Practical Computing

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80p June 1983 Volume 6 Issue 6



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Handling interrupts on the BBC Micro

REVIEWS: DEC Rainbow; Cromemco C-10

BBC software; ProPascal; Spectrum WP

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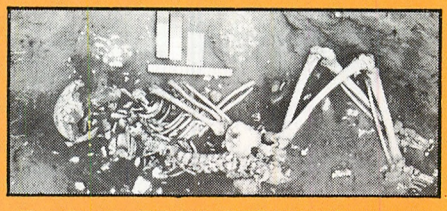

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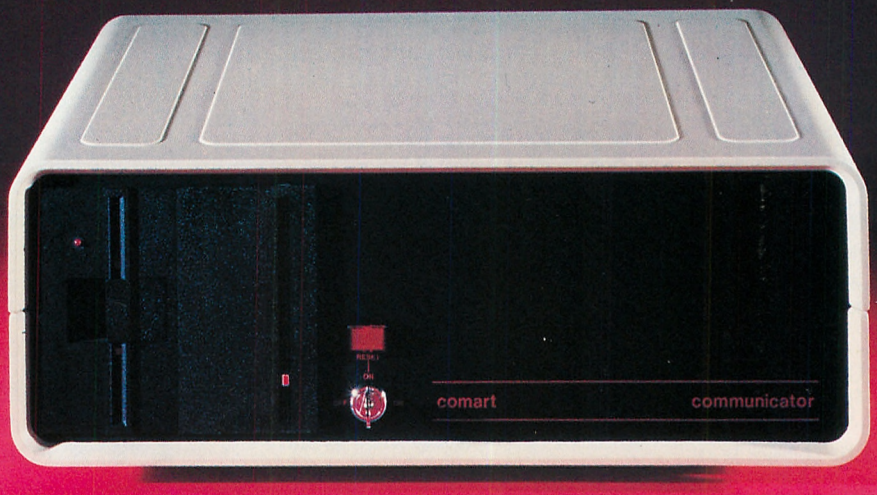

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Every effort is made to check articles and listings but *PC* cannot guarantee that programs will run and can accept no responsibility for any errors.

High noon

THE WORLD of microcomputing is very like Hollywood's idea of the Wild West, except that we are still waiting for the sheriff to come in and clean up the town. Some of the cowboys in the industry seem to think they can get away with anything. As the industry is growing so quickly that widespread confusion is inevitable, to some extent they are correct. At least, they can get away with a great deal before they are finally stopped.

Someone can, for example, copy half a dozen popular games on to a cassette, and sell it at £10 a time through the small ads in the back of a computer magazine. Even 100 responses will bring in a tidy £1,000 for the cost of a few blank tapes and a little time. With several hundred thousand Sinclair owners, the potential returns are staggering.

Of course, copying a company's games is theft, and can be prevented. But why does it happen at all? In a society, or subset of society, which is stable and law-abiding, such infringements are quickly spotted and can be quickly stopped. Insofar as anarchy reigns, it becomes correspondingly more and more difficult to do. In the world of computer games, anarchy appears to reign supreme.

If another company were to start marketing a game called Scrabble or Monopoly, and offer a game that is a facsimile of the real thing, then Spears and Waddingtons and their heavyweight lawyers would descend on the perpetrators like the proverbial ton of bricks. So obvious is the theft, and so certain the arrival of swift retribution, that no sensible company, let alone a reputable one, would even consider such a ploy. The justice of the case is obvious.

But what if the game is a computer game? Copies are not only legion, they are the norm. Companies do not hide the fact that their "new" game is a version of Pacman or whatever. They are more likely to boast that it is exactly like the "real thing", and may even call it by the same name.

Here, reputable companies are involved, Commodore and Acornsoft among them. To cite just one example, Acornsoft's Snapper and Commodore's Jelly Monsters are at least inspired by the well-known arcade game Pacman, yet neither company pays royalties to the inventor of Pacman or its licencees. Jelly Monsters will shortly be the subject of a court case so this is not the place to discuss it. However, the types of argument used in such cases are clear.

The problem is, where does the originality of a computer program lie? If a disputed program looks virtually the same as the original program, and the coding is virtually identical, then it is reasonable to surmise that one is a copy of the other. If the visual display is the same but the coding is different, or *vice versa,* then the situation is by no means as clear.

Ideas taken from a mailing list or simple database program could easily be used to write a home-accounts program. The function and visual appearance of the two programs may be completely different, so no one notices that one was sourced from the other. Nevertheless the amount of code used might be such that in a novel it would constitute plagiarism.

On the other hand, one program might produce a visual copy of another, yet by being written from scratch by different programmers, and for different micros, have no common coding at all.

There is considerable room for argument about where exactly inspiration stops and theft begins. What is certain, however, is that while the major companies continue to argue among themselves they are in a poor position to police the rest of the industry.

When two alsations are fighting over a large bone, a passing poodle can easily walk off with it.

● Commodore (U.K.) has just withdrawn Jelly Monsters and launched Cosmic Crunchers.

5 Years ago...

"I talk to the trees", ran the song. A silly thing to do, perhaps, but there is an inanimate object to which you can talk which will understand you, the Apple II micro system.

Keen Computers of Nottingham, which markets Apple products, is selling a voice input system which allows you to give spoken commands to your machine.

The system is called the Speech Lab Model 20A and costs £165. It comprises a microphone, the voice recognition board, manual, and six demonstration programs.

The programs are either tape or listings and allow the beginner to do voice prints on the screen; play Mastermind and Blackjack; teach the cursor to go up and down, left and right; recognise people by their voices; and play Shooting Stars.

As Keen says, the advantages of using voice input are enormous as "speech is a human's highest capacity output channel".

Speech Lab is in two models. Model 20 has a vocabulary of 32 words. It is available as the 20S for S-100 computers and the 20A for the Apple II unit.

Software for Speech Lab includes seven complete programs, three of which are offered in source and on paper tape and four in source alone. The three paper tape and source are: speech basic programming language; assembly language recognition program; and hardware self-test program.

The source programs are provided in Speech Basic to plot and correlate speech data. Two recognition programs offered will clarify speech concepts.

