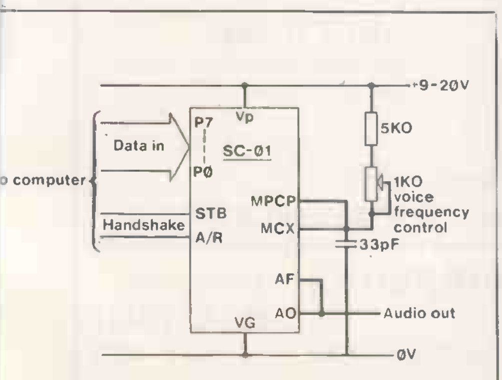
(table continued on page 119)

185 milliseconds, and Stop simply terminates the last sound which, if it is a vowel, would otherwise go on indefinitely.

The chip's 64 phonemes are accessed by numeric codes 0 to 63, but its eight-bit input accepts codes up to 255. The two most-significant bits are used to provide inflection; simply by adding 64, 128 or 192 to the code for a phoneme, it can be accented in three additional ways by raising the pitch of the sound — the higher the code number, the higher the frequency. Only vowels and some voiced consonants are affected, but accenting the consonant after the vowel helps to avoid a "cracked" sound. Even so, the effect is peculiar and tends to make the speech less clear and natural.

It is accepted that two-bit manual inflection control inputs must have external latches and must be switched at the same input voltage as the SC-01's power supply. Neither of these points is mentioned in the Votrax documentation, though one of the circuits shows a latch in use and another shows the two lines connected to the positive supply, and this could explain the poor performance of the inflection function in the Voxbox.

The Votrax documentation gives a simple circuit which allows an analogue voltage to control inflection, which could allow sliding pitch changes, giving a far more natural effect — though at the cost of far more complex programming. Careful choice of long or short versions of the vowels is vital to good accenting, and trials so far suggest that this may be more important to clarity than changes in pitch.



The Voxbox uses the SC-01 in its most basic and flexible configuration, in which the chip receives its phoneme codes directly from the parallel port of the computer, the eight parallel I/O lines carrying the code in binary form. In the case of the Pet, handshake lines CA1 and CB2 are used to tell the micro when the SC-01 is ready for the next code and the SC-01 when there is a code on the bus.

The chip requires only a 9V to 2V dc supply, one fixed and one variable resistor and one capacitor to deliver a 2V peak-to-peak audio signal with pitch and speed-of-speech variable over a wide range.

Crude connections

A small IC power amplifier — an LM-380 in the Voxbox — and its half-dozen associated components, a volume-control and a speaker complete the configuration used in the Voxbox. The unit is solidly constructed using components with brand names such as RS Components. Unfortunately it is housed in a teak-effect cabinet more appropriate to the hi-fi market than to a computer peripheral.

The weak link is the connection to the computer, a ribbon cable terminating in an edge connector without a shroud, ends or a key. The connector's contacts have to be lined up visually with the tracks on the Pet PCB. A heavy-duty multiway cable and a keyed and shrouded connector would be essential for prolonged classroom use.

Three final criticisms: first, the unit should have a mains pilot lamp. Second, since the CB2 line is used, a simple switch could have been fitted to allow the unit to double as a soundbox; come to that, a CMOS analogue switch and a few gates would allow software switching between the two functions. Finally, the 7in. by 4in. elliptical speaker and the cabinet are pretty robust, yet the volume of its output is very low — too quiet for classroom use. If you are prepared to void your warranty by trying different resistors in the audio circuit, you will discover why Mutek has kept the Voxbox so quiet: if the output is boosted significantly, the speech becomes very distorted. The Wideband unit is much louder than the Voxbox, and far more distorted, so the answer seems to be a more powerful amplifier than the 2W LM-380.

Despite these minor niggles, the Voxbox is an excellent unit, and the price is remarkably low. In the U.S.A. the chip alone is sold for $70 ex-works and in the U.K. it costs £50. The Voxbox provides access to some remarkable technology at a low price, and Mutek's manual, though small, is excellent.

Listing 1 gives a pair of Pet subroutines which will drive the Voxbox in any program which demands speech output. However, it is an extremely clumsy framework in which to explore the SC-01's idiosyncrasies and develop a vocabulary. For these purposes, the SC-01 Assembler has been developed to allow phonetic mnemonics such as A.

(continued on page 119)

Listing 1. Subroutines to control SC-01 chip from 4032 Pet.

```
100 REM  SUBROUTINE TO SPEAK WORD
110 :
120 REM    SET USER-PORT TIMER REGISTER
130 :
140 POKE59464,44:POKE59465,67
141 :
142 REM    SET INTERRUPT LINE
143 :
144 POKE59468,207
145 :
160 REM    SET PORT LINES AS OUTPUTS
170 :
180 POKE59459,255
190 :
200 REM    SEND PAUSE CODE
210 :
220 P=62:GOSUB390
230 :
240 REM    SEND PHONEME CODES
250 :
260 FORN=1TOW%(0):P=W%(N):GOSUB390:NEXT
270 :
280 REM    SEND PAUSE CODE & STOP CODE
290 :
300 P=62:GOSUB390:P=63:GOSUB390
310 :
320 RETURN
330 :
340 :
350 REM  SUBROUTINE TO SPEAK PHONEME
360 :
370 REM    PUT PHONEME CODE ON LINES
380 :
390 POKE59457,P
400 :
410 REM    PULSE SC-01 STB LINE
420 :
430 POKE59468,239:POKE59468,207
440 :
450 REM    WAIT FOR SIGNAL FROM SC-01 A/R LINE
460 :
470 IFPEEK(59469)=96THEN470
480 :
490 RETURN
```

(table continued from page 117)

Like	L AH_2 I_3 K	Speech	S P Y T CH
Machine	M I_3 SH Y Y N	Speech therapy	S P E T CH TH EH_1 R UH_3 P Y
Make	M A AY K	Synthesiser	S I_1 N TH UH_3 S AH_2 I_2 Z ER
Mark Richardson	M AH K R I_2 T CH UH_3 D S UH_3 N	System	S I_1 S T UH_3 M
Me	M E	Ten	T EH_1 N
Memory	M EH_2 M UH_3 R Y_1	Their	THV EH_1 UH_3
Microcomputer	M AH_2 I_3 K R O_1 K UH_3 M P Y_1 U_1 T ER	Them	THV EH M
Microprocessor	M AH_2 I_3 K R O_1 P R O_1 U_1 S EH_2 S ER	Three	TH R E
Mr Marsden	M I_2 S T UH_3 M AH Z D UH_3 N	To	T U_1
My	M AH_1 Y_1	Today	T U_1 D A AY
Nicky Richards	N I K Y_1 R I_1 T CH UH_3 D Z	Try	T R AH_2 Y_1
Nine	N AH_2 Y_1 N	Two	T U_1 U_1
Number	N UH_2 M B UH_3	Understand	UH_1 N D UH_3 S T AE_1 N D
One	W UH_1 N	Us	UH_1 S
Peripheral	P UH_3 R I_2 F UH_3 R UH_3 L	Vocabulary	V UH_3 K AE B IU L UH_3 R Y
Program	P R O_1 U_1 G R AE_1 M	Voxbox	V AW_2 UH_2 K S B AW_2 UH_3 K S
School	S K U L	Wayne Adkin	W A_1 AY N AE D K I_3 N
Seven	S EH_2 V UH_3 N	We	W E
She	SH E	Would	W OO D
Six	S I_2 K S	You	Y_1 U_1 W
		Your	Y O_1 UH_3

(continued from page 117)

AH, EH_3, etc, to be entered directly. with suffixes for inflection if required.

Up to five attempts at a word can be made, compared and scratched, and the numeric codes can be displayed and copied for use in programs. Listing 2 is the latest version of this program, which will store over 300 words and their codes in memory and disc files. The program can easily be adapted to use cassette files.

Transatlantic drawl

The SC-01 chip was developed in the U.S.A., and its phonemes are tailored to American English. The ER dipthong, for instance, has a heavily rolled R at the end, and there is no clean short O as in the British rendering of "dog"; the choice is between a New York "darg" and a Boston "dawg".

The chip also lacks a flat, short A, as in "hat". The AE vowel veers towards E as in "egg", giving words containing it a hint of a South African accent.

Votrax publishes an initial vocabulary of over 1,300 words. It is not supplied with the Voxbox but if you can get hold of it you will find it gives an interesting guide to the phonetic possibilities, though without providing many acceptable English pronunciations. Mutek, in its excellent little manual, lays down a few ground rules and gives a shortlist of 11 words to start you off.

The two publications together give the British user no more than a starting point, especially as neither goes into the question of inflection. A great deal of work will be needed to produce a basic English dictionary for the SC-01, but after a few weeks of experimenting with the Assembler program the device can be made to produce clear, if slightly alien-sounding, English. Given a software framework like the Assembler, this is not a programming problem. No computing expertise is called for: an open mind, a good ear and the willingness to try, try and try again are the paramount requirements.

If the SC-01 is widely adopted for use in education — as it must be until something better is developed — users will have to combine to share their vocabularies. There is little to be gained by reinventing the wheel again and again.

Programming the SC-01 makes you listen very critically to your own speech. The first lesson you learn is that spoken words, unlike written ones, do not have spaces between: if you write a sentence for the Voxbox with pauses between the words, the result sounds extremely stilted. In natural speech, most words blend together. Careful listening and experimentation is needed to achieve natural-sounding artificial speech.

English vowels are very variable, and in some situations may degenerate into an "indeterminate vowel" typified by the last syllable in "mission"; this sound is represented by the UH family of SC-01 mnemonics. The lesson for SC-01 users is to ignore spelling and to think aurally.

"Fantastic" success

The sentence "This is a fantastic machine" was an early success:

THV I_2 S I_3 Z UH_3 F AE_1 N T AE S T I_3 K M I_3 SH E N

There are no pauses at all. THV is the voiced TH sound, I_2 is the second-shortest of the I family, and I_3 is the shortest. Z is used in IS because the S is voiced, and the indefinite article is the indeterminate vowel, UH_3. AE is a short A as in "cat". UH_3 was tried for the A of "machine", but surprisingly the short I turned out to sound more natural. The CH is, of course, soft — hence SH — and the E phoneme is the long E as in "tea".

All the vowels in this sentence are fairly simple, but many English sounds require two or more phonemes. The word "nice", for example, is programmed as:

N AH_2 I_3 S

which demanded careful study of the relative lengths of the vowel phonemes. The I sound seems to be preferable to the Y in this role, as the latter emphasises the diphthongal nature of the vowel to a degree which makes it sound artificial.

Table 1 gives mnemonics for 70 names, words and phrases. None of these attempts is perfect. A period of learning is needed before you can begin to develop good codes for this chip, and rather unlikely combinations of phonemes sometimes produce the best sounds. The examples do, however, demonstrate some of the possibilities.

Help for handicapped

The two obvious areas of use for speech output in education are where printed displays would defeat the object. such as spelling, and with children who cannot read a display. Mentally handicapped, vision-impaired and some physically handicapped children are obvious examples. The facility may have more subtle applications; for example, in making computer-assisted learning software seem more friendly and personal to disturbed children, or in supplementing material appearing on the screen with audible prompts to avoid visual clutter.

It is wise to resist the temptation to start writing classroom CAL with speech output until you have accumulated a reasonable vocabulary and acquired more skill in interpreting words, but listing 3 shows how parallel string and integer arrays can be used to handle speech output. It is a simple program which stores the first names of a group of boys together with the SC-01 codes for those names.

Each Data statement in the program contains the name and the elements of an integer array, of which the first, which is read as N%(X,0) is the number of codes used. It controls the loop which fills the integer array, and the first suffix matches

(continued on next page)

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that of the name in the string array.

When a name is typed in, it is compared with the elements of the string array and if a match is found the array elements with the same first suffix are transferred into the array used by the speech-output routine. If no match is found, the program politely rejects the input. There may be other, more elegant ways of handling data for the SC-01, but this is offered as a practical method of accessing the chip's facilities with simple, compact software.

Listing 4 is an experimental program to give a severely physically disabled user control over the speech synthesiser with

(continued on page 123)

Listing 2.

```
100 rem  sco-1 assembler program
110 :
120 rem  paul marsden - - - - april 1982
130 :
140 :
150 rem  dimension arrays, set lower-case mode
160 :
170 dimmn$(63),wt%(10,30),w%(30),w$(350),wa%(350,30):poke59468,14
180 :
190 :
200 rem  input file?
210 :
220 print"Do you want to add words developed on"
230 print"this run to an existing file?"
240 print"y or n?"
250 geta$:ifa$<>"y"anda$<>"n"then250
260 ifa$="n"thennw=0:goto350
261 :
262 :
270 rem  read in file
280 :
290 print"File input":print"____________"
300 print"Put the dictionary file disk in drive 0."
310 input"Type the file name.";f1$:dopen#5,(f1$):input#5,f1
320 print"Reading file";str$(f1):input#5,nw:printnw;"words in file"
330 forn=1tonw:input#5,w$(n):printw$(n):input#5,wa%(n,0):forn1=1towa%(n,0)
340 input#5,wa%(n,n1):nextn1:nextn:dclose#5:print"File loaded":gosub1670
341 :
342 :
343 rem  set port timer, load phonetic mnemonics
344 :
350 poke59464,44:poke59465,67:restore:forx=0to63:readmn$(x):next:goto700
360 :
370 :
380 rem  subroutine to speak word
390 :
400 poke59459,255:poke59468,207:p=62:gosub460
410 forn=1tow%(0):p=w%(n):gosub460:next:p=62:gosub460:p=63:gosub460:return
420 :
430 :
440 rem  subroutine to speak phoneme
450 :
460 poke59457,p:poke59468,239:poke59468,207
470 ifpeek(59469)=96then470
480 return
490 :
500 :
510 rem subroutine to print previous attempts
520 :
530 ifq=0thenreturn
540 n=1
550 forn1=1towt%(n,0):x=wt%(n,n1):ifx>63andx<128thenx=x-64:i$="-1"
560 ifx>127andx<193thenx=x-128:i$="-2"
570 ifx>191thenx=x-192:i$="-3"
580 printmn$(x);i$;" ";:i$="":next:n=n+1:ifwt%(n,0)>0thenprint:goto550
590 return
600 :
610 :
620 rem subroutine to print numeric codes
630 :
640 print"":forn=1toq*2:print:next:forn=1toq:forn1=1towt%(n,0)
650 x=wt%(n,n1):printx;:next:print:next:return
660 :
670 :
680 rem  assembler routine
690 :
700 print"Type your word:   ":input"";w$:q=0
710 print"Right or Wrong?"
720 geta$:ifa$<>"r"anda$<>"w"then720
730 ifa$="w"then700
740 forn=1tonw:ifw$(n)=w$thensu=n:q=1:goto760
750 next:su=0:goto770
760 forn=0towa%(su,0):wt%(1,n)=wa%(su,n):next:goto1280
770 print"Type mnemonics for your word."
780 print"To use inflection, type - then 1, 2"
790 print"or 3 after mnemonic - eg ah2-1."
800 print"Type * when word is finished.":z=0:t=0
810 print"Type # to compare words."
820 print"Type @ to display numeric codes."
830 print"Press RETURN after each entry."
840 print:gosub530
850 rem  input loop
860 print"                    ":input"";mn$:i$=right$(mn$,2)
870 ifi$="-1"theni=1:goto910
880 ifi$="-2"theni=2:goto910
890 ifi$="-3"theni=3:goto910
900 i$="":i=0:goto920
910 mn$=left$(mn$,len(mn$)-2)
920 ifmn$="*"then1060
930 ifmn$="@"thengosub640
940 ifmn$="#"then1430
950 forn=0to63:ifmn$(n)=mn$then970
960 next:goto860
970 z=z+1:w%(0)=z:w%(z)=n
980 ifi=1thenw%(z)=w%(z)+64
990 ifi=2thenw%(z)=w%(z)+128
1000 ifi=3thenw%(z)=w%(z)+192
1010 print"";tab(t);mn$(n);i$:t=t+len(mn$(n))+len(i$)+1:goto860
1020 :
1030 :
1040 rem  listen to word
1050 :
1060 print"Press L to listen to word."
1070 geta$:ifa$<>"l"then1070
1080 gosub400
1090 :
1100 :
1110 rem  listen again, store in temporary array or discard
1120 :
1130 print"Listen again, Store or Discard?"
1140 geta$:ifa$=""then1140
1150 ifa$="l"thengosub400
1160 ifa$="d"then1280
1170 ifa$="s"then1230
1180 goto1140
1190 :
1200 :
1210 rem  store word in temporary array
1220 :
1230 q=q+1:forn=0to30:wt%(q,n)=w%(n):next:ifq=5then1440
1240 :
1250 :
1260 rem  options
1270 :
1280 ifq=1thenv$="version":goto1300
1290 v$="versions"
1300 print"You have"q;v$;" of this word stored."
1310 ifq=1thenprint"Add another or Store in file?":goto1360
1320 print"Compare or Add another?"
1330 geta$:ifa$<>"c"anda$<>"a"then1330
1340 ifa$="a"then770
1350 goto1430
1360 geta$:ifa$<>"s"anda$<>"a"then1360
1370 ifa$="a"thenpoke59468,207:goto770
1380 goto1750
1390 :
1400 :
1410 rem  compare stored versions and scratch
1420 :
1430 ifq=1thenprint"":goto1280
1440 print"";w$:print"";q;v$
1450 print"Type a number between 1 and";q:print"to hear a version of the word."
1460 print"Type S then the number to scratch a version."
1470 print"Type A to add another attempt."
1480 geta$:ifa$=""then1480
1490 ifa$="s"then1530
1500 ifa$="a"andq<5then1340
1510 v=val(a$):ifv<1orv>qthen1480
1520 forn=0towt%(v,0):w%(n)=wt%(v,n):next:gosub400:goto1480
1530 geta$:ifa$=""then1530
1540 v=val(a$):ifv<1orv>qthen1530
1550 forn=vto5:forn1=0to30:wt%(n,n1)=wt%(n+1,n1):next:next:q=q-1:goto1430
1560 :
1570 :
1580 rem  data for phoneme mnemonics
1590 :
1600 dataeh3,eh2,eh1,pa0,dt,a2,a1,zh,ah2,i3,i2,i1,m,n,b,v,ch,sh,z,aw1,ng
1610 dataah1,oo1,oo,l,k,j,h,g,f,d,s,a,ay,y1,uh3,ah,p,o,i,u,y,t,r,e,w,ae,ae1
1620 dataaw2,uh2,uh1,uh,o2,o1,iu,u1,thv,th,er,eh,e1,aw,pa1,stop
1630 :
1640 :
1650 rem  press space subroutine
1660 :
1670 print"_____________________________________"
1680 print"        Press space to continue        "
1690 geta$:ifa$<>" "then1690
1700 return
1710 :
1720 :
1730 rem  add another word or save file on disk
1740 :
1750 ifsu>0thenx=su:goto1770
1760 nw=nw+1:x=nw
1770 print"";nw-1;"words in array.  This is";x
1780 w$(x)=w$:wa%(x,0)=wt%(1,0):forn=1towa%(x,0):wa%(x,n)=wt%(1,n):next
1790 print"Add another word or Record file?"
1800 geta$:ifa$<>"a"anda$<>"r"then1800
1810 ifa$="a"then700
1820 :
1830 :
1840 rem  save file on disk
1850 :
1860 print"File storage":print"____________"
1870 print"Put the file disk in drive 0."
1880 print"Type the name of the file."
1890 inputf1$:dopen#5,(f1$),w
1900 print#5,f1:print"Writing file";str$(f1):print#5,nw
1910 printnw;"words in file":forn=1tonw:print#5,w$(n):printw$(n)
1920 print#5,wa%(n,0):forn1=1towa%(n,0):print#5,wa%(n,n1):nextn1:nextn:close5
1930 print"File written.":gosub1670:run
```

Listing 3.

```
100 REM  [illegible] NAMES PROGRAM
110 :
120 REM  FOR [illegible] PHONEME SYNTHESISER
130 :
140 :
150 REM  PAUL MARSDEN - - - - APRIL 1982
160 :
170 :
180 REM  DIMENSION ARRAYS. INITIALISE PORT
190 :
200 DIMBN(80,30),BN$(80),W(30)
210 POKE59459,255
220 POKE59468,205
230 :
240 :
250 REM  LOAD NAMES AND PHONETIC CODES
260 :
270 READNB
280 FORN=1TONB:READBN$(N):READBN(N,0):FORN1=1TOBN(N,0):READBN(N,N1):NEXTN1:NEXT
N
290 GOTO480
300 :
310 :
320 REM  SUBROUTINE TO SPEAK WORD
330 :
340 P=62:GOSUB400
350 FORN=1TOW(0):P=W(N):GOSUB400:NEXT:P=62:GOSUB400:P=63:GOSUB400:RETURN
360 :
370 :
380 REM  SUBROUTINE TO SPEAK PHONEME
390 :
400 POKE59457,P
410 POKE59468,237:POKE59468,205
420 IFPEEK(59469)=96THEN420
430 RETURN
440 :
450 :
460 REM  MAIN PROGRAM
470 :
480 PRINT"PLEASE TYPE YOUR FIRST NAME."
490 N$=""
500 PRINT"";:GETA$:IFA$=""THEN500
510 A=ASC(A$)
520 IFA=13ANDN$=""THEN500
530 IFA=13THENPRINT" ":GOTO560
540 IFA<65ORA>90THEN500
550 PRINTA$;:N$=N$+A$:GOTO500
560 FORN=1TONB
570 IFN$=BN$(N)THEN600
580 NEXT
590 PRINT"SORRY - I DON'T TALK TO STRANGERS!":FORT=1TO2000:NEXT:GOTO480
600 FORN1=0TOBN(N,0):W(N1)=BN(N,N1):NEXT
610 GOSUB340
620 GOTO480
630 :
640 :
650 REM  DATA
660 :
670 DATA8:REM NUMBER OF BOYS (BN)
680 DATA PAUL,4,37,53,53,24
690 DATA TERRY,4,42,2,43,41
700 DATA ANDREW,6,47,13,30,43,55,45
710 DATA CHRIS,4,25,43,9,31
720 DATA RICHARD,6,43,10,42,16,51,30
730 DATA CLIVE,5,25,24,8,10,15
740 DATA JOHN,5.30,26,48,35,13
750 DATA MARTIN,5,12,21,42,9,13
```

Listing 4.

```
100 REM  SC-01 SPEECH SYNTHESISER CONTROL PROGRAM
110 REM  USING CRITICALLY-DAMPED SCAN TECHNIQUE
120 :
130 REM  WORDS AND PHONEME-CODES LOADED INTO ARRAYS FROM DATA
140 :
150 :
160 REM  PAUL MARSDEN - - - - APRIL 1982
170 :
180 :
190 PRINT"]THIS PROGRAM DEMONSTRATES THE SELECTION"
200 PRINT"OF SYNTHESISED WORDS WITH A SINGLE"
210 PRINT"SWITCH.  THIS VERSION IS DESIGNED TO"
220 PRINT"RESPOND TO ANY KEY ON THE COMPUTER'S"
230 PRINT"KEYBOARD.  VERSIONS FOR DISABLED PEOPLE"
240 PRINT"WILL RESPOND TO SPECIAL SWITCHES WHICH"
250 PRINT"ARE CONNECTED TO THE COMPUTER THROUGH"
260 PRINT"THE USER PORT."
270 PRINT"QYOU PRESS A KEY TO INITIATE THE FORWARD"
280 PRINT"SCAN AND RELEASE IT TO STOP.  PRESSING"
290 PRINT"THE KEY AGAIN STARTS A SLOW REVERSE"
300 PRINT"SCAN, AND RELEASING IT CAUSES THE WORD"
310 PRINT"DISPLAYED AT THAT TIME TO BE SPOKEN."


320 READNW:REM NUMBER OF WORDS
330 DIMWD%(500),W$(NW),W%(NW,30):REM DIM ARRAYS TO MATCH NO. OF WORDS
340 FORN=1TONW
350 READW$(N):REM WORD
360 READW%(N,0):REM NUMBER OF PHONEMES
370 FORN1=1TOW%(N,0)
380 PEADW%(N,N1):REM PHONEME CODES
390 NEXTN1
400 NEXTN
410 PRINT"QPRESS SPACE BAR TO START..."
420 GETA$:IFA$<>" "THEN420
430 SP=10:R=50:REM SCAN TIMINGS
440 PRINT"]QQQQQQQQQQQQ";
450 PRINT"PRESS KEY TO START SCAN."
460 :


470 FORT=1TO200:NEXT:REM DELAY IN CASE SPACE-BAR IS HELD TOO LONG
480 :
490 :
500 POKE59459,0:REM ALL LINES INPUTS
510 IFPEEK(151)=255THEN510:REM LOOP UNTIL SWITCH CLOSED
520 N=1
530 PRINT"]QQQQQQQQQQQQ";TAB(20-(LEN(W$(N))/2));W$(N)
540 FORN1=1TOSP:REM SPEED RATING FOR INDIVIDUAL
550 IFPEEK(151)=255THEN600:REM IF SWITCH OPENS EXIT LOOP
560 NEXTN1
570 N=N+1:IFN>NWTHENN=1:REM NEXT WORD - IF PASSED LAST RETURN TO FIRST
580 GOTO530
590 REM  THIS WILL LOOP INDEFINITELY UNLESS THE SWITCH IS RELEASED


600 X=N:REM RECORD N WHEN SWITCH OPENED
610 PRINT"]QQQQQQQQQQQQPRESS KEY TO START REVERSE SCAN."
620 IFPEEK(151)=255THEN620:REM WAIT UNTIL SWITCH CLOSED
630 PRINT"]QQQQQQQQQQQQ";TAB(20-(LEN(W$(N))/2));W$(N)
640 FORN1=1TOR:REM R SLOWS DOWN REVERSE SCAN
650 IFPEEK(151)=255THEN700
660 NEXTN1
670 N=N-1:IFN=0THENN=X:REM CYCLE BACK THROUGH WORDS -
    TO N IF SCAN REACHES 0
680 GOTO630
690 REM  WILL CYCLE INDEFINITELY UNLESS SWITCH IS OPENED


700 POKE59459,255:POKE59465,67:POKE59468,207:REM CONFIGURE PORT
710 POKE59457,62:POKE59468,239:POKE59468,207:REM PAUSE PHONEME
720 FORN1=1TOW%(N,0)
730 POKE59457,W%(N,N1):POKE59468,239:POKE59468,207:REM PHONEMES
740 IFPEEK(59469)=96THEN740:REM HANDSHAKE
750 NEXTN1
760 POKE59457,62:POKE59468,239:POKE59468,207:REM PAUSE PHONEME
770 PRINT"]QQQQQQQQQQQQPRESS KEY TO STORE OR DISCARD WORD."
780 IFPEEK(151)=255THEN780
790 PRINT"]QQQQQQQQQQQQRELEASE KEY TO STORE WORD."
800 FORN1=1TO3*R
810 IFPEEK(151)=255THEN1530
820 NEXTN1
830 PRINT"]QQQQQQQQQQQQRELEASE KEY TO DISCARD WORD."
840 FORN1=1TO3*R
850 IFPEEK(151)=255THEN440
860 NEXTN1:GOTO770
861 :
862 :
870 DATA62,"ASSISTANCE",8 ,35 ,31 ,10 ,31 ,42 ,35 ,13 ,31
880 DATA"BROOKSIDE SCHOOL",12 ,14 ,43 ,22 ,25 ,31 ,8 ,34 ,30 ,31 ,25
890 DATA40 ,24
900 DATA"COMMUNICATION";13 ,25 ,35 .12 ,41 ,55 ,13 ,9 ,25 ,2 ,10 ,17
910 DATA35 ,13
920 DATA"COMPUTER",8 ,25 ,35 ,12 ,37 ,41 ,55 ,42 ,58
930 DATA"CONTROL",8 ,25 ,35 ,13 ,42 ,43 ,53 ,55 ,24
940 DATA"DATA FILE",9 ,30 ,6 ,33 ,42 ,35 ,29 ,8 ,9 ,24
950 DATA"DISABLED",9 ,30 ,9 ,31 ,32 ,33 ,14 ,35 ,24 ,30
960 DATA"EIGHT",3 ,6 ,33 ,42
970 DATA"FANTASTIC",9 ,29 ,47 ,13 ,42 ,46 ,31 ,42 ,9 ,25
980 DATA"FIVE",4 ,29 ,21 ,34 ,15
990 DATA"FOUR".3 ,29 ,38 ,53
1000 DATA"GOOD AFTERNOON",11 ,28 .22 .30 ,21 ,29 ,42 ,35 ,13 ,40 ,55
     .13
1010 DATA"GOOD EVENING".8,28,22,30,44,15,13,9,20
1020 DATA"GOOD MORNING",8 ,28 ,22 ,30 ,12 ,19 ,13 ,9 ,20
1030 DATA"GOOD NIGHT",7 ,28 ,22 ,30 ,13 ,8 ,34 ,42
1040 DATA"GOODBYE",6 ,28 ,22 ,30 ,14 ,21 ,41
1050 DATA"HE",2 ,27 ,44
1060 DATA"HELLO",5 ,27 ,35 ,24 ,53 ,45
1070 DATA"HELP",4 ,27 ,2 ,24 ,37
1080 DATA"HERS",4 ,27 ,43 ,43 ,18
1090 DATA"HIS",3 ,27 ,11 ,18
1100 DATA"I",2 ,21 ,34
1110 DATA"IT".2 ,9 ,42
1120 DATA"LANGUAGE",8 ,24 ,47 ,20 ,28 ,45 ,9 ,30 ,26
1130 DATA"LIKE",4 ,24 ,8 ,9 ,25
1140 DATA"MACHINE",6 ,12 ,9 ,17 ,41 ,41 ,13
1150 DATA"MAKE",4 ,12 ,32 ,33 ,25
1160 DATA"ME",2 ,12 ,44
1170 DATA"MEMORY",6 ,12 ,1 ,12 ,35 ,43 ,34
1180 DATA"MICROCOMPUTER",14 ,12 ,8 ,9 ,25 ,43 ,53 ,25 ,35 ,12 ,37 ,34
1190 DATA55 ,42 ,58
1200 DATA"MICROPROCESSOR",14 ,12 ,8 ,9 ,25 ,43 ,53 ,37 ,43 ,53 ,55 ,31
1210 DATA1 ,31 ,58
1220 DATA"MR MARSDEN",11 ,12 ,10 ,31 ,42 ,35 ,12 ,36 ,18 ,30 ,35 ,13
1230 DATA"MY",3 ,12 ,21 ,34
1240 DATA"NINE",4 ,13 ,8 ,34 ,13
1250 DATA"NUMBER",5 ,13 ,49 ,12 ,14 ,35
1260 DATA"ONE",3 ,45 ,50 ,13
1270 DATA"PERIPHERAL",9 ,37 ,35 ,43 ,10 ,29 ,35 ,43 ,35 ,24
1280 DATA"PROGRAM",8 ,37 ,43 ,53 ,55 ,28 ,43 ,47 ,12
1290 DATA"SCHOOL",4 ,31 ,25 ,40 ,24
1300 DATA"SEVEN",5 ,31 ,1 ,15 ,35 ,13
1310 DATA"SHE",2 ,17 ,44
1320 DATA"SIX",4 ,31 ,10 ,25 ,31
1330 DATA"SPEECH",5 ,31 ,37 ,41 ,42 ,16
1340 DATA"SPEECH THERAPY",11 ,31 ,37 .44 ,42 ,16 ,57 ,2 ,43 ,35 ,37 ,41
1350 DATA"SYNTHESISER",10 ,31 ,11 ,13 ,57 ,35 ,31 ,8 ,10 .18 ,58
1360 DATA"SYSTEM",6 ,31 ,11 ,31 ,42 ,35 ,12
1370 DATA"TEN",3 ,42 ,2 ,13
1380 DATA"THEIR",3 ,56 ,2 ,35
1390 DATA"THEM",3 ,56 ,59 ,12
1400 DATA"THREE",3 ,57 ,43 ,44
1410 DATA"TO",2 ,42 ,55
1420 DATA"TODAY",5 ,42 ,55 ,30 ,32 ,33
1430 DATA"TRY",4 ,42 ,43 ,8 ,34
1440 DATA"TWO",3 .42 ,55 ,55
1450 DATA"UNDERSTAND",9 ,50 ,13 ,30 ,35 ,31 ,42 ,47 ,13 ,30
1460 DATA"US",2 ,50 ,31
1470 DATA"VOCABULARY",10 ,15 ,35 ,25 ,46 ,14 ,54 ,24 ,35 ,43 ,41
1480 DATA"VOXBOX",10 ,15 ,48 .49 ,25 ,31 ,14 ,48 ,35 ,25 ,31
1490 DATA"WE",2 ,45 ,44
1500 DATA"WOULD",3 ,45 ,23 ,30
1510 DATA"YOU",3 ,34 ,55 ,45
1520 DATA"YOUR",3 ,41 ,53 ,35
1521 :
1522 :
1530 WN=WD%(0):WD%(0)=WD%(0)+W%(N,0)
1540 FORN1=1TOWD%(0):WD%(WN+N1)=W%(N,N1):NEXT
1550 PRINT"]QQQQQQQQQQQQPRESS KEY TO HEAR SPEECH OR ADD A WORD."
1560 IFPEEK(151)=255THEN1560
1570 PRINT"]QQQQQQQQQQQQRELEASE KEY TO HEAR SPEECH."
1580 FORN1=1TO3*R
1590 IFPEEK(151)=255THEN1650
1600 NEXTN1
1610 PRINT"]QQQQQQQQQQQQRELEASE KEY TO ADD A WORD."
1620 FORN1=1TO3*R
1630 IFPEEK(151)=255THEN440
1640 NEXTN1:GOTO1570
1650 POKE59459,255:POKE59465,67:POKE59468,207:REM CONFIGURE PORT
1660 POKE59457,62:POKE59468,239:POKE59468,207
1670 FORN1=1TOWD%(0)
1680 POKE59457,WD%(N1):POKE59468,239:POKE59468,207
1690 IFPEEK(59469)=96THEN1690
1700 NEXTN1
1710 POKE59457,62:POKE59468,239:POKE59468,207
1720 GOTO440
READY.
```

(continued from page 120)

only one switch. It stores words and data in arrays and uses a technique known as critically damped scanning to scan very rapidly through the stored words when a single switch is closed. In this case the switch is a key, but any switch could be used, interfaced to the parallel I/O port.

The scan stops when the switch is open, and closing it again starts a slower reverse scan. When the switch opens, the word which is being displayed is spoken by the SC-01. A further closure starts two alternating options, Discard and Store, the choice being made by the opening of the switch. If Store is chosen, the codes for the word are added to an array. The next closure offers the choice of hearing the stored speech or adding another word.

Though not intended for use in its present form, the program provides a glimpse of some dramatic possibilities for people who are at present limited to sign language.

A suite of utilities has been developed to back up the SC-01 Assembler. They allow the alphabetical sorting of vocabulary files, the manipulation of file contents and the display of mnemonics and codes. There is also a program which writes Data statements containing the words and their codes automatically, enabling vocabulary to be built into programs quickly and easily without errors. Copies of these programs, together with vocabulary files and applications programs on Pet cassette or 4040-format disc, or in listing form for translation to other micros, will be supplied at reasonable cost by the author. Phone Derby 556435 or write to him at 96 Allestree Lane, Allestree, Derby DE3 2HT.

Programming for a purpose

Arnold Maughan sets out the fundamental principles of applications programming.

COMPUTER PROGRAMS must work, they must work every time, and as far as possible they should be crash-proof. Programs must be easy to maintain; clever programs using unusual or complex techniques may be fun to write, but maintenance programmers would much prefer the simple, obvious solution.

Even if you are going to maintain your own programs it is as well to remember the comment: "When I wrote this routine God and I knew what it did — now God alone knows!" Good, maintainable programs are not necessarily those with lots of comments in them. The names "comment line" and "remark" are unfortunate; what is required is not comments but explanations of obscure routines. Far more important than a lot of comments is the design of the program as a whole.

Programs must be reasonably efficient in terms of size and speed. If you are using compiled programs, masses of comments are of no importance as far as the object program size is concerned, but in interpreted Basic the comments use up valuable memory. It is often better to sacrifice some speed in order to achieve easy maintenance.

It is easy to write bad programs in Basic, and Basic is often condemned as a result. Yet this is not to say that it is difficult to write good programs. Basic is easy to learn; the question of writing good or bad programs depends more on your methods of programming than on the language. Structured languages such as Algol, Coral, Pascal and Comal impose certain techniques upon programmers, forcing them to write better structured programs, but that does not mean that good programs cannot be written in Basic, Cobol or, for that matter, in an assembler language.

Specialised tasks frequently require specialised languages. For example, the acronym Coral stands for Computer Online Radar Application Language, a language designed for radar programs. For ordinary business applications Cobol or one of the extended versions of Basic are perfectly satisfactory provided they are used correctly. The trouble is that most programmers are far too eager to start coding. Even the discipline of flowcharting does not really help if you are inclined to get bogged down in details before planning the overall concept of the program.

In my systems-analysis courses I warn students about the dangers of "bursting into print" when writing reports. Unless the aim, language and structure of a report have been considered first, it will end up as a mere collection of words totally lacking in impact. The recipient is left wondering what the precise purpose of the report is and what it has to do with him.

The first decision

How do you set about designing a program? First you need an overall picture of what you want the program to do, and to picture it in such a way that even if you add to the program or alter some of the routines you do not have to rewrite the program or even redraw our overall picture. If you employ standard flowchart techniques this is difficult if not impossible, so instead you use the structured programming tools, and use what is known as the top-down method.

Branching, particularly unconditional branching, makes a program difficult to read. The Goto statement, if used correctly, is a perfectly sound way of branching through program steps, but in a program which is littered with untidy Gotos it becomes impossible to find out what routines do. Even worse, it is unclear what effect a change in a subroutine will have elsewhere in the program.

Suppose you had say the *Tale of Two Cities* on a disc in your word processor and gave the instruction to remove all sentences with the name Jerry Cruncher in them. The only way you could find out what effect this would have on the book would be to read the old version and the new version side by side, sentence by sentence. Yet this is the same problem inflicted on maintenance programmers unless you use properly designed programs.

Debugging problems are legion. For example I am in the habit of using Z% in Basic as the counter in a loop, and for nested loops I use Z1%, Z2% and so on. This is fine as long as I remember that the loop is a nested one. Anyone amending an old program written in a disorganised fashion could easily overlook the fact that a routine is inside a loop with Z% as the counter. The results of such a mistake could be interesting but not very helpful. For example, line counts which are unexpectedly zeroed could cause headings to

Program description.

- Line 10 clears the VDU screen; your micro might accept the simpler CLS instruction.
- Line 20 dimensions the arrays; though not strictly necessary in most Basics this stage will not do any harm.
- Line 30 sets MR% to the maximum count of records to be held in the file plus one; it is done in this way so that if you wish to change the maximum this is the only line of coding that has to be altered.
- Line 40 sets the file full indicator FF% to 0.
- Lines 50 and 60 open the Address and Index files.
- Lines 70 and 80 field the files.
- Lines 90 to 140 read the maximum values into MX% array and prompts into PR$ array.
- Lines 150 and 160 are data.
- Line 170 reads the number of records on the Address file from the field RC$ in the first record of the Index file.
- Line 180 converts RC$ to the integer value in RC%.
- Line 190 checks the value of this integer; if the file is full the file full indicator is set to one, if the value is outside the range it is set to zero. Some Basics can give odd values after line 180 if it is a new file.
- Line 200 displays the name of the program. Notice it is displayed at this point as many VDUs take quite a time to clear after the instruction in line 10. If this line appeared earlier, part of the display could be chopped off by the clear-screen routine.
- Lines 210 to 270 display the menu of procedures available; some lines have been left blank in case you do not have a renumbering facility, and the blank lines will be used later on.
- Line 280 is a conditional branch to end the run.
- Line 290 validates the number of the procedure selected, at present only one is listed, more will be added later.
- Line 300 branches to the selected subroutine.
- Line 310 checks the size of the file. If it has reached the maximum permitted, the File Full indicator FF% is set.
- Line 320 branches back to the menu.
- Line 330 checks the File Full indicator.
- Line 340 prints the File Full message.
- Line 350 prints the End of Run message.
- Line 360 sets RC$ equal to the size of the Address file.
- Line 370 puts the value into the Index file.
- Line 380 closes the files, and line 390 ends the run.
- Lines 1000 and 1010 are included to allow testing of the branch routine in line 300.

Variable names.

- FF% — File Full indicator
- KY$ — Key of records for sorting purposes (NA$(1) + NA$(2))
- MR% — Maximum size of file
- MX% — Eight-dimension array of maximum size of NA$ fields
- NA$ — Eight-dimension array of Name and Address fields
- PR$ — Eight-dimension array of NA$ prompts
- RC$ — Record count, also RC%
- TY% — Procedure type indicator
- Z% — Loop counter

be printed out at odd places, or simple delay loops which mess up other loops designed to read a fixed number of records.

When a bug appears in a large monolithic program, the task of finding its cause can be daunting. The £1,000,000 gas bill or the demand for payment of an account of nil value could well be examples of this sort of thing.

So how can embarrassing errors of this kind be prevented, and how can you simplify maintenance? The effective solution is the top-down approach — writing your programs as a number of self-contained units which can be written and tested separately. You should be able to validate the data sent to each unit and check the data leaving it so that debugging becomes a relatively simple matter. If the data entering a unit or block is sound, and data leaving it contains errors, then the bug must be within the unit.

The top-down or structured technique can be adopted even when using a non-structured language such as Basic. The first step in formulating a structured design is to specify what the program is about under the heading:

PROCESS NAMES AND ADDRESSES

This simple statement which will never be made redundant as far as this program is concerned: it tells you that the program is going to process names and addresses.

The next problem is to establish what is to be done to these names and addresses. First of all they have to be created, so now you add another box:

PROCESS NAMES AND ADDRESSES

CREATE NAMES AND ADDRESSES

This box is on the second level of the diagram and can only be entered by coming down the line from the first-level box. You will have to go down to third, fourth and other levels in all probability, but in every case the line is from the top down, and then back up to the top again. Even though you may have to add other boxes, those constructed so far will never be made redundant.

Other advantages appear when you use this technique. The use of menus to give users alternative routines within the program is controlled from the top, and does not affect existing boxes at a lower level. For example if you decide that you want to sort your names and addresses, you can add another second-level box:

PROCESS NAMES AND ADDRESSES

CREATE NAMES AND ADDRESSES

SORT NAMES AND ADDRESSES

The Create Names box is unaffected by the addition. The top, control box has merely be given another choice, represented by another line drawn down the diagram.

The task of debugging remains a very simple matter. Write the control box and test that the files have been specified correctly, and that they are opened and closed correctly. Try out the Create Names box or routine. Can you crash it by putting in too many characters? Have you made it recursive so that names and addresses can be added without going back to the control box? Have you catered for disc capacity? Is it easy for anyone to use? Are the prompts self-explanatory? Will it still be clear in six months time?

The example program is written in Microsoft V Basic running under CP/M on a Comart Communicator. It has been kept as simple as possible to allow it to be used on other Basics with the minimum of alteration.

The first question is to establish what is to be input into this part of the program and what should be passed to the other routines? Files must be opened and fielded; any arrays required must be dimensioned; constants must be set and indicators preset. The menu of processing alternatives must be set up in this routine so that the operator can input the number of the process required. The number of records already in the file must be read from the second file so that old records are not overwritten in the creation routine.