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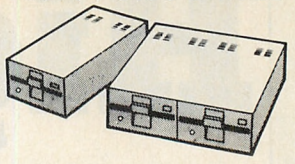

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SEIKOSHA GP250X **Only: £235 (£7 carr.)**

SOFTY-2

Price includes FREE 2532

Softy is an intelligent EPROM Programmer & Emulator. Has Memory Map, TV Display, RS232 & Centronics I/P & O/P. Copies, Emulates and Programs EPROMS. RS232 & Centronic routines standard. Includes PSU. Price: £169

SPECIAL OFFER

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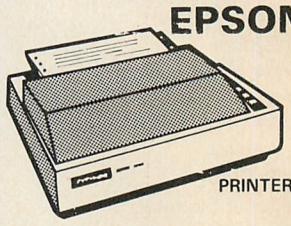
2532	300p	275p
2732	320p	290p
2764	450p	395p
4116-200n	85p	80p
6116	390p	360p

Just 'phone your order through, we do the rest.

EPSON



PRINTERS

FX80FT/3 10'' Tractor/Fiction Feed, 160 CPS, bidirectional, logic seeking, 9 x 9 matrix, hi-res bit image, normal & Italic & Elite Char. Super & subscript, Proportional spacing. **£399 (£7 carr)**

MX100FT/3 136 columns, 15'' carriage, plus all the facilities of MX80FT/3

Only: £425 (carr. £7)

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CRYSTALS

32.768KH	100	16.0MHz	200
1MHz	275	18.0MHz	180
1.6MHz	392	18.432M	150
1.8MHz	395	19.968M	150
1.843M	200	20.0MHz	200
2.0MHz	225	24.0MHz	170
3.2768M	150	24.930M	325
3.5759d	98	48.0M	175
3.6864M	300	100.0M	375
4.0MHz	150		
4.433619	100		
5.0MHz	160		
6.0MHz	140		
6.144MHz	150		
6.5536M	200		
7.0MHz	150		
7.168MHz	160		
7.68MHz	200		
8.0MHz	150		
9.0MHz	200		
9.375M	350		
10.0MHz	175		
10.7MHz	150		
10.24MHz	200		
12.0MHz	175		
12.528M	300		
14.31818	170		

WEMON

Watford's specially designed 4K Ultimate Monitor IC for UK101 & Superboard

Only £10.

IDC CONNECTORS

Speed block type	PCB Plug with latch Strt Pins	Angle Pins	Female Header Socket	Female Card Edge Connectors
10 way	90p	99p	85p	120p
16 way	130p	150p	120p	—p
20 way	145p	166p	125p	195p
26 way	175p	200p	150p	240p
34 way	205p	236p	160p	320p
40 way	220p	250p	190p	340p
50 way	235p	270p	200p	395p

JUMPER LEADS Ribbon Cable Assembly DIL Plug (Headers)

Single Ended Lead 24" Long

Length	14pin	16pin	24pin	40pin
24"	145p	165p	240p	325p

Double Ended Leads

6"	185p	205p	300p	465p
12"	198p	215p	315p	490p
24"	210p	235p	345p	540p
36"	230p	250p	375p	595p

IDC female receptacle jumper leads

	24" 20way	26way	34way	4way
1 end	160p	200p	260p	300p
2 end	290p	370p	480p	525p

DIL SOCKETS

	Low Prof	Wire Wrap
8pin	8p	25p
14pin	10p	35p
16pin	10p	42p
18pin	16p	52p
20pin	16p	52p
22pin	25p	70p
24pin	25p	70p
28pin	28p	80p
40pin	30p	99p

RIBBON CABLE

Ways	Grey	Colour
	Price per Foot	
10	15p	28p
16	25p	40p
20	30p	50p
26	40p	65p
34	60p	85p
40	70p	90p
64	100p	135p

DIL PLUGS (Headers)

	Solder	(IDC)
14 pin	38p	15p
16 pin	42p	95p
24 pin	88p	100p
40 pin	195p	130p
		218p

AMPHENOL PLUGS

24way IEEE	560p
36way Centronics	
Parallel	550p

ZIF DIL SOCKETS

24way	575p
28way	850p
40way	975p

VIDEO MONITORS

- ZENITH 12" Hi-Res, Green Monitor, 40/80 column select switch. Attractively finished — £75
- **SANYO 3125 Colour, 14" RGB and V.H. Sync. Attractive Metal Cabinet.** — £199
- SANYO Connecting Cable — £7
- MICROVITEC 1431. 14" Colour Monitor. RGB Input. Cable included — £249

EURO (DIN) CONNECTORS

	Female Strt Pins	Female Angle Pins	Male Strt Pins	Male Angle Pins
DIN41617 31way 41612 A-B	170p	—	—	175p
2 × 32way 41612 A-C	275p	320p	220p	285p
2 × 32way 41612 A B C 3 × 32way	295p	340p	240p	300p
	360p	385p	260p	395p

EDGE CONNECTORS

	.156" TWO ROWS	.1"
2 × 18way	145p	180p
2 × 22way	200p	199p
2 × 23way		185p
2 × 25way		225p
2 × 28way		210p
2 × 30way		245p
2 × 36way		295p
2 × 40way		315p
2 × 43way		395p

D CONNECTORS: Miniature

	9way	15way	25way	37way
Male				
Solder	80p	110p	160p	250p
Angle	160p	210p	250p	355p
Pins	120p	130p	195p	295p
Female				
Solder	110p	160p	210p	350p
Angle	165p	215p	290p	440p
Pins	150p	180p	240p	420p
Covers	100p	95p	100p	110p

IDC 25way 'D' plug 385p Skt 450p

● Circle No. 103

Obsolete so soon

MANY YEARS AGO when cars first began to be popular, it was predicted that everyone would have a car in years to come. Furthermore, it was necessary in those early days to have a chauffeur to deal with the technicalities and it was therefore easy to conclude that chauffeurs were in for a rosy future.

Although the prediction has come true in the sense that everyone does have access to a car, the need for chauffeurs on a large scale did not happen because cars became sophisticated enough for the average person to drive and maintain themselves.

It is not inconceivable that increasing capacity of memory storage in today's microcomputers will herald the day when the average business will buy a computer with all the functions — payroll, ledgers, etc. — built into the machine and serviced by the manufacturer.

In other words, the user will be able to "drive" it away without need of expensive analysts, programmers and software consultants — or "chauffeurs", to use the analogy of the motor car.

If one considers the sheer number of eager young computing entrepreneurs searching for a career in computing, one may well wonder what the future holds for them. I know of many people who joined the computer industry in its early days, myself included, who can already feel a degree of obsolescence, with expertise which becomes more out of date with each day that passes.

Operating a computer used to be a professional occupation not capable of being performed without sound training of the right people. Except for the very large mainframes, the average person is easily coming to terms with the use or operation of computers as part of their daily life.