Keep it simple

To keep the program simple the main file called Address will hold fixed-length records of 128 bytes. The fields within the record are also of fixed length, restricted to a maximum of 22 characters for the surname, four for the title, three for the initials, 27 characters for each of the three lines of address, eight characters for the postcode and 10 for the telephone number. In order to allow the records to be sorted into alphabetic order the title, initials and surname are kept in separate fields.

A second file called Index will be created to hold the number of records held on the file Address. Later on Index will also hold the key of each record — surname and initials — and record number, sorted into alphabetic order of keys.

The data name for each line of the name and address will be NA$, an array of eight fields. To verify that the length of each field is correct, a table called MX% holding the maximum length of each field plus one is used. A table of prompts called PR$ is also created.

Example program.

```
10 PRINT CHR$(24)
20 DIM NA$(8),MX%(8),PR$(8)
30 MR% = 2001
40 FF% = 0
50 OPEN "R",1,"ADDRESS",128
60 OPEN "R",2,"INDEX",27
70 FIELD 1,22 AS NA$(1),3 AS NA$(2),4 AS NA$(3),27 AS NA$(4),
        27 AS NA$(5),27 AS NA$(6),8 AS NA$(7),10 AS NA$(8)
80 FIELD 2,25 AS KY$,2 AS RC$
90 FOR Z% = 1 TO 8
100     READ MX%(Z%)
110 NEXT Z%
120 FOR Z% = 1 TO 8
130     READ PR$(Z%)
140 NEXT Z%
150 DATA 5,4,23,28,28,28,9,11
160 DATA "Title","Initials","Surname","Line 1","Line 2","Line 3",
        "Postcode","Telephone no:"
170 GET 2,1
180 RC% = CVI(RC$)
190 IF (RC% > 0) AND (RC% < MR%) THEN 200 ELSE
    IF RC% = MR% - 1 THEN FF% = 1 ELSE RC% = 0
200 PRINT"Name and address program (NAMADD)"
210 PRINT TAB(20);"Select procedure required by number"
220 PRINT TAB(30);"1 to create new records"
260 PRINT TAB(30);
270 INPUT "99 to end run";TY%
280 IF TY% = 99 THEN 330
290 IF (TY% < 1) OR (TY% > 1) THEN 210
300 ON TY% GOSUB 1000
310 IF RC% = MR% - 1 THEN FF% = 1
320 GOTO 210
330 IF FF% THEN 340 ELSE 350
340 PRINT"ADDRESS file full"
350 PRINT CHR$(7);RC%;"records on file - end of NAMADD run"
360 LSET RC$ = MKI$(RC%)
370 PUT 2,1
380 CLOSE
390 END
1000 '***CREATE NEW RECORDS***1000
1010 RETURN
```

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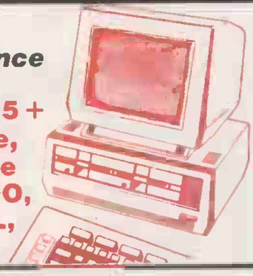

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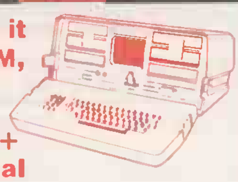

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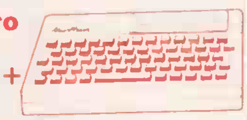

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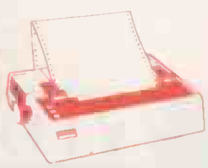

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● Circle No. 189

Wordpro revisited

David Osborne outlines some extra features which can be wrung from Pet users' favourite word-processing package.

THERE IS NO DOUBT that word processing is here to stay; it is possibly the most important office development that has so far come out of the microcomputer revolution. At the touch of relatively few buttons, whole pages of documents can be rewritten, sections of prose can be revised, and standard, but nevertheless still personal, letters can be sent to different people.

A number of word processors and word-processor packages are currently available on the market, and the prospective buyer is presented with a bewildering array of functions. A package currently available for the Pet microcomputer is Wordpro which is marketed by Professional Software. It is a powerful piece of software which allows a great deal of flexibility for the user.

Disc or tape

Although it is produced at five levels of sophistication, Wordpro I to V, the functions available at each level are similar, and this allows files developed at one level to be used at another level when a system has been upgraded. However Wordpro I is a tape-based system whereas the others are disc based. All levels of Wordpro require at least 32K of RAM. Wordpro I to III operate on either 3032 or 4032 Pets; Wordpro IV is used with the 8032 version; and Wordpro V is for the new 8096 Pet.

Wordpro's main advantages over some other programs now available lie in two areas. First the amount of text which can be stored in the system is virtually limitless. In effect all words in all books presently published could be stored, edited and printed out continuously using the Wordpro system. Although the system has a limited capacity to store information in the computer, the file-handling capacity of Wordpro is very strong. Each file can be appended to the next for the purposes of printing out a document. So, providing continuous stationery or an automatic sheet feeder is used, and as long as the disc drive is periodically served with the appropriate discs, the final document can be any length from one page to infinity.

The second advantage of Wordpro, is that all of the printing or formatting commands are embodied within the text itself. Thus to a particular portion of text, the centring command, ce1, is inserted at the appropriate text line. When the printer then reaches the ce0 command later in the text, centring is discontinued.

Examples of other such formatting commands as "ju" for right justifying; "lm" for the left margin position; "hd" for creating a page header and page numbers, and so forth. Formatting is a very simple procedure with Wordpro which can be done at any time during the editing process. Furthermore all of the formatting commands are easily remembered and are easily seen when reading through the text on the screen.

File names

When setting up a Wordpro file, it is always good practice for the first line to be a comment line containing simply the current file name, for example

cm:file 1

It reminds you of the name of the file when memorising it on disc particularly when, after editing, you wish to memorise the edited file under the old file name. Moreover, putting the file name at the beginning of the file is very useful when using Wordpro's backslash facility. If the cursor is placed over the first letter of the file name, when Shift and Clr-Home are pressed together to memorise the file, then pressing backslash puts the file name on to the status line. Again, this helps to ensure that files are memorised under their correct names and reduces the risk of corrupting other files.

The cm command can be used to help in cases when a document is so long that it has to be split into a number of separate files. It is useful to include, as the second comment line, all of the page-formatting information that the printer requires: left and right margin positions, right justification or not, line spacing, headers and footers, etc. On a normal, global, printing these instructions would be ignored because of the cm command. The value of this line becomes apparent if you wish to print out single files at a later date, perhaps because each file represents a separate section of the document. All that then needs to be done is, after recalling the appropriate file, to remove the cm: part of the line leaving the printer's formatting instructions intact.

Moving margins

The margin-release formatting command is used to produce insetted pieces of text. To inset by, say, five characters you simply move the left margin by five positions for example lm10 to lm15. By including ma5, margin release by five characters, before the text to be inset, the first line of text will be started at the lm10 position, while the remainder will begin at lm15.

The command works well except that its mnemonic, ma, appears confusing even to experienced users. All of the other two-word format commands which require numerical information, for example, left margin position and right margin position, employ as the command the first letters of each word, that is lm10; rm75. Using the same convention, margin release should be "mr" instead of "ma".

To adapt Wordpro to this convention simply requires one Poke command before the initial running of the program:

```
POKE 3874,82
```

for Wordpro III+, or

```
POKE 3823,82
```

for Wordpro IV.

The search and search-and-replace functions are extremely useful in Wordpro, enabling particular character strings to be searched for automatically and replaced with others. The function is easy to use and is explained well in the manual.

String replacement

Not immediately apparent is how to search for or replace strings which include the Wordpro control characters that are often in the text. These include the characters for underlining on-off, small quarter bars produced by Ctrl with square brackets; shifted spaces and hyphens; and the control sign itself, a tick. These characters do not appear on the status line if typed while in the search-and-replace mode, but they can be searched for and replaced using a procedure which utilises Wordpro's backslash facility.

The technique relies on the fact that when putting information on to the status line, pressing Backslash will produce the character presently under the cursor plus the next 17. So to search for the shifted space character you simply need to create this character as the first line of the file and to place the cursor over it. Then, at the appropriate point of the search-and-replace function, pressing Backslash will cause the shifted-space character, a half block, to appear on the status line.

To search for a string containing a control character, and to replace this with another string containing the same or a different control character is a more complex process. As an example, the margin release command is changed from ma to mr and so it is necessary to change all occurrences of ma5 in the text to mr5. The procedure to do this might appear

(continued on next page)

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complex, but it is really only a variation on the backslash theme.

To make the needed change two extra lines are inserted at the beginning of the text. The first contains the characters to search for, ma5, and the second the characters to replace it with, mr5. By placing the cursor over the control tick in the first line it is possible, at the appropriate stage, to get ma5 on to the status line for the program to start its search.

Memorise characters

Unfortunately the cursor cannot then be moved down to the second, replace, line unless you exit from the search-and-replace mode by pressing Ctrl. The problem can be overcome, as the program has memorised the characters for which it has been asked to search. All that is now needed is to exit from the search-and-replace mode and take the cursor to the beginning of the second line which contains your replace characters mr5. The search-and-replace procedure must be repeated, pressing Return at the search stage and Backslash at the replace stage. The search-and-replace procedure can then be completed normally.

At the top and bottom of each page, Wordpro allows the user to put information such as the page number, or the chapter or section numbers. However, for future editing purposes it is useful to put into this header or footer the current file name. Then, if only a few alterations are to be made to the document, it is a relatively easy task to recall the appropriate file immediately without having to guess in which file the corrections need to be made.

Easily erased

If this header or footer information is included as a separate line at the beginning of each file, it can be very easily erased on the final copy. For example, if the header for each file was

hd2;,<>,filename

it would produce at the top of each page the page number in the centre with the file name at the left-hand margin. For the final copy, of course, the file name will not be needed and so, by using a global search and replace, all occurrences of hd2 can be replaced with cm:hd2. The information is still retained in the files — it is simply not acted on when the final printout is made.

One important feature of Wordpro is its facility for linking files. It means that a document can be as long as is necessary; its length is not limited to the amount of text that can be stored in a file. Because each successive file is linked to the preceding one, no break occurs when the files are printed out.

When editing these linked files, it is sometimes difficult to remember the name of the next file in the link. Particularly if the files are not named sequentially, as in File1, File2, File3, etc. Of course, you could go to the end of the file, by pressing Ctrl-Up-arrow, and the name of the next linked file would be given after the nx command, but this is tedious. It is then necessary to go back to the beginning of the file and recall the next file by name.

An easier way of recalling the next linked file from anywhere in the text, is to press the Clr-home key after pressing R in the Recall-Memorise-Insert sequence. It puts the name of the next linked file on the status line, ready for pressing Return to recall the file.

Wordpro allows a range of printers to be used, although its preferred printer is the Spinwriter. If letter-quality printing is required, a cheaper daisywheel is the Ricoh printer, which is also marketed by Tandy. Except for a few facilities this printer produces as good a copy as any other. Furthermore, many of these other facilities can be accessed by Wordpro with the Ricoh printer, by slightly altering the program with a couple of Pokes.

Printers

The first facility offered is the ability to set up Wordpro to accept different printers. If a Spinwriter is attached to the Wordpro IV system, then simply pressing Ctrl answers all of the initial questions, setting up the system for a Spinwriter, device 4, a Pet disc, device 8, and the maximum number of lines in main text. To alter Wordpro IV+ to accept an ASCII printer such as the Ricoh, Poke 6361,24. After loading the program, to accept an ASCII printer press Ctrl twice. For users of Wordpro III+ no alteration appears to be needed.

Another useful facility of Wordpro is the ability to send specific characters to the printer. It means that the daisywheel can be made to print symbols such as a pound sign or μ, or it can be made to feed or reverse half a line for subscripts and superscripts.

Suppose you wish the printer to backspace one character. The ASCII number for this is 8, and this number can be sent to the printer by first assigning 8 to a particular Wordpro control number, say 0. It is done early in the text by typing a control line such as 0=8. Now, whenever a backspace, 8, is required then Ctrl-0 is typed in the text, which appears as up-arrow and 0 on the screen, to produce the backspace at the printer.

The facility can be used to produce subscripts and superscripts, which cannot be obtained initially using the Ricoh printer with Wordpro. For the Ricoh the control characters for half a line feed, subscript, and half a line reverse superscript, are 27,28 and 27,30 respectively. Thus the control line needs to be typed as

√0=27:1=28:2=30

With this control line, the formula H_2SO_4 would appear on the screen as:

H↑0↑12↑0↑2SO↑0↑14↑0↑2

Since ↑0↑1 feeds half a line, and ↑0↑2 reverses this feed, the line can be read as:
H, down ½ line (↑0↑1), 2, up ½ line (↑0↑2), S, O, down ½ line (↑0↑1), 4, up ½ line (↑0↑2).

The procedure might appear complex, but is not too difficult if common control characters which are often used, such as ↑0↑1 for subscript, are placed in extra text and then appended as required.

Control characters

In addition to controlling the printer operation, these control characters can also be used to access some of the special symbols on a standard daisywheel. Unless the program is modified, symbols such as £, μ, © and some of the foreign characters cannot be used. For some reason Wordpro removes the eighth bit of any character which it sends to the printer, and many of these special characters have ASCII numbers higher than 128.

As long as the Pet-printer interface being used allows the eighth bit to be sent, Wordpro can be easily modified to exclude this bit-removing instruction by:

```
POKE 15231,234:POKE 15232,234
```

for Wordpro III+ or

```
POKE 16650,234:POKE 16651,234
```

for Wordpro IV+.

A simple one-line Basic program can be set up initially to obtain the appropriate ASCII numbers for the various special characters:

```
10OPEN4,4:CMD4:FORI=33TO255:PRINT
"    ";I;"    ";CHR$(I):NEXT:CLOSE4
```

Now the special characters used can be added to the initial control line. With the Ricoh daisywheel, special characters are produced by the ASCII numbers shown in table 1.

Table 1. ASCII codes for some characters on the Ricoh daisywheel.

ASCII	Character
94	^
96	`
131	£
133	μ
134	°
135	´
136	†
137	™
138	®
139	©
140	¼
141	¾
142	½
143	¶
155	é
156	ù
157	è
158	¨
159	ƒ
219	ä
220	ö
221	ü
222	β

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● Circle No. 191

How to reach the centre of the maze

The essence of the Micromouse problem is the ability to find your way to the centre of any maze you are presented with. Roy Sayers presents a program to perform this task on an Apple.

EVEN IF YOUR knowledge of electronics is almost non-existent and you would have difficulty in physically making a micromouse, the problem of how to reach the centre of a maze can be intriguing. It is a simple matter to set up a picture of a maze and mouse using low-resolution graphics, and the problem then becomes a purely logical one.

The first question to answer is "What strategy do I use?"

Consider the maze board as a rectangular grid. At any instant, the mouse can go left, right, up or down, disregarding for the moment the small matter of maze walls. By choosing the move that results in the distance covered being a minimum, you can ensure that the mouse will aim for the centre.

Lines 750 to 840 draw the maze shown in figure 1. The centre has co-ordinates 16, 16, though on the Apple, the origin is the top left hand-corner.

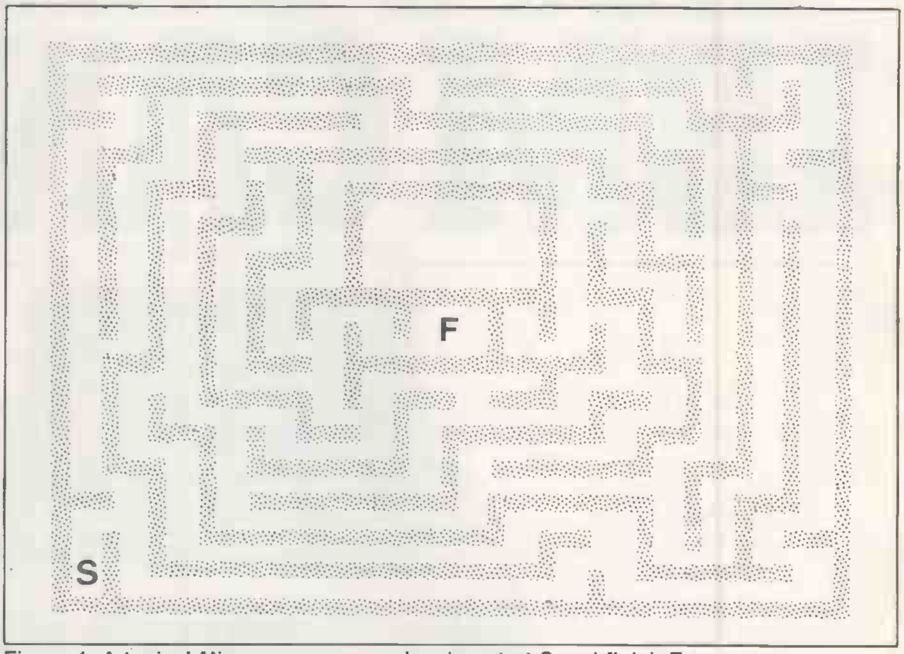

Figure 1. A typical Micromouse maze showing start S and finish F.

The walls of the maze are colour 15, white. Before the mouse makes a move, it looks left, right, up and down, using the SCRN function to detect a wall. If moving in a certain direction is possible, lines 410 to 440 calculate the distance N(I) from the centre, otherwise the distance remains at the high initialised value.

Lines 480 to 560 sort these four distances N(1) to N(4) into ascending order, so that N(1) is the shortest distance and N(4) the longest. P(1) to P(4) retain the original values of N(1) before sorting. You may now think that you have solved the problem — just take the route indicated by N(1). Yet there are one or two difficulties still to be overcome.

Consider the situation in figure 2, where squares 4 and 5 are equal distances from the centre and the mouse is approaching from the left. 1→2→3→4→5. When the mouse is on square 5, it compares the two possibilities, left or right. Clearly, going left takes it closer to the centre, so it would go left, then right, then left — see figure 3.

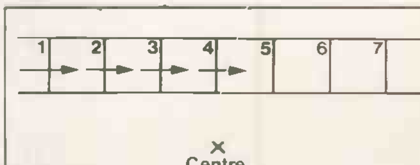

Figure 2.

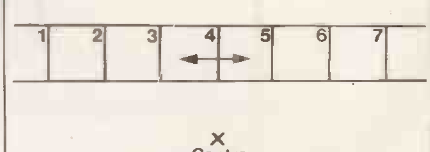

Figure 3.

```
10  REM     ******************************
20  REM    *                             *
30  REM    *   MAZE-SOLVING ON APPLE II  *
40  REM    *              BY             *
50  REM    *                             *
60  REM    *         ROY SAYERS          *
70  REM    *                             *
80  REM    ******************************
90  GR : REM                              SET LOW RESOLUTION GRAPHICS MOD
    E
100 GOTO 720: REM                        GO TO MAZE DRAWING ROUTINE
110 NORMAL : HOME : CLEAR
120 INPUT "STARTING POINT?";X,Y
130 IF  SCRN( X,Y) = 15 THEN  PRINT "SORRY, THERE IS A WALL IN THE WAY. C
    HOOSE A DIFFERENT PAIR OF COORDINATES.": GOTO 120
140 DIM X(200),Y(200),A(200)
150 DIM B(200)
160 COLOR= 0: PLOT 16,16: REM              CENTRE OF MAZE
170 DEF  FN F(K) = (16 - K) * (16 - K): REM  FUNCTION TO HELP CALCULATE T
    HE                                              CURRENT DISTANCE FROM
     THE CENTRE
180 FOR I = 1 TO 4: REM                   INITIALISE N(I) AND P(I) TO HIGH
    VALUES
190 N(I) = 1000:P(I) = 1000
200 NEXT I
210 COLOR= 0: PLOT X,Y: REM               "UNPLOT" OLD X,Y
220 COLOR= 3:X = X + E:Y = Y - F: PLOT X,Y: REM  PLOT NEW X,Y
230 TALLY = TALLY + 1
240 X(TALLY) = X:Y(TALLY) = Y: IF (X = X(1) AND Y = Y(1)) OR (X = X(2) AND
    Y = Y(2)) THEN 310
250 IF X(TALLY) <  > X(TALLY - 2 * CUL - 2) THEN 310
260 IF Y(TALLY) <  > Y(TALLY - 2 * CUL - 2) THEN 310
270 IF X(TALLY - 1) <  > X(TALLY - 2 * CUL - 1) THEN 310
280 IF Y(TALLY - 1) <  > Y(TALLY - 2 * CUL - 1) THEN 310
290 X(TALLY - 1) = 0:X(TALLY - 2 * CUL - 1) = 0:Y(TALLY - 1) = 0:Y(TALLY
    2 * CUL - 1) = 0:X(TALLY - CUL - 1) = 0:Y(TALLY - CUL - 1) = 0
```

```
300 CUL = CUL + 1
310  IF X = 16 AND Y = 16 THEN 990
320 L =  SCRN( X - 1,Y): REM                LOOK LEFT
330 R =  SCRN( X + 1,Y): REM                LOOK RIGHT
340 U =  SCRN( X,Y - 1): REM                LOOK UP
350 D =  SCRN( X,Y + 1): REM                LOOK DOWN

360  REM      **************************************************
370  REM      * FOR EACH OF L,R, U AND D, CALCULATE THE SQUARE  *
380  REM      * OF THE DISTANCE TO THE CENTRE, UNLESS THERE IS  *
390  REM      * A WALL IN THE WAY                               *
400  REM      **************************************************
410  IF L = 0 THEN P = X - 1:N(1) =  FN F(P) +  FN F(Y):P(1) = N(1)
420  IF R = 0 THEN P = X + 1:N(2) =  FN F(P) +  FN F(Y):P(2) = N(2)
430  IF U = 0 THEN Q = Y - 1:N(3) =  FN F(X) +  FN F(Q):P(3) = N(3)
440  IF D = 0 THEN Q = Y + 1:N(4) =  FN F(X) +  FN F(Q):P(4) = N(4)

450  REM      **************************************************
460  REM      * START SORTING THE ARRAY N                       *
470  REM      **************************************************
480  FOR G = 1 TO 3: REM  START SORTING THE  ARRAY N
490  FOR T = G + 1 TO 5
500  IF N(G) >  = N(T) THEN 520
510  GOTO 550
520 S = N(G)
530 N(G) = N(T)
540 N(T) = S
550  NEXT T
560  NEXT G: REM  ARRAY N SORTED , N(1) SMALLEST

570  REM      **************************************************
580  REM      * ARRAY N SORTED, N(1) SMALLEST                   *
590  REM      **************************************************
600  FOR J = 1 TD 4: REM  START LOOKING FOR BEST ROUTE, IN ORDER L,R U,D
610  IF L <  > 0 THEN 640
620  IF N(J) = P(1) AND A <  > 2 THEN A = 1:E =  - 1:F = 0: GOTO 180
630  REM  *** A  INDICATES THE DIRECTION IN WHICH THE MOUSE IS MOVING***
640  IF R <  > 0 THEN 660
650  IF N(J) = P(2) AND A <  > 1 THEN A = 2:E = 1:F = 0: GOTO 180
660  IF U <  > 0 THEN 680
670  IF N(J) = P(3) AND A <  > 4 THEN A = 3:E = 0:F = 1: GOTO 180
680 .IF D <  > 0 THEN 700
690  IF N(J) = P(4) AND A <  > 3 THEN A = 4:E = 0:F =  - 1: GOTO 180
700  NEXT J
710 A = 0: GOTO 600

720  REM      **************************************************
730  REM      * START MAZE-DRAWING ROUTINE                      *
740  REM      **************************************************
750  GR : COLOR= 15
760  RESTORE
770  READ A,B,C
780  IF A =  - 1 THEN 810
790  HLIN A,B AT C
800  GOTO 770
810  READ A,B,C
820  IF A =  - 1 THEN 110
830  VLIN A,B AT C
840  GOTO 810
850  DATA  0,32,0,0,32,32,2,14,2,16,26,2,6,12,4,14,24,4,26,30,4,2,4,6,8,22
     ,6,24,26,6,30,32,6,6,10,20,14,16,20,18,20,20,22,24,20
860  DATA   0 ,2 ,4
870  DATA  4,6,8,12,20,8,22,24,8,28,30,8,6,8,10,8,10,12,24,26,12,10,20,14,
     22,24,14,2,4,18,8,10,18,12,22,18,24,26,18
880  DATA  4,6,22,10,12,22,16,22,22,24,26,22,2,4,24,8,14,24,18,24,24,26,28
     ,24,0,2,26,8,16,26,18,24,26,28,30,26,6,18,28,20,22,28,30,32,28,4,20,3
     0,24,30,30,-1,0,0
890  DATA  6,16,2,18,24,2,28,32,2,2,6,4,8,18,4,20,22,4,24,30,4,4,8,6,10,20
     ,6,22,28,6,8,10,8,12,18,8,22,24,8,6,12,10,14,16,10,20,22,10
900  DATA  6,8,22
910  DATA  10,14,22
920  DATA  16,18,22,20,22,22,30,32,22,28,30,20
930  DATA  8,14,12,16,20,12,2,4,14,14,16,14,20,24,14,22,26,16,14,18,18,26,
     28,18,8,16,20,18,20,20
940  DATA  0,32,0,0,32,32
950  DATA  4,6,24,8,12,24,14,18,24,22,24,24,26,30,24,2,4,26,6,10,26,12,16,
     26,18,22,26,24,28,26,0,2,28,4,24,28,26,30,28,2,4,30,10,26,30,-1,0,0

960  REM      **************************************************
970  REM      * DISCARD INEFFICIENT PATHS                       *
980  REM      **************************************************
990  FOR K1 = 1 TO TALLY
1000  IF X(K1) = 0 AND Y(K1) = 0 THEN 1020
1010 N1 = N1 + 1:A(N1) = X(K1):B(N1) = Y(K1)
1020  NEXT K1

1030  REM      **************************************************
1040  REM      * PLOT THE MOST EFFICIENT PATH                    *
1050  REM      **************************************************
1060  FOR I2 = 1 TO N1
1070  COLOR= 3
1080  PLOT A(I2),B(I2)
1090  NEXT I2
1100  INPUT "DO YOU WANT TO DO IT AGAIN?";W$: IF W$ = "NO" THEN 1150
1110  IF W$ = "YES" THEN 750

1120  REM      **************************************************
1130  REM      * PRINT THE MAZE ON THE EPSON MX-80 PRINTER      *
1140  REM      **************************************************
1150  INPUT "DO YOU WANT A PRINT-OUT OF THE MOUSE'S PATH?";Z$
1160  IF Z$ = "NO" THEN 1340
1170  PRINT : PRINT : PRINT : PRINT : PRINT
1180  FOR BB = 0 TO 32
1190  FOR AA = 0 TO 32
1200  IF  SCRN( AA,BB) = 15 THEN A$ = A$ + "**": GOTO 1230
1210  IF  SCRN( AA,BB) = 3 THEN A$ = A$ + "@@": GOTO 1230
1220 A$ = A$ + "  "
1230  NEXT AA
1240  PR# 1
1250  PRINT  CHR$ (15)
1260  PRINT  CHR$ (27)"A" CHR$ (2) CHR$ (27)"2"
1270  PRINT A$
1280 A$ = ""
1290  NEXT BB
1300  PRINT  CHR$ (18)
1310  PRINT  CHR$ (27)"A" CHR$ (12) CHR$ (27)"2"
1320  PR# 0
1330  GOTO 1100
1340  END
```

In the program, this situation is detected by part of the conditions in 620, 650, 670 and 690. It is overcome by looking at N(2), the second-shortest route, which will allow the mouse to continue in its original direction, without oscillating.

Consider the poor mouse, happily approaching the centre only to find that in square 5 it can get no closer — figure 4. It can only go down, and if it has just been going up, lines 620, 650, 670 and 690 would, as explained above, construe this as oscillation. The conditions are not satisfied so eventually you come to statement 710, which gives A an arbitrary value of 0. The condition in line 620 now is satisfied, and the mouse backs off quite happily.

One of the rules in the Micromouse competition allows mice to have a second run at the maze to demonstrate any learning that may have taken place. This program enables elementary learning by means of lines 250 to 300. These lines check to see if the mouse has come to a cul-de-sac. If so, the flag Cul is incremented by 1. After a cul-de-sac, the mouse has to retrace its steps, with $P_{10}=P_8$, $P_{11}=P_7$, etc. All these retraced steps are useless, and by setting their values to zero they are ignored on the second run. The second run is plotted in under a second, in lines 1060 to 1090. ◼

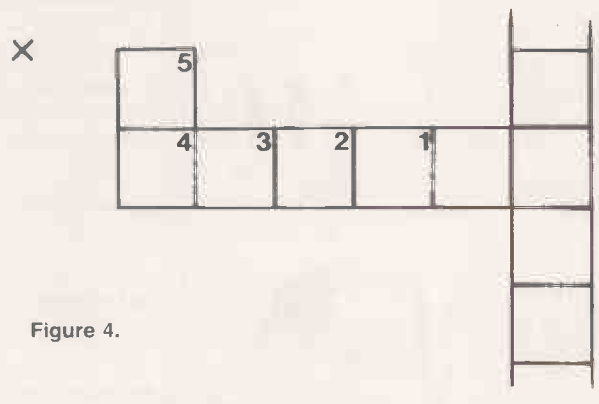

Figure 4.

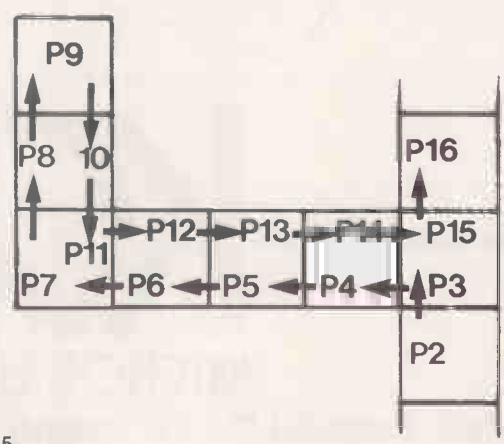

Figure 5.

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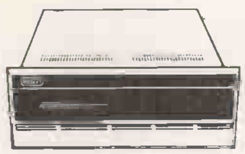

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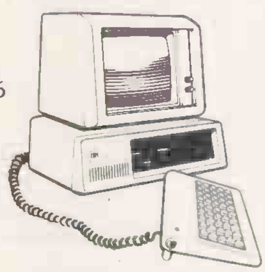

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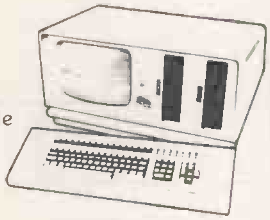

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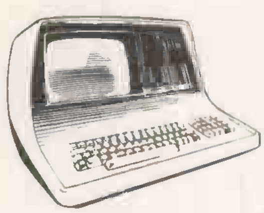

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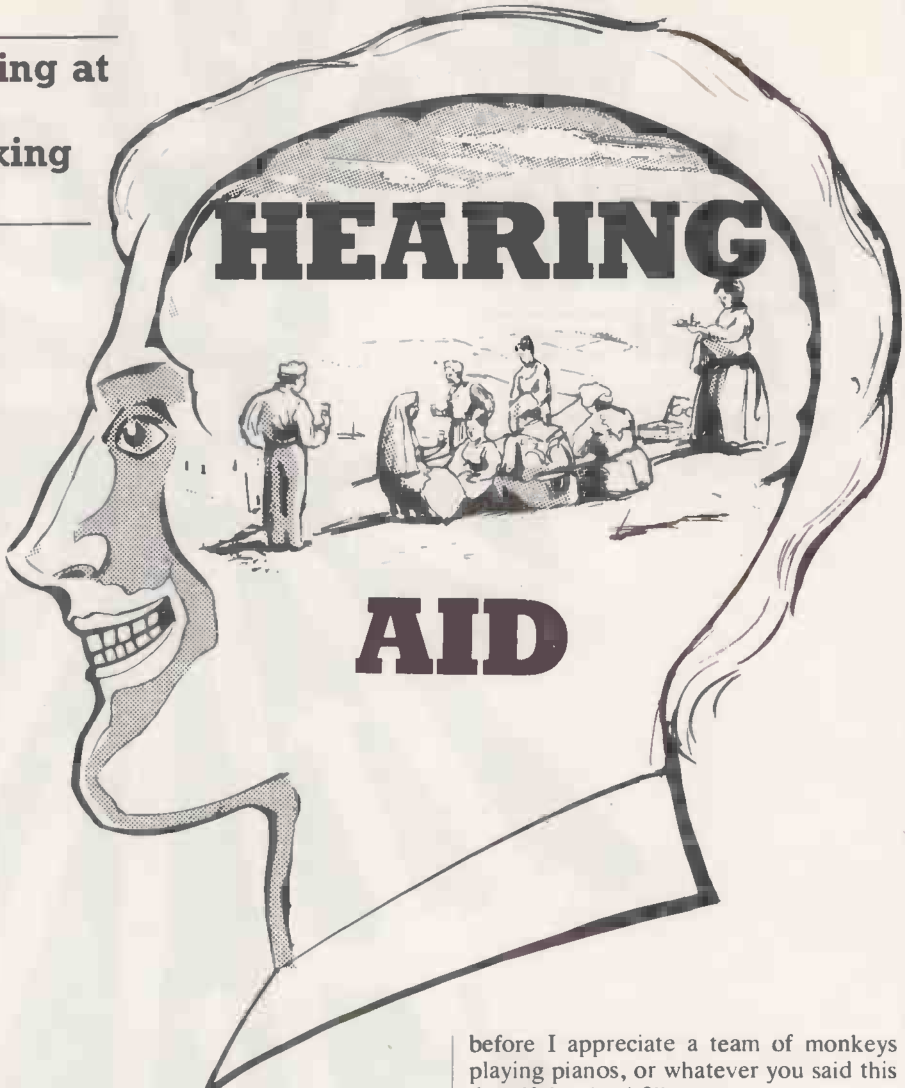
● Circle No. 192

Anderson thought nothing at all of the music. It was merely a sonic fog making conversation difficult.

HEARING AID



It was one of those parties where the decor was very expensive and very sparse, and the drinks likewise. Anderson studied his thimbleful of terrifyingly high-class sherry, and had a wistful vision of a large tumbler of Algerian plonk. Of course one should not be dwelling on the alcohol famine, one should be making witty conversation: only Anderson found himself cut off from conversation by the peculiar noises, probably musical, coming from speakers in each corner of the room. He had heard of the cocktail party effect, whereby you could unerringly pick a single voice from amid all the others, but for him it never seemed to work.

The host was doing things at an intricate console which seemed wasted on a mere hi-fi system; it was obviously capable of running vast automated factories, with possibly a sideline in tax avoidance. A different and louder sound of probable music drifted over the chattering crowd.

Anderson made a face, knocked back his homeopathic dose of sherry, and realised this had been a tactical error since there would be nowhere to put down the glass until another tray of drinks came by, if one ever did. Worse, Nigel had abandoned the console and was moving towards him with the manner of a snake converging on a rabbit.

"Hel-lo, Colin. What do you think of the music?"

Anderson did not think anything at all of the music. Music was simply music, a kind of sonic fog which made conversation difficult or even dangerous. Audibility was now down to 18 inches. Music, bloody music.

"Technically interesting," he said cautiously.

Nigel Winter moved a little closer and twinkled at Anderson with the confidence of one whose shirt would never become limp and vaguely humid, like that of his audience.

"So tuneful, isn't it," he said with a smile.

"Oh yes. It makes me want to take all my clothes off and do the rumba," said Anderson without conviction.

"Ah, but seriously, don't you think there's a Mozartian flavour there?"

"Pretty damn Mozartian, yes." He knew it was a mistake before he had finished saying it.

"Caught you. You were not listening — hear it now? It is what they call stochastic music, random notes, very experimental. The composer simply conceptualises his starting figures for the random-number generators. Intellectually it is all tremendously absorbing; I'm afraid I was pulling your leg about Mozart."

Anderson thought fleetingly of his days at Oxford, when people like Nigel could, with a certain legitimacy, be divested of their trousers and placed in some convenient river.

A fume from the sherry — there had not been enough to make it fumes in the plural — coiled about Anderson's brain and lovingly urged him to say: go to hell, you loathsome little person.

"You must remember I am tone-deaf," he said, falling back on his final line of defence. "Unless the pitch is different enough, I mean really different, I can't tell one note from another."

"Oh, that's just an excuse," said Nigel. "I am sure you really are not. I have read how true tone-deafness is extremely rare, and most people who say they have got it are simple musically illiterate. You are not trying, that is all. You really should make an effort."

"How much effort do I have to put in before I appreciate a team of monkeys playing pianos, or whatever you said this dreadful noise is?"

Nigel sniffed. "Really, Colin, one has to master traditional music before one can expect to follow conceptual works which reject its conventions. Now do promise me you'll try."

Rather to his horror, Anderson heard himself mumble something that sounded hideously like acquiescence. Then Nigel was gone, off to adjust the noise machine further, and Anderson was left peering suspiciously at his tiny, empty glass.

by David Langford

"What brought you to us?" asked the white-coated man, suddenly and treacherously forcing quantities of ice-cold goo into Anderson's left ear.

"I saw the small ad in The Times," he said. "Ouch."

"There, it doesn't hurt a bit, does it?" said the man from Computer Audio Services, kneading the stuff with his fingertips until Anderson felt his eardrum was pressing alarmingly against his brain.

"Just a moment while it hardens," the man said chattily. "I am so glad when people are not ashamed of coming to

(continued on page 137)

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(continued from page 135)
CAS. After all, the world is so complicated today that busy men like yourself just cannot take time out to learn little things like musical appreciation. That is what I always say," he added with the epigrammatic air of a man who always said it.

"I am tone-deaf," Anderson said.

"Oh quite. There is no need for excuses with us, Mr Anderson. We understand."

"But I am tone-deaf."

"Of course, now this is not going to hurt a bit." For the next several seconds Anderson enjoyed the sensation of having his ear cleared of blockages with a rubber suction-plunger. Blockages such as eardrums, he thought. At last the mould was out.

"There. It will be cured, machined, drilled, tapped and ready in 15 minutes. Now I think you had decided to try our Analyser aid, our cheapest model," he said reproachfully.

"The cheapest model," Anderson responded with rather more enthusiasm.

"But I expect that in no time at all you will want to trade it in for our Scholar, with 50 times the memory storage at less than twice the price. You could be ready to cope with fifty composers and not just one."

"The Analyser," Anderson said inexorably.

"Well, of course it is your decision. Now which composer data set would you prefer? With the Analyser, of course, you can only have one."

Anderson contemplated the bandaged finger which he had cut on some broken glass in his pocket. He massaged it gently and said, "Mozart."

"Oh, a very good choice sir. What was the name again?"

Anderson told him again, and wonders of technology were duly set into motion. The result was a transparent ear-mould with the thumbnail-sized bulge of the Analyser protruding; there was also a discreet invoice which made his credit card seem ready to wilt Dali-fashion, as he passed it over.

"The battery is extra, sir. Would you be wanting a battery?"

"On the whole, yes."

"Then if you'll sign here. Thank you so much. I'm sure you will find your computer aid a real social help, and something which a busy person like you need not be in the slightest ashamed of using, even in the best company."

"A tone-deaf person like me."

"Of course."

After playing for an afternoon with his new toy Anderson felt himself rather well up on music and Mozart. Similar to his first day with a pocket calculator which had given him the air of an expert on the theory of numbers. In the evening he paid a call.

"Hello, just thought I'd drop in to say thanks for the party."

"Why, how charmingly old-fashioned of you, Colin. Do come in and have a quick one. I really do not know why I throw these parties; one loses so much glassware. I'll only be a second, now." And Nigel vanished, presumably to manipulate the combination lock on his secret drinks cupboard.

The room's trendy bareness seemed to shout louder at Anderson now it was emphasised by the lack of crowd. He wandered to the intricate hi-fi console and peered at it.

"Oh! Did you want to hear some music?"

"I was just thinking I'd probably appreciate it more without all those people yelling their heads off."

"Well, well." Nigel looked at him with eyes slightly narrowed, and then turned to the smart brushed-aluminium console. Anderson noted that the drinks provided for single callers were no bigger than those at vast parties. Already the sound of what might very well have been music was spilling from each corner of the room.

"Now what do you think of this delightful tune," said Nigel with a false smile.

Anderson cupped his ear at the nearest speaker with the gesture he had been practising, and flipped a fingernail at the Analyser nestling there. The noise was like a small gunshot; he suppressed the resulting wince before it reached the outside world.

"Interesting," he said with what he hoped was an air of deep concentration. Nigel watched him, faintly smiling. Then after a moment, a mechanical version of the still small voice of conscience whispered in Anderson's ear, saying: "Random notes, 87 percent probability . . . random notes, 92 percent probability . . . random notes, 95 percent probability . . ."

"Oh, this is more of your stochastic music," Anderson murmured. "Now I can listen to it properly I can see it is just random notes. I mean, I can hear it is random."

Nigel's smile became at once more visible and less convincing. "Of course that was rather obvious, after our little chat on Saturday," he said, and fiddled again with the controls. "Let us have something of the real thing."

The speaker noises changed to something quite definitely though indefinably different, and Nigel turned again towards his guest like a restaurant waiter offering a selection of red herrings. "What do you think of that?"

Anderson consulted the Analyser, and after a short pause came back with, "Come on, Nigel, pull the other one. It is random again, surely? Only this time it is the change in pitch between successive notes that is randomised over a certain interval, so it sounds that little bit more musical than just random notes."

"Unable to fool you," said Nigel, hardly smiling at all. "Anything you would like to hear?"

"I've been listening to a few things by the chap you recommended, Mozart. Not bad."

"Good grief. Did I recommend him? I must have been quite tiddled. Still, there should be something of his in the databank." He turned back towards the controls.

A minute or two later Anderson was able to say with quiet confidence, "Ah yes, that is the K169 string quartet."

Following an irresistible urge, he breathed gently over his fingernails and polished them on the lapel of his jacket. Half-heartedly his host caused the equipment to play further noises which the Analyser rapidly identified as the Serenade in D Major; adding the useful information that it had been composed in Salzburg. Nigel seemed a little shaken by this onslaught, and was breathing more heavily as he returned to the console.

"Not recognised," said the small voice. "Transition probability analysis suggests Mozart work, 82 percent probability."

"That is Mozart all right," said Anderson, thinking fast. "But hardly one of his best pieces; in fact I must admit I do not recognise it at all."

"Er, yes, just an obscure oboe quartet I thought might amuse you. H'm." A thought appeared to have struck Nigel, and he savagely punched another sequence on the keyboard, as though squashing small insects.

"Not recognised. Transition probability analysis suggests not Mozart work, 79 percent probability."

"You have got the wrong composer, old chap."

"It is so easy to make mistakes with equipment as sophisticated as this," Nigel said viciously. "I'll have to throw you out soon, I am meeting someone tonight, but first, what do you think of this one?"

The lights on the hi-fi console flickered alarmingly for nearly a minute; Anderson fantasised that Nigel's expensive gadgetry, like Nigel, was baffled and irritated. Then more musical noises seeped through the room. Anderson cupped his ear attentively, and clicked his fingernail again at what was hidden inside. There was a pause.

"Not recognised. Transition probability analysis suggests Mozart work, 94 percent probability."

The transition probability jargon was something to do with sequences of notes favoured by given composers. In the long run they left their fingerprints all over their work so obviously that even a

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machine could catch them red-handed.

"Ah, you can't mistake Mozart," Anderson sighed, wondering if he was overdoing it a trifle.