If all this is leading to a society which will see the employed as the elite few, then the career-wise person would be well advised to look in the direction of the leisure industry for a secure future, or indeed for any other industry which is likely to be in demand and undermanned by the above criteria.

Ted Keating,
Haverhill,
Suffolk.

Pascal semicolon

CONGRATULATIONS on your languages section in April. However, I must point out an error in the article on Pascal. The author says that the statement

```
if x = y then if w = z then a: = 1
  else b: = 1
```

has two distinct possible meanings. This is not true. Version 2 is correct while version 1 is not. For version 1 to be correct a semicolon would have to be inserted:

```
if x = y then if w = z then a: = 1;
  else b: = 1;
```

Dr Allan's explanation is correct, however.

Once again, congratulations on a great magazine.

John Robinson,
Hall Green,
Birmingham.

Smalltalk now

I WAS pleasantly surprised to see even a short article on Smalltalk in the April 1983 issue. However, there is one point in which Christopher Roper was, quite understandably, mistaken. There is an implementation of Smalltalk outside Xerox — and it is British. It just has not been released yet.

After years of hanging around waiting for Xerox to release something, it slowly dawned on me that Smalltalk was perpetually on the verge of being released. It also dawned that people at Parc had left enough hints lying around in various papers and articles for someone who was sufficiently foolhardy to try, to be able to design their own interpreter. The only question mark hung over whether or not a fully featured Smalltalk system would be able to run at an acceptable speed without microcode support.

The answer to that question has turned out to be yes. Just six weeks ago, my interpreter reached the stage where I could perform timing tests on it. On a Motorola 68000, it runs nearly 10 times as fast as an APL interpreter performing similar tests. For those who understand the Smalltalk jargon, it executes up to 10,000 bytecodes per second. Naturally the system's performance will be degraded as the high-level user-interface features are added,but Smalltalk-80 is designed to minimise such degradation.

If I can find a friendly hardware vendor, the 68000 interpreter should be available as soon as I finish it. I also plan to have an MS-DOS version running by the end of the year — but nothing any smaller than that. Looking further ahead, there are at least two British companies who are currently investigating the idea of producing 32-bit desk-top machines with Smalltalk.

Watch this space . . .

Ian D Kemmish,
Weybridge,
Surrey.

Logo directory

MAY I SAY, firstly, how I enjoyed your feature on programming languages. I hope that this might prove to be a starting point for a series which could explore the characteristics of each language in greater depth and detail.

One omission was a directory for Logo. If any readers would like to contact Pam Valley, Secretary, BLUG, c/o Shell Centre for Mathematics, University of Nottingham, we will gladly provide them with information.

Derek Radburn,
British Logo User Group.

Boris for all

PLEASE COME CLEAN about Boris Allan. In fairness to your readers you should stop the hoax now. Admit it is a Buzz-Word Generator Program. Is it original? Or is it a micro version, scaled down from one of the well-known mainframe packages?

That such a simple program as Boris Allan, with obvious bugs in the maths and logic routines, can provoke such a deluge of critical letters is remarkable. It is an argument for artificial intelligence, as the program passes a version of the Turing Test.

Nigel Guthrie,
Edinburgh.

● OK, we admit it. Boris stands for Binary Organic Rhetorical Information Synthesiser. A copy will be sent to anyone who submits a clean Sinclair Microdrive with an SAE. Offer closes 1 May.

Heat and light

CAN YOU please stop Boris Allan walking on water? When he writes on subjects that he understands well, such as the social implications of computers and the misinterpretation of statistics, he is interesting and thought-provoking. Unfortunately, when he writes on mathematical subjects and program design he is capable of generating very much more heat than light.

The April issue has the two aspects well illustrated. The article on the invalid use of computer graphics is well thought-out and lucidly argued. In the article on Pascal, however, he says "People need an interactive programming language, not a modified batch language". I suggest that this varies very much according to the needs of the user of the computer.

As microcomputers move into the office there are going to be more and more people who use computers without knowing or caring how they are programmed. Who cares or knows which language was used to write programs like WordStar and Supercalc? As a user I cannot amend them, and have no wish to try, even though I write programs for myself and others. If I am to write programs to be used by other people who

(continued on next page)

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.

(continued from previous page)
may have no easy way to contact me, the structuring facilities of a language like Pascal can be very valuable in allowing me to create a maintainable program which cannot be amended easily without access to the source.

The very interactive nature of Basic can cause problems if the user happens to type a line number between loading a program and running it. I know that this should not happen, but I can remember a case in which many hours were spent trying to locate a program bug that was not present in the program on the disc. The operator had accidently typed a valid line number before typing Run.

This does not mean that I would reject Basic. For many purposes it is very difficult to beat, especially if the program is to be modified frequently in relation to the number of times it is to be run. Boris Allan is very scathing about "fitting wheels to a ship so that it can travel on land", but there is no doubt that fitting rails to a ship so that trains can travel across the sea has been a very effective way of solving a transport problem.

In the March issue, Boris Allan asks if 1 man + 1 woman = 2 children. The question is nonsense as we are talking about different things. Mathematical axioms and theorems apply to abstract creations such as integers and rational numbers. These creations do not exist as separate entities but we do find them convenient to describe certain real-life objects and so make use of all the theorems which we can prove, given certain axioms. The integers, for example, describe very well the behaviour of money and other countable items. I am sure that Boris Allan would complain bitterly if his employer said that it was impossible to prove that the associative law applied to the additions on his pay slip and so the total would be less than expected.

Please let us have more articles on numerical analysis, data validation and efficient algorithms. They will make more difference to our programming than arguments about proofs.

David H Wild,
Hemel Hempstead,
Hertfordshire.

Kalman filters

I WAS PLEASED to see my article in the April issue of *Practical Computing* though there were a couple of errors.

The statement in figure 5 about the relationship between w_k and v_k is incorrect. It should read

w_k and v_k are assumed to be totally independent of each other

This is a fundamental assumption in the derivation of the Kalman filter equations.

In the Kalman filter equations, in line 830, the filter uses the noisy input to the system. In fact, it should use the deterministic, no-noise input. To correct this, simply delete lines 730 and 740, and change line 830 to:

830 X = PH * X + DE * (U + W)

This in fact makes very little difference to the thermocouple simulation given in the article.

In figure 7, the dynamic equation describing the thermocouple should be:

dv/dt = −9.59v + 0.39(T + random noise)

Bill Hill,
University of Manchester.

Eigensolutions

● Intrepid readers who tackled Mark Walker's article How to Compute Eigensolutions in the May issue will have been thwarted by the program in listing 1. We are printing the correct version of the Power procedure here, with our apologies.

Olivetti M-20

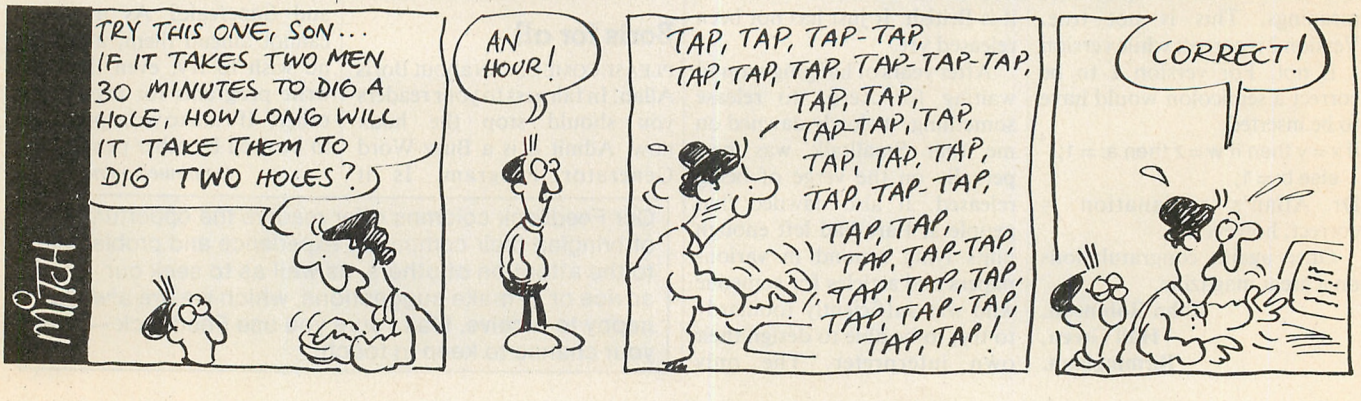
THANK YOU for your review of the Olivetti M-20 in the April 1983 issue. I would like to correct a few misunderstandings.

The allocation of memory by the M-20 is not as inefficient as suggested by your review. The figure of the 58K user memory displayed by the M-20 is the maximum Basic user area allowed on the machine. As with most microcomputers there is an instruction to set up the memory size required for Basic programs. The default value on the M-20 is compatible with the minimum 128K machine and gives the size produced in your report. To increase it you simply use the Set Basic command. As to the "missing 100K", 16K is the display bit map, 52K is the operating system, and 32K the interpreter, which may be removed when using the editor or other languages.

(continued on page 13)

Eigensolutions. Listing 1.

```
1000 DEF PROC_power (N,ACCURACY)
1010 REM Given a coefficient matrix A(N,N) this routine produces the eigensoln.
1020 REM with the largest modulus, to a precsion of ACCURACY. Requires arrays
1030 REM M(N), EIGVEC(N) (for the eigenvector); and a variable EIGVAL for the
1040 REM eigenvalue.
1050 LOCAL i% , j% , temp , sum , converge
1060 temp = 0
1070 FOR i% = 1 TO N
1080   EIGVEC(i%) = 1    :   REM any non-zero value will do
1090   M(i%) = 0    : REM serves as a comparison for testing convergence
1100   NEXT i%
1110 REM Evaluate trial solution vector
1120 FOR i% = 1 TO N
1130   sum = 0
1140   FOR j% = 1 TO N
1150     sum = sum + A(i%,j%) * EIGVEC(j%)
1160     NEXT j%
1170   M(i%) = sum
1180   NEXT i%
1190 REM Normalise trial soln. to give approximate eigenvector in EIGVEC
1200 EIGVAL = M(1)
1210 FOR i% = 2 TO N
1220   IF ABS(M(i%)) > ABS(EIGVAL) THEN EIGVAL = M(i%)
1230   NEXT i%
1240 FOR i% = 1 TO N  :  M(i%) = M(i%) / EIGVAL  :  NEXT i%
1250 REM Test convergence of eigenvalue
1260 IF ABS (EIGVAL - temp) <= ACCURACY THEN 1320
1270 temp = EIGVAL    :   REM Prepare for next iteration
1280 FOR i% = 1 TO N
1290   EIGVEC(i%) = M(i%)
1300   NEXT i%
1310 GOTO 1110
1320 REM Test convergence of eigenvector
1330  converge = TRUE
1340 FOR i% = 1 TO N
1350   IF ABS(EIGVEC(i%) - M(i%)) > ACCURACY THEN converge = FALSE
1360   NEXT i%
1370 IF NOT converge THEN 1270
1380 REM Soln. done; EIGVAL,EIGVEC have largest modulus eigensolution
1390 ENDPROC
```



NEW!

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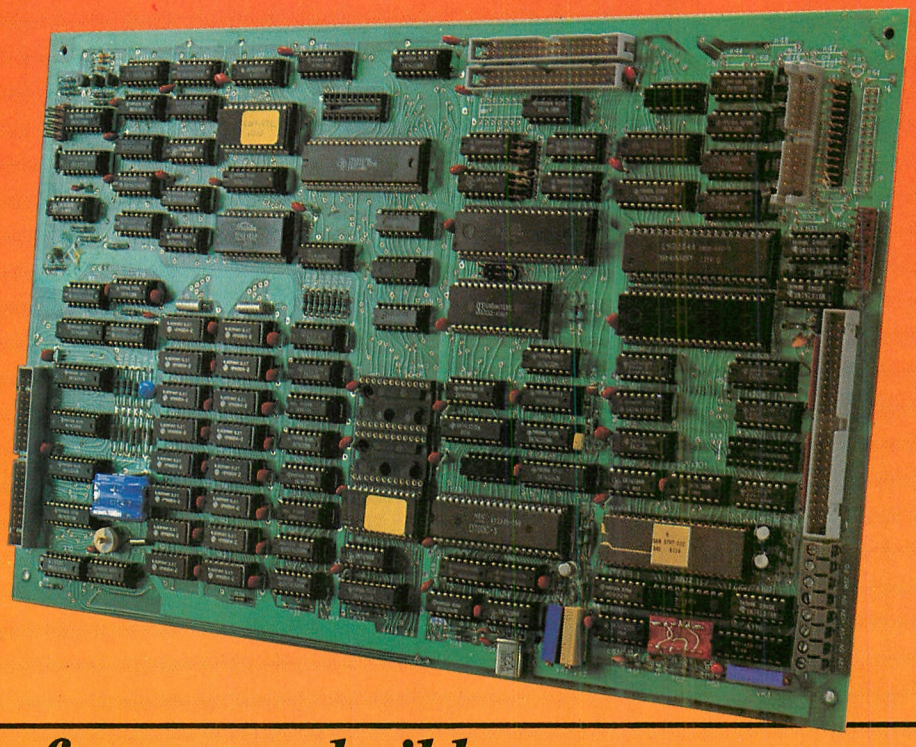
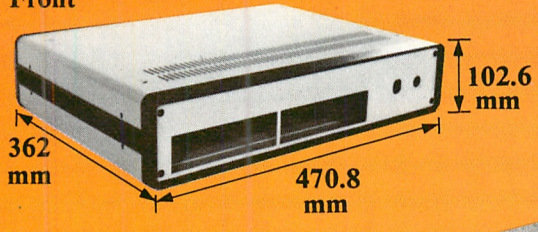
- 2 Port Parallel
- On Board Real Time Clock/ Calendar with Battery back-up
- External I/O BUS
- ASCII Keyboard Port
- Disk operating system (optional): CP/M 2.2, CP/M 3.