Nigel seemed to have brightened surprisingly. "This really is a very sophisticated system, you know. I am rather proud of it. One thing you can do with it, if you know how, is to have the processor run through a selection of someone's works and cobble up a sort of cheap and nasty imitation; something to do with transition probabilities, it says in the manual.

"It's nice to see you making an effort, musically, but you really will have to try much harder, old chap."

"It's very kind of you," he said with a titanic effort.

The CAS salesman studied him wisely. "Now if you cared to exchange it for the Scholar model we could in fact allow quite a generous trade-in price, Mr Anderson."

"And then I suppose I would have a wonderful machine that could not fail to spot imitations of 50 composers rather than just one?"

"Our clients usually find the Scholar very satisfactory," the other said severely.

"So will I — if it can tell inspired music from cobbled-together computer rubbish, the way this one does not."

The salesman sighed. "To handle that would need a full-scale artificial intelligence. CAS is not in that business — yet. Now if you come back next year, when we hope to have chased out the last bugs, then perhaps we can sell you our Mark III model — the AudioBrain."

Anderson reflected for a moment, and then leant forward with what he considered to be an expression of great shrewdness. He had practised it in the mirror for use on Nigel.

"If you are likely to market it next year there must be prototypes around the place right now. In fact you must be market-researching the thing already. It surely would not hurt to let me try one out for you."

Licking his lips, the CAS man murmured that it would be, well, rather irregular, but Anderson reached for his wallet.

"How am I doing, Nigel?" he asked confidently, back in the bare, expensively carpeted room.

"Not bad," Nigel muttered. "You must be trying a bit harder than you were — I told you understanding music was mainly a matter of trying."

Despite having defeated Nigel in umpteen straight sets of hard-fought musical appreciation, Anderson still did not feel wildly happy. It might have been that he was tiring of the game; it might have been the articifial-intelligence program built into this new hearing aid, which was now saying: "You should be able to tell this for yourself, dumbo. Only a real musical illiterate could miss spotting that one. You are not trying, that is all. You really should make an effort."

"But I am tone-deaf," Anderson said aloud.

"That is what they all say," said the AudioBrain. "Come off it."

It was another of those parties whose expensive minimalism extended to the furniture, the pictures on the walls and inevitably the drinks.

"Hello Nigel, long time no see," said Anderson.

"Um. How is the culture, then? Still working to better yourself on the musical front?"

"Pardon?"

"I said, are you still slogging away at the musical appreciation?"

"Pardon? Oh, that. No, I find I cannot handle music any more. I am going deaf — and not just tone-deaf." He pushed back his hair and tapped the thing plugged into his ear.

"Oh what a tragedy, I didn't know, I am so sorry."

Anderson decided again that he liked the AudioBrain a good deal more with its battery removed.

Data structures

Deciding how information is to be stored has a crucial effect in dictating the final shape of any program. David Bolton explains how dynamic structures and linked lists can be exploited to make most effective use of available memory.

DATA IN a computer is quite frequently not accessed in the order that it is stored. For instance floppy-disc files may not be stored over several continuous sectors, but be spread all over the disc with links between sectors. Cassette storage is however the opposite: a file is read in the order it is recorded on tape. The way that the data is stored is termed its physical storage, whereas the logical order is the order in which the processing is carried out. Convenience is the reason for this difference.

On disc files, if the alternative method of storing files over continuous sectors is employed, after a number of file creations and deletions the free space on disc can be so fragmented that even if only 50 percent of the disc is occupied, it will not be possible to store a file. Processing must be halted until a utility program can be run to collect all the free space together — see figure 6.

It is more convenient for a chess game to store the whole board, showing which piece is where. A space battle game with several ships on both sides covers such a large area it probably could not be stored in this way. Instead the co-ordinates of each ship are stored. It would be possible to swap these methods but there would be little if anything gained.

Data is generally built up of simple types such as real and integer variables, characters and perhaps Boolean logical variables. These simple types can be built up into structures such as arrays or more complex mixed types. Such structured types are usually predeclared before use although Basic and Algol 68 allow dynamic arrays. Pointers can be used to allow dynamic data structures, that is structures which grow and shrink during program execution. A pointer is simply an address in main memory where the structure is held.

Linked lists using pointers offer an efficient solution to some problems providing that the number of pointers is kept small for each item in the list. Very fast access and multiple access paths, which are the basis of databases, are available through pointer-based structures.

Consider how you would set about devising a simple text editor which could change, insert and delete lines in a block of text. When a line is inserted at a certain point, then the rest of the block would have to be physically shifted to make space. Similarily when a line is deleted then the rest of the block has to move up to replace it – see figure 2.

An alternative method using linked lists to store the text can insert and delete lines without moving any text other than the line involved — see figure 3.

Three pointers S, E and F indicate the start and end of the text; F shows where the free space starts. All unused text lines and the last line have their pointers set to 0, an "impossible" value. If this is done in Basic then the pointers are just indices to the text and pointer arrays; and in machine code the pointers will be actual machine addresses.

To insert a line C after line X, for example:

1 Search text for line X.
2 Input new text into line pointed to by F. Notation is $(F)_t$.
3 Set new line's pointer = line X's pointer; $(F)_p = (X)p$.
4 If $(F)_p$ is zero then set E = F. Alter end of text pointer.
5 Set line X's pointer to new line; $(X)_p = F$.
6 Add 1 to F; F = F + 1.

Figure 3, shows a block of text having inserted line G after line A.

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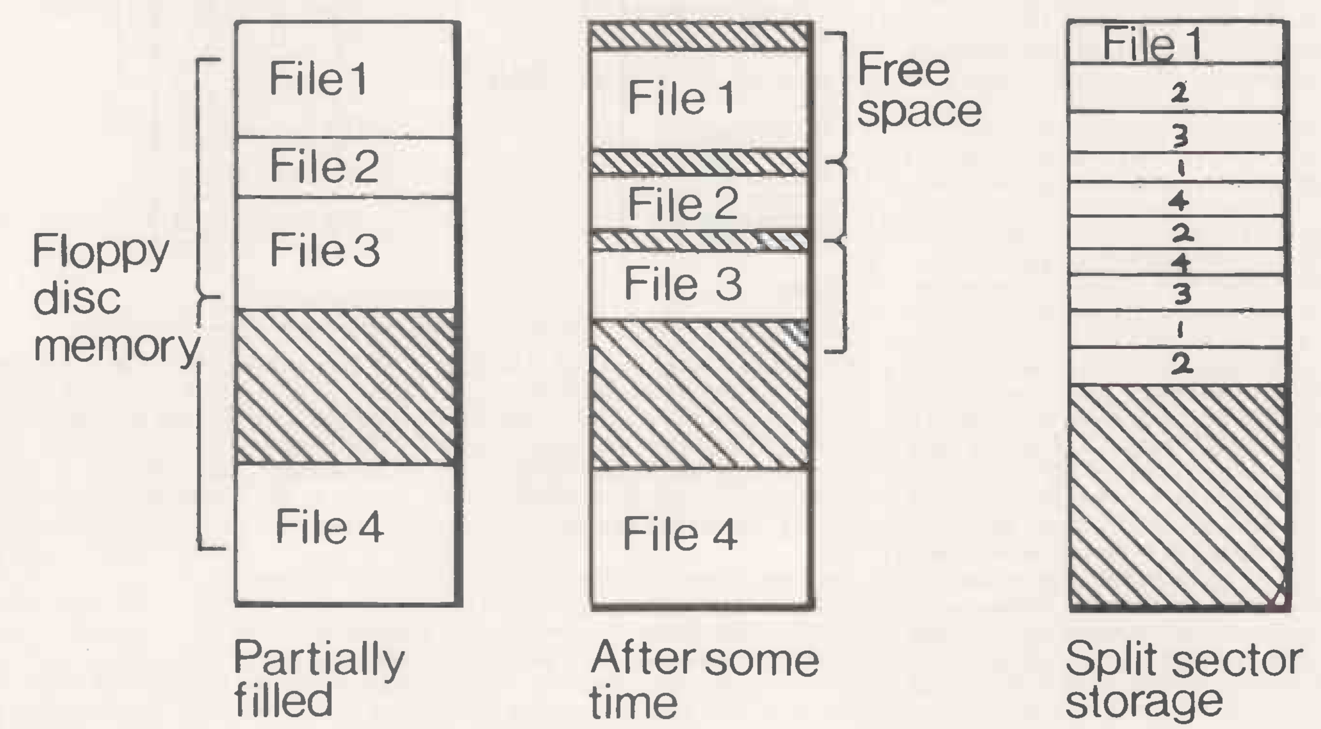

Figure 1.

(continued from previous page)

To delete line G after line X, for example:

G is given by $(X)_p$.
1 Search text for line X.
2 Set line X's pointer = to line G's pointer; $(X)_p + (G)_p = ((X)_p)_p$.
3 Set line G's pointer = 0; $(G)_p = 0$ or $((x)_p)_p = 0$.
4 If $(X)_p = 0$ then set E = X. End of text check.

Two other subroutines, Insert or Delete, are needed before a line. Checks should be made against the start of text.

As it stands, when a line is deleted, the space it occupied is not recovered. Inserts or changes will eventually use up the space, and at this point the text will have to be written to disc or cassette. Note that the text in figure 6 will be written to tape or disc in the line order A G B C, and when read back it will be stored in this order.

The best use for the F pointer is to have it as the start of a free space list. Each deleted or unused line pointer points to the next free line in the list. One change in the insertion after the routine is that F is not incremented by 1, but instead takes on the value of that line's pointer. All of the memory has to be filled before it becomes necessary to write to tape or disc — an unlikely event.

Basic interpreters sometimes use linked lists to store lines of program text. The Pet for example has a pointer at the start of each line, giving the address of the next line. However the lines are all maintained in ascending line number, so that if a line is inserted then the rest of the program has to be moved down in memory and all the pointers changed. Surprisingly no benefit is derived from the linked list, other than faster execution. Possibly the lack of 16-bit addressing modes in the 6502 microprocessor explains this. However 8080 and Z-80 based Basics should be able to take advantage of linked lists structures.

The stack is a very natural structure. If you remove your clothes and throw them on the floor in that order, then when you put them back you will find that what you removed last is first in the pile. It is also the structure that occurs in every computer. Subroutine return addresses are stored on a stack so that the most recently executed subroutine will return correctly. The 6502 processor has a stack in the second 256 bytes of memory, 256 to 511; 8080 and Z-80 micros can have a stack anywhere and of practically any length.

Recursion is a technique whereby a subroutine can call itself any number of times and return eventually with the correct answers and without corrupting any data. The method used in languages like Pascal or Algol is to put all the data along with the return addresses on to the stack. The eight queens problem of fitting eight queens on a chessboard so that none can be taken, can be solved recursively. A routine is used to put a queen down, and it

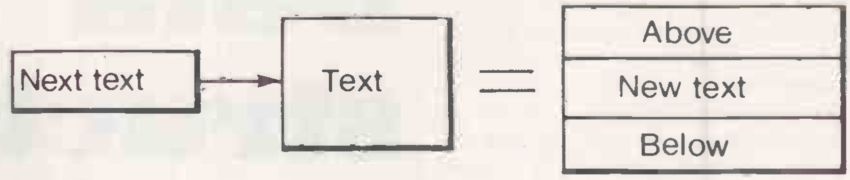

Figure 2.

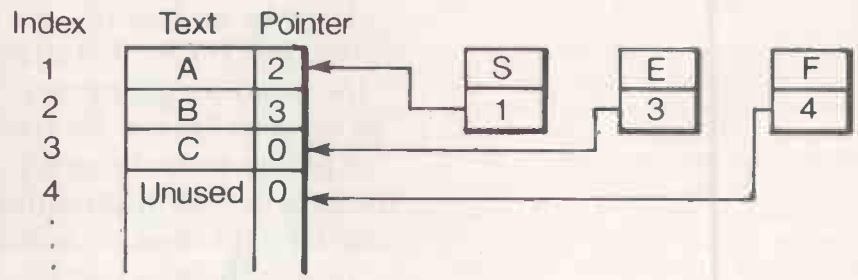

Figure 3.

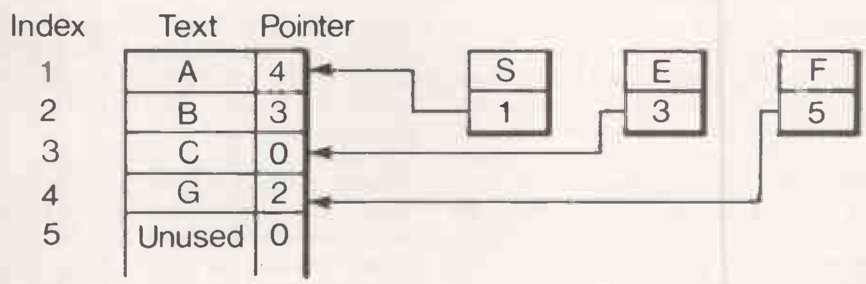

Figure 4.

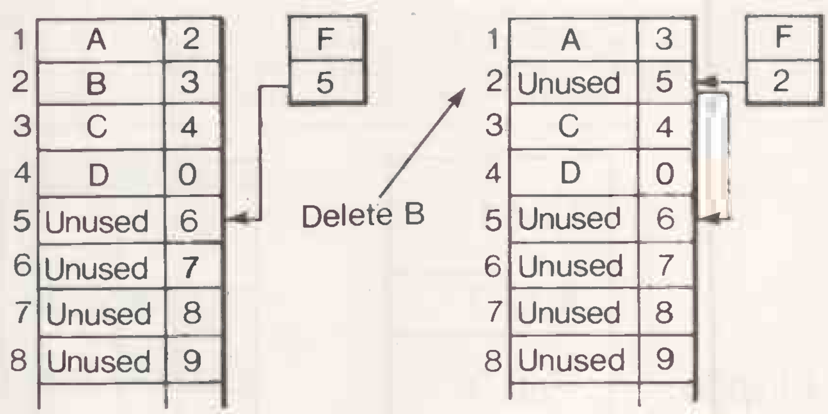

Figure 5.

then calls itself and so on and so on until all eight are down. Checks are made, and the last queen moved for all of the legal moves. These checks are made as each queen is put on the board. The program might place five or six without much difficulty, but the last two could be awkward.

Imagine the program has six down and is trying without success to put down the seventh. After trying all positions, the subroutine returns one level and moves the sixth queen somewhere else. It then tries the seventh again and so on. It could happen that it would have to return all the way to the second or third queen. But this program will try out as many combinations as it needs to solve the problem. It is not quick, but it is thorough.

Slightly more practical though is a maze-searching algorithm for a micromouse. In the simplified maze in figure 6, square 25 is the target. The stack can be used to keep track of the route and to detect backtracking.

The route 10-9-8-15-22-29-30-23-16 is a deliberate blind alley intended to slow down the mouse. If the mouse has gone 1-2-3 and up the alley, it reaches the end and can go no further. So it removes 16 from the stack, the last value added, and

(continued on page 145)

ddl Systems

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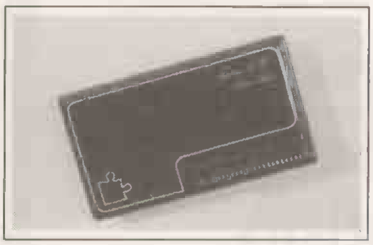

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● **Circle No. 198**

Push
1 Create a new item and store the data.
2 Set new item's pointer = stacktop.
3 Set stacktop = new item address.
Pull
1 Retrieve data from stack.
2 Set stacktop = pointer of item on stack.

Table 1.

(continued from page 142)

compares the square it is going into with the current top value of the stack. They both equal 23, so it is backtracking and knocks 23 off the stack and so on back to 10. The current value on stack is 3, but there are two options 11 and 3, so it chooses 11 and puts this on the stack. Eventually when the mouse reaches its destination it will have the most direct route on the stack.

High-level languages which use stacks quite often use linked lists to implement them. Two operations must be defined: Push which adds a value to the top of the stack and Pull which retrieves the top item on the stack — see table 1.

One check should be made when pulling, to prevent a Pull on a stack with no elements:

Is STACKTOP = 0

Simulation programs often use queues to simulate queues in post offices or supermarkets. Large multi-tasking computers have to queue up jobs and printer output, as a processor can work a thousand times as fast as a piece of machinery.

A queue is a data structure in which items are Pushed on to the rear of a queue and subsequently Popped off the front. If linked lists were not used here then either the queue would move backwards through memory or else the whole queue would have to be shifted up whenever an item was Popped off the front. Two pointers are used to indicate the start and rear of the queue and each item has a pointer to its successor — see figure 8.

Figure 6.

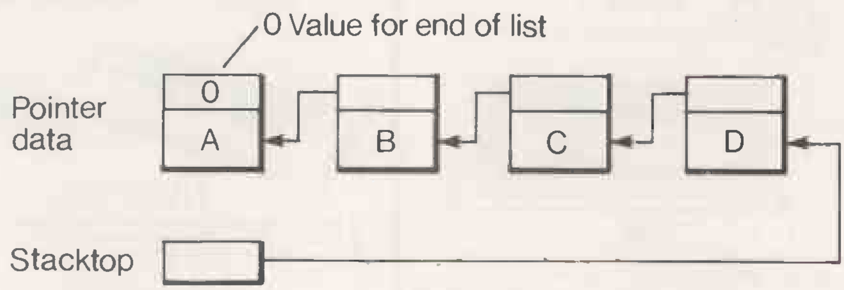

Figure 7.

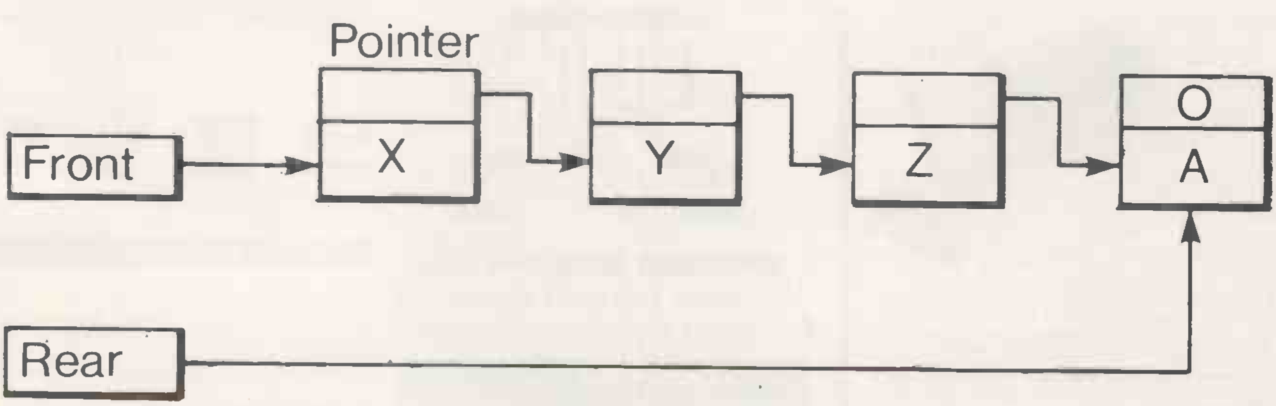

Figure 8.

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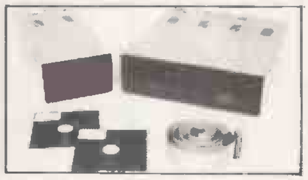

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● **Circle No. 199**

AIRLANDER

You are in the pilot's seat of an airliner full of passengers — short of fuel, and able to make only one pass of the runway. This is the scene set by Nicholas Lloyd in a simulation game written for the Pet.

```
*AIR-LANDER*

1 REM** AIR-LANDER
2 REM** NICHOLAS LLOYD     1981
3 REM** CHANGES FOR NEW 4000 SERIES PETS
4 REM** WITH LARGE SCREENS:
5 REM** ALTER NO'S ABOVE ARROWS IN REMS
6 REM** STARTING:'REM##' TO THOSE
7 REM** FOLLOWING IN THE REMS
10 PRINT"          A I R - L A N D E R"
15 PRINT"          ________________________"
20 PRINT"CONTROLS"
25 PRINT"    ________"
30 PRINT"'B'  AIR BRAKES     '>'   UNDER-CARRIAGE DOWN"
40 PRINT"'S'    SLOWER             'F'     FASTER"
50 PRINT"              '8'(DOWN)"
60 PRINT"(LEFT)'4'     '6'(RIGHT)"
70 PRINT"               '2'(UP)"
75 PRINT" H I - S C O R E :"Q
80 PRINT"    PRESS 'SPACE-BAR' TO CONTINUE"
140 WAIT59410,4,4
145 REM** SET UP VALUES
150 C$="                                   "
160 B$="++++++++++++++++++++++++++++++++++++++"
170 D2=(INT(RND(5)*300)-150)*9:U$="UP":B=0:PRINT"":Z$="OFF"
180 F1=700:T1=5:A1=T1*50:D1=(INT(RND(2)*100)+300)*100
190 H1=INT(RND(5)*750)+1300:C=0:Z=0
200 A$="                                        ":GOTO400
210 REM** INITIAL DISPLAY
215 PRINT""A$:PRINT"                                    "
220 FORA=1TO10:PRINT"                                    ":NEXTA
225 PRINT"                               "
230 PRINTA$:PRINT"AIR SPEED          POSITION↑         "
235 PRINTA$:PRINT"WHEELS             POSITION←         "
240 PRINTA$:PRINT"THRUST             ALTITUDE          ":PRINTA$
250 PRINT"FUEL           A.BRAKES          ":PRINTA$
270 PRINT"                                 ":PRINTA$:RETURN
280 REM** DASHBOARD SUBROUTINE
281 PRINT""
290 PRINT"                                 "
300 PRINTTAB(11);A1;TAB(30);D1
310 PRINT"                                 "
320 PRINTTAB(12);U$;TAB(30);D2
330 PRINT"                                 "
340 PRINTTAB(11)T1;TAB(30)H1
350 PEINT"                                 "
360 PRINTTAB(11);F1;TAB(31);Z$
372 RETURN
400 GOSUB210:GOSUB280
500 REM** CONTROLS
501 Z$="OFF":IFH1<1000ANDPEEK(151)=12THENU$="DOWN":Z=Z+5:A1=A1-3
502 REM##                            ↑62
503 IFB<>0THENA1=A1+B*10:B=0
505 IFPEEK(151)=39ANDF1>0THENT1=T1+1:A1=A1+30:B=1:IFA1>500THENA1=A1-30:GOTO560
507 REM##         ↑70
510 IFPEEK(151)=40ANDF1>0THENT1=T1-1:A1=A1-30:B=-1:IFA1<100THENA1=A1+30:GOTO560
511 REM##         ↑83
515 IFPEEK(151)=30THENA1=A1-3:Z$="ON":GOTO560
517 REM##         ↑66
520 IFPEEK(151)=18THENA1=A1-9.8:C=C+1:D1=D1-(A1*100/60):GOTO570
525 REM##         ↑50
530 IFPEEK(151)=50THENA1=A1+9.8:C=C-1:D1=D1-(A1*100/60):GOTO570
535 REM##         ↑56
540 IFPEEK(151)=42THEND1=D1-(A1*.5):D2=D2-(A1*.1):GOTO570
545 REM##         ↑52
550 IFPEEK(151)=41THEND1=D1-(A1*.5):D2=D2+(A1*.1):GOTO570
555 REM##         ↑54
560 D1=D1-(A1*100/60)
570 IFT1>10THENT1=10
572 IFT1<=0THENA1=A1-5:T1=0
575 F1=F1-(T1*1.5):H1=H1+(9.8*C*(A1/250)):IFA1>500THENA1=A1-10
577 IFF1<0THENF1=0
578 IFH1<0THENH1=0
580 IFC>0THENC=C-.5
582 IFC<0THENC=C+.5
584 IFA1>T1*50THENA1=A1-(A1*.005)
595 D1=INT(D1):D2=INT(D2):F1=INT(F1):A1=INT(A1):H1=INT(H1)
596 GOSUB280
597 IFF1<=30THENGOSUB1000
600 IFD1<2000AND(D2>100ORD2<-100)THENGOSUB1100
603 IFA1<100THENGOSUB1200
605 IFH1<150THENGOSUB1300:GOTO619
610 PRINT"":FORA=1TO10:PRINT"                                        ":NEXTA
615 GOSUB4000
619 IFD1<0ANDH1>0ANDABS(D2)<100THEN5400
680 GOTO500
1000 REM** FUEL SUBROUTINE
1010 PRINT"":FORE=1TO6
1020 PRINT"LOW FUEL":FORA=1TO40:NEXTA
1030 PRINT"LOW FUEL":FORA=1TO40:NEXTA:NEXTE:Z=Z-5
1040 IFF1<=0THENT1=0
1050 RETURN
```

(listing continued on next page)

AIRLANDER is a flight simulation game in which you must try to land the jet safely on the runway. When you have landed you are given a score which will vary according to your speed at touch-down, fuel left, position relative to the airport and whether or not you crashed the aeroplane.

Large-screen Pets

For the large-screen 4000-series Pets, certain changes should be made to the program, this involves changing the numbers in the Peek(151) statements to those in the Rems on the lines below. The lines in which the changes should be made are: 501, 505, 510, 515, 520, 530, 540 and 550. The numbers in the Rems on the lines below should be substituted for the numbers above the arrows.

To speed up this program on 3000-series Pets the following command should be typed before running the program:

POKE59458, 62

Rules and regulations

Lines 10 to 80 give a simple summary of the controls. Lines 145 to 200 set up the initial values for the position of the aircraft. D1 and D2 are the values for the position of the aircraft and are like coordinates, the airport being the origin. D2 is the distance to the left or right of the airport and D1 is the distance out from the airport. H1 is the altitude of the aircraft, F1 is the fuel, T1 is the thrust and A1 is the air speed. H1, D1 and D2 are all given in metres and air speed is in kilometres per hour. U$ is the condition of the undercarriage, initially up, and Z$ is the condition of the air brakes, initially off. Lines 210 to 270 set up the dashboard and lines 280 to 372 are the subroutines to update the information.

Air speed is shown on the top left of the eight readings. Below this is the register for the state of the undercarriage, up or down; below this is the thrust, a value between 0 and 10; and below this is the fuel guage. The reading in the top right is for the distance out from the airport, and the reading below is for the distance to either side of the airport: it takes negative

(continued on next page)

(continued from previous page)
values if you are to the left of the airport. Below this is the altitude and below this is the register for the state of the air brakes, on or off.

Aircraft control

Between lines 500 and 680 is the main part of the program from which the various subroutines are called and the aircraft is controlled. Pressing key 4 moves the plane to the left and key 6 moves the plane to the right, the amount by which it moves depending upon air speed. When the plane is turning, the rate of decrease of distance out from the airport decreases. Pressing key 8 makes the plane descend, and pressing key 2 makes the plane ascend. The rate of change of height increases the longer either of these keys is pressed and then carries on changing at a decreasing rate for a while after the key is released. Pressing key S decreases the thrust and hence air speed, while key F increases thrust and hence air speed.

Air speed also varies as the plane ascends and descends. Pressing the > key lowers the undercarriage, although it may only be lowered when the plane descends to below 1,000 metres. Pressing key B puts on the air brakes for the period during which the key is pressed.

Between lines 1000 and 1050 is the low-fuel subroutine which makes a panel on the dashboard flash with the words "low fuel" when fuel is below 30. On either side of the airport up to an infinite height is a range of mountains which the plane cannot cross. When the plane is off course and approaching these mountains a panel flashes in the same way as for low fuel. The subroutine for this is between lines 1100 and 1150. Between lines 1200 and 1250 is a similar subroutine for stalling, which occurs when the air speed falls below 100 kilometres per hour.

Descent and landing

Until the aircraft descends to below 150 metres the display in the top part of the screen shows moving clouds; the subroutine to show them is between lines 4000 and 4080. The subroutine between lines 1300 and 3000 is the low-altitude subroutine which displays the ground below 150 metres and is shown as you near the airport. If you are off course and nearing the mountains this is shown on the screen. The subroutine between lines 5000 and 5400 gives a report after your flight, and the subroutine from line 6000 gives your score.

It is quite hard to land the plane. Try to reduce air speed by reducing thrust. Correct the course while the plane continues to descend. After your finger has been taken off the 2 make sure your undercarriage is down. Use the air brakes to slow up when you are about to land, as the maximum landing speed is about 250 kilometres per hour.

(listing continued from previous page)

```
1100 REM** MOUNTAIN SUBROUTINE
1110 IFD1<=0THEN5300
1120 PRINT"[graphics]":FORF=1TO6:B=1
1130 PRINT"[graphics]MOUNTAINS":FORA=1TO40:NEXTA
1140 PRINT"[graphics]MOUNTAINS[graphics]":FORA=1TO40:NEXTA:NEXTF
1150 RETURN
1200 REM** STALLING SUBROUTINE
1210 PRINT"[graphics]":FORG=1TO6
1220 PRINT"[graphics]STALL":FORA=1TO40:NEXTA
1230 PRINT"[graphics]STALL[graphics]":FORA=1TO40:NEXTA:NEXTG:Z=Z-10
1240 H1=H1-35:T1=0:A1=A1+28:IFH1<=0THEN5200
1250 PRINT"[graphics]          [graphics]":RETURN
1300 REM** LOW ALTITUDE SUBROUTINE
1310 IFD1>=5000THEN1400
1320 IFD1<5000ANDABS(D2)>100THEN1500
1330 IFD1<5000ANDD1>=3000ANDABS(D2)<=100THEN1600
1340 IFD1<3000ANDD1>=1800ANDABS(D2)<=100THEN1700
1350 IFD1<1800ANDD1>=1200ANDABS(D2)<=100THEN1800
1360 IFD1<1200ANDD1>=600ANDABS(D2)<=100THEN1900
1370 IFD1<600ANDD1>0ANDABS(D2)<=100THEN2000
1400 PRINT"[graphics]":FORA=1TO10:PRINTB$:NEXTA
1410 IFH1<=0THEN5000
1420 GOTO3000
1500 IFD1>500THEN1510
1505 PRINT"[graphics]":FORA=1TO10:PRINTC$:NEXTA:GOTO1520
1510 PRINT"[graphics]":FORA=1TOINT(10.5-(D1/500)):PRINTC$:NEXTA
1520 GOTO3000
1600 PRINT"[graphics]":FORA=1TO10:PRINTB$:NEXTA:PRINT"[graphics]":Z=Z+5
1620 PRINTTAB((D2/10)+18)"[graphics]/ \":IFH1<=0THEN5000
1630 GOTO3000
1700 PRINT"[graphics]":FORA=1TO10:PRINTB$:NEXTA:PRINT"[graphics]":Z=Z+5
1720 PRINTTAB((D2/10)+18)"[graphics]/   \[graphics]/     \":IFH1<=0THEN5000
1730 GOTO3000
1800 PRINT"[graphics]":FORA=1TO10:PRINTB$:NEXTA:PRINT"[graphics]":Z=Z+5
1820 PRINTTAB((D2/10)+16)"[graphics]     [graphics]/    \[graphics]/       \[graphics]/       \
1830 IFH1<=0THEN5060
1840 GOTO3000
1900 PRINT"[graphics]":FORA=1TO10:PRINTB$:NEXTA:PRINT"[graphics]":Z=Z+10
1920 PRINTTAB((D2/10)+15)"[graphics]       [graphics]/  |  \[graphics]/   |    \"
1930 PRINTTAB((D2/10)+13)"/   |      \[graphics]/       |      \"
1940 IFH1<=0THEN5060
1950 GOTO3000
2000 PRINT"[graphics]":FORA=1TO10:PRINTB$:NEXTA:PRINT"[graphics]":Z=Z+15
2010 PRINTTAB((D2/10)+15)"[graphics]"
2020 PRINTTAB((D2/10)+15)"[graphics],        [graphics]"
2030 PRINTTAB((D2/10)+15)"/    |    \[graphics]/    |    \"
2040 PRINTTAB((D2/10)+13)"/      |      \[graphics]/      |      \"
2050 PRINTTAB((D2/10)+11)"/        |        \":IFH1<=0THEN5060
3000 RETURN
4000 REM** CLOUD SUBROUTINE
4010 D$="[graphics]          [graphics]"
4020 E$="[graphics]     [graphics]          [graphics]"
4030 F$="[graphics] " '   [graphics]         [graphics]         [graphics]"
4040 H=INT(RND(2)*3):PRINT"[graphics]"
4045 G=INT(RND(6)*20):FORS=1TOG:PRINT"[graphics]";:NEXTS
4050 IFH=0THENPRINTD$
4060 IFH=1THENPRINTE$
4070 IFH=2THENPRINTF$
4080 RETURN
5000 REM** LANDING SUBROUTINE
5010 FORA=1TO1000:NEXTA:PRINT"[graphics]":POKE158,0
5020 PRINT"[graphics]YOU CRASH-LANDED AT";A1;"KMH":Z=Z-70
5030 PRINT"[graphics]"D1;"METRES FROM THE AIRPORT AND";D2
5040 PRINT"[graphics]METRES OFF COURSE.THE PLANE IS A RIGHT[graphics]OFF"
5045 IFU$<>"UP"ANDA1<200THENPRINTINT(RND(2)*10);"PEOPLE WERE INJURED.":GOTO6000
5050 IFU$<>"DOWN"ORA1>200THENPRINT"[graphics]THERE WERE NO SURVIVORS.":Z=Z-100:GOTO6000
5060 FORA=1TO1000:NEXTA:PRINT"[graphics]":POKE158,0
5070 IFABS(D2)<20THENPRINT"[graphics]YOU LANDED ON THE RUNWAY";D2;"METRES "
5075 IFABS(D2)<20THENPRINT"[graphics]OFF-CENTRE AND";D1;"METRES FROM THE ":Z=Z+30
5080 IFABS(D2)>20THENPRINT"[graphics]YOU JUST MISSED THE RUNWAY,YOU  WERE"
5085 IFABS(D2)>20THENPRINT"[graphics]";D2;"METRES OFF-CENTRE AND";D1;"METRES"
5087 IFABS(D2)>20THENPRINT"[graphics]FROM THE ":Z=Z+10
5090 PRINT"[graphics]AIRPORT.YOUR LANDING SPEED WAS";A1;"KMH."
5100 IFU$<>"DOWN"THENPRINT"[graphics]YOUR UNDER-CARRIAGE WAS NOT DOWN:THE"
5105 IFU$<>"DOWN"THENPRINT"[graphics]PLANE WAS A RIGHT-OFF.":Z=Z-50
5110 IFA1<250THEN6000
5120 D=INT((A1-250)/20):FORE=1TOD:F=INT(RND(3)*10)
5130 IFF=7THENPRINT"[graphics]YOUR LANDING SPEED WAS TOO GREAT;THE"
5140 IFF=7THENPRINT"[graphics]PLANE BROKE UP":Z=Z-80:GOTO6000
5150 NEXTE:GOTO6000
5200 PRINT"[graphics]YOUR PLANE STALLED AND CRASHED ON ITS"
5210 PRINT"[graphics]NOSE,THERE WERE NO SURVIVORS."
5220 PRINT"[graphics]YOU WERE";D2;"METRES OFF-COURSE"
5230 PRINT"[graphics]AND";D1;"METRES FROM THE AIRPORT.":Z=Z-150:GOTO6000
5300 PRINT"[graphics]YOU SMASHED INTO A MOUNTAIN AT";A1
5310 PRINT"[graphics]KMH.":Z=Z-200
5320 PRINT"[graphics]YOU WERE";D2;"METRES OFF-COURSE.":GOTO6000
5400 PRINT"[graphics]YOU FLEW STRAIGHT OVER THE AIRPORT":Z=Z-60
6000 REM** SCORE
6020 PRINT"[graphics]"
6060 Z=Z+INT((200/(ABS(D1)+1))+(150/(ABS(D2)+2))+(F1/15)+(30-(H1/150)))
6065 IFZ<0THENZ=0
6070 PRINT"[graphics]YOU SCORED";Z;"POINTS.":IFZ>QTHENQ=Z
6075 PRINT"[graphics] H I - S C O R E :";Q:POKE158,0
6077 PRINT"[graphics]DO YOU WANT ANOTHER GO";:INPUTH$:IFLEFT$(H$,1)="Y"THEN10
6080 POKE158,0:PRINT"[graphics]":END
```

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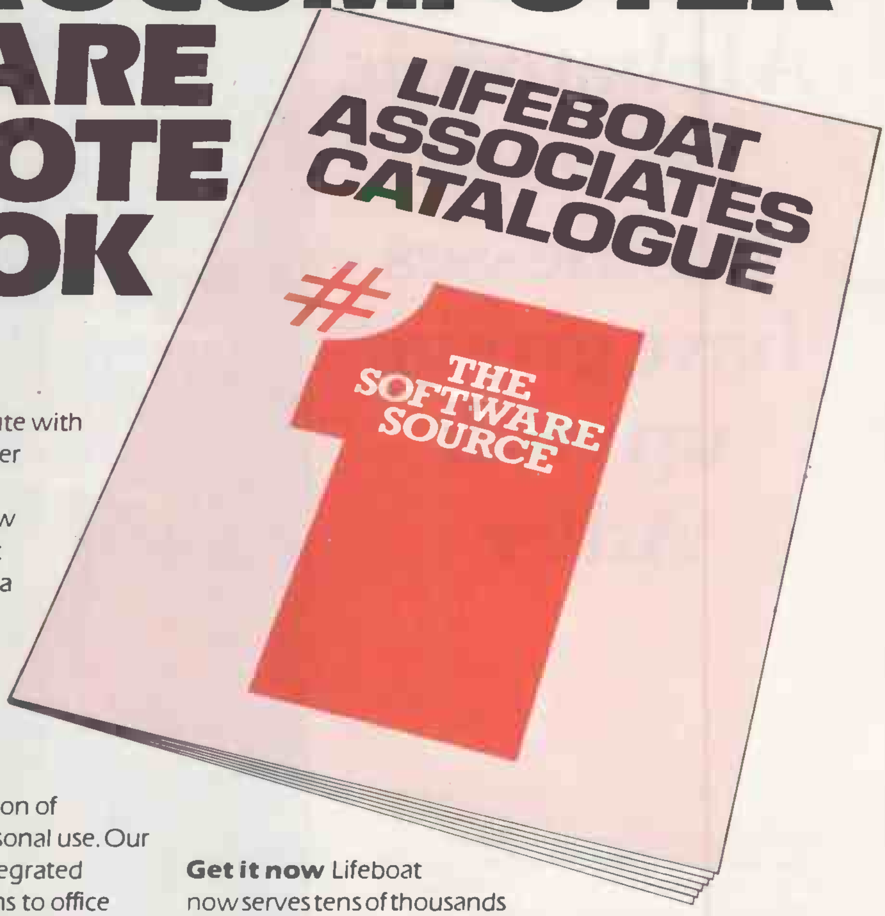

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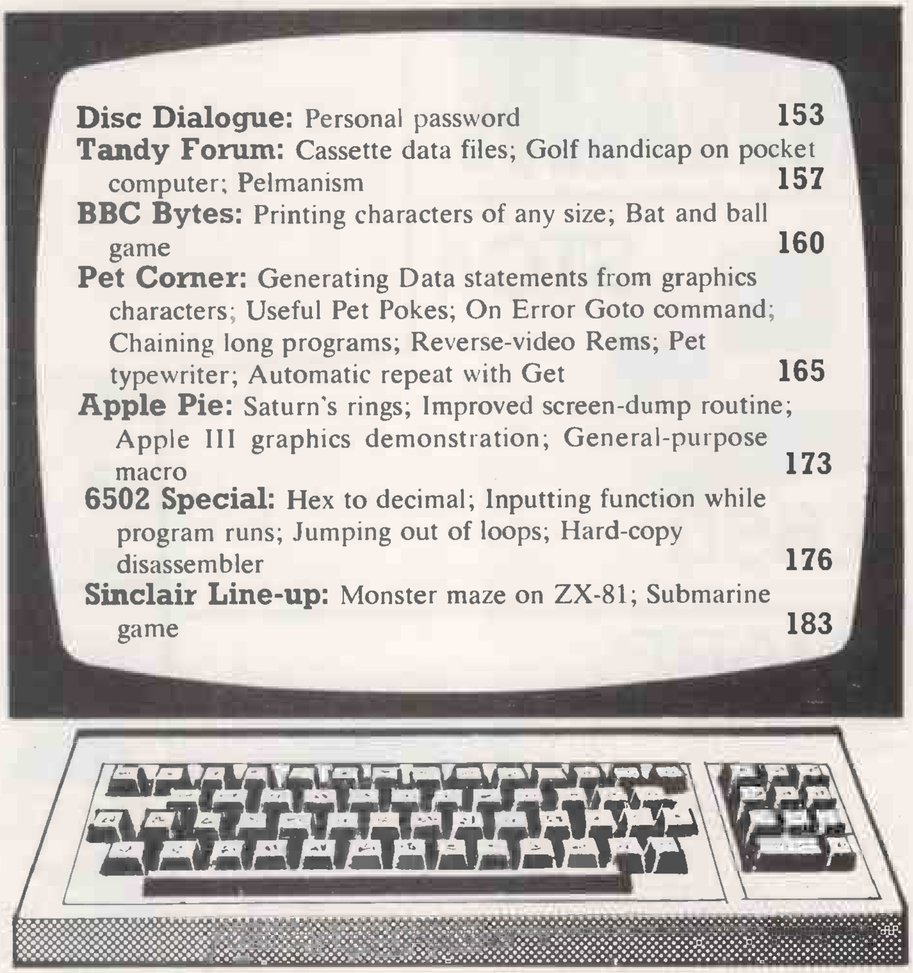
● Circle No. 203

Open File

This regular section of *Practical Computing* appears in the magazine each month, incorporating Tandy Forum, Apple Pie, Sinclair Line-up and other software interchange pages.

Open File is the part of the magazine written by you, the readers. All aspects of microcomputing are covered, from games to serious business and technical software, and we welcome contributions on CP/M, BBC Basic, Microsoft Basic, Apple Pascal and so on, as well as the established categories.

Contributors receive £30 per published page and pro rata for part pages, with a minimum of £6. Send contributions to: Open File, *Practical Computing*, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.



Guidelines for contributors

Programs should be accompanied by documentation which explains to other readers what your program does and, if possible, how it does it. It helps if documentation is typed or printed with double-line spacing — cramped or handwritten material is liable to delay and error.

Program listings should, if at all possible, be printed out. Use a new ribbon in your printer, please, so that we can print directly from a photograph of the listing and avoid typesetting errors. If all you can provide is a typed or handwritten listing, please make it clear and unambiguous; graphics characters, in particular, should be explained.

We can accept material for the Pet, Vic and Sharp MZ-80K on cassette, and material for the larger machines can be sent on IBM-format 8in. floppy discs.