also available – for system builders

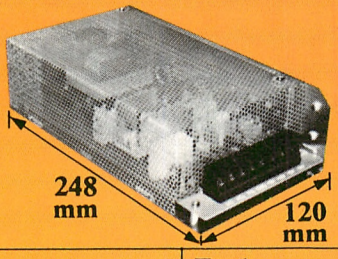
Front



Low profile metal enclosure to house MICRONIX 80HD board, two half height 5¼" floppies (⅔ height floppies optional), a switch mode power supply for the complete system. The panels have cutouts for floppies, connectors and a fan (as illustrated). Thoughtfully constructed for easy accessibility. Cover and base grey/beige. Frame dark brown.

Back





Switch mode slimline power supply model FEM 7030SS for a complete computer system enough power for MICRONIX 80HD, two mini floppies and CRT. Meets safety standards.
Input: 220/240V 50Hz.
Output: +5V @ 7A; +12V @ 3A
—5V @ 1A; —12V @ 1A
88 Watts

Micronix 80HD (Please state whether 5¼" or 8" board required)	Enclosure
64K £445 + £5 P & P (£15 overseas) + VAT	for ½ height floppies £75 + £10 P & P + VAT
128K £499 + £5 P & P (£15 overseas) + VAT	for ⅔ height floppies £80 + £10 P & P + VAT
CP/M 2.2 for Micronix 80HD £125 + VAT	horizontal mounting rails (set of four) £25 + £2 P & P + VAT
CP/M 3 for Micronix 80HD £250 + VAT	Power Supply £77 + £3 P & P + VAT
Hard Disk utilities for Micronix 80HD £75 + VAT	

micronix computers Ltd
(formerly Vincelord Ltd).
Suite 2, 26 Charing Cross Road, London WC2. Tel. 01-240 0213/0217. Telex. 295173 VILORD G

● Circle No. 104

It's a picture.



*PRICES START AT £995 EX. VAT.

And it's worth a thousand words.

The brilliant new Commodore 700 is arguably the most aesthetically pleasing micro-computer ever designed.

Beauty and brains allied in the most literal sense.

Beneath the soft-sculpted lines of the 700 lies the most impressive achievement in technology from one of the world's leading micro-computer companies.

Built to a standard and to a specification which no competitor comes close to emulating, and at a price* which makes this fact all the more remarkable, the Commodore 700 is unique.

It is a very special computer indeed.

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SUMMARY SPECIFICATION

1. Tilt and swivel anti-glare 80 column green-on-black display screen.

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3. Ten special function keys are programmable in BASIC or machine code to execute twenty special operations.

4. Capable of addressing 896K of user RAM. Available with either 128K or 256K as standard. Configured in 64K banks with switching managed by the 6509 processor.

5. The full RAM is available for machine code programs. BASIC programs can be up to 64K in length with the remainder of the RAM available for variables and/or data.

6. Integral dual disk drives with direct memory access available as an option.

7. An optional dual processor – the Z80 or 8088 – can operate concurrently with the standard 6509. This enables access to the existing library of CP/M® programs.

8. Interfaces through several ports – IEEE-488, RS 232C, CBM cassette, 8 bit parallel, and cartridge slot. Built-in networking capability.

9. Supports a full range of peripherals including dual disk drives, hard disks, dot matrix and letter quality printers, and plotters. Works with all existing Commodore systems peripherals.

10. Standard language is BASIC 4.0 plus, so existing Commodore 8000 system programs in BASIC are easily converted. Soft loaded languages will include UCSD Pascal and Forth.

11. Includes a sound synthesis chip to produce a full range of "noise" and music effects.



*DETAILS CORRECT AT TIME OF GOING TO PRESS
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For a thousand words and more on the Commodore 700, and the address of your nearest Commodore dealer, telephone or write to us at:
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Telephone: Slough (0753) 79292.

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● Circle No. 105

A two-minute operation turns your BBC Micro into the heart of a word processor.

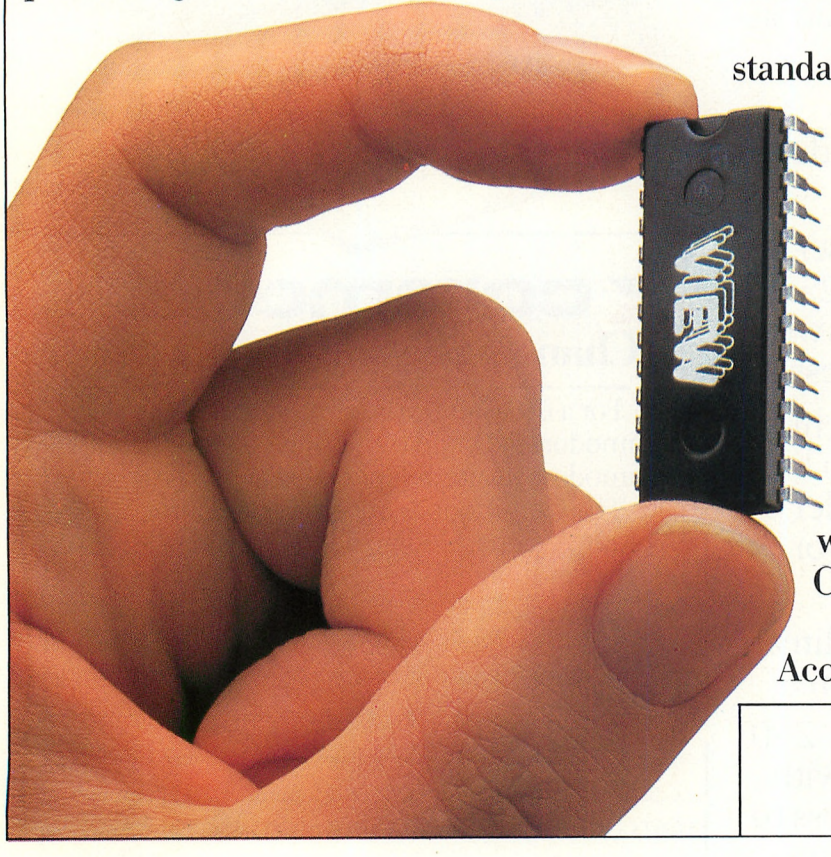
VIEW is a software program from Acornsoft (the software division of Acorn Computers Ltd., who designed and built the BBC Micro) that enables you to use your BBC Micro, together with a printer, as a fully operational word processor.