Personal password

IN RESPONSE to the article by Adrian Hill in *Practical Computing* August 1982 on using CP/M's internal routines, David Rigby of Ballydare, County Antrim sent

(continued on page 155)

Personal password.

```
               ;
               ;PASSWORD PROGRAM
               ;
0100                    ORG     100H
0100 3E17               LD      A,23
0102 2100F0             LD      HL,0F000H
0105 F70F               EMT     CLEAR
0107 DD218803           LD      IX,UNIT
010B F719               EMT     INIT
010D 0E19               LD      C,25
010F CD0500             CALL    FDOS
0112 328803             LD      (UNIT),A
               ;
               ;INPUT FILENAME
               ;
0115 219B02    FNAME:   LD      HL,MES
0118 F717               EMT     MSG
011A 0E0A               LD      C,10
011C 118F03             LD      DE,FTEMP
011F CD0500             CALL    FDOS
0122 DD218F03           LD      IX,FTEMP
0126 DD7E03             LD      A,(IX+3)
0129 FE3A               CP      ':'
012B CA4701             JP      Z,DRIVE
012E DD4601             LD      B,(IX+1)
0131 78                 LD      A,B
0132 FE0C               CP      12
0134 EA1501             JP      PE,FNAME
0137 218F03             LD      HL,FTEMP
013A 110200             LD      DE,2
013D 19                 ADD     HL,DE
013E 0E00               LD      C,0
0140 ED5B8D03           LD      DE,(FILE)
0144 C36801             JP      LOOP1
               ;
               :SET DRIVE
               ;
0147 218F03    DRIVE:   LD      HL,FTEMP
014A 23                 INC     HL
014B 23                 INC     HL
014C 7E                 LD      A.(HL)
014D D641               SUB     65
014F 328803             LD      (UNIT),A
0152 DD4601             LD      B,(IX+1)
0155 78                 LD      A,B
0156 FE0E               CP      14
0158 EA1501             JP      PE,FNAME
015B 0E00               LD      C,0
015D 218F03             LD      HL,FTEMP
0160 110400             LD      DE,4
0163 19                 ADD     HL,DE
0164 ED5B8D03           LD      DE.(FILE)
               ;
               ;TRANSFER FILE NAME FOR COMPARING
               ;
0168 7E        LOOP1:   LD      A.(HL)
0169 FE2E               CP      '.'
016B CA7701             JP      Z.GOTPNT
016E 12                 LD      (DE),A
016F 13                 INC     DE
0170 23                 INC     HL
```

(listing continued on page 155)

(continued from page 153)

an alternative machine-code Password program.

The program allows the user to give each file its own personal password. The password consits of two characters which are stored in two unused locations in the file control block.

When the program is run the user is prompted for a file name. It is given in the form

D:FILENAME. EXT:

The drive specification if omitted is assumed to be the logged-on drive. The only requirement is that the drive is given in capitals; the file name and extension can be in lower-case or capital letters.

If a match is found the user is asked if the file is to be secured or released and for two characters for the password. If the two locations in the FCB contain zero then the file is secured by rewriting the file name and extension in lower-case letters and the password is inserted into the locations, and the FCB rewritten to the directory.

If the file is to be released and the two locations do not contain zero then the contents of the two locations are compared with the password. If they match then the file is released by converting the file name and extension to upper-case characters and the FCB rewritten to the directory. Otherwise no action needs to be taken.

The program was written on Research Machines 380-Z, COS version 4.0 using CP/M version 1.4, but should run on earlier versions of the machine.

(listing continued from page 153)

```
0171 0C                 INC     C
0172 10F4               DJNZ    LOOP1
0174 C31501             JP      FNAME
0177 3E09      GOTPNT:  LD      A,9
0179 91                 SUB     C
017A 47                 LD      B,A
017B 3E20               LD      A,' '
017D 12        LOOP2:   LD      (DE),A
017E 13                 INC     DE
017F 10FC               DJNZ    LOOP2
0181 1B                 DEC     DE
0182 23                 INC     HL
0183 0603               LD      B,3
0185 7E        LOOP3:   LD      A,(HL)
0186 12                 LD      (DE),A
0187 13                 INC     DE
0188 23                 INC     HL
0189 10FA               DJNZ    LOOP3
               ;
               ;READ IN DIRECTORY AND SEARCH
               ;FOR OCCURANCE OF FILE
               ;
018B DD218803  READSC:  LD      IX,UNIT
018F F71A               EMT     RDSEC
0191 0604      COMPARE:LD       B,4
0193 21B903             LD      HL,BUFF+1
0196 C5        FLCHLP:  PUSH    BC
0197 E5                 PUSH    HL
0198 ED5B8D03           LD      DE,(FILE)
019C CDBE01             CALL    SEARCH
019F CAE801             JP      Z,FOUND
01A2 E1                 POP     HL
01A3 112000             LD      DE,20H
01A6 19                 ADD     HL,DE
01A7 C1                 POP     BC
01A8 10EC               DJNZ    FLCHLP
01AA 3A8A03             LD      A.(SECTOR)
01AD 3C                 INC     A
01AE 328A03             LD      (SECTOR),A
01B1 FE11               CP      A,11H
01B3 C28B01             JP      NZ,READSC
01B6 21CA02             LD      HL,MES1
01B9 F717               EMT     MSG
01BB C30000             JP      EXIT
01BE 060B      SEARCH:  LD      B,11
01C0 1A        SERLOP:  LD      A,(DE)
01C1 BE                 CP      A,(HL)
01C2 2007               JR      NZ,NOGO1
01C4 13                 INC     DE
01C5 23                 INC     HL
01C6 10F8               DJNZ    SERLOP
01C8 E600               AND     A.0
01CA C9                 RET
01CB C620      NOGO1:   ADD     32
01CD BE                 CP      A.(HL)
01CE C2D801             JP      NZ,NOGO2
01D1 13                 INC     DE
01D2 23                 INC     HL
01D3 10EB               DJNZ    SERLOP
01D5 E600               AND     A,0
01D7 C9                 RET
01D8 D640      NOGO2:   SUB     64
01DA BE                 CP      A,(HL)
01DB C2E501             JP      NZ,NOMATCH
01DE 13                 INC     DE
01DF 23                 INC     HL
01E0 10DE               DJNZ    SERLOP
01E2 E600               AND     A,0
01E4 C9                 RET
01E5 F6FF      NOMATCH:OR       A,0FFH
01E7 C9                 RET
               ;
               ;MATCH FOUND
               ;
01E8 DDE1      FOUND:   POP     IX
01EA 21DA02             LD      HL,MES2
01ED F717               EMT     MSG
01EF F721               EMT     KBDW
01F1 F72A               EMT     OUTNC
01F3 F5                 PUSH    AF
01F4 3E0D               LD      A.13
01F6 F72A               EMT     OUTNC
01F8 F1                 POP     AF
01F9 FE52               CP      82
01FB CA1002             JP      Z,RELEASE
01FE FE72               CP      114
0200 CA1002             JP      Z.RELEASE
0203 FE53               CP      83
0205 CA4602             JP      Z,SECURE
0208 FE73               CP      115
020A CA4602             JP      Z,SECURE
020D C30000             JP      EXIT
               ;
               ;RELEASE FILE
               ;
0210 CD7602    RELEASE:CALL     PASSWD
0213 DD560C             LD      D,(IX+12)
0216 DD5E0D             LD      E,(IX+13)
0219 7C                 LD      A,H
021A BA                 CP      D
021B C28B02             JP      NZ,NOREL
021E 7D                 LD      A,L
021F BB                 CP      E
0220 C28B02             JP      NZ,NOREL
0223 DD360C00           LD      (IX+12),0
0227 DD360D00           LD      (IX+13),0
022B 060B               LD      B,11
022D DD7E00    LOOP4:   LD      A,(IX+0)
0230 FE20               CP      32
0232 CA3A02             JP      Z,NEXT1
0235 D620               SUB     32
0237 DD7700             LD      (IX+0),A
023A DD23      NEXT1:   INC     IX
023C 10EF               DJNZ    LOOP4
023E 216B03             LD      HL,MES6
0241 F717               EMT     MSG
0243 C38202             JP      WRITE
               ;
               ;SECURE FILE
               ;
0246 CD7602    SECURE:  CALL    PASSWD
0249 DD560C             LD      D,(IX+12)
024C DD5E0D             LD      E,(IX+13)
024F 7A                 LD      A,D
0250 FE00               CP      0
0252 C29302             JP      NZ,NOSEC
0255 DD740C             LD      (IX+12),H
0258 DD750D             LD      (IX+13),L
025B 060B               LD      B,11
025D DD7E00    LOOP5:   LD      A,(IX+0)
0260 FE20               CP      32
0262 CA6A02             JP      Z,NEXT2
0265 C620               ADD     32
0267 DD7700             LD      (IX+0),A
026A DD23      NEXT2:   INC     IX
026C 10EF               DJNZ    LOOP5
026E 217A03             LD      HL,MES7
0271 F717               EMT     MSG
0273 C38202             JP      WRITE
               ;
               ;ENTER PASSWORD
               ;
0276 210903    PASSWD:  LD      HL,MES3
0279 F717               EMT     MSG
027B F721               EMT     KBDW
027D 67                 LD      H,A
027E F721               EMT     KBDW
0280 6F                 LD      L,A
0281 C9                 RET
               ;
               ;WRITE MODIFIED DIRECTORY
               ;
0282 DD218803  WRITE:   LD      IX,UNIT
0286 F71B               EMT     WRSEC
0288 C30000             JP      EXIT
028B 213303    NOREL:   LD      HL.MES4
028E F717               EMT     MSG
0290 C30000             JP      EXIT
0293 215503    NOSEC:   LD      HL.MES5
0296 F717               EMT     MSG
0298 C30000             JP      EXIT
               ;
               ;MESSAGES
               ;
029B 656E7465  MES:     'enter the file name in the form',0DH,'FILENAME.EXT ',0DH,0FFH
02CA 66696C65  MES1:    'file not found',0DH,0FFH
02DA 646F2079  MES2:    'do you want the file released or',0DH,'secured (R/S)',0FFH
0309 656E7465  MES3:    'enter the password (two characters only)',0DH,0FFH
0333 77726F6E  MES4:    'wrong password. access is denied'.0DH,0FFH
0355 66696C65  MES5:    'file already secured'.0DH,0FFH
036B 66696C65  MES6:    'file released',0DH,0FFH
037A 66696C65  MES7:    'file secured'.0DH,0FFH
               ;
               ;WORK AREA
               ;
0388 00        UNIT:    DEFB    0
0389 03        TRACK:   DEFB    3
038A 01        SECTOR:  DEFB    1
038B B803      ADDRS:   DEFW    BUFF
038D A403      FILE:    DEFW    BUFF2
038F 14        FTEMP:   DEFB    20
0390           BUFF1:   DEFS    20
               ;
               ;EQUATES
               ;
03A4 =         BUFF2    EQU     $
03B8 =         BUFF     EQU     $+20
0000 =         EXIT     EQU     0000H
0005 =         FDOS     EQU     0005H
000F =         CLEAR    EQU     15
0017 =         MSG      EQU     23
0019 =         INIT     EQU     25
001A =         RDSEC    EQU     26
001B =         WRSEC    EQU     27
0021 =         KBDW     EQU     33
002A =         OUTNC    EQU     42
0000                    END

038B ADDRS   03B8 BUFF    0390 BUFF1   03A4 BUFF2   000F CLEAR
0191 COMPAR  0147 DRIVE   0000 EXIT    0005 FDOS    038D FILE
0196 FLCHLP  0115 FNAME   01E8 FOUND   038F FTEMP   0177 GOTPNT
0019 INIT    0021 KBDW    0166 LOOP1   017D LOOP2   0185 LOOP3
022D LOOP4   025D LOOP5   029B MES     02CA MES1    02DA MES2
0309 MES3    0333 MES4    0355 MES5    036B MES6    037A MES7
0017 MSG     023A NEXT1   026A NEXT2   01CB NOGO1   01D8 NOGO2
01E5 NOMATC  028B NOREL   0293 NOSEC   002A OUTNC   0276 PASSWD
001A RDSEC   018B READSC  0210 RELEAS  01BE SEARCH  038A SECTOR
0246 SECURE  01C0 SERLOP  0389 TRACK   0388 UNIT    0282 WRITE
001B WRSEC
```

Data files

I WAS INTRIGUED by Frank Johnson's solution to the slow data files problem in Tandy Forum, October 1981, writes R P Sainsbury of Salisbury, Wiltshire. However, it suffers from two problems: the motor relay is still switched on and off during each record; and the short leader means that the automatic recording-level system on some recorders may not settle in time. My modification of Johnson's idea solves this. It is arranged that the relay is not switched off at the end of the record, and is only stopped by a separate statement in the program or by the program stopping. The first record is recorded with the normal leader, but subsequent records are recorded with a 10-byte leader. When data has finished being recorded or read, the motor can be switched off again. This can be acheived by the statements

POKE 16445,0:OUT 255,0

When using 32-character mode Poke and Output 8. Alternatively, set up the USR vector with

POKE 16526,248:POKE 16527,1

and then execute X = USR (0) each time you want to stop the motor. This calls the ROM stop the tape routine, and works in either display mode.

The listings give the assembler code and a Basic loader for the facility. It is totally relocatable, and the loader asks the question

TARGET ADDRESS?

which you can answer with the address in decimal where you want the routine to begin, or just press Enter to load from Memory Size address. Note that if Memory Size has not been set, line 20 resets it and loads the code without the prompt.

Users with the new ROMs should note the modification necessary as indicated at the bottom of the listing. Tandy modified the Print processing, which apparently merely permits the Shift - @ to be used in Print @ statements.

It should also be noted that the program is not compatible with disc Basic, since it uses three Dos exits to link it into Basic. Every time Print or Input is executed, the code at the appropriate label in the assembler code is called.

Every time Basic prints a carriage return, the label Newlin is called. Its purpose is to revert the output-device flag to video output just after a carriage return has been sent to cassette, which fools Basic into thinking the output has not been going to cassette, so it does not turn it off. In line 00250 23 bytes have been reserved with DEFS instruction, to be filled with code moved from the ROM starting at 219A9H.

Users who have purchased Compak-2, release 1, will probably have found that the command

/END

which terminates Compak-2, crashes out with an ?OM Error message. String functions no longer work, and issuing

PRINT FRE("X")

returns a value greater than your memory size.

The program was written on a disc-based system, and the cassette versions are merely copies from the disc. Compak-2 expects to find the memory addresses 16457 and 16458 the address of the top of memory as located by disc boot-up. This value is not the same as Memory Size contained at 16561 and 16562. When you issue

/END

to Compak-2 it is supposed to reset Memory Size to maximum using this value, and then do a Clear 50.

On a level II system, location 16457/16458 is not referenced at all in the ROM, and contains zero. Hence, Memory Size is reset to address zero, which causes the ?OM Error when Compak-2 attempts the Clear 50.

The problem can be cured as follows. First, check the values stored at 16561/16562 when you enter Basic without reserving Memory Size. Now, go back and reserve Memory Size for Compak-2, then Poke into 16457 and 16458 the values found at 16561 and 16562 previously.

Now load Compak-2 from tape and execute in the usual way; /End should now work. Molimerx, the supplier of Compak-2, now renamed Impakt-2, says that the bug has been cleared, so new purchasers should have no problem with /End.

Golf handicap

MOST GOLFERS will know that the handicapping rules are due to be changed at the beginning of 1983, writes John Heap of Leeds. The new rules are designed to make handicaps a truer reflection of aver-

(continued on next page)

Data files.

```
00010       ;FASTER CASSETTE FILES MKII R.P. SAINSBURY DEC. '81.
00020               ORG     7F00H               ;CAN BE ALTERED IF REQUIRED
00030       PRINTC  CP      23H                 ;PRINT TO CASSETTE?
00040               RET     NZ                  ;MUST BE VDU OR PRINTER!
00050               LD      A,(403DH)           ;TEST PORT MASK
00060               AND     4                   ;TO SEE IF MOTOR ALREADY ON
00070               LD      A,(HL)              ;RECOVER CURRENT CHR.
00080               RET     Z                   ;NORMAL LEADER IF 1ST RECORD
00090               POP     BC                  ;CLEAR RETURN ADDR. FROM STACK
00100               CALL    01FEH               ;START
00110               LD      B,10                ;TEN-BYTE LEADER
00120               CALL    0289H               ;WRITE LEADER
00130               JP      2096H               ;CONTINUE IN ROM.
00140       NEWLIN  LD      A,(409CH)           ;TEST OUTPUT DEVICE TYPE
00150               OR      A
00160               RET     P                   ;IGNORE IF NOT CASSETTE
00170               XOR     A                   ;RESET DEVICE FLAG TO VIDEO
00180               LD      (409CH),A
00190               RET
00200       INPUTC  CP      23H                 ;INPUT FROM CASSETTE?
00210               RET     NZ                  ;MUST BE KEYBOARD!
00220               POP     BC                  ;CLEAR STACK
00230               XOR     A                   ;INDICATE INPUT FROM CASSETTE
00240               LD      (40A9H),A
00250               DEFS    23                  ;COPY ROM 21A9H-21BFH INC.
00260               CALL    022CH               ;BLINKING ASTERISKS!
00270               JP      21C3H               ,CONTINUE IN ROM.
00280               END

10  DEFINT B-Z:A=PEEK(16561)+PEEK(16562)*256+3
20  IF A>32698 THEN POKE 16561,183:POKE 16562,127:CLEAR 50:
DEFINT B-Z:A=32698
30  IF A<32698 A1=A:INPUT"TARGET ADDRESS";A1 ELSE 60
40  IF A1<A THEN PRINT"TOO LOW":GOTO 30
50  IF A1+69>32767 THEN PRINT"TOO HIGH":GOTO 30 ELSE A=A1
60  FOR I=A TO A+39:READ D:POKE I,D:NEXT
70  R=8617:FOR I=I TO I+22:POKE I,PEEK(R):R=R+1:NEXT
80  FOR I=I TO I+5:READ D:POKE I,D:NEXT
90  FOR I=1 TO 3:READ X,D:D=D+A
100 POKE X+1,PEEK(VARPTR(D)):POKE X+2,PEEK(VARPTR(D)+1)
110 POKE X,195:NEXT:END
120 DATA 254,35,192,58,61,64,230,4,126,200,193,205,254,1,6,10,205,
137,2,195,150,32,58,156,64,183,240,175,50,156,64,201,254,35,192,193,
175,50,169,64,205,44,2,195,195,33
130 DATA 16842,0,16848,22,16854,32


NEW ROMS:- change the 21st DATA item from 150 to 121.
           This changes line 00130 in the source code
           to read:
00130       JP      2079H               ;CONTINUE IN ROM.
```

(continued from previous page)
age rather than peak ability. The system is more complex than the old one and will commit clubs to rather more work involved in handicap revision and maintenance. This program simplifies the procedure by performing all the calculations on a Tandy Pocket Computer or Sharp PC-1211 pocket computer. It has the advantage that its memory is non-volatile, so for around £70 or so you can provide your golf club with a useful, simple service and gain their eternal gratitude.

Any qualifying scores such as medal rounds, stablefords — which will be converted — and others deemed to be so must be recorded in a handicap record, which will almost certainly be a loose-leaf binder with one page for each club member. Each member will have a decimal handicap and a playing handicap recorded in the handicap record.

After a round, the player's gross score is subtracted from standard scratch score to give the gross differential; if this is the same as the playing handicap no revision is necessary and the existing figures are carried down in the handicap record. Where the gross differential is greater then the playing handicap the decimal handicap is revised as follows:

Category	Handicaps	Addition of
1	0-4	0.1
2	5-11	0.2
3	12-18	0.2
4	19-24	0.2
5	25-28	0.3

The addition is made once, regardless of the number of strokes by which the gross differential exceeds the playing handicap. The same procedure is followed for incomplete scores and no returns. The playing handicap is the decimal handicap rounded to the next whole number, but increases in the playing handicap will only be posted quarterly.

Golf handicap.

```
 10 "G":INPUT"S.S.S. = ";S
 20 INPUT"DEC H/C = ";D
 30 INPUT"GROSS SCORE = ";G
 40 P=INT(D+0.5):N=G-P:Q=P
 50 IF N=S GOTO 500
 60 IF N<S GOTO 200
 70 IF P>24 LET I=0.3:GOTO 100
 80 IF P>4  LET I=0.2:GOTO 100
 90 I=0.1
100 D=D+I:GOTO 500
200 E=S-N
210 IF P<5  LET I=0.1:GOTO 300
220 IF P<12 LET I=0.2:GOTO 300
230 IF P<19 LET I=0.3:GOTO 300
240 IF P<25 LET I=0.4:GOTO 300
250 I=0.5
300 D=D-I:P=INT(D+0.5)
310 E=E-1:IF E>0 GOTO 210
500 E=G-S:P=INT(D+0.5)
510 IF P<Q LET A$="*":GOTO 530
520 A$=" "
530 BEEP 2:USING"###":PRINT"GROSS DIFF = ";E
540 USING"###.#":PRINT"DECIMAL H/CAP = ";D
550 USING"###":PRINT"PLAYING H/CAP = ";P;" "
    ;A$
560 GOTO 20
```

Where the gross differential is less than the playing handicap the decimal handicap is reduced by the following amount for each stroke which is less:

Category	Reduction of
1	0.1 per stroke
2	0.2
3	0.3
4	0.4
5	0.5

Where a reduction takes the handicap into the next category, subsequent reductions must be at the new rate. Where a playing handicap is reduced it must be posted, and become operative immediately. The club must record the gross differential, the decimal handicap and the playing handicap after each round for each player.

The computer program requests input of Standard Scratch Score — line 10. It then asks for input of a player's decimal handicap, line 20, and gross score, line 30.

The program then calculates and prints the values to be recorded — the gross differential, the new decimal handicap and the new playing handicap. Where the playing handicap has been reduced it prints an asterisk to remind the club that this must be posted. It then moves on to the next player and continues on this loop until switched off.

The version of Basic used on the Pocket Computer PC-1211 is limited but fairly standard, and the program should be easily converted to other machines.

Pelmanism

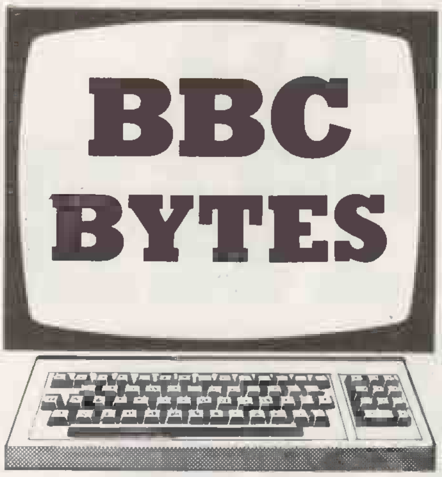
THE CARD GAME of Pelmanism has always been one of my particular favourites, writes Peter Hewitt of Lytham St Anne's, Lancashire, and this computer version is a fairly straightforward interpretation. In particular it has a fast shuffle and deal, unlike many of the other card games, where the message "Shuffling" usually portends a lengthy wait.

The program is uncompromisingly machine-dependant, making full use of the features of TRS-80 Basic which set it apart from the other machines. It uses an input routine, lines 210-230, in preference to the Input command in order to safeguard the display. Cards which are "turned over" are marked in line 290, and matched cards are removed and added to the player's pile in line 330.

The listing is formatted to ensure readability. The spaces and comments can be removed to produce a compact program that fits comfortably into 4K.

Pelmanism.

```
20  CLEAR 260: RANDOM: DEFINT A-T: DEFSTR V-Z:
    L3 = 63: L4 = 64: L5 = 128: L6 = 52: L7=1011
30  DIM P(55),.X(L6), Q(L6), XS(4), XD(13), H(4)
40  FOR I = L5 TO 896 STEP 192:
    FOR J = 5 TO 55 STEP 5:N = N+1: P(N) = I+J:
    NEXT J,I :'BLOCK LOCATIONS'
50  Z1 = CHR$(26) + STRING$(4,24):
    Z = CHR$(156) + STRING$(2,140) + CHR$(172) + Z1 + CHR$(149)
    + "  " + CHR$(170) + Z1 + STRING$(4,131): 'BLOCK OUTLINES'
60  ZC = "    " + Z1 + "    " + Z1 + "    ": XF = "##":
    YC = CHR$(95) + " ":
    XG = "P L A Y E R  # -   Y O U R   G U E S S : " + YC + YC:
    'INITIALISE STRINGS'
70  FOR I = 1 TO 4: READ XS(I): NEXT: FOR I = 1 TO 13:
    READ XD(I): NEXT : 'CARDS'
80  DATA  H, C, D, S, A, 2, 3, 4, 5, 6, 7, 8, 9, X, J, Q, K
90  CLS: PRINT CHR$(23): PRINT @ 22, "PELMANISM";:
    PRINT @ 86, STRING$(9,131);: PRINT @ 156, "B Y";:
    PRINT @ 210, "PETER  HEWITT";:
    PRINT @ 326, "DO YOU WANT INSTRUCTIONS?";
100 W = INKEY$: IF W = "" THEN 100
110 IF W ="N" THEN 120ELSE IF W <> "Y" THEN 100ELSE GOSUB 420
120 CLS: XP = "PLAYER": N=0: FOR I = 3 TO 323 STEP L4:
    N = N + 1: ZJ = MID$(XP,N,1): PRINT @ I, ZJ;:
    PRINT @ I+57, ZJ;: NEXT: PRINT @ 451, "1";:
    PRINT @ 508, "2"; : 'VERTICAL PRINTING'
130 H(1) = 44: H(2) = 44: H(3) = 0: H(4) = 122: CP = RND(2)
140 FOR I = 1 TO 4: FOR J = 1 TO 13 : 'THE SHUFFLE AND DEAL'
150 N = RND(L6): IF Q(N) THEN 150: 'IS BLOCK OCCUPIED?'
160 Q(N)= -1: X(N) = XD(J) + XS(I): PRINT @ P(N)-L5, Z;
170 NEXT J,I: FOR I = 1 TO L6: PRINT @ P(I)-L3, USING XF;I;:
    NEXT: 'CARDS ONTO SCREEN'
180 CP = CP+1: IF CP>2 THEN CP = 1 : 'SELECTS PLAYER '
190 FOR I = 1 TO 6: PRINT @ 970, CHR$(237);:
    FOR J = 1 TO 5: NEXT: PRINT @ 970, USING XG; CP;:
    FOR J = 1 TO 5: NEXT J,I: NT = 0: 'FLASH PLAYER NUMBER'
200 WN = "": PA = L7: W = INKEY$: 'INITIALISE, KILL BOUNCE'
210 W = INKEY$: IF W = "" THEN 210: 'READ NUMERIC INPUT'
220 I = ASC(W): IF I = 8 THEN PA = PA - 2: PRINT @ PA, YC;:
    WN = LEFT$(WN, LEN(WN)-1): GOTO 210
    ELSE IF I = 13 THEN NU = VAL(WN): GOTO 260:
    'BACKSPACE OR RETURN'
230 IF W < "0" OR W > "9" OR LEN (WN) = 2 THEN 210
    ELSE PRINT @ PA, W;: WN = WN + W: PA = PA + 2:
    GOTO 210: 'BUILD NUMBER'
260 IF NU < 53 AND NU <> NW THEN 280: 'NOT IN RANGE OR USED'
270 PRINT @ L7, "N O !";: FOR JJ = 1 TO 500: NEXT:
    PRINT @ L7, YC;YC;"  ";:GOTO 200: 'ERROR IN INPUT DATA'
280 IF NOT Q(NU) THEN 270 ELSE J = P(NU) - L3: FOR I = 1 TO 8:
    PRINT @ J, "  ";: FOR JJ = 1 TO 5: NEXT JJ:
    PRINT @ J, X(NU);: FOR JJ = 1 TO 5: NEXT JJ,I :
    'FLASH SELECTED CARD'
290 J = J + L3: AX = J/L4: AY = AX * 3 + 1:
    AX = (J - AX*L4)*2 + 1: SET(AX,AY): SET(AX+5,AY):
    SET(AX+1,AY-7): SET(AX+4,AY-7) :'MARK CARD'
300 NT = NT+1: IF NT=1 THEN PRINT @ L7, YC;YC;: LW = J:
    NW = NU: GOTO 200: 'GET NEXT CARD IF THIS IS FIRST'
310 LU = J: IF LEFT$ (X(NW),1) = LEFT$(X(NU),1) THEN 330
    ELSE FOR JJ=1 TO 700: NEXTJJ: PRINT @ LW - L5, Z;:
    PRINT @ LW - L3, USINGXF; NW; :
    'CHECK IF SAME CARD OTHERWISE TURN-OVER AGAIN'
320 PRINT @ LU-L5, Z;: PRINT @ LU-L3,USING XF;NU;:GOTO180
330 IF H(CP) > 0 THEN FOR JJ = 1 TO 300:
    NEXT JJ: AX = H(CP+2): AY = H(CP):
    FOR I = AY TO AY-1 STEP-1: FOR J = AX TO AX+5:
    SET(J,I): NEXT J,I : 'ADD CARDS TO PLAYERS DECK'
340 H(CP) = H(CP) - 2: PRINT @ LW-L5, ZC;:
    PRINT @ LW-L3, USING XF; NW;: PRINT @ LU-L5, ZC;:
    PRINT @ LU-L3, USING XF;NU; : ' REMOVE CARDS FROM TABLE'
350 PRINT @ 960, 44-H(1);: PRINT @ 1021, USING XF; 44-H(2);:
    Q(NU) = 0: Q(NW) = 0: 'SCORE'
360 IF (H(1) + H(2)) > 36 THEN 190: 'END OF GAME?'
370 PRINT @ 965,
    "<--------------- G A M E   O V E R ----------------->";:
    FOR JJ = 1 TO 3000: NEXT
380 PRINT @964, CHR$(248);:PRINT @967,
    "D O   Y O U   W A N T   A N O T H E R   G A M E ?";:
    W = INKEY$
390 W = INKEY$: IF W = "" THEN 390
400 IF W = "Y" THEN RUN ELSE CLS:PRINT @473, "G O O D B Y E ";:
    PRINT @896, "": END
420  PRINT @ L5, "THE 52 'PLAYING  CARDS' ARE LAID";:
     PRINT        "OUT, FACE  DOWNWARDS,  IN RANDOM";:
     PRINT        "ORDER,   AND  NUMBERED  1 TO 52.";
430  PRINT "          ----------          ";
     PRINT "EACH PLAYER, IN TURN, ENTERS THE";:
     PRINT "NUMBERS,  CORRESPONDING  TO  TWO";:
     PRINT "CARDS TO BE 'TURNED OVER'.  WHEN";
440  PRINT "CARD VALUES  (NOT SUITS)  MATCH,";:
     PRINT "THEY ARE PUT INTO HIS HAND. NOTE";:
     PRINT "THAT 10 IS SHOWN AS 'X'. YOU CAN";
450  PRINT "DELETE  ANY  DIGIT  BY  ENTERING";:
     PRINT "<BACKSPACE>.   ALWAYS  TERMINATE";:
     PRINT "INPUT  WITH <ENTEP> OR <NEWLINE>";:
     PRINT " ---- HIT ANY KEY TO START ----";
460 W = INKEY$: IF W = "" THEN 460ELSE RETURN
```



Character sizes

A PROCEDURE which can be put into another program to print characters of any size on the screen has been devised by Nicholos van Someren of Cambridge.

Lines 10 and 20 set the routine up. It will work in any mode and on calling the procedure, parameters are passed for the co-ordinates of the bottom-left corner of the string, the width and height of each pixel, and the string to be printed. Letters are printed in graphics foreground colour on graphics background colour.

The procedure uses the Osword call at &FFF1 with the accumulator containing 10 to read out each character definition, so user-determined characters can be printed as well.

Character sizes.

```
  10 MODE4
  20 DIM X% 9
 999 END
1000 DEFPROCBIGLET(XMIN,YMIN,W,H,A$)
1010 A%=10:Y%=X%/256
1020 FORL=1TOLEN(A$):?X%=ASC(MID$(A$,L,1))
1040   CALL&FFF1
1050   FOR X=8TO1STEP-1:T=X?X%:M=128:FOR Y=1TO8
1060        P=INT(T/M):T=T MOD M
1065        G=0
1070        IF P=0 G=2
1080        MOVE (XMIN+W*(Y-1)),(YMIN+H*(8-X))
1090        PLOT65+G,W-1,0:PLOT81+G,-W+1,H-1:PLOT81+G,W-1,0
1100        M=M/2:NEXT:NEXT
1110   XMIN=XMIN+8*W:NEXT
1120 ENDPROC
```

Bat and ball

THE GAME written by Robert Johnson of East Kilbride, Glasgow, is entirely in Basic. It is played with a yellow ball on a red court surrounded by a white border. At the top of the screen out of the court, the score and the number 3, which is the number of lives the player has, are displayed.

Use the M key to move the bat right and the Z key to move the bat left. Score a point each time the ball bounces on the floor and lose a life each time the ball bounces on the ceiling. Press Return to play the game. The game commences with the ball coming up from the bottom of the screen from a random position. This ensures that each game is different.

The bat position is about two-thirds of the way up the screen, and the object of the game is to keep the ball bouncing between the bat and the floor. Each time the ball hits the bat, the bat moves down slightly making the game progressively more difficult. Each time the ball hits the floor one point is scored. If the ball misses the bat it will proceed up towards the top of the court and upon striking the ceiling one life will be lost.

As your skill improves a score of 50 may be achieved, whereupon the bat returns to its original starting position, but is now of a reduced size. The score count continues, as does the game with further bat size reductions occurring at 100 and 150 points. When three lives have been lost the game is over. If the Y key is pressed a new game automatically commences. Your highest score from the previous game will be displayed in the corner of the screen. If the N key is pressed the program finishes.

Line 20: Mode 4 is a suitable mode for displaying text on the screen as it is 40 characters wide.

Line 30 to Line 90: These lines cause the title of the game to be displayed and also the instructions on how to play the game, but note that Tab (X, Y) will move the cursor directly to position X, Y on the screen and is a very powerful statement for positioning text exactly where it is required. The origin for the text commands is at the top left of the screen so Tab (10, 6) means 10 character spaces from the left hand side and six lines down. The Input Statement at line 90 is effectively Input Q with some printing in between which is in inverted commas and appears so on the screen. However, the program will not continue until the Return key is pressed.

Line 110: Mode 5 is the mode selected for the game as this is a four-colour mode.

Line 140:

GCOL 0, 129 selects a red background

: permits another Basic statement to be added without introducing another line number.

CLG clears the graphics sreen. The graphics area of the screen is left in the colour selected which is red.

CGOL 0, 128 selects a black background, ready to draw in the text window area.

Line 160: VDU 28 allows a text area to be defined. The full instruction in this case is VDU 28, 0, 3, 19, 0 which defines a four-line text window at the top of the screen. The CLS instruction clears the text area of the screen leaving it in the current text background.

Line 170: Prints the score which is equal to zero at the start of the game; the number 3 which represents the number of lives; and the highest score which is equal to zero during first game but takes highest score value in all subsequent games.

Line 180: The statement VDU 5 removes the cursor from the screen.

Lines 190 to 220: Draw in the white bat

Lines 230 to 260: Draw in the white border

Line 270: Sets the starting co-ordinates for the ball. The Y co-ordinate is fixed at 10, that is above the lowest border. The X co-ordinate is a random number between 10 and 1,260 that is clear of both edge borders.

Lines 290 to 440: Repeat-Until loop. It is essentially the ball moving sequence which continues "until" the ball collides with either the bat or a wall boundary.

Lines 300, 310 and 320: are bat drawing instructions which occur when the score (S) reaches 50, 100 and 150 respectively.

Line 330: X $ = INKEY $ (1) is the instruction that tests to see if a key has been pressed on the keyboard. The 1 in the bracket is the time the computer must wait before giving up, in this case one-hundredth of a second.

X$ is the value of the key pressed. Note that in practice the key does not have to be pressed during the one-hundredth of a second, since it is stored in a buffer.

Line 340: If the key pressed is M then the bat must be moved right assuming the right-hand edge of the bat is not touching the right-hand wall.

Line 350: If the key pressed is Z then the bat must be moved left assuming the left-hand edge of the bat is not touching the left-hand wall.

Lines 360 to 420: These are the ball-drawing and the ball-moving instructions. At line 370 the foreground colour yellow is selected which is the colour for the ball. Line 390 draws the ball, a small yellow square. Line 400 gets a new foreground red colour which is the same as the background colour, and at line 410 the ball is drawn again in red. It may seem a strange thing to do as the ball will now disappear. But at line 420 the co-ordinates of the ball are incremented so that next time round the loop it will be draw in yellow in a new position followed by the disappearing trick. When the program is running the net effect is a rapidly moving ball which seems to spin and twirl as it goes along.

Line 440: Is the get out from the Repeat-Until loop. A get out will only occur if the ball collides with a border or the bat.

Y > 870 then bounce required off ceiling

Y < 10 then bounce required off floor

X < 10 then bounce required off left-hand border

X > 1,260 then bounced required off right-hand border

Y > BAT − 15 and Y < BAT + 15. If this condition is satisfied then a bounce may be required from the bat. Checks on the X positions of the bat and ball will determine if this bounce is required.

(continued on page 162)

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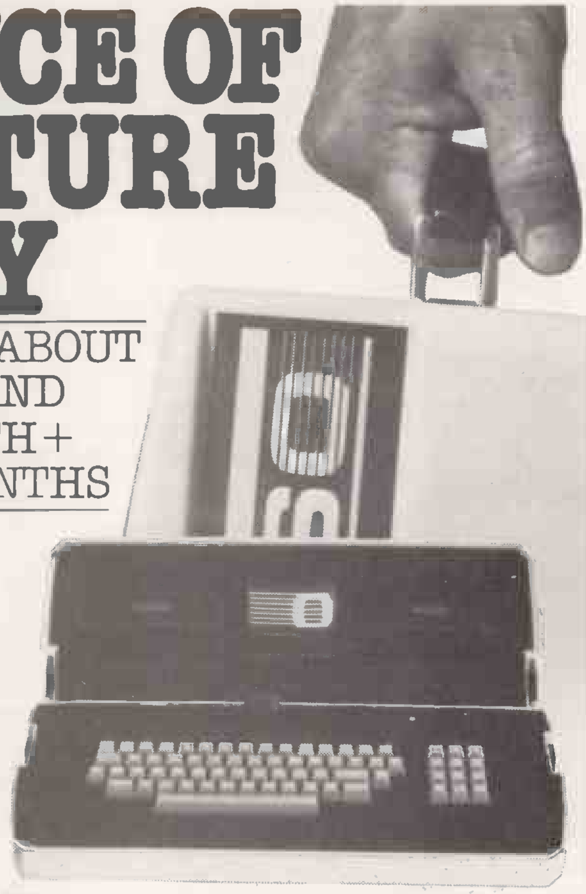

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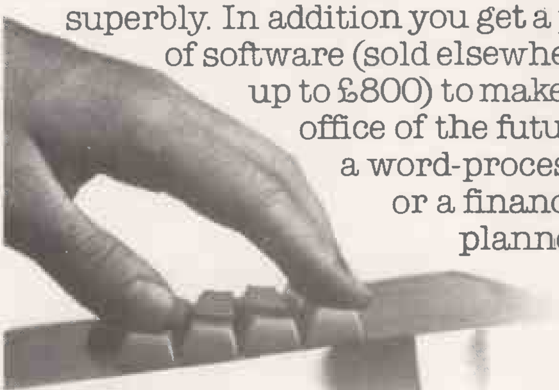

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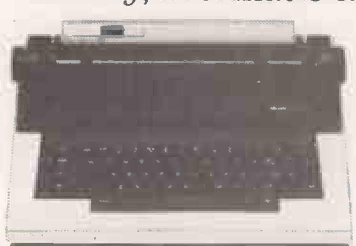

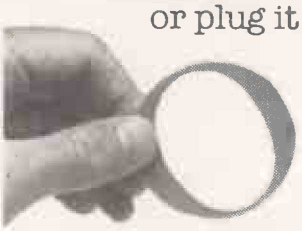

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(continued from page 160)

Line 450: The T = + 1 in this line simply means that the ball is moving upwards. T is a tally variable. If the test conditions in this line are satisfied then a bounce off the bat is required, which is achieved by changing the sign of Q which means that next time the ball is moved the Y co-ordinate will be decreased, see line 420. Note also the redrawing of the bat 10 points lower on the screen, Bat = Bat − 10.

The Y = Y−50 moves the ball well away from the bat so that next time round the loop it is no longer in the bat's vicinity.

Line 460: Is similar to line 450 only the ball is moving down onto the bat, T = − 1. It is rather unfortunate for the player since the ball will be bounced back up to the ceiling with another loss of life.

Line 470: Bounce required off the ceiling achieved by changing the value of Q. Note the sign change of T as the ball will be moving downwards from now on. A ceiling bounce means a loss of life so that life counter L is decreased by 1. This is achieved by homing the test cursor to the top left, VDU 30, and printing out the new life count. Note that if L = 0 it is the end of the game so the program jumps to the finishing routine starting at line 530.

Line 480: Bounce required off the floor achieved by changing the value of Q. T changed to positive as ball will be moving upwards from now on. A floor bounce means an increase in the score count S so this too is carried out on this line.

Line 490: Bounce required off left-hand border is achieved by changing the value of P.

Line 500: Bounce required off right-hand border is achieved by changing the value of P.

Line 510: All of the conditions between lines 450 to 500 may not have been satisfied, which means the ball could miss the bat, so line 510 puts the program back into the Repeat-Until loop.

Line 520: End of Game routine commences.

Line 530: If the score is greater than the current highest score then the highest score counter (H) must be changed.

Line 540: Clears the screen ready to display the final score.

Lines 550 to 570: The final score is displayed on the screen and also the request for another game: Y or N.

Lines 580 to 610: The program hangs in this loop until either the Y or N key is pressed. If the Y key is pressed then the game is restarted with the current highest score displayed. If the N key is pressed the program is terminated.

Bat and ball.

```
 10REM***PRINT INSTRUCTIONS***
 20MODE4:CLS
 30PRINT TAB(10,6)"BOBS BAT AND BALL"
 40PRINT TAB(10,7)"____ ___ ___ ____":PRINT:PRINT
 50PRINT"Use the M key to move the bat right.":PRINT:PRINT
 60PRINT"Use the Z key to move the bat left.":PRINT:PRINT
 70PRINT"Score a point each time the ball bounces on the floor.":PRINT:PRINT
 80PRINT"Loose a life each time the ball bounces on the ceiling.":PRINT:PRINT
 90INPUT"Press return to play the game",Q
100H=0
110MODE5
120LET S=0::LET L=3:LET T=+1:LET U=1:LET X2=711
130REM***DEFINE GRAPHICS COLOURS***
140GCOLO,129:CLG:GCOLO,128
150REM***DEFINE TEXT AREA***
160VDU28,0,3,19,0:CLS
170PRINT"SCORE= ";S,L:PRINT"HIGHEST SCORE= ";H
180VDU5
190REM***DRAW BAT***
200LET BAT=700:LET X1=528
210MOVEX1,BAT
220DRAW X2,BAT
230GCOLO,3
240MOVEO,0
250REM***DRAW BORDER***
260DRAW1279,0:DRAW1279,900:DRAWO,900:DRAWO,0
270LET X=RND(1250)+10:LET Y=10
280LET P=15:LET Q=15
290REPEAT
300IFS=50 AND U=1 THEN GCOLO,1:MOVEX1,BAT:DRAWX2,BAT:GCOLO,3:LET X2=671:LETU=-
1:GOTO200
310IFS=100 AND U=-1 THEN GCOLO,1:MOVEX1,BAT:DRAWX2,BAT:GCOLO,3:LET X2=631:LET
U=1:GOTO200
320IFS=150 AND U=1 THEN GCOLO,1:MOVEX1,BAT:DRAWX2,BAT:GCOLO,3:LET X2=591:LET U
=-1:GOTO200
330X$=INKEY$ (1)
340IFX$="M" AND X2<1250 THEN GCOLO,3:MOVEX2,BAT:DRAWX2+40,BAT:MOVEX1,BAT:GCOLO
,1:DRAWX1+40,BAT:X1=X1+40:X2=X2+40
350IFX$="Z" AND X1>40 THEN GCOLO,3:MOVEX1-40,BAT:DRAWX1,BAT:MOVEX2-40,BAT:GCOL
O,1:DRAWX2,BAT:X1=X1-40:X2=X2-40
360REM***DRAW AND MOVE BALL***
370GCOLO,2
380MOVEX,Y
390DRAWX+5,Y:DRAWX+5,Y+5:DRAWX,Y+5:DRAWX,Y
400GCOLO,1
410DRAWX+5,Y:DRAWX+5,Y+5:DRAWX,Y+5:DRAWX,Y
420X=X+P:Y=Y+Q
430REM***BOUNCE REQUIRED***
440 UNTIL Y>870  OR Y<10 OR X<10 OR X>1260 OR (Y>BAT-15 AND Y<BAT+15)
450IF (Y>BAT-15 AND Y<BAT+15)AND T=+1  AND X>X1 ANDX<X2 THEN LET Q=-Q:GCOLO,1:
MOVEX1,BAT:DRAWX2,BAT:BAT=BAT-10:GCOLO,3:MOVEX1,BAT:DRAWX2,BAT:VDU7:Y=Y-50: GOTO
 290
460IF (Y>BAT-15 AND Y<BAT+15)AND T=-1  AND X>X1 ANDX<X2 THEN LET Q=-Q:GCOLO,1:
MOVEX1,BAT:DRAWX2,BAT:BAT=BAT-10:GCOLO,3:MOVEX1,BAT:DRAWX2,BAT:VDU7:Y=Y+50: GOTO
 290
470IFY>870 THEN LET Q=-Q:LETT=-1:VDU7:GCOLO,0:VDU30:PRINT"        ";S,L:GCOLO,3
:VDU30:L=L-1:PRINT"SCORE= ";S,L:VDU5:GCOLO,2:IFL=0 GOTO530:GOTO290
480IF Y<10 THEN LET Q=-Q:LETT=+1:VDU7:Y=Y+20:GCOLO,0:VDU30:PRINT"        ";S:GC
OLO,3:VDU30:S=S+1:PRINT"SCORE= ";S:VDU5:GCOLO,2:GOTO290
490IFX<25 THEN LETP=-P:VDU7:X=X+20:GOTO290
500 IF X>1250 THEN LET P=-P:VDU7:X=X-20:GOTO290
510GOTO290
520REM***END OF GAME ROUTINE***
530IFS>H THEN GCOLO,0:VDU30:PRINT"        ";S,L:PRINT"HIGHEST SCORE= ";H:GCOLO,
3:VDU30:H=S:PRINT"SCORE= ";S,L:PRINT"HIGHEST SCORE= ";H:VDU5:
540GCOLO,128:VDU28,0,3,19,0:CLS
550PRINT TAB(0,10);"YOUR SCORE WAS ";S:PRINT:PRINT
560PRINT"ANOTHER GAME?":PRINT:PRINT
570PRINT"Y OR N":PRINT:PRINT
580 LET A$= INKEY$(1)
590 IF A$="Y" THEN CLS:S=0:L=3:GOTO110
600 IF A$="N" THEN END
610GOTO580
```

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Graphics data

ONE OF THE more time-consuming aspects of programming with graphics is the translation of the pictures in one's mind into program statements, says Dave Stoner of Hatfield, Hertfordshire. With this program the user draws the desired pictures in normal screen mode and leaves the program to generate Data statements dynamically within the user program. All characters typed by the user are imaged one for one within the generated statements.

The user may signal the end of the current Data statement by typing a Return. The appropriate Data statement is generated, and then the screen is restored to its state before Return was typed, allowing the user to continue drawing. This Data-statement generation is performed automatically if the number of characters typed for the current statement reaches 66.

The program consists of two sections, the main section and a Get Character section, which is just a Get In$ with a cursor.

Graphics data.

```
63000 GOTO  63300
63010 TITLE:  GRAPHIC DATA STATEMENT CREATION
63020 AUTHOR: D.STONER. 05-FEB-82
63030 SYSTEM: PET,3000 SERIES (NEW ROM)
63040 GLOSSARY:-
63050   CCHAR :CHARACTER UNDER CURSOR (POSSIBLY INVERTED)
63060   CDN$  :CURSOR DOWN
63070   CHAR  :CHARACTER UNDER CURSOR
63080   CLEAR$:CLEAR SCREEN
63090   CR    :CARRIAGE RETURN
63100   HOM$  :CURSOR HOME
63110   IN$   :CHARACTER FROM KEYBOARD
63120   INC   :INCREMENT BETWEEN DATA LINES
63130   KB    :(O.S.)ADDRESS OF LAST BYTE OF KEYBOARD BUFFER
63140   LINNUM:LINE NUMBER OF NEXT DATA STATEMENT TO BE PRODUCED
63150   NKB   :(O.S.)NUMBER OF OUTSTANDING CHARACTERS IN KB BUFFER
63160   PCHAR :ADDRESS ON SCREEN OF CURSOR
63170   PIC$  :ACCUMULATED STRING TYPED IN FOR CURRENT DATA LINE
63180   PRLINE:(O.S.)LINE NUMBER WHERE CURSOR IS.
63190   QUOTE$:QUOTE CHARACTER
63200   Z     :GENERAL LOOP VARIABLE
63210 *
63220 *
63230 ********MAIN PROGRAM**************
63300 INPUT  "START LINE/INCREMENT";LINNUM,INC
63310 CDN$="":CLEAR$="":CR=13:HOM$="":KB=624:NKB=158:PRLINE=216
63320 QUOTE$=CHR$(34)
63330 RESTORE:PRINT CLEAR$;
63340 READ  PIC$: IF PIC$<>"****"THEN PRINT PIC$;: GOTO 63340
63350 PIC$  =""
63360 GOSUB 63600
63370 IF    (ASC(IN$) AND 127)=CR THEN 63390
63380 PIC$  =PIC$+IN$:IF LEN(PIC$)<66 THEN 63360
63390 PRINT CLEAR$CDN$CDN$CDN$
63400 PRINT LINNUM"DATA"QUOTE$PIC$QUOTE$
63410 LINNUM=LINNUM+INC
63420 PRINT "LINNUM="LINNUM":INC="INC":GOTO63310"HOM$
63430 POKE  NKB,2:POKE KB-1,CR:POKE KB,CR
63440 STOP
63450 *
63460 *
63470 *******GET CHARACTER FROM KB******
63600 PCHAR=32768+PEEK(PRLINE)*40+POS(0)
63610 CHAR =PEEK(PCHAR): CCHAR=CHAR
63620 COUNT=0
63630 FOR  Z=0TO1 STEP 0
63640 COUNT=((COUNT+1)AND3)
63650 IF   COUNT>0 THEN 63680
63660 CCHAR=( (CCHAR+128) AND 255)
63670 POKE PCHAR,CCHAR
63680 GET  IN$: IF IN$=""THEN NEXTZ
63690 POKE PCHAR,CHAR: PRINT IN$;
63700 RETURN
63999 DATA"****"
```

Handy Pokes

SOME HANDY Pokes are suggested by Paul Bradshaw of Sunderland, Tyne and Wear.

Poke 144, Peek(144)+31 disables the cursor, the clock, and the Stop key.

Poke 158,255 reveals the file name used in the last cassette operation.

Poke 167,0 causes the cursor to flash in a program; Poke 167,1 cancels it and stops the cursor flashing in a program.

Error instruction

THE PET has an excellent Basic but unfortunately lacks the Onerr Goto instruction by which the programmer can instruct the computer to jump to a specified line number in the event of an error, writes Paul Bradshaw of Sunderland. There is, however, a method of simulating this command, which has come in very handy for graph-plotting routines and the like, where it is undesirable to drop to command level in the event of an error.

The simulation makes use of Pet's keyboard buffer which is normally used to store incoming keystrokes while the computer is occupied with calculations. The subroutine Pokes a Goto instruction into the buffer in such a way that when the Pet is stopped by an error, the Goto will be executed and program execution resumes at a specified line number.

Error instruction.

```
60000 REM *** ONERR GOTO L ***
60010 A$="GOTO"+ STR$(L)+ CHR$(13)
60020 FOR J=1 TO LEN(A$):POKE 622+J, ASC(MID$(A$,J,1))
      :NEXT
60030 POKE 158, J-1: RETURN
```

To use the routine, where you would type

Onerr Goto 1000

type instead

L=1000: GOSUB 60000

To make the Pet stop normally in the event of an error, use Poke 158,0. This instruction should also be used before any Input or Get statements, and also immediately before the program terminates. After Input or Get, the routne can be reinitialised by Gosub 60000.

Longer chains

WHEN READING any of the manuals or other literature on the Pet, you are left with the distinct impression that it is a difficult, if not formidable task to chain programs together, writes Gerald Ryder of Dublin. One is always cautioned that the program to be loaded in program mode must not be longer than the loading

(continued on next page)

Longer chains — listing 1.

```
100 REM****************************
110 REM** FOR THIS MENU PROGRAM **
120 REM** PEEK(42)=181          **
130 REM** PEEK(43)=007          **
140 REM****************************
150 PRINT"⌐                 MENU"
160 PRINT"                  ----"         :PRINT
170 PRINT"       (1)    PROGRAM 1":PRINT
180 PRINT"       (2)    PROGRAM 2":PRINT
190 PRINT"       (3)    PROGRAM 3":PRINT
200 PRINT"       (4)    PROGRAM 4":PRINT
210 PRINT"       (5)    PROGRAM 5":PRINT
220 PRINT"       (6)    END        ":PRINT
230 PRINT"TO RUN ANY PROGRAM ON THE MENU JUST ENTER ONE OF THE NOS. 1-6
240 GETA$:IFA$=""THEN 240
250 K=VAL(A$):PRINT"⌐"
260 ON K GOTO 270,280,290,300,310,320
270 LOAD"0:PROGRAM 1",8
280 LOAD"0:PROGRAM 2",8
290 LOAD"0:PROGRAM 3",8
300 LOAD"0:PROGRAM 4",8
310 LOAD"0:PROGRAM 5",8
320 END
```

Listing 2.

```
100 REM*******************************
110 REM*   INPUT LARGEST VALUE OF    *
120 REM*   PEEK(43) FOR ALL PROGRAMS *
130 REM*   INCLUDING MENU AND START  *
140 REM*   MENU PROGRAM              *
150 REM*******************************
160 INPUT"MAX VALUE OF PEEK(43) FOR ALL PROGRAMS INCLUDING MENU";MA
170 POKE43,MA+1:CLR
180 LOAD"0:MENU",8
```

Listing 3.

```
100 REM**********************************
110 REM* INPUT VALUES OF PEEK(42) &     *
120 REM* PEEK(43) FOR ALL PROGRAMS      *
130 REM* INCLUDING MENU AND START MENU*
140 REM**********************************
150 INPUT"NUMBER OF PROGRAMS ON MENU";N
160 FOR J=1 TO N
170 PRINT:PRINT"FOR PROGRAM ";J;" INPUT THE VALUES OF PEEK(42),PEEK(43)
180 INPUT P(J,1),P(J,2)
190 NEXT J
200 PRINT"FOR THE MENU PROGRAM INPUT THE VALUES OF PEEK(42),PEEK(43)"
210 INPUT P(0,1),P(0,2)
220 MA=0:L=0
230 FOR J=0 TO N
240 M(J)=P(J,1)+P(J,2)*256
250 IF M(J)>MA THEN MA=M(J):L=J
260 NEXT J
270 K1=P(L,1):K2=P(L,2)
280 PRINT"⌐310 POKE42,"K1":POKE43,"K2
290 PRINT"GOTO 310"
300 POKE 623,19:POKE 624,13:POKE 625,13:POKE 158,3:END
310 REM*POKE STATEMENT WILL APPEAR HERE
320 CLR
330 LOAD"0:MENU",8
```

(continued from previous page)
program. It is, however, quite easy to chain any number of programs of different sizes in any order and still retain values of numeric variables which can be passed from one program to another.

"Any order" presumes all of the programs are accessible on disc, and that string variables could be passed as well if they were redefined within a program by a statement such as

A$=A$+" "

which places the string in variable memory.

The procedure could be adapted to programs stored on tape, but only if they were stored in the sequence in which they were to be called. An easy way to chain a number of programs together in variable order is via a menu program, an example of which appears in listing 1. This menu will load any of the programs 1 to 5 by a single key depression. What is needed is to set the End of Program/Start of Variables pointers at the beginning to the values that they would assume for the longest of the programs in question, including the menu program itself. However, it is not possible to do this within the menu since a CLR is needed to make all of the pointers self-consistent, and putting a CLR inside the menu would lose the variable values each time the menu was reloaded.

The procedure is to end each program on the menu with the statement

LOAD"0:MENU",8

and then load each of the programs directly into memory to determine the values of Peek(42) and Peek(43) which are the values of the low and high bytes of the End of Program/Start of Variables pointers for the Pet in Basic 2. It would also be a good idea to have already inserted into each program a Rem statement of the form:

REM PEEK(42)=XXX: PEEK(43)=XXX

where the three-digit values XXX could be edited in after Peeking. In this way one would have a permanent record of these values until a program was altered.

After determining these pointer values for each program on the menu, and for the menu itself, you can simply do a "Start Menu" program such as:

```
10 POKE 42,K1: POKE 43,K2
20 CLR
30 LOAD"0;MENU",8
```

where K1,K2 are the values of Peek(42), Peek(43) for the longest program, including the menu. They give the maximum value to

PEEK(42)+256*PEEK(43)

for all programs. Listings 2 and 3 show programs to do the Poking.

In the first and shorter version of start Menu it is sufficient to know the values of the high byte, Peek(43), but up to 256 bytes of variable memory may become inaccessible since the largest high byte is merely incremented by one. If this loss of memory is important to you, the second version uses both pointer values and writes its own Poke statement dynamically — see lines 280 to 310. This is necessary because one of the values K1,K2 may be lost when the other is Poked if one uses a simple direct statement within the program after calculating K1,K2

Reverse-video Rems

SOME HINTS and ideas for the Pet have been sent by Paul Bradshaw of Sunderland. The first listing will enable owners of new-ROM, Basic 3.0, Pets to have a variable cursor flash speed. Type in the program, and be sure to Save it before you Run it. After you have Run the program, the command

X=USR(N)

will set the cursor flash speed to N, where N is an integer from 0 (slow) to 255 (fast). The normal cursor speed is N=236.

Have you ever tried to highlight a Rem statement by typing it in reverse field? It does not work. All Rem statements which are typed in reverse field are returned to normal by the Basic interpreter. The second listing shows a program which will enable Rem statements to be changed to reverse field.

Suppose you want the line

10 REM WRITTEN BY PB

to appear in reverse field. Assuming you have typed in and Run the third listing — save it before running it — the statement

X=USR(L)

will reverse the Rem statement in line L. In any Rem to be reversed, there must be two spaces after the word Rem to allow space for the reversing character. Type:

10 REM (two spaces)WRITTEN BY P.B.

followed by

X=USR(10).

It occasionally happens when developing a program that the program crashes and is replaced by a meaningless 43690 ++++++++++++++++. This is very often the result of inadvertently altering the pointer to the start of the program, and can be cured by typing:

POKE 40,1: POKE 41,4

When you purchase a program, your first action should be to make a back-up copy in case the original is accidentally destroyed. Several commercial programs, however, conserve the main memory by using the second cassette buffer to store part of the program. With these programs, attempting to make a back-up copy by normal techniques results in an incomplete copy being made, and the copy does not work.

To make a back-up copy of such a program, type:

POKE 40,58: POKE 41,3: SAVE:

Variable cursor speed.

```
5 REM ****** VARIABLE CURSOR FLASH SPEED
10 DATA32,210,214,165,17,133,15,169,0,133
20 DATA16,120,169,80,133,144,169,3
30 DATA133,145,88,96,198,16,165,16,197
40 DATA15,240,7,169,0,133,168,76,46,230
50 DATA169,1,133,168,169,0,133,16,76,46,230
60 S=0:FORJ=826TO873:READX:POKEJ,X:S=S+X:NEXT
70 IFS<>5201THENPRINT"[illegible]TYPING ERROR IN DATA LINES!":END
80 POKE0,76:POKE1,58:POKE2,3
90 NEW
```

Reverse-video Rems.

```
5 REM [illegible]
10 DATA32,210,214,32,44,197,144,17,165,92
20 DATA24,105,6,133,92,144,2,230,93,160
30 DATA0,169,18,145,92,96
40 S=0:FORJ=826TO851:READX:POKEJ,X:S=S+X:NEXT
50 IFS<>2656THENPRINT"[illegible]TYPING ERROR IN DATA LINES!":END
60 POKE0,76:POKE1,58:POKE2,3:NEW
```

Pet typewriter

PROMPTED BY Andy Scott's typewriter program in the June issue, Ken Rose of Southampton has added one of his own. Do not attempt to write such a program using Input or Input# statements — it is quite unnecessary.

If you assemble the line character by character using Get instructions, not only do you avoid all the problems of quotes, leading spaces and punctuation, but you generate the opportunity to test the validity of each character as it is typed. This enables you to eliminate any response to keys that are not needed and could upset the line-editing procedure. Editing the lines as the individual characters are entered enables printing to be instantaneous.

Another advantage of using Get rather than Input or Input# instructions is the ability to eliminate the blinking cursor in favour of a fixed pointer, which is much easier on the eye if there is a lot of typing to be done.

The line itself is assembled as two separate strings. One string contains the characters to the left of the cursor and the other the characters to the right of the cursor. On each cursor movement a character is shunted from one to the other. The fact that such keys as Clr-home, Clr-Up and Clr-Down are inactivated during the running of the program makes it impossible to jump out of the line being edited until it is complete.

Other keys that are inactivated are the backslash, square brackets and arrows. This is because they would need to be preceded by a Cursor Up instruction in the string in order to appear the same on the printed page as on the screen. To edit these, change of shift instructions into the strings would vastly complicate the line-editing procedure by upsetting the character count. Because these characters do not appear on a normal typewriter keyboard anyway, they have been ignored.

The line numbering of the program betrays the fact the facility to preset margins was edited in later after the program was written. This feature is an obvious asset to any typewriter program. The left margin has been set by a

POKE 226,M

instruction. Thus a Cursor-Left instruction at the beginning of the line can override the margin for such operations as paragraph numbering.

The program was specifically written for the 8032 Pet but the principles on which it operates could be used for any business keyboard machine. CHR$(27), the Escape code, is used to avoid ever leaving the video in the quotes mode. It is harmless where it is redundant. The incorporation of a distinctive audio warning of actual line overflow by changing the jingle produced by CHR$(7) may need to be changed for other types of processor.

Escape from the program at any time is by the use of the Stop key. Return to the program with paging and margins unaltered requires Goto 25. If the right margin has been indented it is necessary to Poke 213,79 after leaving and to Poke 213,MR on re-entry if the same margin is needed.

Pet typewriter.

```
5 REM *** LETTER WRITER -- [\]←↑ AND REVERSE CHR'S ARE NOT ACCEPTED ***
6 REM ***       MARGINS TO CONTROL LINE LENGTH MUST BE PRESET       ***
7 REM ***     DELETE KEY WILL OVERRIDE LEFT SIDE MARGIN CONTROL     ***
10 INPUT"[illegible]POSITION OF LEFT MARGIN  (0TO79)";ML
12 ML$="":IFMLTHENFORN=1TOML:ML$=ML$+CHR$(32):NEXT
14 INPUT"POSITION OF RIGHT MARGIN (0TO79)";MR
16 IFMR<MLORMR>79THENPRINT"[illegible]";CHR$(7);CHR$(22);:GOTO14:        REM CHECK MR
18 SP$="":FORN=MLTOMR:SP$=SP$+CHR$(32):NEXT
20 OPEN4,4:PRINT#4,CHR$(147);:PRINT"[illegible]";CHR$(14);:POKE213,MR:   REM SET SCREEN
25 L$=ML$:R$=SP$:PRINTML$;:                                              REM INDENT
30 PRINT"[illegible] ↑ [illegible]";:                                    REM POINTER
35 GETG$:IFG$=""THEN35
40 A=ASC(G$):L=LEN(L$):R=LEN(R$):IFL=MR-6THENPRINTCHR$(7);:              REM ALARM
45 IFA>31ANDA<91ORA=160ORA>192ANDA<219THEN90:                            REM VALIDATE
50 IFA=13THEN100:                                                        REM RETURN
55 IFA=29ANDL<MRTHENL$=L$+LEFT$(R$,1):R$=RIGHT$(R$,R-1):GOTO95:          REM C-RIGHT
60 IFA=20ANDL>0 THENL$=LEFT$(L$,L-1):R$=R$+CHR$(32):GOTO95:              REM DELETE
65 IFA=157ANDL>0THENR$=RIGHT$(L$,1)+R$:L$=LEFT$(L$,L-1):GOTO95:          REM C-LEFT
70 IFA<>148THEN80:                                                       REM INSERT
75 IFRIGHT$(R$,1)=CHR$(32)THENR$=CHR$(32)+LEFT$(R$,R-1):PRINTG$;CHR$(27);
80 GOTO35:                               REM IF NO SPACE ON LINE,IGNORE "INSERT"
90 IFL<=MRTHENL$=L$+G$:R$=RIGHT$(R$,R-1):GOTO95
92 POKE231,120:PRINTCHR$(7);:POKE231,16:GOTO35:                          REM OVERFLOW
95 PRINTG$;CHR$(27);:GOTO30
100 PRINT:PRINTCHR$(22);:PRINT#4,"[illegible]";L$;R$:IFL>MRTHENPRINT"[illegible]";
105 GOTO25
```

Repeating Get

TRY THE following program on your Pet, suggests Paul Bradshaw of Sunderland, Tyne and Wear.

```
10 GET A$
20 PRINT A$;
30 GOTO 10
```

Run this program, press the A key and hold it down. You will observe that the A character is printed only once, regardless of how long it is held. There are many situations where it would be desirable for Get to return the character currently being pressed: for example, in a games program it is more convenient to hold a key down instead of pressing it repeatedly. This can be achieved very simply by using Poke 151, 4 immediately before the Get command.

To illustrate this point, modify line 10 of the program to read

```
10 POKE 151,4:GET A$
```

Now when the program is Run and the A key pressed and held, A is printed repeatedly until the key is released. This method of continuous input replaces the clumsy Peek (151) solution.

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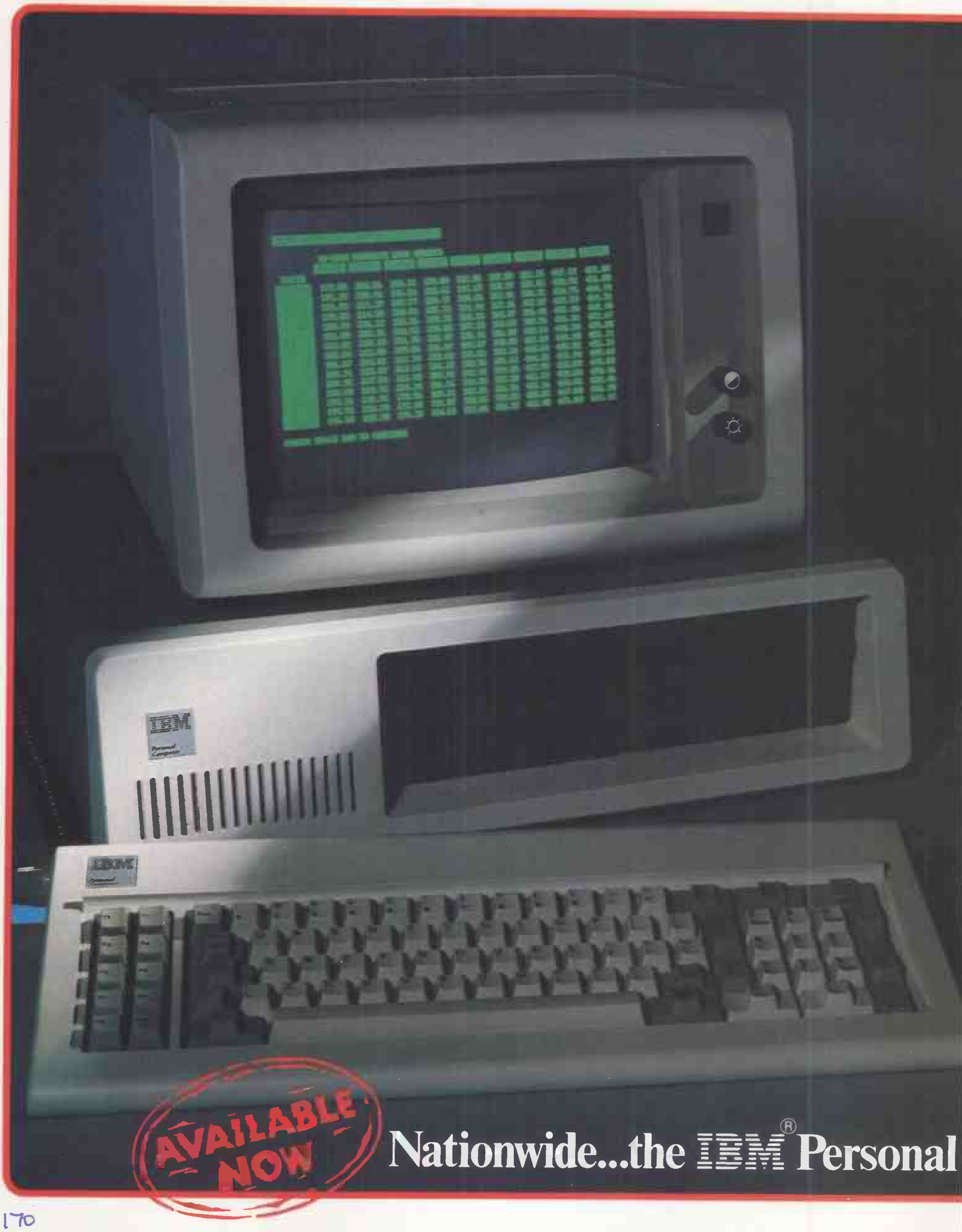

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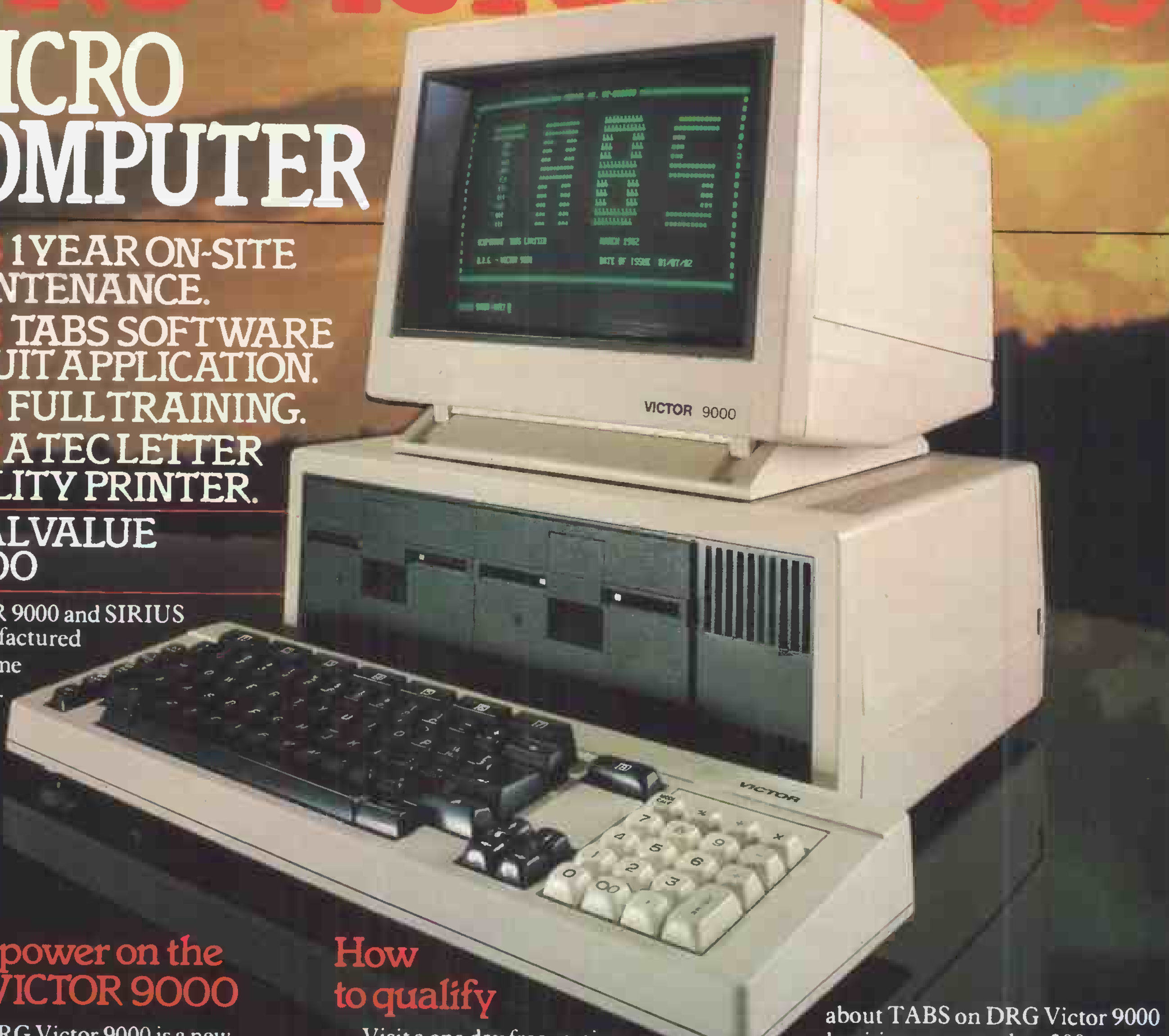

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TABS

Saturn's rings

THE REVIEW of the IOSL graphics board for the Nascom in February's *Practical Computing* inspired me to write this program to draw a picture of Saturn on my Apple II plus, writes Robert Cowell of Wolverhampton, West Midlands. The program uses the formula for an ellipse written by Mike James.

Both the rings and the planet are drawn by repeatedly using this formula, altering the values of R1 and R2 to change the size and shape of each ellipse. The resulting image can be saved on disc with the statement:

BSAVE SATURN, A 16384, L 8192

Saturn's rings.

```
5 REM ########   SATURN  DRAWER   ########
6 REM    +++ WRITTEN BY  RAR COWELL +++
7 REM          ( APPLESOFT - 48K )
8 REM
10 HGR2 : HCOLOR = 3
20 PI = 3.141
30 X = 128 : Y = 100
40 R2 = 28  : INC = .08
44 REM
45 REM DRAW RINGS
46 REM
50 FOR R1 = 100 TO 65 STEP -5
60 R2 = R2 - 1
70 FOR TH = 0 TO 2 * PI - INC STEP INC
80 HPLOT R1*COS(TH)+X,R2*SIN(TH)+Y TO R1*COS(TH+INC)+X,R2*SIN(TH+INC)+Y
90 NEXT
100 HPLOT TO R1+X,Y
110 NEXT
114 REM
115 REM BLANK OUT RINGS WHERE PLANET GOES
116 REM
120 HCOLOR = 0
130 FOR Z = 3 TO 1.95 * PI - INC STEP .02
140 HPLOT 128 , 100  TO  50 * COS(Z) + 128 , 50 * SIN(Z) +100
150 NEXT
160 HCOLOR = 3 : R2 = 50
164 REM
165 REM DRAW PLANET
166 REM
170 FOR R1 = 50 TO 0 STEP -4
180 FOR TH = 0 TO 2 * PI - INC STEP INC
190 HPLOT R1*COS(TH)+X,R2*SIN(TH)+Y TO R1*COS(TH+INC)+X,R2*SIN(TH+INC)+Y
200 NEXT
210 HPLOT TO R1 + X , Y
220 NEXT
224 REM
225 REM DRAW STAR BACKGROUND
226 REM
230 FOR Z = 1 TO 80
240 X = RND( 1) * 279
250 Y = RND( 1) * 191
260 HPLOT X , Y
270 NEXT
999 END
```

Screen dump — program 1.

```
1020  REM

**EXAMPLE SCREEN FOR MICROLINE SCREEN DUMP**
 **FIRST WRITE A TEXT SCREEN USING**
**NORMAL, INVERSE & FLASHING CHARACTERS FOR DEMO PURPOSES**
 **BY IAN.G.TURNER. (COPYRIGHT,1982)**
----------------------------------------


1040  HOME : TEXT : POKE 216,0:ZZ =  FRE (0)
1060 D$ =  CHR$ (13) +  CHR$ (4): REM    (CR) + CTRL-D
1080  REM

 **PROTECT ALL BUT BOTTOM LINE FROM SCROLLING**


1100  POKE 34,23
1120  REM

**MAIN PRINTING LOOPS**


1140  INVERSE : VTAB 1: HTAB 5: PRINT "
    ";
1160  VTAB 2: HTAB 5: PRINT "      APPLE SCREEN DUMP      ";
1180  VTAB 3: HTAB 5: PRINT "                              ": NOR
MAL
1200  FLASH : FOR Z = 4 TO 10: VTAB Z: HTAB Z - 3: PRINT "TEST L
INE ";Z: NEXT Z: NORMAL
1220  FOR Z = 11 TO 19: VTAB Z: HTAB Z - 3: PRINT "TEST LINE ";Z
: NEXT Z
1240  PRINT "======================================"
1260  HTAB 5: PRINT "PRESS (P) TO DUMP SCREEN"
1280  HTAB 7: PRINT "OR PRESS (Q) TO EXIT"
1300  GET Q$: IF Q$ = "P" THEN  PRINT D$;"RUN DUMP"
1320  IF Q$ = "Q" THEN  POKE 34,0: HOME : END
1340  GOTO 1300
```

Program 2.

```
20020  REM
**TEXT SCREEN DUMP **
**(AUTO OPERATION)**
**INCL INVERSE & FLASHING CHARACTERS**
**FOR 40 COL APPLE 2**
**TO INTERFACE TO AN OKI MICROLINE 82A PRINTER**

20030  REM
**COPYRIGHT IAN.G.TURNER**

       (==VARIABLES USED ==)

     QQ  -) VALUE OF SCREEN PEEK RETURNED
     QX-QY-QZ    LOOP COUNTERS
```

(listing continued on next page)

Screen dump

WHEN I TRIED Shaun Hope's complex screen-dump routine — Apple Pie, *Practical Computing*, May 1982 — I ran up against all sorts of problems, writes Ian Turner of Bodmin, Cornwall. My system uses an Oki Microline 82A printer.

The most serious drawback seems to be the lack of provision in the routine to handle the inverse and flashing characters available on the Apple screen when transposed to my printer. After studying Shaun Hope's listings, I rewrote it for my printer, and while doing so covered all the screen characters in a manner which gives a shorter, simpler program.

Program 1 merely gives a mixed screen display suitable for demonstrating the dump facility; program 2 is the part that does all the work. My program uses the same looping structures to read the Peek locations of the screen memory, and also a similar method of tackling the 39th column to ensure a new line-feed for the printer.

My approach differs considerably from Shaun Hope's in the use of a string variable to handle the conversion of ASCII values between the screen and the printer. The final version is a far simpler conversion, which is to be found in the three lines 20540 to 20580. This method results in no penalty in speed of execution, and a considerably more easily understood program.

(continued on next page)

(listing continued from previous page)

```
20080  REM

**PRESERVE SCREEN**
**===============**


20100  POKE 33,40: POKE 34,23
20105  PRINT  CHR$ (13) +  CHR$ (4);"PR£1"
20107  PRINT  CHR$ (17) CHR$ (24);
20108  PRINT  CHR$ (27) CHR$ (65);
20109  PRINT  CHR$ (30) CHR$ (31);: REM

**MAIN SCREEN READING LOOP**
**========================**


20200  FOR QX = 1024 TO 1104 STEP 40
20220  FOR QY = QX TO QX + 896 STEP 128
20240  FOR QZ = 0 TO 38: REM

** RESET FROM GRAPHICS MODE IF SCREEN CHARACTER IS INVERSE
OR FLASHING **
**=======================================================
====== **


20250  IF QQ = 63 THEN  PRINT  CHR$ (15);: REM

**FIND NEXT SCREEN CHARACTER**
**==========================**


20260 QQ =  PEEK (QY + QZ)
20280  GOSUB 20540
20300  PRINT  CHR$ (QQ);
20320  NEXT QZ: REM

**RESET FROM GRAPHICS MODE IF SCREEN CHARACTER IS INVERSE
OR FLASHING**
**=======================================================
======**

20330  IF QQ = 63 THEN  PRINT  CHR$ (15);: REM

**FIND NEXT SCREEN CHARACTER**
**==========================**


20340 QQ =  PEEK (QY + 39)
20360  GOSUB 20540
20380  PRINT  CHR$ (QQ)
20400  NEXT QY,QX: REM

** CLEAR PRINTER BUFFER**
** ====================**


20440  PRINT  CHR$ (24): REM

**SET TO 10 CPI AND 6 LPI AGAIN**
**=============================**


20480  PRINT  CHR$ (30): PRINT  CHR$ (27) CHR$ (54): REM

**RESET FULL SCREEN SIZE**
**SWITCH PRINTER OFF**
**==================**


20520  PRINT  CHR$ (13) +  CHR$ (4);"PR£0": POKE 34,0: END :
REM

**SUBROUTINE TO CONVERT SCREEN CODES TO PRINTE*
**=============================================**


20540  IF QQ )  = 0 AND QQ (  = 31 THEN QQ = QQ + 64
20550  IF QQ = 32 OR QQ = 96 THEN  PRINT  CHR$ (14);:QQ = 63
20560  IF QQ )  = 97 AND QQ (  = 159 THEN QQ = QQ - 64
20580  IF QQ )  = 224 AND QQ (  = 254 THEN QQ = QQ - 192
20600  RETURN
```

(continued from previous page)

Most other sections of the routine are self-explanatory, and if a printer is plugged into a slot other than the normal slot 1, then only line 20120 need be changed. The size of the output characters can be altered by changing the printer commands in line 20160, and if so wished the program could have a Return statement added after line 20520 to create a subroutine.

The theory of the use of this routine is merely to allow you to create hard copy of screen menus and other displays that are required in the course of program development by simply protecting the screen concerned using

Poke 34,23

and then running the dump routines directly from the disc drive.

Apple III graphics

THIS SHORT demonstration of how to set up and use Apple III graphics comes from S D Collier of Llangollen, Clwyd. It may save other "new recruits" some time deciphering the Apple III's modular grahics system.

Apple III graphics.

```
1     REM SOS driver .GRAFIX & file BGRAF.INV must be present on boot-up.See app
      endix I Apple Business Basic
3     REM Short Graphics demonstration creating patterns by S D Collier 14 June
      1982
5     GOSUB 1000:REM set up grafix routines

15     FOR Q=1 TO 20:REM number of times repeated
16       REM L=step,X + Y =center of pattern
17       L=(21*RND(1))+9:X=280:Y=96
20       PERFORM PENCOLOR(%C):REM black=0,white=15

30     FOR A=0 TO 192 STEP L/2
40       PERFORM MOVETO(%X,%Y)

50     PERFORM LINETO(%0,%A)
60     NEXT

70     FOR A=0 TO 560 STEP L
80       PERFORM MOVETO(%X,%Y)
90       PERFORM LINETO(%A,%192)

100     NEXT
110     FOR A=192 TO 0 STEP-L/2

120     PERFORM MOVETO(%X,%Y)
130     PERFORM LINETO(%560,%A)

140     NEXT
150     FOR A=560 TO 0 STEP-L

160     PERFORM MOVETO(%X,%Y)
170     PERFORM LINETO(%A,%0)
180     NEXT

190     C=ABS(C-15)
200     FOR A=1 TO 5000:NEXT:REM pause a moment

210     NEXT Q


1000     OPEN#1,".GRAFIX":INVOKE"BGRAF.INV":REM open graphics files

1001     PERFORM GRAFIXMODE(%2,%1):PERFORM FILLPORT:PERFORM GRAFIXON:REM set res
         olution & buffer,clear screen,switch graphics page on

1002     C=15:RETURN
```

Ampersand macro

THIS SMALL machine-code/Applesoft program enables users to write their own single-key, Basic command Macro, via the & key. It was written by David Kyle of Keynsham, Bristol, to relieve the frustration of typing, say

Home:LIST 5500-5550

when editing a large program.

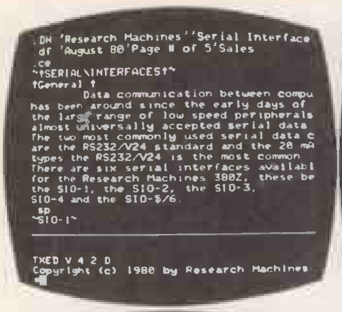
The program sits at location \$310 to \$32A. If it is included as the Hello program on the Master Boot disc the facility becomes available on start-up. Needless to say, the & vector is adjusted; consequently, it cannot be used with any other program that requires the & key.

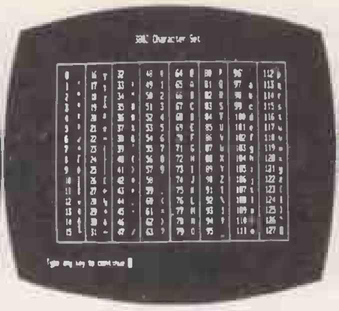
The command Macro to be executed is written at the line number given by the variable LN. It is not restricted to a single line, but this number is simply the starting execution point. It is recommended that the Macro is written using very high line numbers, in this case 60,000, so that it lies beyond any user program.

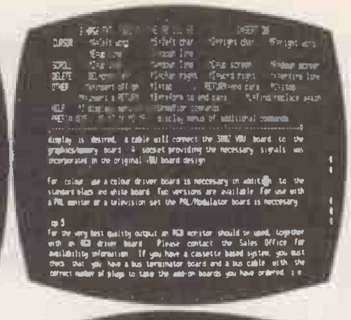
The Macro is executed by pressing the & key. The program then uses Findln, \$D61A and NWST, \$D7D2, to commence the Macro. Lines may be inserted or deleted without affecting operation of the Macro.

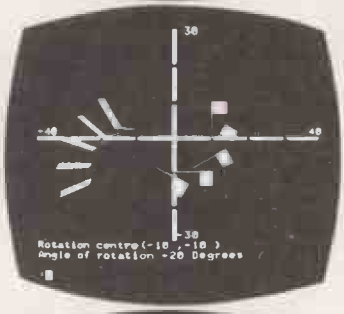
Ampersand macro.

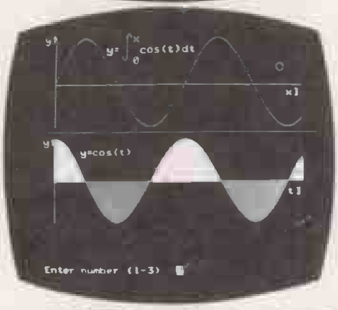
```
10   DATA 169,96,133,80,169,234,13
       3,81,32,26,214,24,198,155,14
       4,2,198,156,165,155,133,184,
       165,156,133,185,76,210,215
20   FOR X = 1 TO 29
30   READ Y
40   POKE 3 * 256 + X + 15,Y
50   NEXT
60   POKE 1014,16: POKE 1015,3
65 LN = 60000
70 X =  INT (LN / 256)
80   POKE 785,LN - (X * 256)
90   POKE 789,X
59999  END
60000  HOME : LIST
```

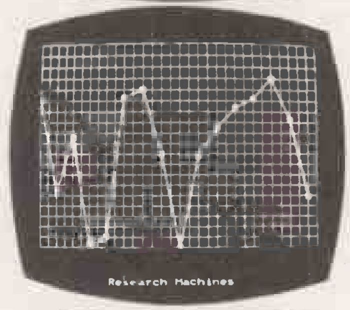












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Hex to decimal

THIS ROUTINE for a Microtan II by R Moffat of Belfast converts a single hex byte into its decimal value, which is then stored in three consecutive memory locations as units, tens and hundreds. Opinions may vary as to how short a "good" hex-to-decimal routine should be, and it could be put to a wide range of uses. Since relatively few pure machine-code routines are published it is offered in the hope that others will submit programs which can be used on all 6502 machines, and are not dependent on a particular system's quirks.