View is supplied as a Rom chip that can easily be fitted to your BBC Micro by your local dealer, in a painless two-minute operation.

Then, once installed, you only have to switch on and View is operating immediately. (You can easily switch back to normal computing with a single command.)

Also included in the View package are two special books: 'Into View,' that takes you by easy stages through all the word processing commands and explains the many ways in which View can help you, and the 'View Guide,' which provides a quick reference to all View facilities.





You'll find that View is, by any standards, a thoroughly professional system, yet still surprisingly simple for the beginner to master.

The 'Spark-Jet Printer' shown in the photograph is the ideal choice of printer for your word processing application. Extremely quiet, it offers high resolution graphics from monitor or T.V. screen and is available now from dealers.

If you'd like more information, write to Acornsoft, 4a Market Hill, Cambridge CB2 3NJ.

Or, for details of your local Acornsoft dealer, phone 01-200 0200.

ACORNSOFT

● **Circle No. 106**

(continued from page 8)

The handling of non-Olivetti printers is the same as other microcomputers. The SForm command merely simplifies the selection of different typefaces, character sizes, etc.

The lack of Character Delete key can easily be overcome by programming any other key, even the S1 Return key.

Overall your report's main criticism seemed to be lack of CP/M and therefore a limited range of accessible software. In reply, we can only point out that, according to the BIS Peddar Annual Census, the two most popular machines in our price range were the Apple II and Commodore Pet. Neither runs CP/M as standard but even so has a wide range of software.

One of the reasons for the use of the high-level languages in computers is to provide software portability. The operating system is simply the interface between the languages, the user and the hardware. By providing standard languages it is possible to establish a wide range of software. The market for the M-20 is primarily the professional with a problem to solve. It is this area with quality software where the M-20 is and will continue to be successful.

However, as you suggest, for the enthusiast and to further widen the software choice, we now offer a CP/M-80 emulator and CP/M-86 or MS-DOS on the 16-bit 8086.

R J Garrett,
British Olivetti Ltd,
London SW15.

● Apologies for overlooking the Set Basic command. However, 58K of free RAM is not remarkable in a 16-bit micro.

The Apple IIe and Commodore micros have five years worth of software to back them up. Also, both offer cheaper CP/M options than the M-20 if the price of the micro itself is included.

An 8086 add-on makes sense to someone who already owns an M-20, with its Z-8001 microprocessor, but someone who wants a CP/M-86 machine might as well buy one.

Sorcerer group

WITH THE RECENT dissolution of the Canadian Sorcerer User Group, the disappearance of the U.S. Sorcerer group and the end of the North American production of the Sorcerer microcomputer it is now more important than ever that current Sorcerer owners have some means of exchanging information. This letter is to publicise the existence of Isis, the International Sorcerer Information Service. It is a not-for-profit monthly newsletter aimed at providing a forum for such an exchange. Membership in Isis is $15 — Canadian funds in Canada, U.S. dollars elsewhere.

Each issue of Isis contains, among other items, a full-length program listing, software reviews, requests for information and offers of help. Interested individuals can contact Isis through me.

Maurice Dow,
84 Camberley Crescent,
Brampton,
Ontario,
Canada L6V 3L4.

Newbrain software

I WAS VERY PLEASED to see Richard Nash's letter in the April issue asking for some software for the Newbrain and I hope it will get some response. I have been using a Newbrain since August and have not seen one program published for it.

If anyone is interested, the Newbrain's clock can be accessed by two calls:

CALL 62383, sets the clock to zero

CALL 62399, x gives a value of x at 50 per second.

The Newbrain's interpreter uses a graphics C as a symbol for print. As it does not convert ? to a full Print, using graphics C is as fast to type in and considerably improves the presentation of programs as it lists out as Print. In fact all the reserved words can be typed out in this way using graphics or inverse characters.

Rory Stafford,
Taghmon,
County Wexford,
Ireland.

A4 stationery

IN ANSWER to Garrick Wales' plea for a supplier of continuous A4 paper in April's Feedback, look no further. Paperweight specialises in business forms and computer stationery in many depths, including 11.66in. deep.

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(continued on next page)

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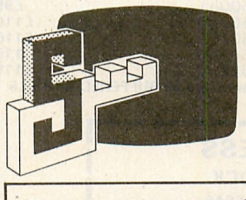

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Apple confusion

CONFUSE-AN-APPLE in the March issue contained two bugs which crept into the published listings.

The first, in the demo listing, is the variable POS$ which is a reserved word so cannot be a variable name as well. Changing it to PS$ cures the problem.

The second is location $937C in the machine-code section, which should read FC and not F6. But this error does not stop the demo program working.

My article may also have been misleading in stating that the program "sits in memory just below DOS". Unfortunately I do not have disc drives on my system, so I was unable to prove that it actually works with DOS. My investigations have found, however, that DOS frequently resets the COut hook unless it is specifically told about any changes that have been made. This, I understand, can be accomplished by returning from the SetBug routine, through DOS itself, at location $3EA.

The amendment program in listing 1 should put things to rights. Again, I'm afraid, it is untested. Changes will then have to be made to the demo program, but I have modified it anyway to produce a better demonstration. A revised Demo program is given in listing 2.

Geoff Buckeridge,
Bristol.

Micro Business Basic

THOUGH Micro Business Basic appeared in the languages guide in the April issue, our address and telephone number did not. Solitaire Business Systems Ltd products are now sold under the Solitaire-KPG banner from our new sales offices at 578-586 Chiswick High Road, London W4 5RP; telephone 01-995 3573.