Hex to decimal.

```
A9 00           LDA  #00
85 41           STA  UNITS      ;LOCATION 41
85 42           STA  TENS       ;LOCATION 42
85 43           STA  HUNDREDS   ;LOCATION 43
A2 01           LDX  #01
A5 40   START:  LDA  HEXNUM     ;LOCATION 40

29 01           AND  #01
F0 1F           BEQ  SHIFT
8A              TXA
A8              TAY
E6 41   NEXT:   INC  UNITS
A5 41           LDA  UNITS
C9 0A           CMP  #0AH
30 12           BMI  REPEAT
E9 0A           SBC  #0AH
85 41           STA  UNITS
E6 42           INC  TENS
A5 42           LDA  TENS
C9 0A           CMP  #0AH
30 06           BMI  REPEAT
E9 0A           SBC  #0AH
85 42           STA  TENS
E6 43           INC  HUNDREDS
88      REPEAT: DEY
D0 E3           BNE  NEXT
8A      SHIFT:  TXA
0A              ASL  A
AA              TAX
46 40           LSR  HEXNUM
D0 D4           BNE  START
60              RTS
TOTAL BYTES = 55 (DECIMAL)
```

Input functions.

```
5 DEFFNA(T )=++++++++++++++++++++++++++++++++++++++++++++++++++++++0
10 DATA+,-,*,/,^,AND,OR,>,=,<,SGN,INT,ABS,USR,FRE
11 DATAPOS,SQR,RND,LOG,EXP,COS,SIN,TAN,ATN,PEEK
20 PRINT "WHAT FUNCTION" : INPUT "Y=" ; FU$
30 RESTORE : FOR FC = 1 TO 25 : READ FC$
40 FOR X = 1 TO LEN( FU$ )
50 IF MID$( FU$ , X , LEN( FC$ )) <> FC$ GOTO 100
60 T$ = "" : IF X > 1 THEN T$ = LEFT$( FU$ , X-1 )
70 FU$ = T$ + CHR$( 162+FC ) + MID$( FU$ , X+LEN( FC$ ) , 90 )
100 NEXT X , FC
110 IF LEN( FU$ ) > 50 THEN PRINT "TOO LONG" : GOTO 20
115 PRINT "O.K."
120 FOR X = 1 TO 50 : POKE 780+X , 163 : NEXT X
130 FOR X = 1 TO LEN( FU$ )
140 POKE 780+X , ASC( MID$( FU$ , X , 1 )) : NEXT X
150 INPUT "IN TERMS OF";T$
160 POKE 777 , ASC( T$ ) : POKE 778 , ASC( RIGHT$( T$ , 1 ))
170 IF LEN( T$ ) = 1 THEN POKE 778 , 32
```

Input functions

IN 6502 SPECIAL, *Practical Computing*, March 1982, Robert Schifreen provided a very interesting routine which allowed the input of a function during the running of a program, writes J S Roach of Wilmslow, Cheshire. The routine has the severe drawback of only allowing +, −, * and / to be used. This new routine can easily be modified to recognise all Basic keywords.

Line 5 operates just as line 10 does in the Schifreen version. The routine was written on a UK 101, and so accepts a +0 at the end of line 5. Lines 10 and 11 hold the keywords for which the program will parse; the order in which they appear in the listing is very important.

Line 20 resets the data pointer which is at locations 008F to 0090 hex, and then reads the FCth keyword, which is stored as FC$. Lines 40 to 100 replace all occurrences of FC$ in FU$ with the corresponding token for FC$ which the interpreter recognises. This token happens to be CHR$(FC+162), which is why the order of the keywords is so important.

Lines 110 to 115 check the length of the resultant tokenised string that might be in line 5, and replaces it with the tokenised +. Lines 130 to 140 put the tokenised string FU$ in its correct place in line 5. Lines 150 to 170 ask for the variable in terms of which the entered equation is expressed, and puts it in its correct place in line 5.

Loops

JUMPING OUT of For-Next loops and Gosubs before they are finished usually results in out-of-memory error as the stack becomes clogged up with return addresses, etc., writes Dave Woolcock of Preston, Lancashire. To jump out of a For-Next loop without causing any errors, include the statement:

IF (whatever) THENI = N +1; NEXT, GOTO (wherever)

at an appropriate position in the loop.

For subroutines there is no easy solution. Return is the only way out, but will send the program back to where it was called from, not where you want it to go to. The first program — listing 1 — will cancel a Return for a UK 101 with the new Basic 1 chip just by Calling it and then using Goto. For the original Basic 1 chips use the program in listing 2. Poke addresses 11 and 12 with its start address,

(continued on page 181)

Loops — listing 1.

```
entry    68         pla
         68         pla          ditch CALL return address
         68         pla          pick up GOSUB token
         c9 8c      cmp #$ 8c
         d0 05      bne error    error if not a GOSUB
         68         pla
         68         pla          ditch GOSUB's line no.
         68         pla
         68         pla          ditch GOSUB's line pointer
         60         rts          & exit
error    a2 03      ldx #$ 03
         4c 4e a2   jmp $a 24e   fix error pointer and jump.
```

Listing 2.

```
entry    a2 0b      ldx #$ 0b
loop     68         pla
         ca         dex          ditch 10 usr stack levels.
         d0 fc      bne loop
         c9 8c      cmp #$8c     error if not GOSUB token.
         d0 05      bne error
         68         pla
         68         pla          ditch GOSUB's line no.
         68         pla
         68         pla          ditch GOSUB's line pointer
         60         rts          & exit
error    a2 03      ldx #$ 03
         4c 4e a2   jmp $a 24e   fix error code and jump.
```

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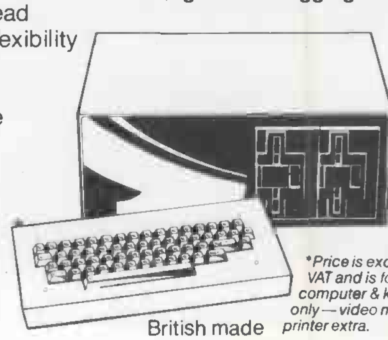

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(continued from page 176)
perform an XUSR(X) from within the subroutine and then use Goto. To kill two or more levels of subroutines just Call the program the required number of times.

If the program is not in a Gosub at the time or is also in an unfinished loop, then a No-Return error occurs; old Basic 1 chips produce squiggles. The program can be located anywhere convenient, e.g., in page 2. If you have new Basic 1 or an input-vector unmask routine, you can embed the program in a Rem statement. To do this, enter line

O REM """""" line of quotes """"""

then enter the monitor and locate the start of the quotes, ASCII 22. It should be at $0306 for the first line of a program.

Enter the program in hex from the next location $0307 and execute a warm start. The Rem line should now contain a few graphic nonsense characters, plus some spare quotes which can be edited away. The quotes allow the Basic program Rem line to be saved and loaded without the interpreter detokenising them. Line 0 is preferred as it cannot be shifted by inserting other Basic program lines. The routine is then operated by Call 775.

This routine useful for using control keys to override the normal exists from keyboard-polling subroutines. It should work on the OSI Superboard, as well as the UK 101.

Disassembled program

A PROGRAM for the Microtan 65 by Graham Richards of Sidcup, Kent produces hard copy of a disassembled program, using XBug and the Uart on Tanex. It could be adapted to run a parallel interface, using the VIA by amending the Init and Print routines, while maintaining the same protocol. The procedure will be useful to those users with version 1 Tanbug and will also be helpful to those with version 2 who dislike the fact that spaces are omitted from the hard copy it provides.

The program occupies locations $1E9B to $1FFF.

Step 1: Copy part of XBug into RAM using C command:
CF3C3,F4B9,1F09

Step 2. Modify it slightly using M command:

```
M1F89,CB,11  }
M1F8A,F3,1F  }  internal jump addresses
M1FAE,CB,11  }
M1FAF,F3,1F  }

M1F22,20     }
M1F23,FA,C6  }  JSR Print Screen
M1F24,FD,1E  }

M1F25,A5,4C  }
M1F26,01,0D  }  jump to get next page
M1F27,C9,1F  }
```

Step 3. Load the Print, Initialisation and Print Screen routines using the T command:
T1E9B

Step 4. Ensure that the start and end addresses are correctly entered into locations:

1EBB	Start add. Low.
1EBF	Start add. High.
1EFC	End add. Low.
1F01	End add. High.

Step 5. Run the program. The starting address is $1EB0, so type
G1EB0.

On the Go command, the initialisation routine sets up the Uart for non-interrupt mode and the required baud rate — in this case 300 baud. Then the start address is placed into location 1C/1D; this cannot be done using the M command. The program then jumps to subroutine 1F09 which is the part of XBug copied into RAM and altered.

This subroutine calls other subroutines left in XBug and fills up the screen with a page of the disassembled program. A jump to the Print Screen subroutine is then made which, in conjunction with the Print Character subroutine, dumps the screen to the printer. This is a useful subroutine pair in its own right.

Before a return is executed, a check is made to see if the end address has been passed, if so the return address to XBug is removed and a return to Init is made where the program breaks.

Disassembled program.

```
                   ;      PRINT SUBROUTINE
                   ;      ****************
                   ;
1E9B    297F              AND    #$7F
1E9D    C920              CMP    #$20         ;CHECK FOR PRINTABLE CHAR.
1E9F    B002              BCS    $1EA3
1EA1    A920              LDA    #$20         ;IF NOT MAKE IT A SPACE
1EA3    48                PHA                 ;SAVE CHAR.
1EA4    ADD1BF            LDA    $BFD1
1EA7    2910              AND    #$10
1EA9    F0F9              BEQ    $1EA4        ;LOOP UNTIL UART IS READY.
1EAB    68                PLA
1EAC    8DD0BF            STA    $BFD0        ;OUTPUT CHAR.
1EAF    60                RTS
                   ;


                   ;      INITIALISATION ROUTINE
                   ;      **********************
                   ;
1EB0    A98B       START: LDA    #$8B
1EB2    8DD2BF            STA    $BFD2        ;INITIALISE UART
1EB5    A996              LDA    #$96         ;300 BAUD
1EB7    8DD3BF            STA    $BFD3
1EBA    A9XX              LDA    #$SALOW      ;MOVE START ADDRESS TO 1C/1D
1EBC    851C              STA    $1C
1EBE    A9XX              LDA    #$SAHIH
1EC0    851D              STA    $1D
1EC2    20091F            JSR    $1F09        ;DISSASSEMBLE ROUTINE
1EC5    00                BRK
                   ;


                   ;      PRINT SCREEN ROUTINE
                   ;      ********************
                   ;
1EC6    A900              LDA    #$00
1EC8    8DD31E            STA    $1ED3        ;INITIALISE BASE IN 1ED3/D4
1ECB    A902              LDA    #$2
1ECD    8DD41E            STA    $1ED4
1ED0    A200              LDX    #$0
1ED2    BD0002            LDA    $200,X       ;GET CHAR FROM SCREEN
1ED5    209B1E            JSR    $1E9B        ;PRINT WITH CHAR. CHECK
1ED8    E8                INX                 ;NEXT CHAR
1ED9    E020              CPX    #$20         ;END OF LINE?
1EDB    D0F5              BNE    $1ED2        ;BRANCH IF NOT
1EDD    A90D              LDA    #$D
1EDF    20A31E            JSR    $1EA3        ;PRINT CR-LF WITHOUT CHAR.CHECK
1EE2    A90A              LDA    #$A
1EE4    20A31E            JSR    $1EA3
1EE7    18                CLC                 ;AMEND BASE IN 1ED3/D4
1EE8    8A                TXA
1EE9    6DD31E            ADC    $1ED3
1EEC    8DD31E            STA    $1ED3
1EEF    ADD41E            LDA    $1ED4
1EF2    6900              ADC    #$0
1EF4    8DD41E            STA    $1ED4
1EF7    C904              CMP    #$4          ;END OF SCREEN?
1EF9    D0D5              BNE    $1ED0        ;BRANCH IF NOT
1EFB    A9XX              LDA    #$EALOW
1EFD    38                SEC
1EFE    E51C              SBC    $1C          ;END OF DISSASSEMBLY?
1F00    A9XX              LDA    #$EAHIH
1F02    E51D              SBC    $1D
1F04    B002              BCS    $1F08        ;BRANCH IF NO
1F06    68                PLA                 ;CHUCK RETURN ADDRESS
1F07    68                PLA
1F08    60                RTS                 ;RETURN TO INIT ROUTINE
                          .END
```

Maze monster

THIS IS a very irritating little game that will satisfy those who like being chased around mazes by monsters, confesses Gary Williams of East Finchley. It is written for the ZX-81 with 16K RAM and is in three main sections.

The first section from line 20 to line 3080 is concerned with constructing a simple connected maze in which there is one and only one pathway from any one cell to any other, so there can be no loops and no areas walled away. The maze is stored in the character array M$(,). The maze has been left as the graphics characters in the array to simplify printing the maze out as the game proceeds, even though it complicates finding out whether there is a wall to the top or to the right of your position as the next cell up or right has to be looked at.

The subroutines have been placed at the beginning of the program as this marginally speeds their execution. After the maze has been constructed you are permitted to view it for a time proportionate to its area. It is then blotted out, reappearing as you move through it.

The monster, shown by an asterisk, will blot out any part of your trail it moves along. The monster searches methodically through the maze, with an occasional change of direction as it gropes around for you. It is thankfully blind, and cannot see down passages as this would slow down the movement rate to an unacceptable level.

Your movement is controlled by the unshifted cursor keys 5, 6, 7 and 8. If you are captured you are given another chance at the same maze, if you reach the exit at the bottom and so escape, then you are given a go with another maze.

A full screen-sized maze takes about 10 minutes to construct but it is easy to escape from. Smaller mazes are constructed much more quickly but are sometimes almost impossible.

Maze monster

```
   1 REM *JUMP TO MAZE ALGORITHM
**
  10 GOTO 1000
  20 REM **ROTATE**
  30 LET DIRECTION=DIRECTION+1
  40 IF DIRECTION=5 THEN LET DIR
ECTION=1
  50 RETURN
 100 REM **LOOKAHEAD**
 110 LET P$="▖"
 120 IF XPOS=1 AND V(DIRECTION,1
)=-1 THEN RETURN
 130 IF YPOS=HEIGHT AND V(DIRECT
ION,2)=1 THEN RETURN
 140 LET P$=M$(YPOS+V(DIRECTION,
2),XPOS+V(DIRECTION,1))
 150 RETURN
 200 REM **PLOT**
 210 IF DIRECTION=2 OR DIRECTION
=4 THEN GOTO 250
 220 IF  P$="▖" THEN LET P$="▄"
 230 IF  P$="▐" THEN LET P$="▙"
 240 RETURN
 250 IF  P$="▖" THEN LET P$="▐"
 260 IF  P$="▄" THEN LET P$="▙"
 270 RETURN
1000 FAST
1010 DIM M$(21,32)
1020 PRINT " INPUT HEIGHT (4-20)
"
1030 INPUT HEIGHT
1040 PRINT " INPUT WIDTH (4-31)"
1050 INPUT WIDTH
1060 IF WIDTH>31 OR WIDTH<4 OR H
EIGHT>20 OR HEIGHT<4 THEN GOTO 1
020
1070 DIM V(4,2)
1080 REM INITIALIZE VECTOR ARRAY
1090 LET V(1,1)=0
1100 LET V(2,1)=1
1110 LET V(3,1)=0
1120 LET V(4,1)=-1
1130 LET V(1,2)=-1
1140 LET V(2,2)=0
1150 LET V(3,2)=1
1160 LET V(4,2)=0
1165 REM **SUBROUTINE NAMES**
1170 LET ROTATE=20
1180 LET LOOKAHEAD=100
1190 LET PLOT=200
1200 LET XPOS=1
1210 LET YPOS=2
1220 LET XPOINTER=1
1230 LET YPOINTER=2
1235 REM **DRAW BORDER**
1240 FOR K=1 TO WIDTH
1260 LET M$(1,K)="▖"
1270 NEXT K
1280 FOR K=1 TO HEIGHT
1300 LET M$(K,WIDTH)="▖"
1310 NEXT K
1320 LET M$(2,1)="▐"
1330 LET M$(1,1)="▄"
2000 REM **CONSTRUCT MAZE**
2010 FOR C=1 TO 4
2020 LET DIRECTION=1+INT (RND*4)
2030 GOSUB LOOKAHEAD
2040 IF P$<>" " THEN GOTO 2230
2050 LET XPOS=XPOS+V(DIRECTION,1
)
2060 LET YPOS=YPOS+V(DIRECTION,2
)
2070 LET M$(YPOS,XPOS)="▖"
2080 LET DIRECTION=DIRECTION-1
2090 IF DIRECTION=0 THEN LET DIR
ECTION=4
2100 FOR K=1 TO 3
2110 GOSUB LOOKAHEAD
2120 IF P$=" " THEN GOTO 2200
2125 REM **PLOT INTO M$(,)**
2130 IF DIRECTION=2 OR DIRECTION
=1 THEN GOTO 2180
2140 LET P$=M$(YPOS,XPOS)
2150 GOSUB PLOT
2160 LET M$(YPOS,XPOS)=P$
2170 GOTO 2200
2180 GOSUB PLOT
2190 LET M$(YPOS+V(DIRECTION,2),
XPOS+V(DIRECTION,1))=P$
2200 GOSUB ROTATE
2210 NEXT K
2220 GOTO 2000
2230 NEXT C
2240 LET XPOS=XPOINTER
2250 LET YPOS=YPOINTER
2260 FOR K=1 TO 4
2270 GOSUB LOOKAHEAD
2280 IF P$=" " THEN GOTO 2050
2290 GOSUB ROTATE
2300 NEXT K
2310 IF XPOINTER<WIDTH-1 THEN GO
TO 2350
2320 LET XPOINTER=0
2330 IF YPOINTER=HEIGHT THEN GOT
O 3000
2340 LET YPOINTER=YPOINTER+1
2350 LET XPOINTER=XPOINTER+1
2360 GOTO 2240
2995 REM **PRINT MAZE**
3000 CLS
3010 FOR K=1 TO HEIGHT
3020 PRINT M$(K)
3030 NEXT K
3040 LET XIT=INT (WIDTH/2)-1
3050 PRINT AT 0,XIT;"▐▙";
3060 PRINT AT HEIGHT,XIT;"▐▐";
3070 UNPLOT XIT*2+1,(22-HEIGHT)*
2
3080 PAUSE WIDTH*HEIGHT*10
3085 REM **UNPRINT MAZE**
3090 FOR K=1 TO HEIGHT-1
3100 PRINT AT K,0;"▐";
3120 NEXT K
3130 FOR K=1 TO WIDTH-2
3140 FOR L=1 TO HEIGHT-1
3150 PRINT AT L,K;"▖";
3160 NEXT L
3170 NEXT K
3180 PRINT AT 0,XIT;"▄▄";
3995 REM *INITIALIZE VARIABLES**
4000 LET XPOS=XIT
4010 LET YPOS=2
4020 REM **MONSTER VARIABLES**
4030 LET XMON=XIT
4040 LET YMON=INT (HEIGHT/2)+1
4050 LET DIRMON=3
4060 SLOW
4395 REM **BEGIN MOVEMENT LOOPS*
4400 LET U=0
4410 LET R=0
4500 PRINT AT YPOS-1,XPOS;M$(YPO
S,XPOS+1);
4510 IF M$(YPOS-1,XPOS+1)="▄" OR
 M$(YPOS-1,XPOS+1)="▙" THEN LET
U=1
4520 IF U=0 THEN GOTO 4550
4530 PLOT XPOS*2+1,(23-YPOS)*2
4550 IF M$(YPOS,XPOS+2)="▐" OR M
$(YPOS,XPOS+2)="▙" THEN LET R=1
4560 IF R=0 THEN GOTO 4600
4570 PLOT (XPOS+1)*2,(22-YPOS)*2
+1
4600 PRINT AT YMON-1,XMON;"*";
4610 PLOT XPOS*2+1,(22-YPOS)*2+1
4620 UNPLOT XPOS*2+1,(22-YPOS)*2
+1
4630 REM **INPUT YOUR MOVE**
4640 LET I$=INKEY$
4650 IF I$="5" AND (M$(YPOS,XPOS
+1)="▄" OR M$(YPOS,XPOS+1)="▖")
THEN LET XPOS=XPOS-1
4660 IF I$="6" AND (M$(YPOS,XPOS
+1)="▐" OR M$(YPOS,XPOS+1)="▖")
THEN LET YPOS=YPOS+1
4670 IF I$="7" AND U=0 THEN LET
YPOS=YPOS-1
4700 IF I$="8" AND R=0 THEN LET
XPOS=XPOS+1
4710 IF XPOS=XIT AND YPOS=HEIGHT
 THEN GOTO 9500
4720 PLOT XPOS*2+1,(22-YPOS)*2+1
4730 UNPLOT XPOS*2+1,(22-YPOS)*2
+1
5000 REM **MONSTER MOVES**
5010 IF YPOS=YMON AND XPOS=XMON
THEN GOTO 9000
5020 PRINT AT YMON-1,XMON;"▖"
5030 LET DIRMON=DIRMON-1
5040 IF DIRMON=0 THEN LET DIRMON
=4
5050 IF RND<.01 THEN GOTO 5030
5060 LET P$=M$(YMON-(DIRMON=1),1
+XMON+(DIRMON=2))
5070 IF P$="▖" OR (P$="▐" AND V(
DIRMON,1)=0) OR (P$="▄" AND V(DI
RMON,2)=0) THEN GOTO 5110
5080 LET DIRMON=DIRMON+1
5090 IF DIRMON=5 THEN LET DIRMON
=1
5100 GOTO 5060
5110 LET YMON=YMON+V(DIRMON,2)
5120 LET XMON=XMON+V(DIRMON,1)
5130 IF (YPOS=YMON) AND (XPOS=XM
ON) THEN GOTO 9000
5140 GOTO 4400
9000 REM **CAPTURED**
9010 PAUSE 50
9020 CLS
9030 FOR F=1 TO 20
9040 PRINT "            GOTCHA"
9050 NEXT F
9060 GOTO 3000
9500 REM **ESCAPED**
9510 PAUSE 50
9520 CLS
9530 PRINT "CONGRATULATIONS YOU
ESCAPED"
9540 PAUSE 10000
9550 RUN
```

Submarine

SUBMARINE is a program which makes effective use of the graphics on the ZX-81 to draw a boat, an island and a submarine writes Chris Callender.

The object of the game is to use the keys 5 and 8 to control the submarine and the F key to fire. The boat must score a direct hit in the engine room, marked with a star, in order for it to sink. If it manages to get to the island and deliver supplies you have failed, and should be executed.

Submarine

```
 10 LET X=0
 20 LET SX=20
 30 FOR A=5 TO 21
 40 PRINT AT A,0;"████████████████
████████████████"
 50 NEXT A
 60 PRINT AT 2,X;" ▌ ▐     "
 70 PRINT AT 3,X;" ▐▄██▄   "
 80 PRINT AT 4,X;"▄▄███████▄"
 90 PRINT AT 2,27;"  ▄▄  "
100 PRINT AT 3,27;" ████ "
110 PRINT AT 4,27;"▄█████"
120 PRINT AT 19,SX;" ███  "
130 PRINT AT 20,SX;" ███▐ "
140 PRINT AT 21,SX;" ██████"
150 PAUSE 50
155 LET A$=INKEY$
157 IF A$="F" THEN GOSUB 340
160 PRINT AT 2,X;"          "
170 PRINT AT 3,X;"          "
180 PRINT AT 4,X;"          "
190 PRINT AT 19,SX;"███ "
200 PRINT AT 20,SX;"███ "
210 PRINT AT 21,SX;"██████"
230 LET SX=SX+(A$="8")-(A$="5")
240 IF SX>25 THEN LET SX=25
245 IF SX<0 THEN LET SX=0
250 LET X=X+(RND*5)-1
260 IF X>=19 THEN GOTO 280
270 GOTO 60
280 CLS
290 PRINT AT 10,10;"YOU FAILED"
300 PAUSE 50
310 PRINT AT 10,10;"██████████"
320 PAUSE 50
330 GOTO 290
340 LET N=SX+3
345 FOR Y=18 TO 5 STEP -1
350 PRINT AT Y,N;"+"
360 IF Y=5 AND N=INT (X+1.5) TH
EN GOTO 410
370 PAUSE 20
380 PRINT AT Y,N;"█"
390 NEXT Y
400 RETURN
410 PRINT AT Y,N;"█"
420 PRINT AT Y-1,N;"+"
430 PAUSE 50
440 PRINT AT Y-1,N;"GLUG"
450 PAUSE 50
460 PRINT AT Y-1,N;"████"
470 PAUSE 50
480 GOTO 440
```

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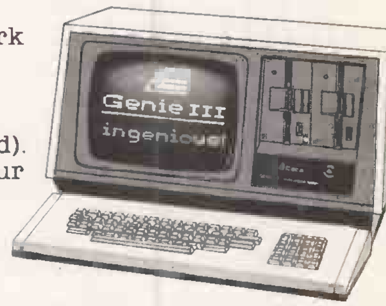

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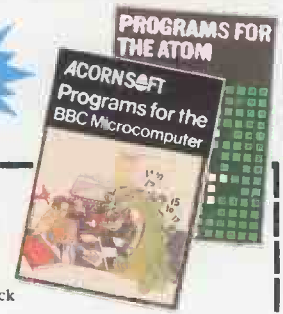

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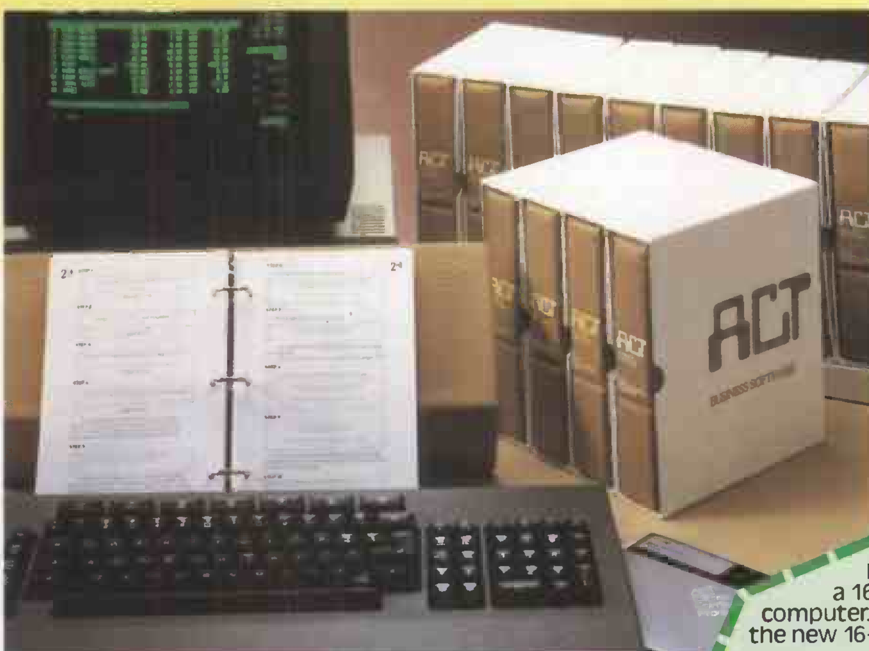

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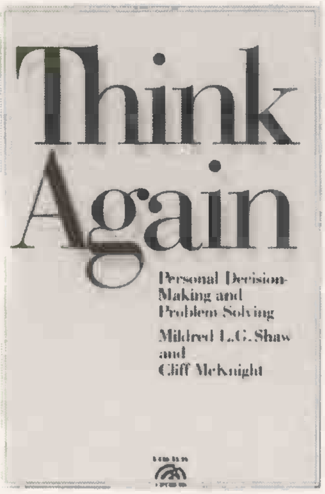
Think Again

By Mildred L G Shaw and Cliff McKnight. 182 pages. Published by Prentice-Hall. ISBN 0 13 917443 5.



DAN IS A teenage boy who is often in trouble. He has been to court several times for petty offences. One could say he has a problem. However by drawing a grid he becomes friendly with a table-tennis playing policeman and gets a job as a plumber.

What this has to do with microcomputers is not at first apparent. But a problem such as Dan's can be expressed in grid form, and then processed by a micro to find a solution. In the appendix of the book are a couple such programs, which can analyse grids and act as an aid to solving problems of a sociological or psychological kind.

The single biggest aid to solving such problems is being able to express them, and by forming a grid this can be made easier. Once the grid has been drawn certain aspects of the problem can be highlighted, by using semi-mathematical techniques. The real object of the exercise is to provide a logical framework from which someone, maybe a counsellor, can work.

The book, although written by two British academics, is typical of the new wave of American psuedo-scientific literature. On the one hand it is so simple that most people's intelligence is insulted, but it will launch into something complicated, and then further insult the reader by saying "this next bit will be difficult". All the time though, the reader is asked to swallow "truths" with no justification, implying that only someone really stupid would disagree.

Conclusions

● I would certainly "Think Again" before parting with any cash for this book.

● If you have a problem to solve, try VisiCalc or a Priest.

Bill Bennett

Using the Unix System

By Richard Gauthier. Reston Publishing Company Inc.

THE UNIX SYSTEM and its derivatives are becoming a sort of de facto standard for 16-bit microcomputer multi-user operating systems. One of the better features of Unix is the large amount of documentation available on the system. So what could this book on Unix offer? Not a lot, would seem to be the answer.

Particularly lacking is a discussion of the wide variety of tools and software available to Unix users. The early part of the book provides material for novices, the features of the Shell, and more general information on files, directories etc. The most useful part of the book is Chapter 9 which deals with the system administrator's view of Unix.

Conclusions

● The book has little to offer the user that other sources of information cannot already provide.

John Cookson

Pet Graphics

By Nick Hampshire. £14.00. John Wiley and Son Ltd. ISBN 0 810 410516.

THE COMMODORE PET was never intended as a high-resolution graphics machine. This book attempts to improve this situation.

The book starts with a description of the method the Pet uses to produce its video display. The examples given in this section are written in Basic. The rest of the book is in machine code.

The second chapter consists of routines to draw horizontal and vertical lines on the screen, fill a block with the required character, or even reverse a block on the screen.

The third chapter allows you to plot bar graphs to far greater resolution than is usually obtained. It is done by splitting each cursor-sized block into either eight horizontal strips or eight vertical strips. The routines are fast enough to show apparently continuous movement, which is useful for animation purposes.

All Pet users are familiar with the upward scrolling of the screen. If you require something different from your Pet then chapter 4 of this book will show you how blocks of the display can be scrolled up, down or left or right.

Every routine in machine code in this book is accompanied by a Basic program of about five lines which allows you to Poke the necessary parameters on to page zero and then call the routine. So even the raw recruit to machine-code programming can usefully incorporate these routines into his Basic program.

Each cursor-sized block on the screen can be divided into quarters and using these parts it is possible to improve the screen resolution from 25 by 40 to 50 by 80, an increase from 1,000 points to 4,000 points.

The sixth chapter introduces another possibility. The screen is made to act as a movable window on a giant page of text. The routine could be useful on a large chart where specific areas might need to be closely examined.

Another possibility is the use of macro characters four blocks high and four blocks wide. Though such an ability is of very limited use it could be invaluable in certain circumstances such as for demonstration purposes or use by the partially sighted.

The final chapters of the book contain the design and constructional details for a light-pen. The circuit is daunting and unless you are competent with a soldering iron it could be more than you are prepared to tackle.

Conclusions

● The Pet Graphics book is one to be bought and read so that you know what capabilities the Pet now has. It is then up to you to incorporate the excellent routines into your programs.

Stephen Potts

How to Buy the Right Small Business Computer System

By C Roger Smolin. 156 pages. $8.95. Published by John Wiley and Sons Inc.

THE TITLE of this book is slightly misleading. All it provides is enough background for the businessman to ask the right questions. The first part of the book deals with the basics of computing and is not convincing. Some good advice and useful text is mixed with inaccuracies and some dangerously misleading comments. In some places the text is simply wrong.

The author persistently describes some of his diagrams as flowcharts even when quite clearly they are not. The view of computer science presented is in many respects still in the 1960s. The discussion of systems analysis is too brief to be useful and his bland assertion that programming is easy is belied by a vast amount of evidence to the contrary.

In attempting to dispel the myths and technical jargon inflicted on purchasers by high-pressure salesmen the author goes too far. The technical details of systems, processor and disc and store sizes are important. Errors in this area are commonly made, usually leading to a choice of software and hardware which is inadequate for the application.

The strength of this book is in its discussion of business applications software. Although the author is American and refers to American practices the principles outlined and the advice given are generally very sound. Particularly welcome is his emphasis on systems integration, still largely ignored by microcomputer software vendors.

Conclusions

● The only reservation about the book I have is the claim that the businessman can purchase his own system after having read it. He would in fact be extremely ill-advised to do so.

● It does provide an excellent basis for the businessman to deal with a consultant, and is a worthwhile and valuable text.

John Cookson

Knight's escape

by Tony Roberts

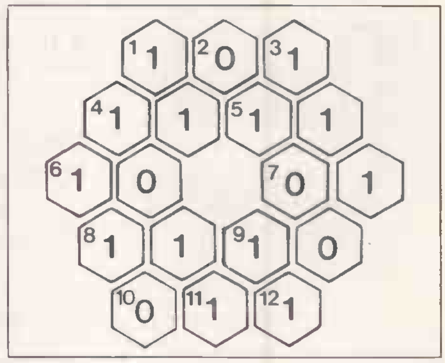
FOR THIS TEST of courage and cunning, you have to pass through the room shown here, stepping knight-fashion from tile to tile on the chess-board like floor. There are two exits, and they both lead to a chamber containing the fierce two-brained Smak-beast. It will surely tear you limb from limb as you exit the room if you do not shoot it first; one bullet in each brain is the only known way to kill the Smak.

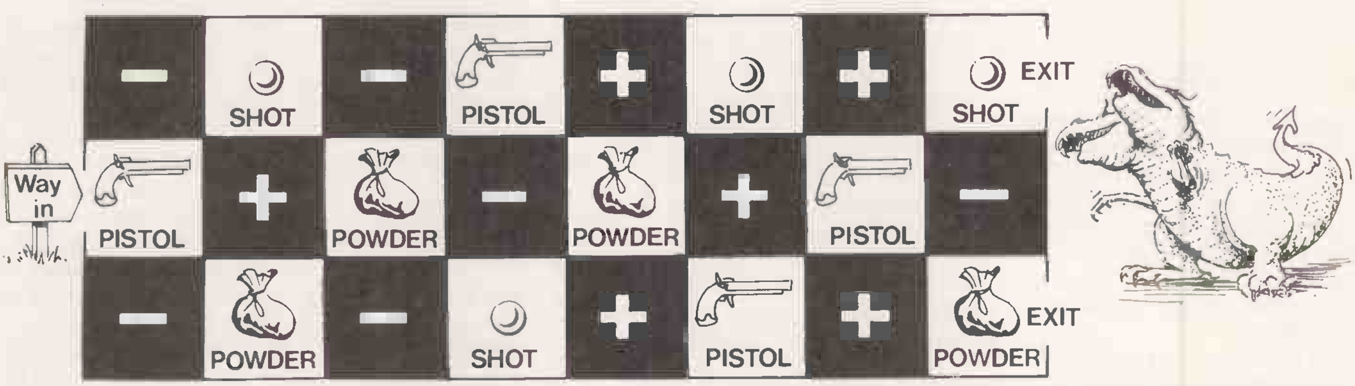
On each white floor tile there lies either a pistol, a bag of gunpowder, or a steel shot. Each black tile is marked with a + or a −, indicating respectively that you must pick up or put down the item in the next white square you stand on. You may pick up the pistol on the first square. You must visit each white square once and once only, but may visit the black squares as often as you wish or not at all. In order to survive the beast, you must leave the room bearing just two pistols, with a bag of powder and a shot in each.

Can you devise a route that will give you a chance of survival?

Solution to September puzzle

The binary birthday solution is in the grid. My age is a perfect square and the sum of the ages of my children. I am, of course, 49 years old.





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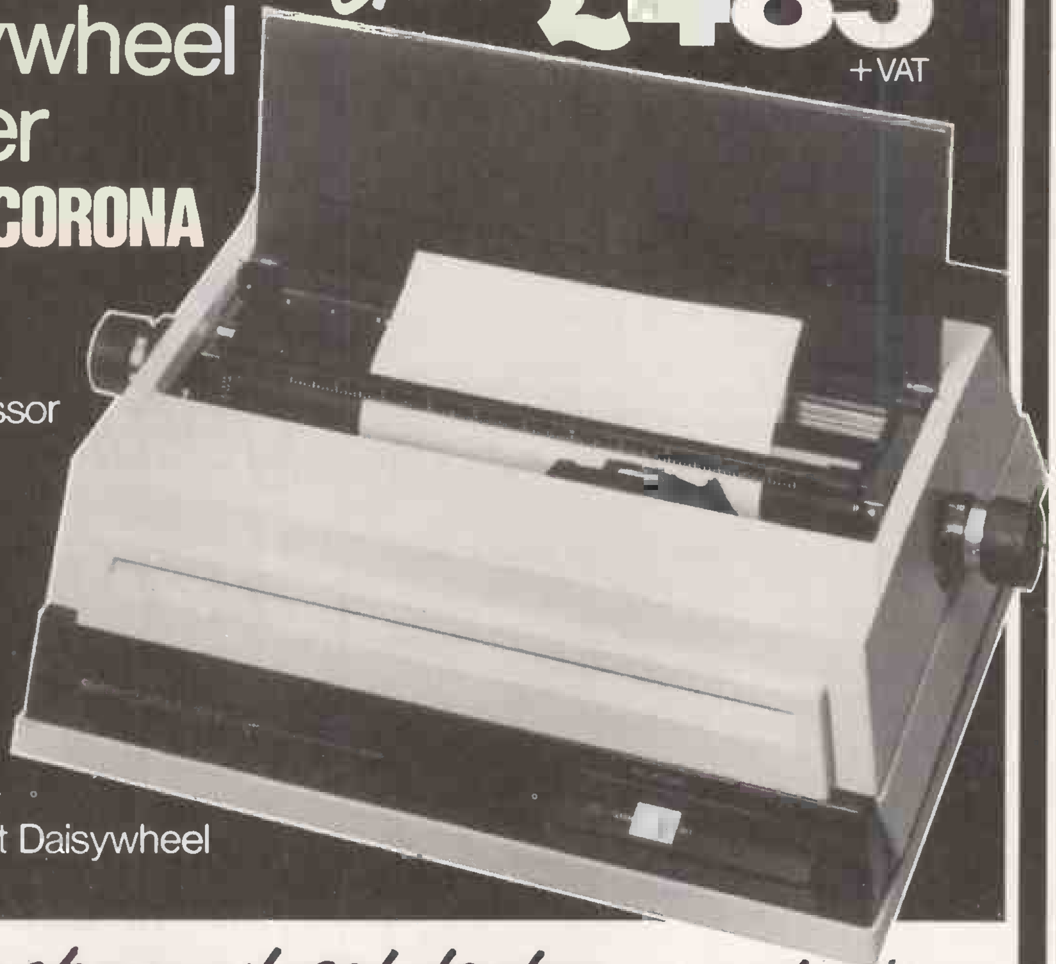

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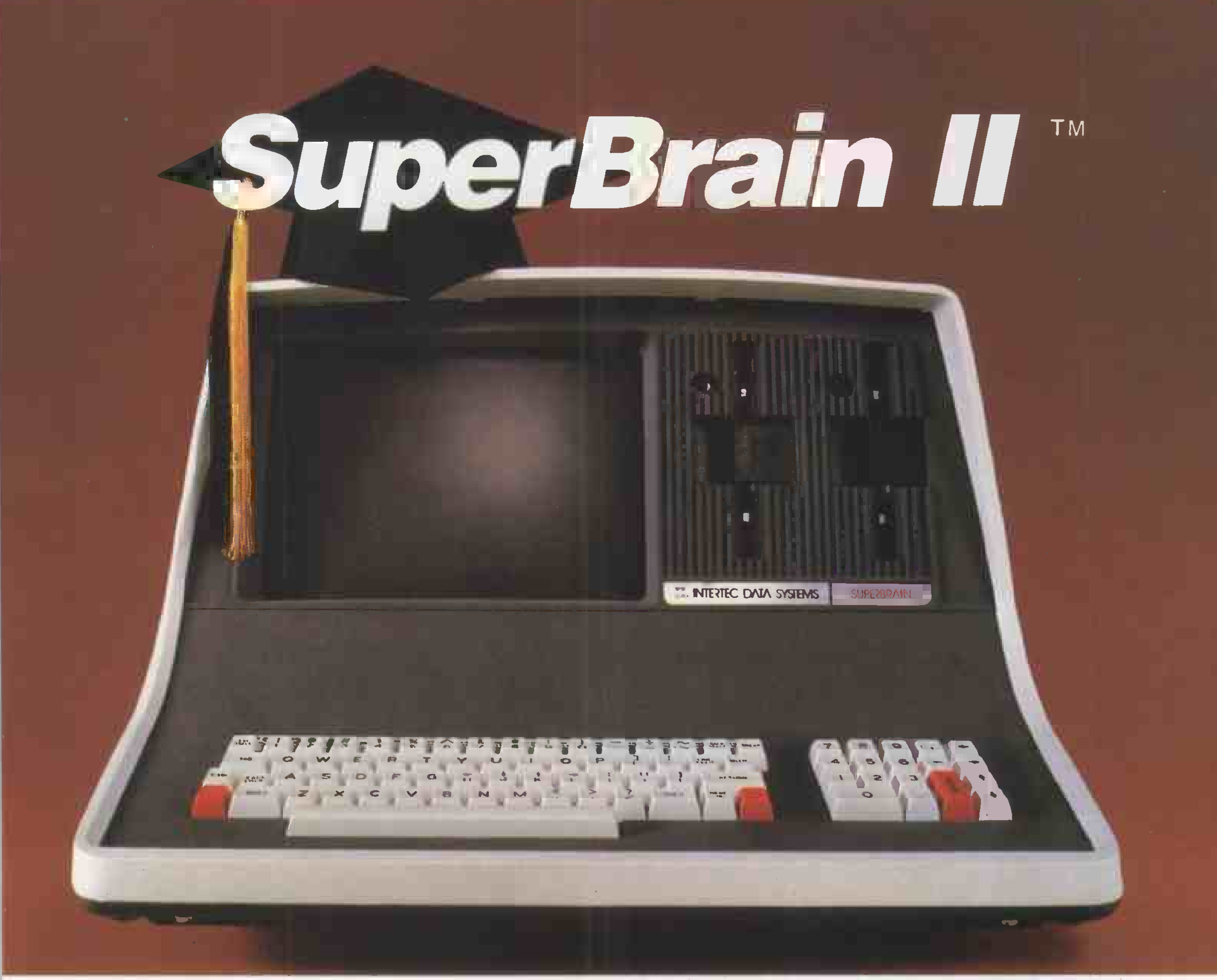

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Microcomputers

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Systems 1, 2, 3, 4, 5: 6502-based. 1-32K RAM COS or DOS. Hex or full keyboard. Personal, scientific business or educational use. Disc module, CMOS RAM Card, 80-by-25 character VDU interface, 8K static memory, analogue interface, daisywheel printer interface, cassette interface, VDU, laboratory interface, in-circuit emulator, universal interface, PROM program, Econet interface, switched-mode PSU. Software includes, Pascal, Lisp, Forth, floating-point extension, ONLI extension. System 1-3 Reviewed September 1979. — *From £65 for System 1 kit; £285 for System 2 kit; £670 for System 3 kit*

Atom: 6502, 2-12K RAM, up to 40K external memory, full keyboard, Basic in ROM, high-resolution graphics, cassette and TV interface, parallel port, I/O lines. Should eventually be able to link into a ring. Acorn Computers Ltd., 4a Market Hill, Cambridge CB2 3NJ (0223) 312772. Reviewed November 1980. — *From £130*

BBC Micro: 6502 or Z-80, 2MHz, second-processor option with up to 96K RAM, 32K in normal operation, full keyboard, cassette and disc interfaces, Centronics type interface, A-D interface, integral loudspeaker and sound generator. Options include: clock, voice synthesiser, Econet, teletext adapter and a 16-bit processor, VDU; eight modes including text and colour. Reviewed January 1982. — *£299 and £399*

ACT SIRIUS

ACT Sirius: 8088 16-bit CPU, 126K to 1Mbyte RAM, 11in. swivel screen displaying 25 by 80 characters or 800-by-400 point high-resolution graphics, programmable type founts. QWERTY keyboard plus numeric keypad and function keys; all keys programmable. Sound synthesis. Integral dual 5.25in. floppies, 1.2Mbyte, 10Mbyte hard-disc option. Operating system is CP/M 86 or MDOS — IBM compatible micro operating system. Basic and Assembler supplied. Pascal, Fortran, Cobol, etc. available. Business and general use. Reviewed March 1982. ACT Microsoft Ltd, Radclyffe House, 66 Hagley Road, Birmingham. (021) 454 8585. — *£2,395 for 128K RAM, dual-floppy based system with VDU.*

ADLER

Alphatronic: 8085A, 64K RAM. 24-by-80 character screen, full QWERTY keyboard with numeric keypad and function keys. Integral, single or dual 5.25in. floppy drives, 160K or 320K. CP/M, BASIC. Reviewed February 1982. Adler Business Systems Ltd, 27 Goswell Road, London EC1. (01) 250 1717.

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APPLE COMPUTER

Apple II Plus: 6502, 16-48K RAM, 8K ROM, colour graphics, 5¼in. discs, general use. Own bus Basic, Pilot, Logo, Lisp, Forth, Pascal and most other languages available. CP/M available with add-on board with Z-80 on it. Reviewed October 1979.

From £695.

Apple III: 6502A with supporting chips, giving it a superset of 6502 instruction set. 96-128K RAM, colour graphics, integral 5¼in., RS-232, four 50-pin expansion slots. Apple Computer (U.K.) Ltd., Finway House, Hemel Hempstead, Hertfordshire HP2 7PS. (0442) 48151.
From £2,496 with monitor and one floppy drive.

ARCHIVES COMPUTERS

Archive II and III: Z-80, 64K, 2K ROM, S-100 bus. Integral 25-by-80 character screen capable of 240-by-100 point graphics. Detachable QWERTY keyboard with programmable function keys. RS-232, current loop and parallel interfaces. Dual 5.25in. floppy drives, 1.6Mbyte; Archive III has 5Mbyte hard disc. CP/M, Basic, etc. Business use. Salmon Electronics Ltd, PO Box 26, Croft, Darlington, County Durham. (0325) 721368.
£3,000 for Model II £4,000 for hard-disc Model III.

ATTACHE

Attache: Z-80, 64K RAM, S-100 bus, RS-232 and parallel interfaces, any terminal. Dual 8in. floppy drives, 1.8Mbyte. CP/M, Basic etc. Colt Computer Systems Ltd, Fairfield Works, Fairfield Road, Hounslow, Middlesex. (01) 577 2686.
From £1,737 Floppy-based system, terminal and printer about £7,000.

ATARI

Atari 400: 6502, 16K RAM, 10K ROM. Additionally uses 8K ROM cartridges for Atari-supplied software, mostly games or educational. Uses domestic TV for 24-by-40 character display with 320-by-192 point 16 colour high-resolution graphics. Touch-sensitive keyboard with full QWERTY layout. Four channel sound synthesis, cassette interface. Cassette audio track can be output through TV under program control. Home use.
From £300.

Atari 800: 6502, 16-48K RAM. Expandable version of 400 intended for more serious user. Full QWERTY keyboard with moving keys, four function keys, 5.25in. floppy discs, 88K per drive, 176K dual unit. Basic, Pilot, Assembler available. Home, education and general use. Reviewed July 1982. Atari International UK Incorp., PO Box 59, Alperton Lane, Wembley, Middlesex HA0 1FJ. (01) 998 8844.
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Canon TX-10/TX-15: 6809, 16K RAM, 8K ROM, optional 16K non-volatile CMOS memory or 16K PROM. Integral 20-character strip display, no graphics, TX-15 has full QWERTY keyboard. TX-10 is numerically orientated, with numeric keypad and 30 program-definable keys. Optional two RS-232 interfaces, no discs, integral 26-column printer. Not user-programmable; the Basic or Assembler programs reside in ROM or PROM. Intended for turnkey applications in business or scientific field. Canon (UK) Ltd, Waddon House, Stafford Road, Croydon, Surrey CR9 4DD. (01) 680 7700. — *From £1,250.*

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DC 1000: Multi-user system. Each user has own Z-80A and 64K RAM under control of master Z-80A. One to 16 users, separate terminals, RS-232 and parallel interfaces. CP/Net. CP/M, MP/M, Basic, etc. Icarus Computer Systems Ltd, 27 Greenwood Place, London NW5 1NN. (01) 485 5574. — *£7,500 single user, hard disc.*

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8000 Series — SuperPet: Upgrade of original Pet. 12in. screen, 5.25in. discs, business and general use. Reviewed October 1980. — *From £895.*

Vic 20: 6502, 5K RAM, 16K ROM, keyboard, personal and game use, IEEE interface, uses special cassette £35, disc and printer soon, RS-232, Modem use, low resolution colour graphics. Reviewed January 1982. Commodore Business Machines, 818 Leigh Road, Slough Industrial Estate, Slough, Berkshire. (75) 74111. — *From £165.*

COMPUCOLOR

Compucolor II: Z-80, 8-32K RAM, 5.25in. integral discs, 13in. colour VDU, RS-232. General use. Dyad Developments, The Priory, Great Milton, Oxfordshire OX9 7PB. (08446) 729. Reviewed June 1979. — *From £998.*

Copernicolor II: 8080A, 8-32K RAM, 5.25in., 8in. and Winchesters available, VDU, RS-232 bus, standard ASCII keyboard with optional keyboards available, graphics 128 by 128, Basic, assembler, Fortran. Based on Compucolor II, wide range of software. General use. Copernicus Ltd, 7 Wey Hill, Haslemere, Surrey. (0428) 52888. — *From £1,200.*

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Minikit: Z-80, 16K RAM, serial and parallel, 5.25in., CP/M, S-100. *From £800.*

Maxikit: Z-80, 16K RAM, serial and parallel, 8in., CP/M, S-100. Computer Centre, 9 De la Beche Street, Swansea SA1 3EX. *From £911.*

CORVUS

Concept: 68000 16-bit CPU, 256K RAM expandable to 512K. Monochrome A4-size screen can be rotated to display either 72 lines of 90 characters or 56 lines of 120 characters. 720-by-560 high-resolution graphics. Detachable QWERTY keyboard with numeric keypad and programmable function keys. Two RS-232C interfaces, four expansion slots, battery-driven clock and sound generation. Hard discs in 6, 10 or 20Mbyte capacities, optional video tape back-up extra. No floppies at present. Merlin Unix look-alike OS, Pascal, Fortran, Cobol and WP. Keen Computers, 5 Giltspur Street, London EC1. (01) 236 5682. *£6,250 with 6Mbyte hard disc.*

CROMEMCO

Single Card Computer: Z-80, S-100, 1K RAM, 20mA-RS-232. OEM and industrial use. *From £273.*

Z2: Z-80, 31A power supply, motherboard, 21 sockets, serious hobbyist and OEM use. Reviewed February 1979. *From £700.*

Z2-H: Z-80A, 64-512K RAM, S-100 bus, CDOS, IOMB formatted fixed disc, two 5.25in. discs, hard discs up to 70MB. *From £6,275.*

System Zero: Z-80 single card S-100 system with power supply. *From £813.*

System Zero/D: Z-80 single board computer, 65K RAM, two 5.25in. floppies, CDOS. *From £2,762.*

System 1: Z-80A, 64K RAM, S-100 bus, model CS-1; 790K storage, model CS-1H; 5.5Mbyte storage, CDOS and Cromix. *From £2,446.*

System 2: Z-80A, 64-512K RAM, S-100 21 slots, CP/M, VDU, two 5.25in. discs, hard discs up to 70MB. Multi-channel interface available. General/business use. *From £2,947 to £8,387 for six users.*

System 3: Z-80A, 64-512K RAM, S-100, CP/M, two or four 8in. discs, hard discs up to 70MB, general/business use. Datron MicroCentres, at 2 Abbeydale Road, Sheffield S7 1FD. (0742) 585490, and at 30 Dundas Street, Edinburgh EH3 6IN (031) 556 7354. Comart, P.O. Box 2, St. Neots, Huntingdon, Cambridgeshire PE19 4NY. (0480) 215005. *From £4,995 to £5,955 for six users.*

DANSK DATA ELEKTONIK APS

SPC/1: Multi-user system, one to eight users. 8085A CPU, 80-416K RAM, each user having 48K. Optional ROM up to 96K. Separate VDU, 256-by-256 point black/white graphics, 80-by-32 colour graphics characters. RS-232, parallel, IEEE-488, GPIB and other interface options. 280K — 1.2Mbyte 5.25in. floppy-disc configurations, 8in. and hard-disc options up to 26Mbyte. Mikados operating system, Comal, structured Basic, Pascal, assembler. Scientific, industrial and business use. Digital Data Electronic Ltd, Clark House, Pump Lane, Hayes, Middlesex. (01) 573 8854. *From £2,700 for single-user system.*

DATA APPLICATIONS INTERNATIONAL

DAI Personal Computer: 8080, 48K RAM, 24K ROM. Uses standard TV, 16-colour 256-by-336 high-resolution graphics mode, QWERTY keyboard, RS-232 and dual cassette interfaces, DIN socket for sound output to domestic stereo, DCE bus for connection to range of over 20 Eurocard industrial interface modules. Optional dual 5.25in. floppy drive, optional CP/M, Basic, 8080 assembler, Cis Cobol available. High-speed hardware maths option. Home use, but also industrial scientific. Reviewed February 1981. Data Applications (UK) Ltd, 16B Dyer Street, Cirencester, Gloucestershire GL7 2PF. *From £595.*

DELTA PRODUCTS

DPS Range: Z-80A, 64-640K RAM, 2K ROM, S-100 bus. Separate terminal. RS-232 and RS-422 interfaces. Dual 5.25in. floppy drives 1.5Mbyte 8in. and hard disc options up to 160Mbyte. CP/M, MP/M, CP/Net, Basic, Pascal, Cobol, PL/1, etc. Can be expanded to 10 users with CP/Net. Business use. Terodec Ltd, Unit 58, Suttons Park Avenue, Earley, Reading, Berkshire RG6 1AZ. (0734) 664343.

From £1,995 for floppy-based single-user system.

DIGITAL DATA ELECTRONICS

SPC/1: 8085, 32-48K RAM, own OS, COMAL, Assembler and Pascal, graphics, up to three 5.25in. drives, up to four 8in. drives, 10MB Winchester, up to four 20MB cartridge, many ports. DDE, Clark House, Pump Lane, Hayes, Middlesex. (01) 573 8891.

From £1,995.

DIGITAL EQUIPMENT CORPORATION

VT-18X: Z-80, 64K RAM, 8K ROM, RS-232 interface, dual 5.25in. floppy drives 360K. CP/M, Basic, etc, available. Intended for use with best-selling DEC VT-100 terminal — 80 by 24 characters, full QWERTY keyboard, various graphics options — to convert it into a personal computer. Business and scientific use. Zygal Dynamics plc, Zygal House, Telford Road, Bicester, Oxfordshire OX6 0XB. (08692) 3361.

From £1,800 for VT-18X alone. About £3,000 with VT-100 included.

DIGITAL MICROSYSTEMS

DSC-3: Z-80, 64K RAM, CP/M, 8in. discs, hard discs up to 28MB, RS-232/V24, business and general use. Two or more of these machines can be linked using HiNet local area network.

From £3,445.

DSC-4: Z-80, 128-512K RAM, CP/M, 8in. discs, hard discs up to 28MB, RS-232, RS-422, business and general use.
Modata, 30 St. Johns Road, Tunbridge Wells, Kent TN4 9NT. (0892) 41555. Extel, 73/3 Scrutton Street, London EC2A 4TA. (01) 739 2041.

From £3,995.

DRAGON DATA

Dragon 32: 6809E eight-bit CPU, 32K RAM expandable to 64K, Basic in ROM. Displays 16 lines of 32 characters on separate TV or monitor, and 256-by-192 high-resolution graphics in up to nine colours, depending on graphics mode. Proper keyboard with QWERTY layout. Five-octave sound generation output through TV, cassette interface allowing use of cassette audio under program control. ROM cartridge socket, joystick port, Centronics-type printer interface. Reviewed October 1982.
Dragon Data, Queensway, Swansea Industrial Estate, West Glamorgan SA5 4EH. (0792) 580651.

£199.

DURANGO

F85: 8085, 64K RAM, own bus and OS, graphics, four RS-232 ports, integral 9in. VDU, 9-by-9 printer, keyboard and two 5.25in. disc drives. General use. Comp Ancillaries, 64 High Street, Egham, Surrey. (07843) 6455.

From £7,500

DYNABYTE

Dynabyte 5000: Z-80, 32-64K RAM, S-100, CP/M, MP/M, CP/Net, RS-232, 5.25in. or 8in. discs, hard discs up to 96Mb, expands to multitask/user system. Business use. Microtech Ltd, Waterloo Road, Uxbridge, Middlesex UB8 2YW. (0895) 58111.

From £1,600 to £12,000.

EACA

Genie I: Z-80, 16K RAM expandable to 48K, Basic in 13.5K ROM. Displays 16 lines of 64 characters on domestic TV. Integral QWERTY keyboard and cassette drive. Optional 5.25in. floppies. Runs Tandy Level I software, TRS-DOS, Newdos 80, LDOS, Smalldos, etc. Reviewed February 1980.

£299.

Genie II: Similar to Genie I but runs Tandy Level II software and has QWERTY keyboard with numeric keypad. *£299.*

Genie III: Z-80A, 64K to 256K RAM, 2K ROM. 24 lines of 80 characters, high-resolution graphics. Detachable QWERTY keyboard with numeric keypad. Dual 5.25in. floppies totalling 740K, optional 5Mbyte hard disc. RS-232 and parallel interfaces. Newdos 80 or CP/M 2.2, Basic, usual CP/M languages available. *£1,699.*
Lowe Electronics Ltd, Chesterfield Road, Matlock, Derbyshire DE4 5LE. (0629) 4995.

EQUINOX

200: Z-80, 64-512 RAM, S-100 bus, CP/M, Omnix, MicroCobol, MVT FAMOS, cartridge disc, six serial and one parallel port, business use. *From £7,500.*

300: WD-16, 64-256K RAM, S-100 bus, CP/M, Omnix, MicroCobol, MVT FAMOS, cartridge disc drive, six serial ports, business use. *From £10,500.*
Equinox, 16 Anning Street, New Inn Yard, London EC2A 3HB. (01) 729 4460/(01) 739 2387.

EUROCALC

Euroc: 8080, 64K RAM, 8in. discs, 15in. VDU, CP/M, business use. *From £8,000.*
Eurocalc, 55/56 High Holborn, London WC1. (01) 405 3113.

EXIDY

Sorcerer: Z-80, 48-55K RAM, S-100, RS-232, CP/M, 5.25in. discs, MBasic, CBasic, Pascal, Algol, Fortran, Cobol, plug-in ROM pack programs, Separate VDU. Liveport, The Ivory Works, St. Ives, Cornwall TR26 2HF. (0736) 798157. Reviewed May 1979. *From £749.*

GRUNDY

Newbrain Model A: Z-80A, 32K RAM expandable to 512K. Dual RS-232 and dual cassette interfaces, video and TV ports. 30-line by 80-characters display, high-resolution graphics. Expansion port, optional battery pack, discs announced. Basic. Other software available in ROM packs. *£199.*

Newbrain Model AD: As model A, with integral single-line 16-character display. *£229.*
Grundy Business Systems Ltd., Science Park, Milton Road, Cambridge CB4 4BH. (0223) 350355.

HAYWOOD

System 1000-8000: Z-80, 32-65K RAM, 6000 is S-100, 3000 single-board, CP/M graphics, 5.25in. discs, three serial and parallel ports. Business, scientific and general use. Haywood Electronics Assoc., Electron House, Leeway Close, Hatch End, Pinner, Middlesex HA5 4SE. (01) 428 0111. *From £2,359.*

HEWART

6800Mk II: 6800 single-board, 1K monitor, 1K user RAM, 1K VDU RAM, 128byte scratchpad, education and home user. S-50 bus. *From £155.*

6800S: 6800, 16K monitor, 8K Basic in ROM, graphics, 5.25in. drive. *From £229.*
Hewart, 95 Blakelow Road, Macclesfield, Cheshire. (0625) 22030.

HEWLETT-PACKARD

85A: 16-32K RAM, 32K ROM, IEEE-488, RS-232, graphics, 5.25in. drives, integral 32-by-16 VDU, integral thermal printer, QWERTY and numeric keypad. Scientific use. *From £1,917.*

HP-83: Similar to HP-85 but without integral printer or tape cassette drive. Reviewed April 1982. — *From £1,486.*

HP-87A: HP custom CPU, 32K-544K, M, 48K ROM, 4,320-character screen graphics, full QWERTY keyboard. RS-232, HP-1L, parallel eight- and 16-bit interfaces and GPIB. 5.25in. dual floppy, 540K; optional 5Mbyte Winchester with floppy backup. Some HP calculators can be connected through the HP-1L interface. HP operating system, CP/M optional. Basic, assembler, etc. Scientific, engineering and business use. — *From £1,783 £3,357 for dual-floppy system.*

HP-125: Two Z-80s, 64K RAM plus separate 10K display RAM, 32K ROM. 80-by-24 character integral screen, detachable QWERTY keyboard. RS-232 and GPIB interfaces. Integral thermal printer. 5.25in. dual floppies, optional 8in. floppies and hard disc. CP/M, Basic and other CP/M languages available. Professional and business use. Hewlett-Packard, King Street Lane, Winnersh, Wokingham, Berkshire. (0734) 784774. — *£3,418 with dual 5.25in. floppies.*

HYTEC MICROSYSTEMS

H-4500 range: Z-80A, 80K RAM. Integral 80-by-24 character screen, detachable QWERTY keyboard with numeric keypad. Integral dual-floppy drives, 1Mbyte or 2Mbyte, or optional 5Mbyte or 12Mbyte hard disc replacing one of the floppies. CP/M, Basic, etc. Use as stand-alone microcomputer or to emulate terminal connected to large computer. Aimed at users of ICL or Honeywell mainframes. Hytec Microsystems Ltd, 9 West Way, Oxford OX2 0JB. (0865) 726644. — *£3,750 for 1Mbyte floppy-based system £5,950 with 5Mbyte hard disc*

H-5000: Hytec's multi-user system, using hard disc and network controller to link several H-4500s or H-4000s, disc-less variant. — *£3,500 for hard disc and controller only*

INDUSTRIAL MICROSYSTEMS

Series 5000: Z-80, 16-56K RAM, CP/M, S-100, two or three 5¼in. discs, two serial and one parallel port, desk unit, business and general use. — *From £1,500*

Series 8000: Z-80, 64-256K RAM, S-100, CP/M, MicroCobol, MVT FAMOS, Omnix, two, three or four 8in. disc drives, two serial and one parallel port, desk unit, business and general use. Equinox, 16 Anning Street, New Inn Yard, London EC2A 3HB. (01) 739 2387/(01) 729 4460. — *From £2,500*

INTERNATIONAL BUSINESS MACHINES

IBM Personal Computer: 8088 16-bit CPU, 64-256K RAM, 4K or 16K video RAM, 40K ROM. Uses IBM monitor or domestic TV to display 25 by 80 characters, 640-by-200 monochrome high-resolution graphics or 320-by-200 colour graphics. Detachable QWERTY keyboard with 10 function keys and numeric keypad. RS-232 and parallel interfaces, five expansion slots. Integral dual 5.25in. floppy discs, 160K each, 5Mbyte up to 120Mbyte hard-disc options. CP/M 86 or IBM's MDOS, Basic and other languages. KGB Micros, 14 Windsor Road, Slough, Berkshire. (0753) 38581. Microcomputerland, 172 Tottenham Court Road, London W1. (01) 637 4071. — *From £2,800*

INTERTEC

Superbrain II: Z-80A, 64K RAM, second Z-80A to handle I/O. Two RS-232 interfaces and battery-operated clock fitted, IEEE-488 and S-100 connector are options. Integral 80-by-24 screen, optional high-resolution graphics, integral QWERTY keyboard with numeric keypad. Built-in dual 5.25in. floppies in 320K to 1.5Mbyte options; 10Mbyte to 96Mbyte hard-disc options. CP/M. Basic, APL, Cobol, Fortran, etc. Business, professional and educational use. Reviewed September 1982. — *From £1,550 for 350K floppy based system*

Compustar: Multi-user system consisting of network of Superbrain-like terminals linked in daisy-chain fashion to a hard disc and controller. Each terminal has Z-80 and 64K RAM and can run CP/M. Four types of terminal, VPU 15, 20, 30 and 40, give a wide range of options.

Encotel, Succombs Hill, Upper Warlington, Surrey. (01) 820 5701. GST (0954) 81991. Icarus Computer Systems Ltd, 27 Greenwood Place, London NW5 1NN. (01) 485 5574.
KGB Micros Ltd, 14 Windsor Road, Slough, Berkshire. (0753) 38581.
Sun, 138 Chalmers Way, North Feltham Trading Estate, North Feltham, Middlesex (01) 751 6695.

From £4,500 for two terminals plus 10Mbyte hard disc £1,200 for each additional terminal

ITHACA INTERSYSTEMS

Pascal Micro DPSI: Z-80, 64K-1MB RAM, full IEEE S-100 bus, CP/M version 2.2, graphics, 8in. and hard discs, RS232, four parallel and two serial ports per S-100 board. Ithaca Intersystems, 58 Crouch Hall Road, London N8 8HG. (01) 341 2447.

From £4,258

JAROGATE

MP5: Multi-user system. Each user has own Z-80B + 64K RAM and also own S100 bus for add-on boards, under control of further Z80B on master board. One RS 232 and IEEE standard for each user. Any terminal, add-on graphics boards. Integral dual 5.25in. floppies, 780K, optional 12Mbyte hard disc. MP/M, CP/NOS, CP/M, Basic, Fortran, Pascal, Cobol, C, etc. available. Business, word processing, or scientific use. Jarogate Ltd, 197-213, Lyham Road, London SW2 5PY. 01-671 6321.

From £1,995 Typical three-user system with hard disc £7,465

KEMITRON ELECTRONICS

K-3000: Z-80A, 64-256K RAM, own bus. Two RS-232 interfaces fitted, IEEE-488, parallel, D-A, A-D and wide range of specialised interface boards available as options. Any terminal. Integral dual 8in. floppy drives 2Mbyte, or 10Mbyte hard-disc option. CP/M or MP/M. Basic, Fortran, etc. Aimed at scientific, industrial or educational user.

£3,300 for 2Mbyte floppy-based system £6,050 with hard disc plus floppy

K-2000: Z-80A, 16-64K RAM. Smaller version of K-3000 built around 5.25in. floppy drives. Two RS-232 interfaces, has eight free slots for specialised interface boards. Kemitron Electronics Ltd, 21-23 Charles Street, Heole, Chester, CH2 3AY. (0244) 21817.

£2,300 for single disc, counter/timer, parallel IO, ADM-5 VDU

KONTRON

PSI-80: Z-80A, 64K RAM, 16K video RAM, 16K ROM, ECB bus. Integral 9in. screen of 80 by 24 characters, QWERTY keyboard. RS-232 interface, Integral 5Mbyte hard disc plus one 5.25in. 300K floppy, KOS, a CP-M compatible operating system, Basic, Pascal, Fortran, Cobol available. Business use. reviewed March 1982.

£6,660 for hard-disc based system

Kobus: Multi-user network system for PSI-80s, Kontron, PO Box 88, Kontron House, Campfield Road, St Albans, Hertfordshire AL1 5JG (0727) 66222.

LSI COMPUTERS

M-One: 8080, 8-16K RAM, own OS, dual Shugart 8in. drives, two serial and one parallel port, 12in. VDU and full keyboard. Business use.

From £5,995 with software package

M-Two: 8085, 64K RAM and 4K EPROM. Launched in December 1980. LSI Computers, Copse Road, St. Johns, Woking, Surrey GU21 1SX. (04862) 23411. — *P.O.A.*

MICRO V

Microstar: 8085, 64K RAM, three RS-232, serial inputs, StarDOS, twin 8in. drives, general use. Data Efficiency Ltd., Maxted Road, Maylands Avenue, Hemel Hempstead, Hertfordshire. (0442) 63561. — *From £4,950*

MICROMATION

Mariner: Multi-user system based on M/Net. Each user has own Z-80 + 64K RAM under control of further Z-80 or master board. S-100 bus, RS-232 interface, maximum 16; parallel interface, maximum eight; tape streamer. Any terminal. Integral 8in. floppy drive 1Mbyte, up to 80Mbyte hard disc. MP/M, CP/M or DBOS, with ISAM support. Business or Scientific user. Rostronics, 115-117 Wandsworth High Street, London SW18 4HY. (01) 874 1171. — *From £3,950*

MICROSOLUTION

British Genius range: Z-80, 64K RAM, CP/M, Basic, BCPL, Fortran, Cis-Cobol, dual 5.25in. or 8in. discs or hard disc. RS-232 and Centronics interface, separate keyboard, 24-x-80-character screen. MicroSolution Ltd., Park Farm House, Heythorp, Chipping Norton, Oxfordshire OX7 5TW. (0608) 3256. — *From £2,850 to £7,000*

MIDWICH

MC: Z-80, 16K RAM, 12K ROM. Domestic TV or monitor used to display 40 by 24 characters, 60-by-80 low-resolution graphics. QWERTY keyboard. RS-232 and cassette interfaces, range of optional boards for specialised control applications; D-A, A-D, etc. Own operating system, Basic. No discs yet, uses cassette. Aimed at educational and laboratory users. Midwich Computer Co., Hewitt House, Northgate Street, Bury St. Edmunds, Suffolk IP33 1HQ. (0284) 701321. — *From £345*

MILLBANK

Millbank System 10: Z-80A, 64K. Integral 12in. screen 24 characters by 80. Full keyboard with numeric keypad and function keys. Two RS-232 interfaces and an RS-449 network interface; optional IEEE-488 instrument interface. Integral 5.25in. twin floppy disc drives, 700K. Option of 1.6Mbyte floppies or 5Mbyte, 10Mbyte or 5+10Mbyte hard-disc units. CP/M. Business use as stand-alone machine, or as front-end pre-processor connected to mainframe. Reviewed December 1980. Millbank Computers Ltd, Millbank House, Amyand Park Road, Twickenham, Middlesex TW1 3HN. (01) 891 4691. — *From £2,995 to £4,775*

MITREFINCH

MF-3000: Multi-user system, from one to 32 users, 16-bit CPU, 64K to 1.25MByte RAM. Cartridge hard-disc unit, 5Mbyte+5Mbyte removable, with 20 to 400Mbyte hard-disc options. Business use. Mitrefinch Ltd, Tower House, Fishergate, York YO1 4KA. (0904) 52995. — *From £8,500*

NASCOM

Nascom 1: Z-80, 2-64K RAM, serial and up to 16 parallel ports, 8K Microsoft Basic, 1K monitor in EPROM. Personal use. Reviewed January 1979. — *From £125*

Nascom 2: Z-80, 1K RAM expandable to 256 with Nascom System 80 case. Nasbus, 8K Basic, 2K monitor and 2K character generator, low/high resolution graphics and colour. 5¼in. single or twin floppy discs, RS-232, parallel port, Kansas City cassette port. — *From £295*

Nascom 3: Z-80, 48K RAM, Basic. Displays 16 lines of 48 characters on domestic TV or monitor, 96-by-48 point graphics. QWERTY keyboard, cassette interface, RS-232 and parallel ports. Optional dual 5.25in. floppy drives totalling 700K available, running NAS-DOS or CP/M. Optional memory extension and I/O boards.
Lucas Logic Ltd., Nascom Division, Welton Road, Wedgenock Industrial Estate, Warwick CV34 5PZ. (0926) 497733. — *£549 with 48K RAM £1,282 with dual floppies*

NORTH STAR

Advantage: Z-80A plus 8035, 64K RAM with 20K display RAM, twin 5.25in. discs, 12in. screen, 24 x 80 characters, 240 x 640 pixels, 87-key keyboard, graphics CP/M or graphics Basic/DOS, provided with Busigraph, diagnostic and graphics demo software. Reviewed June 1982. — *From £2,195*

Horizon: Z-80A, 16-56K RAM, 5¼in. twin drives, S-100 bus, own OS, business, educational or scientific use. Comart, PO Box 2, St Neots, Huntingdon, Cambridgeshire PE19 4NY. (0480) 215005. Equinox, Kleeman House, 16 Anning Street, New Inn Yard, London EC2A 3HB. (01) 729 4460. Reviewed April 1979. — From £395 to £2,500

OHIO SCIENTIFIC

Ohio Superboard and Challenger 1: 6502, 8K Basic in ROM, 2K monitor, 4K RAM, full keyboard and VDU interface. Hobbyist use. Reviewed June 1979. — *From £160*

Challenger 2: 6502, 48K RAM, dual 8in. drives, serial port, low-cost business use. — *From £1,500*

Challenger 3: 6502, Z-80 and 6800, 48-56K RAM, OSI 48-pin bus, serial port for VDU, CP/M, expands to eight users, 10, 20 and 75MB hard disc, business use. — *From £2,300*

Challenger 4: Similar to Challenger 1 but 64 by 32 display, colour and sound option.
CTS (0706) 79332. Reviewed September 1979. Mutek, Quarry Hill, Bath, Wiltshire. (0225) 743289. — *From £450*

OKI

Oki IF-800: Z-80A, 64-256K RAM, 16K or 48K video RAM, 2K ROM. Integral 24-by-80 character screen with 640-by-200 point eight-colour high-resolution graphics. Integral QWERTY keyboard with function keys. Numeric keypad. Built-in printer, speaker, clock. RS-232 and three slots for OKI boards — IEEE, A-D, etc. Dual 5.25in. floppies, 560K. 10Mbyte hard-disc option. OKI operating system. Basic or CP/M. Business or laboratory use. Reviewed April 1982. LSI Computers Ltd, Copse Road, St John's Woking, Surrey. (04862) 23411. — *£4,300 for system with dual floppies, VDU and printer*

OSBORNE

Osborne 1: Z-80A CPU, 64K RAM plus system software held in ROM in separate address space. Twin 5.25in. floppy-disc drives, 200Kbyte, integral 5in. screen displaying 24 by 52 characters at a time, full keyboard and numeric keypad, IEEE-488 and RS-232 interfaces. Portable; above configuration weighs 24lb. CP/M, with MBasic, CBasic, WordStar, Mailmerge and SuperCalc included in the price of £1,250. Reviewed February 1982. Osborne Computer Corporation (UK) Ltd, 38 Tanners Drive, Blakelands North, Milton Keynes, Buckinghamshire MK14 5BW. (0908) 615274. — *£1,250*

PANASONIC

Panasonic: 8085, 56K RAM, full keyboard, integral 24 by 80 VDU, integral twin 5¼ or 8in. floppy drives. Three RS232, business use. Panasonic Business Systems, 9 Connaught Street, London W2. (01) 261 3121. Reviewed June 1979. — *From £4,150*

PEARCOM

Pearcom: 6502 CPU, 32K RAM expandable to 96K. An Apple II plug-compatible machine with 14 expansion slots, as against the Apple's eight, six free EPROM sockets and optional EPROM programmer. Should take all Apple add-ons and software. Other differences in specification are keyboard, with numeric keypad and seven function keys, colour UHF output fitted as standard, monochrome video output with improved 16-level grey scale, and sound going to TV as well as built-in speaker. Aimed at sophisticated Apple users who need the greater expandability. Reviewed June 1982. Pearcom Ltd, Riverside Lane, Stanstead Abbots, Ware, Hertfordshire SG12 8AP. — *£875*

PERFORMANCE BUSINESS MACHINES

PBM-1000: Z-80A, 80K RAM to 336K RAM by bank switching. RS-232 and parallel interfaces, separate terminal. Integral 5.25in. 300K floppy and 5Mbyte hard disc; optional 10Mbyte hard disc. CP/M, Basic etc. MNet for multi-user capacity. Word processing and general business use. Reviewed May 1982. Terodec Ltd, Unit 58, Suttons Park Avenue, Earley, Reading, Berkshire RG6 1AZ. (0734) 664343. — *£4,200 for single-user system with hard disc, floppy and terminal.*

POSITRON COMPUTERS

Positron 900: MC 6809, 64-512K RAM, 36K ROM. Separate VDU. Four RS-232 and one IEEE-488 interface, cassette interface. Dual 5.25in. 100K floppy-disc unit, optional 800K floppy unit, optional 5Mbyte hard disc. ROM contains OS-9 and Basic 09, a Unix look-alike. Pascal, Cis-Cobol, Fortran, C and assembler available. Business and scientific use. — *£8,000 for four users, printer and hard disc.*

Positron 9000: Similar multi-user Unix look-alike system, but with colour and teletext capabilities and integral keyboard. Uses standard TV to display 40 by 24 viewdata-compatible characters in 7 colours, 240-by-250 point four colour graphics. Full QWERTY keyboard with numeric keypad, 12 function keys and Prestel keypad. Integral Modem and Prestel interface. Positron Computers Ltd, Unit 16, Deacon Trading Estate, Newton-le-Willows, Lancashire WA12 9XQ. (09252) 28828. — *£2,870 single user, floppies, printer*

RAIR

Black Box: 8085A, 64-512K RAM, mini-floppy discs, up to sixteen RS232C serial ports, 5MB and 10MB hard discs, IEEE 488 interface, CP/M and MP/M, general and business use. Rair, Wellington House, 6-9 Upper St. Martins Lane, London WC2H 9EQ. (01) 836 6921. Reviewed November 1979 and August 1980. — *From £2,250*

RESEARCH MACHINES

380-Z: Z-80A, 32-56K RAM, serial and parallel I/O, 24 by 80 and 24 by 40 VDU interface, separate keyboard, CP/M, twin 5.25in. or 8in. discs. Optional high-resolution colour graphics, IEEE-488, analogue I-O, 48- and 32-line parallel, local network interface. Scientific, colleges, secondary education. Reviewed December 1978. — *£1,600 to £3,500+*

480-Z: Z-80A, 32-256K RAM network machine two serial, one parallel, joystick interface, analogue output, 24 by 40 and 24 by 80 VDU output, TV output, TTL RGB colour monitor output, 1,200/300 bps cassette interface, sound. Optional Basic in ROM, high-resolution colour graphics, IEEE-488, local network transceiver, hardware floating point. Research Machines, Mill Street, Oxford OX2 0BW. (0865) 49866. — *£550-£1,273*

280-Z: Board version of 380-Z. Research Machines, PO Box 75, Mill Street, Oxford. (0865) 49791. — *From £722 for 4K version*

ROCKWELL

Aim-65: 6502, 1-4K RAM, full keyboard, RS232, discs, hobby use. Portable Microsystems, Forby House, 18 Market Place, Brackley, Northamptonshire NN13 5SF. (0280) 702017. Reviewed July 1979. — *From £250*

SD SYSTEMS

SD-100/200: Z-80, 64-265K RAM, 8K PROM, S-100 bus, RS232, CP/M 12in VDU, twin 8in. drives, business, industrial and general use. — *From £3,750*

MS-610: Z-80A, 64-265K RAM, S-100 bus, CP/M or MP/MII, twin 8in. floppy drives, 1.2Mbytes; optically up to 100Mbyte hard disc, any VDU. Circle Computer Sales Ltd, Unit 12, Woking Business Park, Albert Drive, Woking, Surrey GU21 5JY. (04862) 26881. — *From £5,000 to £7,500*

SEED

System One: 6800, 22-56K RAM, 4K ROM, SS-50C bus. Separate VDU, 80 by 24 characters, optional 512-by-512 point graphics. RS232 fitted, range of optional I/O boards, 5.25in, or 8in. floppy drives. Operating system is SSB DOS 68 or TSC Flex. Basic, assembler, educational, industrial, government or business use. — *From £2,600 with terminal and floppies*

System 19: Multi-user system, one to 16 users. 6809 16-bit CPU, 48K to 1Mbyte RAM, 8D ROM, SS-50C bus, RS-232 interface, separate VDU. 5.25in. or 8in floppies, up to 40Mbyte hard disc. Operating system is OS-9 or SSB DOS 69. Basic, Pascal, Cis-Cobol and C available. Educational, industrial, government or business use. ????tech Engineering Electronics Developments Ltd, Portland House, Coppice Side, Brownhills, Walsall, West Midlands WS8 7EX. (0543) 378151. — *From £2,800 for single-user floppy-based system with terminal*

SHARP ELECTRONICS

MZ-80K: Z-80, 16-48K RAM, 10in. integral VDU, integral cassette, loudspeaker, 5¼in. disc optional, general use. — *From £315*

MZ-80A: Z-80A, 48K RAM and 2K video RAM. Integral 9in. green screen displaying 25 lines by 40 characters including graphic characters. QWERTY keyboard generating full ASCII upper- and lower-case set, numeric keypad. Built-in cassette drive, clock and three-octave sound generation. Optional dual 5.25in. 560K floppy unit. — *£449*

PC-1211: Pocket computer. Programmable in Basic with cassette interface. Sharp Electronics, Sharp House, Thorp Road, Newton Heath, Manchester M10 9BE. (061) 205 2333. Reviewed July 1980. — *From £85*

PC-1500: Pocket computer based around CMOS eight-bit CPU. 3.5K RAM, 2.6K available to user, optional 4K RAM plug-in expansion. Basic in 16K ROM. Integral 26-character one-line LCD display with 7-by-156 dot graphics, upper- and lower-case characters. 65 calculator-style keys — alphabet, numbers, arithmetic functions and user-programmable function keys. Additional printer and cassette storage interface unit. Printer uses four-colour pens under program control and prints on to 1.75in. wide white paper rolls; can plot colour graphs. Business, engineering and home use. Reviewed August 1982. — *£180, optional printer £150*

PC 3201: Z-80, attractive package for business use with separate keyboard and computer unit, printer, display and twin 5¼in. drives. Optional 8in. floppy unit, capacity 2Mbyte. CP/M. — *From £2,995*

SINCLAIR RESEARCH

ZX81: Z-80A, 1-16K RAM, 8K Basic in ROM, cassette and TV interface, thermal printer at £60, touch-sensitive keyboard, education and games use. Animated-display facility. Two modes, fast with screen blinking, slow without. Review June 1981. — *£50*

ZX Spectrum: Z-80A, 16-48K RAM, 16K ROM. Uses domestic TV for 24-by-32 character display of 256-by-192 high-resolution eight-colour graphics. QWERTY layout keyboard with 40 upper/lower case moving keys. 10-octave sound generation, cassette and printer interfaces; optional RS-232 and network interfaces. Discs announced, printer available. Sinclair Basic with graphics commands. Reviewed July 1982. — *From £126 for 16K RAM machine, assembled*

Sinclair Research, 6 Kings Parade, Cambridge CB2 1SN.

SINTROM ELECTRONICS

Perlflex 630/48: Z-80A, 32-48K RAM, S-100, CP/M, twin Micropolis 5¼in. discs, two serial and three parallel ports. — *From £1,995*

Perlflex 1024/64: Z-80, 64K, S-100, CP/M, dual 8in. discs, two serial and three parallel. Sintrom Electroncs, Arkwright Road, Reading, Berkshire RG2 0LS. (0734) 85464. — *From £2,750*

SIRTON COMPUTERS

Midas Range: Z-80, from 8K RAM, S-100 or IEEE bus, CP/M, MP/M, graphics, up to four 5¼in or 8in. drives, hard disc. RS-232, 8-bit parallel, IEEE 488, Sirton Computers, Unit 14, 2[illegible] Willow Lane, Mitcham, Surrey CR4 4NA. (01) 640 6931. — *£785-£2,150*

SMOKE SIGNAL

Chieftain 511-821: 6800/6809, 32-64K RAM, S-50 bus, Flex DOS68/68d/69 dual 5¼in., 8in., dual RS-232, video board, wide range of options, general use. Windrush Micro Designs, Gaymers Way, North Walsham, Norfolk. (069) 245189. — *From £1,807*

SOLID STATE TECHNOLOGY

Athena: 8085, integral dual mini-floppies and mini-cassette, and matrix printer, can be expanded with 10 micros beyond CPU. Memory to 1.2GB. Claims performance similar to DEC PDP-11/34. Butel-Comco, Unit 10, Garrick Industrial Centre, Garrick Road, London NW9 6AQ. 01-202 0262. — *From £3,000*

SORD COMPUTER SYSTEMS

M200 Range: Z-80A, 64K RAM, S-100 bus, Sord OS, graphics, 5¼in., 8in. or hard discs, two RS-232, integral 80×24 VDU, Business use. Exleigh Business Machines Ltd., 11 Market Place, Penzance, Cornwall TR18 2JB. (0736) 66577. — *From £1,850 to £6,950*

M23 Mark III: Z-80A, 128K RAM, two RS-232 interfaces. 12in. green screen, optional colour monitor, 25 lines by 80 characters, character graphics. QWERTY keyboard, numeric keypad, function keys. Sord bus, three expansion slots, dual 5.25in. drives totalling 640K. Sord OS, Basic and Pips spreadsheet/database package included in price. Pascal, Fortran, Cobol, assembler available, CP/M announced. Reviewed July 1982. — *£1,950*

TANDBERG EDUCATIONAL DIVISION

Aecal: Z-80, 4-200K RAM, 10K ROM. Uses standard TV to display 48 by 16 characters or 96 by 48 graphic points. Other graphics options. RS-232 and parallel interfaces. Built around intelligent cassette recorder, can store and retrieve real audio voice and music under program control. Optional 5.25in. 340K floppy. Operating system similar to NASSYS 3. Basic, Pascal, Forth, Comal, Assembler. Aimed at educational and training user. — *Typical price £850*

EC-10: Multi-user system. 8080, 64K RAM, 4K ROM. One integral 80-by-25 character screen, up to seven terminals can be added. Integral keyboard is full ASCII, integral 8in. floppy. Tandberg operating system, but CP/M available. Basic, Assembler, also Cobol, Pascal, etc. available educational use. — *About £3,500 for single-user single-disc system*

Tandberg U.K. Ltd., Revie Estate, Elland Road, Leeds 11, West Yorkshire. (0532) 774844.