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R Baldwin,
KPG Computer Services Ltd,
Highcliffe,
Dorset.

Secure Rems

I HAVE DISCOVERED a useful method for making tidy, undeletable Rems on the Spectrum. Type and enter

```
1 REM XXXXXXXX © J. Bloggs
```

Then enter:

```
FOR A = 23760 TO 23768:POKE A,8:NEXT A
```

This works by placing eight cursor-lefts to delete the line number. Finally type Poke 23756,0 to give the line a random number, making it impossible to delete or edit it.

P Appleton,
Gerrards Cross,
Buckinghamshire.

Apple confusion. Listing 1.

```
$92FA—   20 00 93   JSR   $9300SETBUG
$92FD—   4C EA 03   JMP   $03EADOS
```

Listing 2.

```
10  HIMEM: 37626
20  LIST : LIST : LIST
30  CALL 37626
40  FOR X = 32768 to 33727
50  IF USR (X) = 160 THEN & POKE X, 174
60  NEXT
70  PS$ = "^ CRRRRRRRRRRRRRRRRRRRDDDDDDDDDD^"
80  PRINT, PS$;"A^ RRF^ B^ LDDI^ C^ LLLLNB^ D"
90  CALL 37684
```

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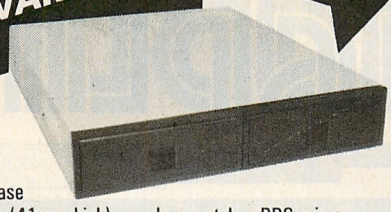

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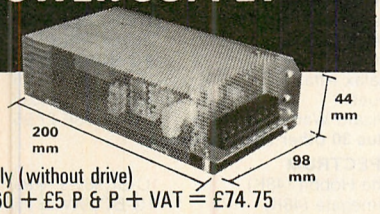

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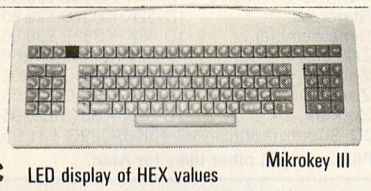

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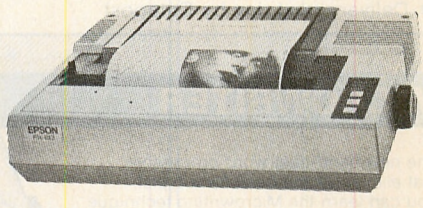

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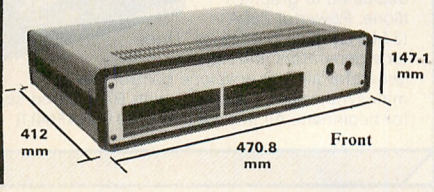

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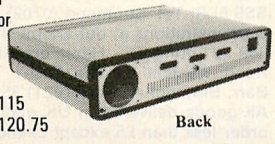

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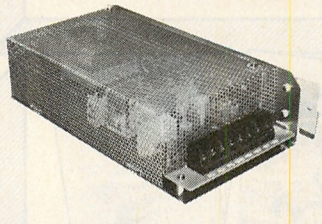

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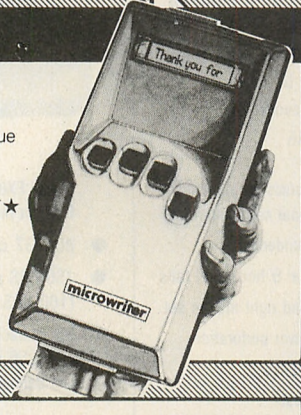

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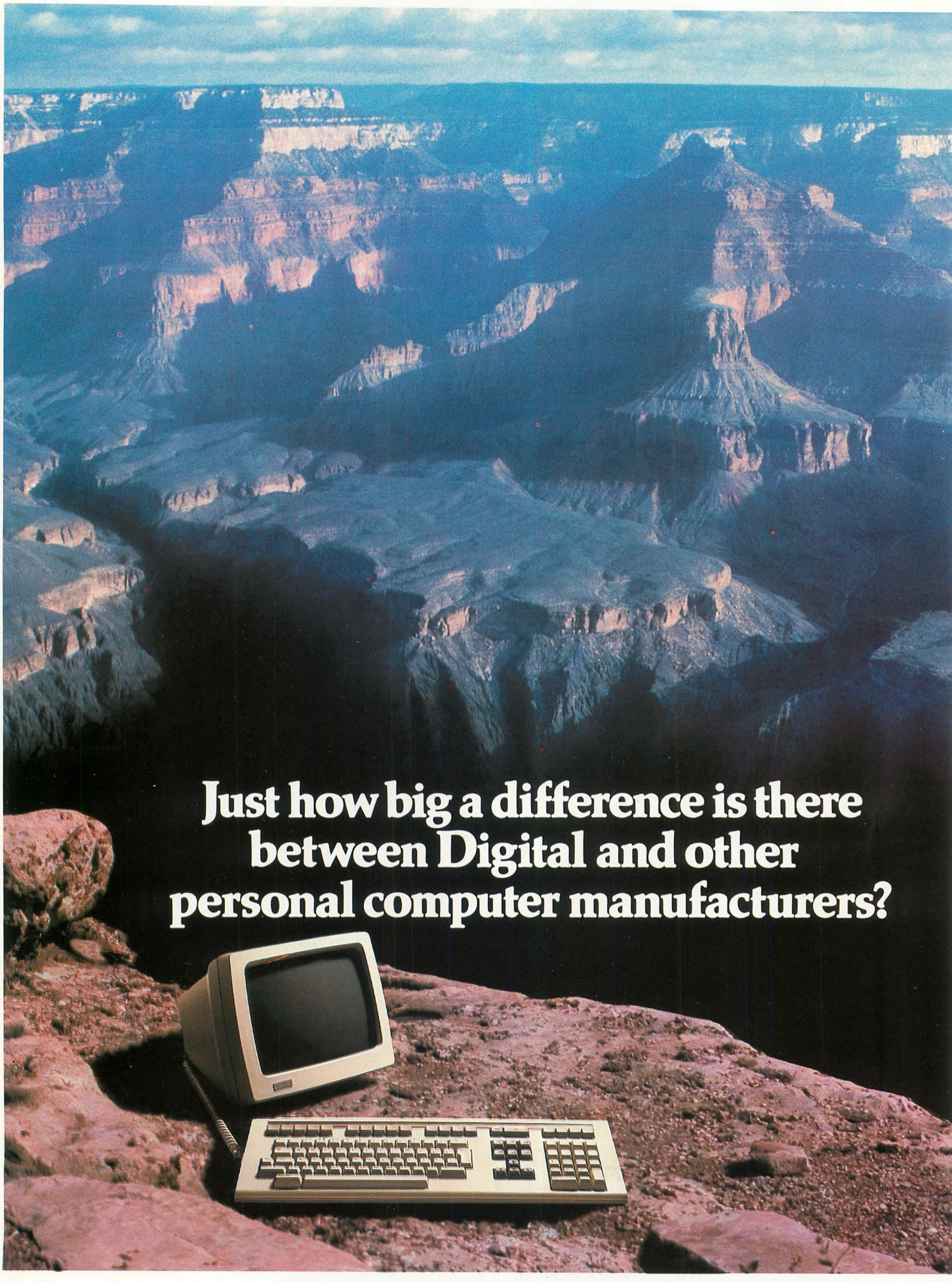
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Where to find your nearest Digital Authorised Personal Computer Dealer.