TANDY

Model 1: Z-80, 4-48K RAM, RS-232, Level I and Level II Basic in ROM, separate keyboard and 12in. VDU, parallel interface, small business and personal use. Reviewed November 1978. — *From £249*

Model 2: Z-80, 64K RAM, integral 8in. disc, integral 12in. VDU, detachable keyboard, CP/M serial and parallel ports, Level III Basic, business use. Tandy Corporation, Tameway Tower, Bridge Street, Walsall, West Midlands WS1 1LA. (0922) 648181. Reviewed March 1980. — *From £2,699*

Model 3: Z-80, 4-48K RAM, 12in. display, integral unit with slots for two 5¼in. drives, 65-key keyboard, 12-key data pad, printer interface, compatible with Model 1 software. — *From £499*

TANGERINE COMPUTER SYSTEMS

Microtan 65: 6502, 1-48K RAM, Tanbus, IEEE 488, Tanbug in ROM (1K), Pixel graphics, 5¼in. discs, 32I/O lines and three serial ports, from single-board upwards. Tangerine Computer Systems, Forehill, Ely, Cambridgeshire. (0353) 3633. — *From £69*

TECHNALOGICS

TECS: 6800, 56K TAM, Basic and Prestel terminal software, RS232, two cassette ports, two parallel ports, 5¼in. discs. Technalogics, Windmill Works, Station Road, Swinton, Manchester M27 2BU. (061) 793 6323. Reviewed November 1979. — *From £895 for kit*

TELEVIDEO SYSTEMS

Televideo 802 and 802H: Z-80A, 64K RAM, 4K ROM, single-user CP/M system. Monochrome green screen based on top of line Televideo terminal, displaying 25 lines of 80 characters. Detachable keyboard with numeric keypad and 11 function keys. Dual 5.25in. floppies totalling 1Mbyte, or one floppy and a 10Mbyte hard disc. Two RS-232C interfaces and one RS-422 network interface; can be attached to Televideo's larger multi-user systems. CP/M, Basic and all the usual CP/M languages. Reviewed August 1982. Midlectron Ltd., Midlectron House, Nottingham Road, Derby DE5 1JQ. Belper (077 382) 6811. — *£2,400 for floppy-based system, £4,400 with hard disc*

TEXAS INSTRUMENTS

TI-99/4: 990 16-bit, 16K RAM, Basic in 26K ROM, high-resolution, colour graphics, up to three 5¼in. discs, joystick, cassette and other ports, RS232, personal use. Texas Instruments Ltd., Manton Lane, Bedford MK41 7PU. (0234) 67466. Reviewed August 1980. — *From £200*

TRANSAM COMPONENTS

Triton: 8080, 32K RAM, CP/M, 1K TB10S in ROM, up to three 5¼in. discs, or four 8in., serial and parallel ports. Reviewed December 1979. — *From £296*

Tuscan: Z-80, 8-64K RAM, S-100 bus, CP/M, RS232, TV and cassette interface, from single-board, personal use to full business system. Transam, 59 Theobalds Road, London WC1. (01) 405 5240. — *From £150*

TRANSDATA LIMITED

Cx502: Z-80A, 64K RAM, CP/M, MicroCobol, 8in. floppy discs, four V24/RS232 interfaces, "flexibus" multi processor architecture. Professional business and scientific use. Communications software available. — *From £2,795*

SHOPWINDOW

MICRO ADS

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Please make cheques payable to Practical Computing and send to Room L310, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.

MZ-80K 48K. Mailing system. Prints addresses on adhesive labels. Ideal for clubs. Cassette £13. Details: S.a.e. R. G. Anthony, 24 The Chase, Sinfin, Derby DE2 9PD.

CASIO FX702 newsletter, £6.50 per year. Issue 1 free. R. Cooper, 11 Braintree Road, Dunmow, Essex.

SPECTRUM BUSINESS SOFTWARE. Matrix Planner, the popular on-screen business planning and modelling system (similar to VisiCalc), is now available for the 48K Spectrum. Includes powerful replicate and print commands. Ideal for home and small business financial planning, forecasting and 'what-if' analysis. £8 from Graham Asher, 60 Maryland Road, Wood Green, London N22 5AN. Price includes cassette and full instructions.

PET 4032 £495. 4022 printer £295. Both perfect condition, hardly used, complete with manuals and cables. Tel: 061 904 9901.

PET 2001. 8K. Small keyboard, integral cassette, programs, visible music monitor. As new. Cost £570, accept £300. Tel: 027 581 3928.

PET 4032. Fatscreen, cassette, programs, 10 months old. £545 ono. Bedford (0234) 42460.

VECTOR GRAPHIC 56K S100 Computer, twin 315K floppies; VECTOR MT Terminal; CENTRONICS 779 Printer with tractor feed; ExecuPlan, CP/M, Basic-80, etc. Durable professional machine. £1950 ono. Phone 0266 880740 evenings.

SPECTRUM. No-frills Edit & Assemble, generating Z80 machine code for compact source programs. Cassette £8.60. Details s.a.e. to I. Krishnan, 12 Giles House, 160 Westbourne Grove, London W11 2RJ.

S100 boards as new. S.D. expandoram 2 64K £150. S.D. versafloppy 2 £125. SSM IO4 parallel serial £80. Ithaca Z80 cpu board £65. Mountain hardware 100,000 day clock £125. Micromation f.d.c. £160. Shugart 801R 8" drive £195. Centronics 737 printer £250. Phone 0435 830680

Complete S100 system comprising desk top enclosure with twin y.e. data drives, 1.2 megabytes 64K RAM, CPM 2.2 plus other software £1400. 12" terminal £300. Tel: 0435 830680.

TRS80/VG non-disc users. The ultimate tool kit. 16 utilities including Renumber, Append, Compress, copy program lines, write system tapes, BBC type editing, shift key keyword entry etc. £10 from P. Barsby, Flat A, 20 Lichfield Road, Walsall, W. Mids.

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OSBORNE ONE with all manuals, software (MBASIC, Wordstar, etc). Three months old, save nearly £500 on list price. £960 ono. Upminster 22610 evenings.

URGENTLY REQUIRED. PET 3032 Baseboard with complete circuitry. Tel: (0993) 882924.

Functions (all HGR), Music (create subroutines) and Educational Wizardry — send disc and £6 for copy of 13th level characters. Visidex, £75. Hamsoft, 1532 Stratford Road, Hall Green, Birmingham, B28 9HA.

BBC SOLIHULL SOFTWARE. Dissembler £2.50. Music (tune editor/player) £3.50. Mouse Maze (3-D colour 32K) £3.50, p & p 40p, s.a.e. catalogue. 123 Links Drive, Solihull, B91 2DJ.

EXIDY SORCERER II, 48K, with BMC 12" monitor; BASIC, Word Processor, Development Pacs; lots of software, manuals, and hardware extras. £700 ono for everything, or sell separately. Tel: 031 667 7351.

SUPERBRAIN 64K micros with twin 5¼" floppies and CP/M. Virtually unused machines, surplus to requirements, £1,500 each. Tel: Mr. S. Ganatra, 01-681 1811.

GET RICH with your TRS80 L2 16K pools prediction program. Last season's data included on tape. Fully updatable. Two methods. Greatly increases chances of a win. Cassette only £10. M. Hannaghan, 66 Cleanthus Road, London SE18 3DD.

BBC. Discover MODE 7 Teletext. Learn its colour, graphics and effects. Reference leaflet and program cassette containing instructive, useful and amusing examples. £3.50. Creative Software, 6 Hillside Gate, St. Albans, Hertfordshire AL1 3QM.

APPLE II disc of 12 programs, £12. Includes monster maze (rescue maidens before monster), Ski Run, Graph Trigonometric

VIC 3.5K software dangermaze, Jet-Attack (both partly in m/c) and Lunarpanic. All on one cassette, £4.50. Nev Phillips, 45 Galaxie Road, Cowplain, Hants.

HP-41C as new with all standard manuals and some extra software. Offers to Steve, 01-946 1889.

ASTRONOMY PROGRAMME FOR THE TRS-80. Calculate the positions of the planets, Sun, Moon, Halley's Comet or any Messier Object for any date up to 31/12/1999 from anywhere on Earth. Compute rise & set times of any of these objects in observer's local time. Positions in R.A. & Dec. and Alt., Az. Planetary distance, apparent size, & magnitudes; plus phase & elongation of inner Planets also given. Needs 16K: cassettes £7.00 from B. Sidney, 20 Melling Road, Cramlington, Northumberland NE23 6AP.

WANTED: Sinclair Mk14 or micro development system. M. McAleer, 17 Comprigney Close, Truro. Tel: Truro 75731.

PRINTER LISTINGS for your BBC Model A or B from cassette. 1p per line (min £1.00) plus 25p p & p. Cheque or P/O to D. C. McMillan, 1a Orangefield Drive, Belfast BT5 6DN. Tel: (0232) 652107.

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Cx502-S: Z-80B, 64-160K RAM, CP/M, MP/M, 8in. 2MB floppy discs, four V-24 serial interfaces. Professional and general use. — *From £3,495*

Cx503: Z-80A, 64K-208K RAM, CP/M, MP/M, MicroCobol 20MB Winchester disc, 8in. floppy disc for back-up, four V24 serial interfaces. Business and general use. — *From £6,490*

Cx504: Z-80A, 64K-208K RAM, CP/M, MP/M, MicroCobol 20MB Winchester disc, cartridge tape back-up, 8in. floppy disc, four RS232 interfaces. Business and general use. Transdata Limited, Battlebridge House, 87-95 Tooley Street, London SE1. (01) 403 5115. — *From £7,990*

VECTOR GRAPHIC

Vector Z-80B range: Z-80B, 64-512K RAM, S-100 bus. Any terminal. Dual floppy drives, 5 to 32Mbyte hard-disc options. CP/M and X-CP/M multi-use operating system. Business and scientific use. — *From £2,300*

Vector 4: Twin Z-80 and 16-bit 8088 CPU, 128-256K RAM. S-100 bus, parallel and two RS-232 interfaces. Integral 80 by 24 screen with 640-by-312 point high-resolution graphics, 16 grey scales and RGB colour output to optional monitor. Detachable full QWERTY keyboard with numeric pad and function keys. Integral dual 5.25in. floppy drives 1.2Mbyte or optional 5Mbyte hard disc plus floppy. CP/M, Oasis or MS-DOS. 8088 is used as fast disc controller when running CP/M. Basic, assembler, etc. Almarc Data Systems Ltd, Great Freeman Street, Nottingham NG3 1FR (0602) 52657. — *£2,175 for floppy-based system*; *£3,825 with 5Mbyte hard disc*

WESTERN DIGITAL

Pascal Microengine: Single-board computer based on five-chip set which executes Pascal P-code directly. 128K RAM, two RS-232 and two parallel ports, floppy-disc controller on board. University and military users. — *£1,650*

Supermicro 1600: WD-9000 chip set. Basically boxed-up version of Pascal Microengine. Dual 8in. 1.2Mbyte floppies, two RS-232 and two parallel ports. External VDU. UCSD Pascal operating system, Basic and ADA, MicroAda, available. — *From £4,126*; *£6,130 with VDU and printer*

Modular Microengine: Same WD-9000 chip set as Supermicro 1600; 128K RAM, etc. Based around Sentinel bus rather than single board, so hardware is readily expandable. Dual 8in. Floppies or optional 10Mbyte hard disc. Pronto Electronic Systems, 466-478 Cranbrook Road, Gants Hill, Ilford, Essex IG2 6LE. (01) 554 6222. — *From £5,305 for dual floppy version*; *£7,480 with hard disc*

ZENITH

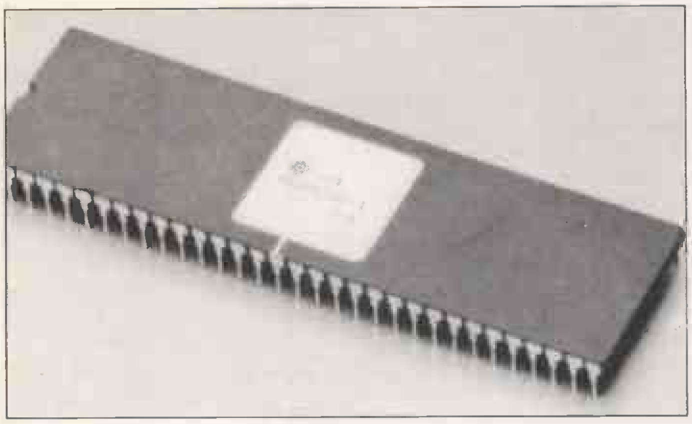
H8: Single-board WH8 assembled, 8080, 16K-65K RAM. Heathbus nine slots, cassette interface, nine-digit LED. — *From £321*

Z89: Z-80, 16-48K RAM, CP/M, integral 5¼in. drive, optional dual external, two RS232, full keyboard, 12in VDU. — *From £1,570*

WH-11A: LSI-II, 16-bit 16-32K RAM, own bus and OS, optional dual 8in. drives, serial and parallel ports. Zenith Ltd., 11b Bristol Road, Gloucester GL2 6EE. (0452) 29451. (01) 636 7349. — *From £1,250*

ZILOG

MCZ Series: Z-80, 64K RAM, RIO OS, Zilog bus, optional graphics, 8in. discs, and hard discs, four RS232, one parallel, stand-alone or networking. Zilog (U.K.) Ltd., Babbage House, King Street, Maidenhead, Berkshire. (0628) 36131. — *From 3,000*



Uncertain on its pins

Boris Allan explains how 16-bit chips manage the flow of data, and the vast address space which is theoretically available to them.

TO A PERSON who is using a 1K ZX-81 the problem above all others is that of memory, or rather lack of memory. Lack of memory was common to all computers not so long ago, and was common to most microcomputers until recently. Now, the user of a 1K ZX-81, 8K Pet, or 2K Atom, is one of the last of an illustrious band of parsimonious programmers, because the main concern for most users is the storage of programs and data on magnetic media, from cassettes to floppy discs to hard discs.

Organising and using information stored on magnetic media has become so important that disc operating systems have become as important as the computers which use them. The popular CP/M, and the increasingly popular Unix, are essentially an environment in which one uses files: not a control program for microcomputers but a control program for disc files. Disc storage, and its control, are so important that new computers, or improvements to older computers, must be able to claim CP/M, Unix, or similar, in their specification.

Whirrs, clunks, and clicks, common to reasonably complex microcomputing systems, are frequent because disc transfers are very important in the running of any serious system. On larger computers this is sometimes so hidden from the user that it is possible to use the computer without any knowledge of what the system is doing with files.

Memory change

A very capacious floppy disc might possibly hold up to 2Mbyte of information, and a hard disc might store up to 160Mbyte or more. A computer based on the Motorola MC-68000, a 16-bit microprocessor, can directly use a memory of 16Mbyte, as 8,000,000 words, with each word being of two bytes. In principle, the MC-68000 can support in main memory as much information as would fill eight of the most capacious floppy discs, or 10 percent of a largish hard disc. The IBM Personal Computer uses floppy discs with a capacity of 160K: the MC-68000 can, therefore, store in main memory as much information as can be stored on 100 IBM floppy discs. The implications are clear, and can be expressed as two theses, where "16-bit" means "16-bit and greater".

THESIS I

When 16-bit microcomputers become established, which is inevitable, the need for conventional control programs will vanish.

THESIS II

There will be a need for data management systems on 16-bit microcomputers, but the nature of such systems will be so different that no present system will be suitable for modification.

The MC-68000 series is possibly the best of current 16-bit microprocessors, and seems the one with the greatest potential.

Bytes and bits

Ordinary eight-bit microprocessors are built around basic elements called bytes, where a byte is a set of eight bits. If eight bits are treated as binary numbers, the value ranges from 0000 0000, which is 0 in decimal, to 1111 1111, which is 255 in decimal. Different eight-bit microprocessors have different modes of organisation, but everything comes down, in the end, to sets of eight bits, which explains why 255 occurs so frequently in many contexts.

All eight-bit microprocessors have an accumulator of eight bits and the accumulator is used for most of the processing of data. The accumulator is a primary storage point for the machine, and it is also the main point at which intermediate results are normally stored. The accumulator is connected to the data bus, which is a set of eight lines or wires able to represent eight bits by being set at different electrical potentials. The data bus connects the accumulator to other parts of the microprocessor by eight pins, one pin for each wire.

There are various other "registers", that is special locations, available to most eight-bit microprocessors, and the registers usually include a processor status register, and index registers. All these registers are of eight bits, that is one byte. On eight-bit microprocessors there is one register, the program counter, which is nearly always of two bytes, 16 bits. If a program is stored in main memory, the program counter points to the next location from which the program has to read an instruction. It is usual to call the obtaining-reading-accessing of the contents of a memory location, "addressing". The addressing is conducted via the address bus which, unlike the data bus, usually has more than eight lines. If the address bus is 16 lines wide it is possible to address, by 16-pin connections to wires, 65,536 memory locations, which is the magical 64K.

If the program counter were only eight bits, even though the address bus had 16 lines, a program could only have 256 steps; but if the address bus had only 12 lines, even though the program counter had 16 bits, it would then only be possible to address a memory of 4K. That the address bus is narrower than the program counter is not rare, because each line or wire on the address bus has to correspond to one pin on the microprocessor chip. There can be physical constraints on the number of pins on a chip and having a narrower address bus is one way of reducing the number of pins one needs.

Sharing buses

A further way of reducing the number of pins is to make the same pin connections do more than one job. It is possible to have the data bus share lines with the address bus, with other pins available to decipher whether it is an address or data being sent. Called multiplexing, this sharing of wires can slow the microprocessor down quite considerably.

On an eight-bit microprocessor the key chunk is the byte, eight bits, but though the Motorola MC-68000 is a 16-bit microprocessor the chunks are not always 16 bits. This microprocessor distinguishes between bytes, which are eight bits, words which are 16 bits, and long words which are 32 bits. All machine instructions are designed to operate on all three types of stored data. The MC-68000 is an implementation of a subset of a complete 68000 architecture, due to the present constraints placed by technology.

All registers on the 68000 are of 32 bits, long words, apart from a 16-bit, or word, status register. There are eight general-

(continued on next page)

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purpose data registers which are available for use by operations on byte, word, or long word, and all data registers can act as an accumulator. The nine general-purpose address registers can act as stack pointers in addition to their eponymous function, and all general-purpose registers can function as index registers. The program counter register is also a long-word, and thus can potentially address 4 gigabyte, which is more than 4,000,000,000 bytes).

Limitations of present technology have meant that only 24 out of the 32 bytes of the program counter are used in the MC-68000. The MC-68000 microprocessor chip uses 64 pins, 32 on each side, to communicate to the outside world, 23 pins are reserved for the address bus, and two pins are for the selection bytes within a word. The 23 pins of the address bus are used to address eight megawords, and if a byte within a word is to be selected, high or low, the appropriate pin is activated, addressing 16Mbyte. Within the MC-68000 chip itself, the address bus is 32 lines, but when the chip has to talk to the world it uses, in effect, 24 lines only.

The data bus is of 16 lines, and 16 pins on the chip, and accesses a word at a time. The internal architecture of the 68000 with its 32-bit long-word registers means that the 68000 can be extended to a 32-bit microprocessor without too many design alterations.

The MC-68000 is a 32-bit microprocessor pretending it is a 16-bit machine as is the National Semiconductor NS-16032, and in this philosophy the MC-68000 and NS-16032 differ from most other 16-bit microprocessors, as most seem based on an eight-bit philosophy. The general registers on the MC-68000 and the NS-16032 are all 32-bit; the general registers on the Intel 8086 and 8088, and the Zilog Z-8001 and Z-8002, are of 16 bits, including address registers.

With an address register of 16 bits you cannot address more than 64K without further complications. In fact, the Z-8002 only addresses 64K, which is no better than most eight-bit processors. The 8086 and 8088 combine a four-bit "segment" address to a 16-bit "offset" address to produce a 20-bit address pointer to one Megabyte. As was noted, the Z-8002 can only address 64K, but the Z-8001 adds seven bits to 16 bits to produce a 23-bit address pointer to 8Mbyte.

That the MC-68000 has totally rejected the eight-bit philosophy is shown by counting the 64 pins on the chip. Eight-bit microprocessors usually have 40 pins, 20 each side, a DIP, Dual In-line Package, and the eight-bit influenced 8086-8088 and Z-8002 also have 40 pins. The more respectable Z-8001, and the better NS-16032, have 48 pins. The MC-68000 has, therefore, 16 pins more than its closest rival: these 16 pins mean an extra 16 connections to the world outside the processor. So what has happened to these 16 connections on the NS-16032, the only other reasonable 16-bit microprocessor?

The answer is multiplexing. On the NS-16032 and 8086, 8088, Z-8001 and Z-8002 the data bus shares pins with the address bus. When a potential is applied to the A-D, Address-Data pins on the NS-16032, another pin, the ADS, ADdress Strobe, informs devices outside that an address is to be selected using the A-D pins. When the address has been selected the ADS changes potential and the processor is ready to send or receive data along lines from the same A-D pins. The NS-16032 is supposed to have a fast processor, but it must be made clear that changing the use of pins from one set of lines to another will take up time. If the program is very memory intensive even a fast processor will have to wait for data to arrive. The 8086, 8088 and Z-8001 and Z-8002 also multiplex the address bus and the data bus, and are reinforced in their inferiority.

The 8086 and 8088, in particular, have been criticised for the poverty of their instruction set, and for the slowness of running. The MC-68000 has a microprogrammed architecture, by which is meant that the basic instruction set of the primitive machine has been amplified by microprogramming to produce more complex instructions. It is simpler to change any bugs, because it is only the microprogram that has to be altered. In more than one sense, programming on the MC-68000 at a low level is still able to use a high level language. The power of the 68000 instruction set is probably greater than any other 16-bit microprocessor. To illustrate, the MC-68000 has 14 operand addressing modes, the 8086 and 8088 have seven modes, the NS-16032 has nine such modes, and the Z-8001 and Z-8002 have 10 modes. To analyse the potential of 16-bit microprocessors using the 8086 and 8088 as examples seems to be rather pointless.

The IBM Personal Computer and the ACT Sirius are 16-bit microcomputers which use the Intel 8088 microprocessor. The 8088 is an eight-bit copy of the 8086 microprocessor, in that the data bus is only eight lines wide on the 8088, whereas the data bus has 16 lines on the 8086. Both the IBM and the ACT machines have been no more successful than ordinary eight-bit machines, because the philosophy behind both machines is still eight-bit.

The Sirius, for example, offers the 8088's maximum of 1Mbyte of memory, 1.2Mbyte floppy discs, and 10Mbyte hard-disc options. Sirius, with its maximum memory, could almost copy all the information on its floppy disc into main memory. Why, then, have complex systems for loading and saving programs on to disc, if it can all be done in main memory?

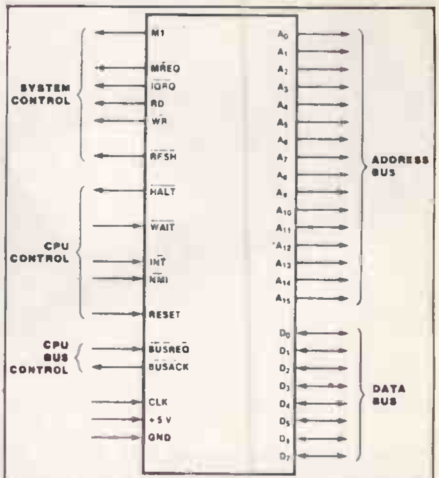


Figure 1. Pin assignments for the Zilog Z-80, an eight-bit chip.

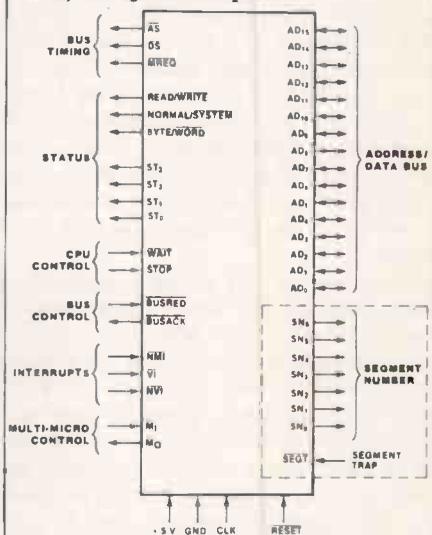
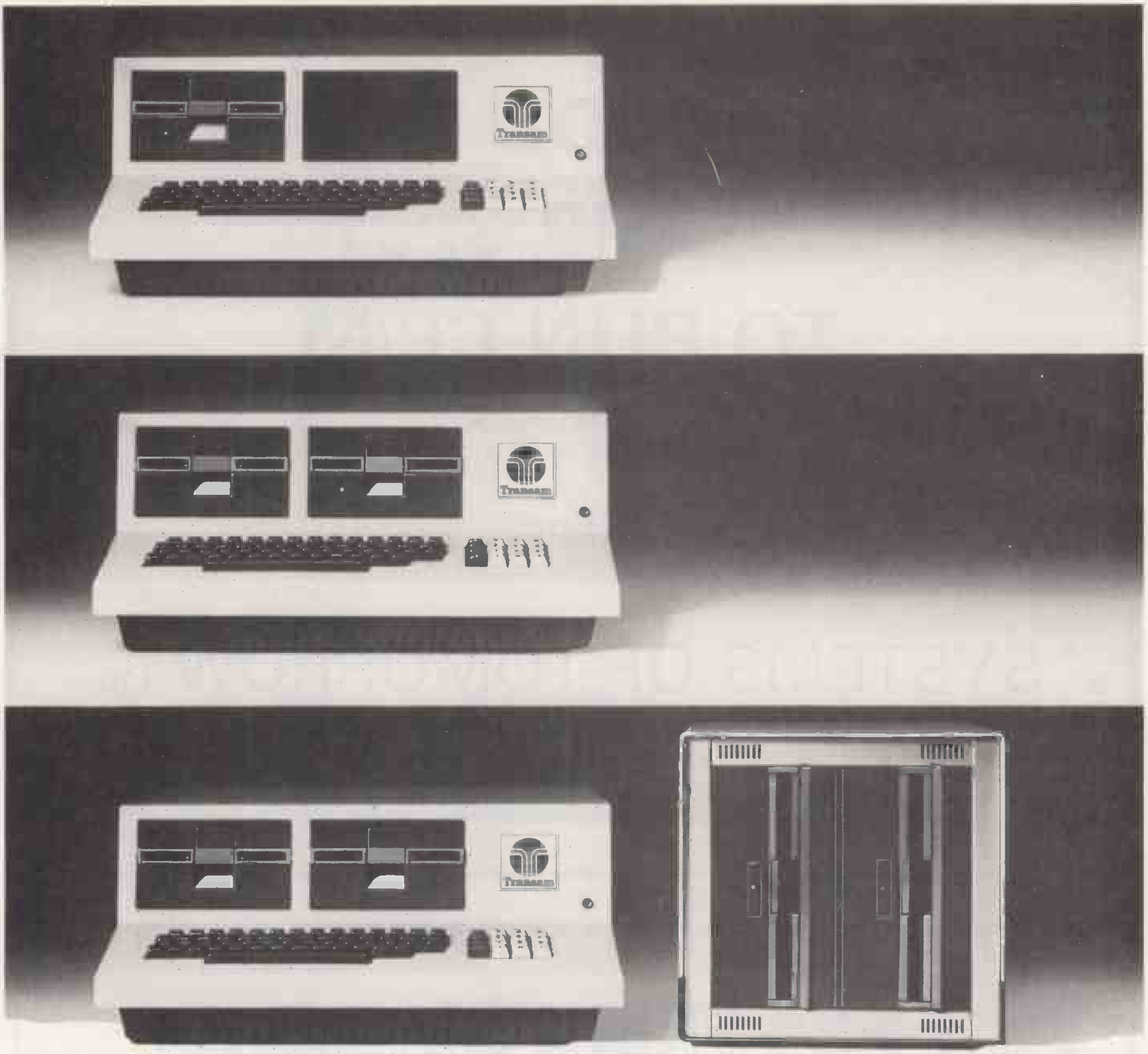


Figure 2. Pin assignment for the 16-bit Zilog Z-8001.

Consider this vision of the future: you have a microcomputer dedicated to your personal use, a computer with as much memory as the largest IBM System 370; and you have a hard disc of the same, or greater, capacity. The session starts by loading all the disc-based information into main memory; you write programs, erase files, give file names, all in memory; occasionally you dump the entire contents of memory onto the disc as a safety measure. You do not need a disc-file control program, you need a control program for memory utilisation. You will not load a file into memory, you load a copy of memory, and on a larger disc there might be more than one memory copy, so there might be a simple program to organise memory copies. The process would be slowed down if the address bus and data bus had to share pins.

That vision perhaps illustrates why the ACT Sirius and the IBM Personal Computer are likely to have as short a life as any ordinary, cheaper, eight-bit microcomputer. Perhaps you can see why control programs for disc files will be pointless on true 16-bit and 32-bit microprocessors; and why floppy discs are out of place with such microprocessors.



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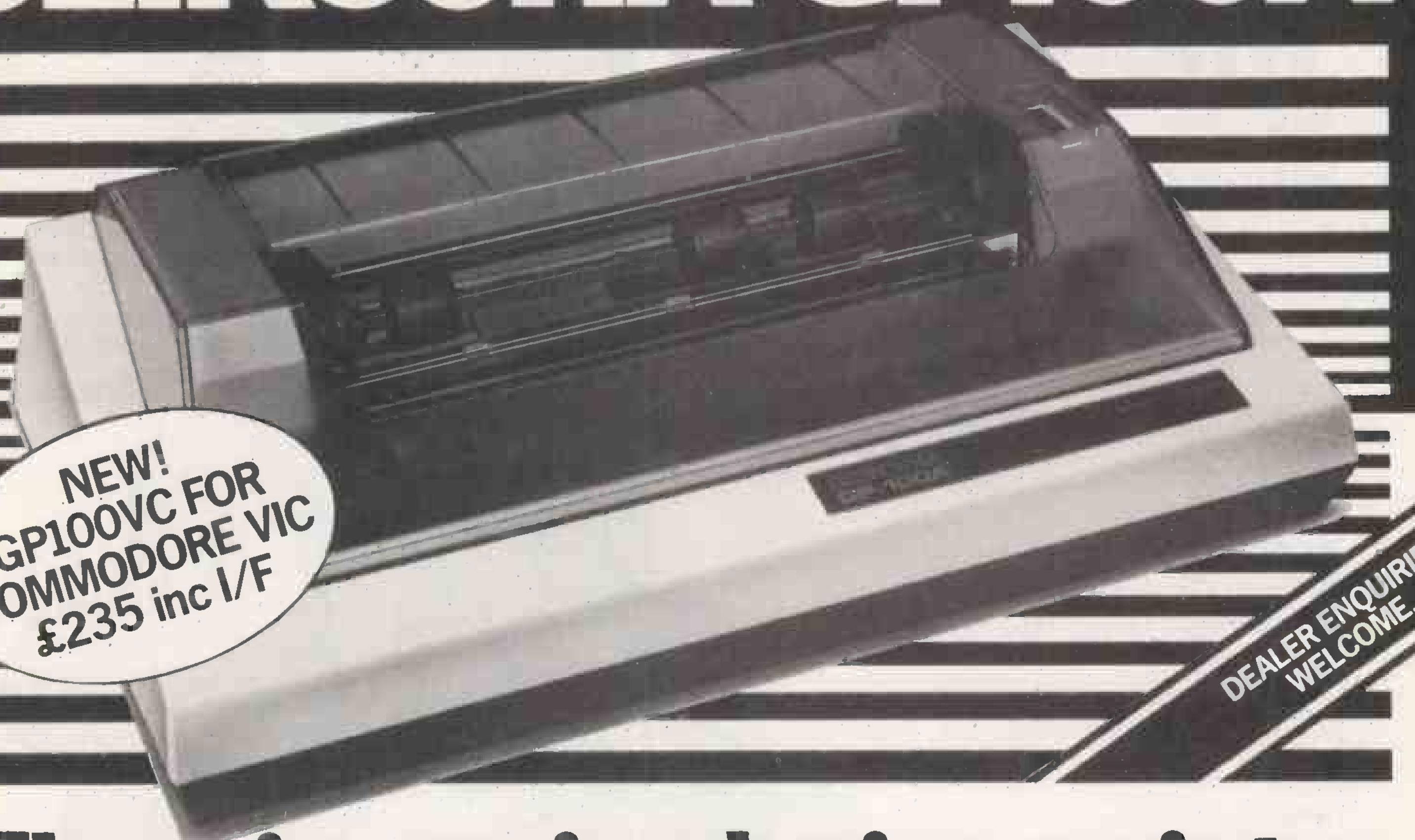

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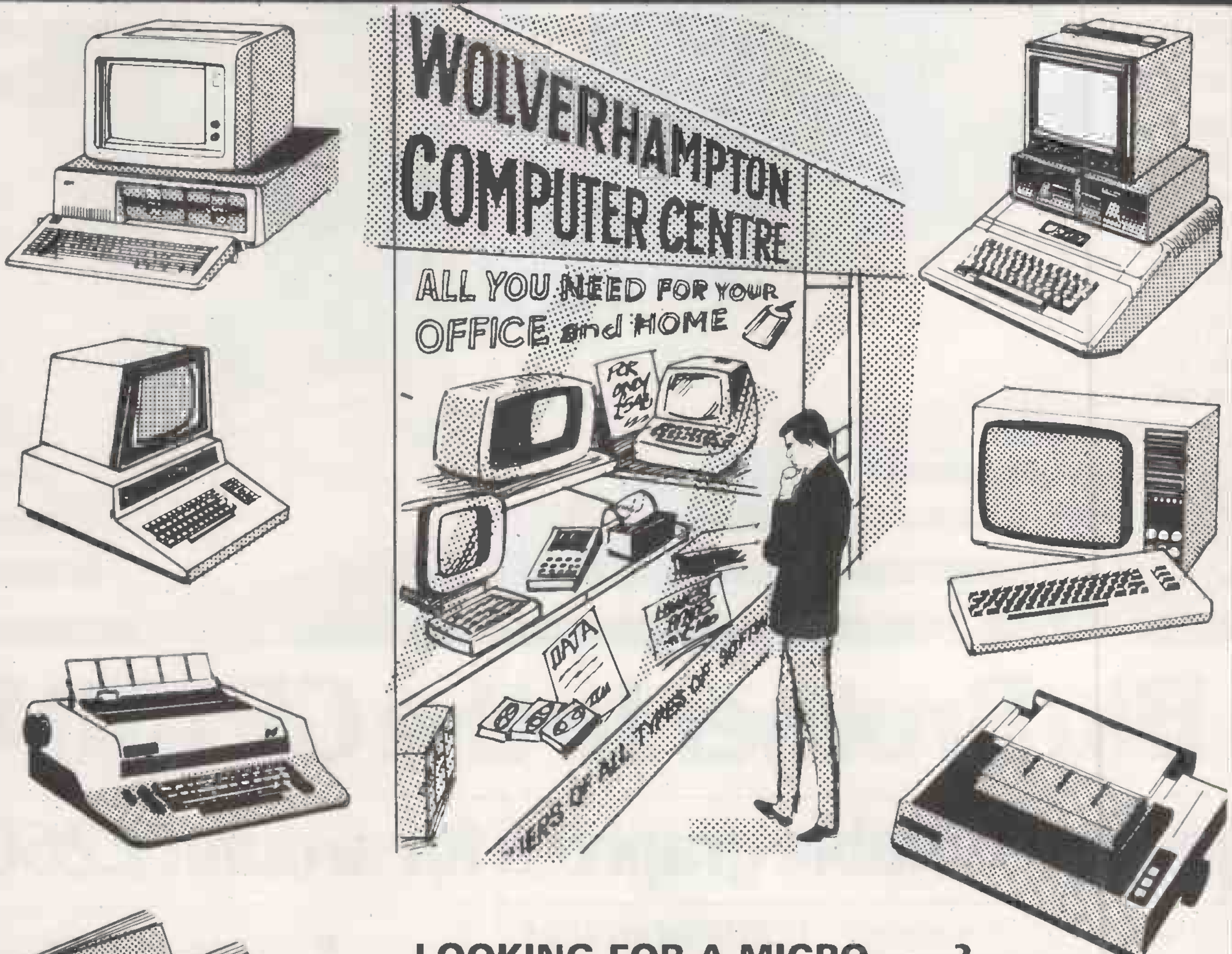

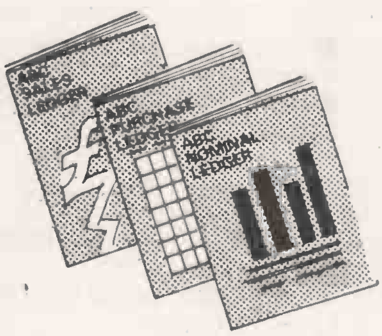

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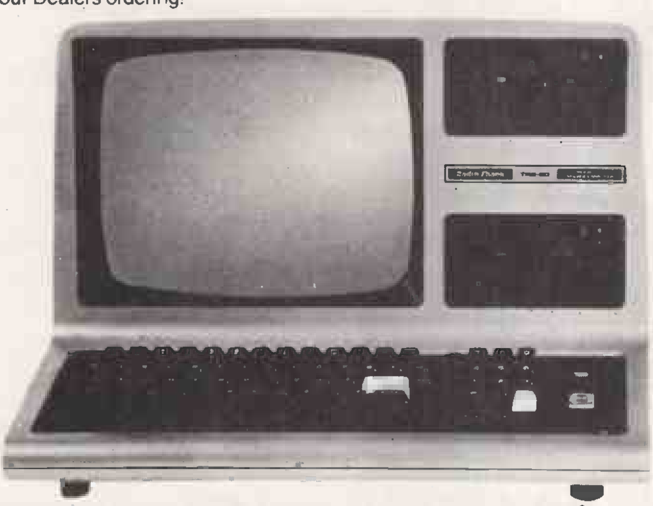

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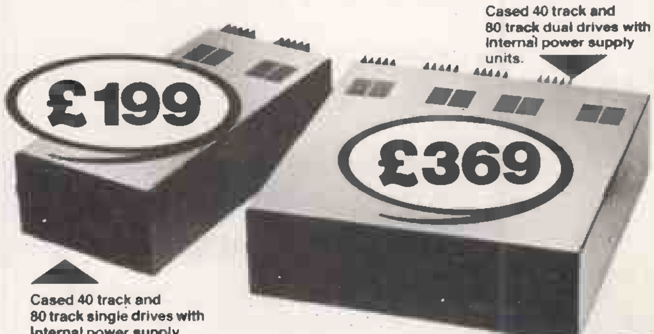

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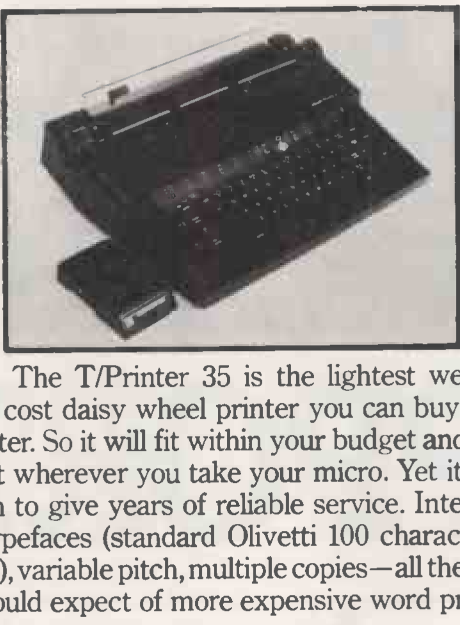

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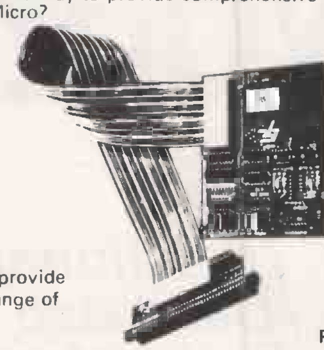

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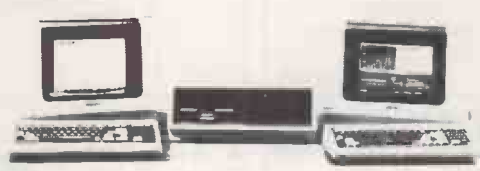

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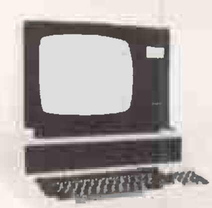

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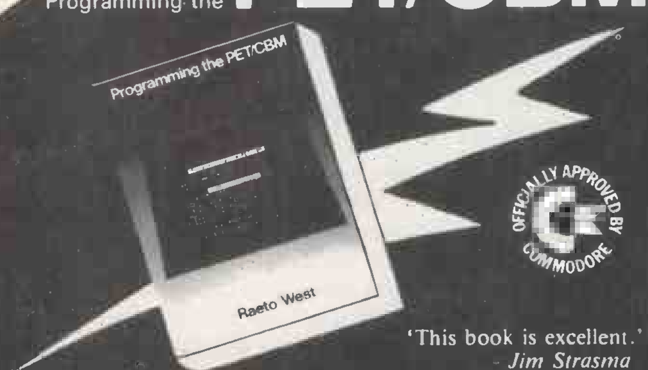

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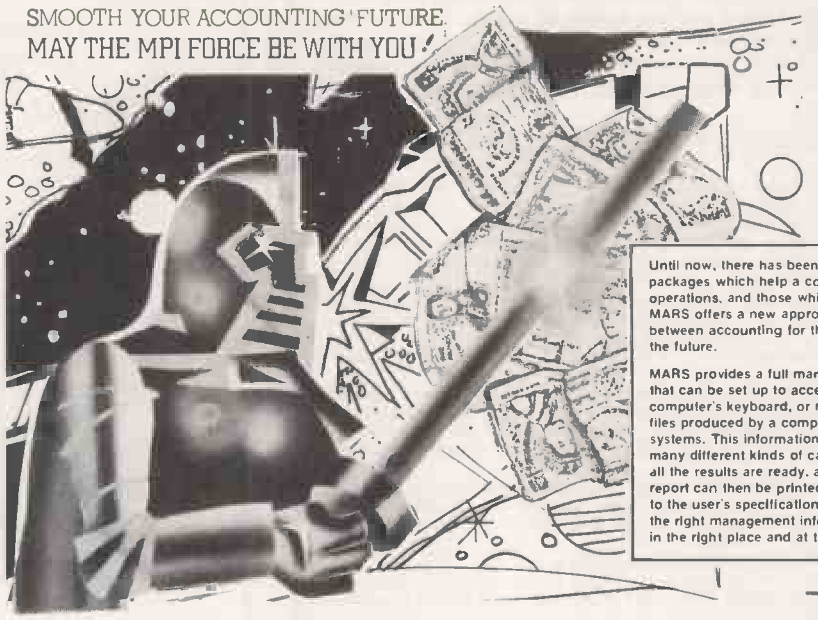

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244