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The Computer Terminal, 44 Cathedral Place,
London EC4. Tel: 01-236 2187.

Demotab Ltd.,
99–101 Regent Street, London W1.
Tel: 01-439 3971.
(Market Research & Advertising Agencies).*

Guestel Ltd., 6–12 New Bridge Street,
London EC4. Tel: 01-583 2255.

Matmos Electronics Ltd.,
14–16 Child's Place, London SW5 9RX.
Tel: 01-373 6607.
(Opticians & Opthamologists).*

Micro Business Systems PLC, Cannon Street,
London EC4. Tel: 01-621 1122.

Personal Computers Ltd., 220–226 Bishopsgate,
London EC2M 4JS. Tel: 01-377 1200.

Planning Consultancy Ltd., 46/47 Pall Mall,
London SW1Y 5JG. Tel: 01-839 3143.

Rank Xerox (UK) Ltd., The Xerox Store,
84 Piccadilly, London W1V 9HE.
Tel: 01-629 0694/5.

The Xerox Store, 110 Moorgate,
London EC2M 6SU. Tel: 01-588 1531/2.

The Xerox Store, 76–77 Holborn,
London WC1V 6LS. Tel: 01-242 9596/7.

Software Sciences, Thorn (EMI) House,
14 Old Park Lane, London W1. Tel: 01-499 7099.

Software Sciences, 88 Old Street,
London EC1. Tel: 01-253 1480.

Sumlock Bondain Ltd., 263–269 City Road,
London EC1V 1JX. Tel: 01-250 0505.

Sytec Products Ltd.,
25 Bruton Lane, London W1. Tel: 01-409 1244.
(Pressure Vessel Design, Surveying,
Structural Analysis).*

HOME COUNTIES

Dataview Ltd., Portreeves House, East Bay,
Colchester, Essex CO1 2XB. Tel: 0206 865835.

Ferrari Software Ltd., 683 Armadale Road,
Feltham, Middlesex. Tel: 01-751 5791.

GSI Ltd., Stanhope Road, Camberley, Surrey.
Tel: 0276 62282.
(Motor Dealers & Manufacturers).*

Key Computer Centres, Enterprise House,
Terrace Road, Walton-on-Thames, Surrey.
Tel: 09322 42777.

Micro Business Systems PLC,
119–120 High Street, Eton, Berkshire.
Tel: 07535 55211.

Microfacilities Ltd., 7–9 Church Road,
Egham, Surrey. Tel: 0784 31333.

Rank Xerox (UK) Ltd., The Xerox Store,
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Chichester, Sussex. Tel: 0243 775111.
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(Sperrings Computer Shops Ltd.),
Spencer House, 12–14 Carlton Place,
Southampton. Tel: 0703 39571.

Software Sciences, Abbey House,
282–292 Farnborough Road, Farnborough,
Hants. Tel: 0252 544321.

South East Computers Ltd., 15 Castle Street,
Hastings, Sussex. Tel: 0424 426844.

South East Computers Ltd., 31 Watling Street,
Canterbury, Kent. Tel: 0227 59917.

South East Computers Ltd., 29 High Street,
Maidstone, Kent. Tel: 0622 681263

SOUTH WEST

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Bristol BS99 7AX. Tel: 0272 277828.

Software Sciences, Unit 39, Southfield Road,
Nailsea, Nr. Bristol. Tel: 0272 851462/3.

South Coast Computers Ltd.,
South Coast House, Wimbourne Road,
Ferndown, Dorset. Tel: 0202 893040.

Whymark Computing, 20 Milford Street,
Salisbury, Wilsthire SP1 2AP.
Tel: 0722 331269.

MIDLANDS

4B Microcentres Ltd., 13/14 North Bar, Banbury,
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Micro Business Systems PLC, Wirksworth,
Derbyshire. Tel: 062-9823120.

MMS Ltd., Ketwell House,
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Tel: 0234 40601.

Zygal Dynamics PLC, Zygal House,
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Tel: 08692 3361.

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Microware Computers Ltd., Diamond House,
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Sigma Systems Ltd., 266 North Road,
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Micro-Centre (Complete Microsystems) Ltd.,
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Tel: 031-556 7354.

Micro Business Systems PLC,
Turnhouse Airport, Edinburgh.
Tel: 031-333 1000.

Pilgrim Business Machines Ltd.,
28 Walker Street, Edinburgh.
Tel: 031-226 5528.
(Solicitors).*

Pilgrim Business Machines Ltd.,
Northfield Place, Aberdeen. Tel: 0224 645104.

Rank Xerox (UK) Ltd., The Xerox Store,
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Tel: 041-333 0495.

NORTHERN IRELAND

Systems Plus Ltd., 19 Glengormley Park,
Newtownabbey, Northern Ireland.
Tel: 023-134 2117.

DIGITAL UK HEADQUARTERS

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Structured Basic

STRUCTURED LANGUAGES like Pascal seem very difficult compared to ordinary Basic, which has an immediacy and simplicity that is difficult to beat. But the very features which encourage rapid *ad hoc* programming in Basic can lead to problems if programs become long or the application very complex.

Structured Basic is the obvious compromise. U-Microcomputers' Structured Basic is an interpreted Basic for the Apple II+ and IIe which includes a full range of structured features.

Disc-based procedures or subroutines, can be called by name and parameters passed to them; variables can be defined as local. Repeat-Until, While-Endwhile, If-Then-Else-Endif and Case statements are fully supported. Additional Apple graphics commands are provided and, according to U-Microcomputers, most Applesoft Dos 3.3 programs will run without needing any modification.

The price is £90. Details from U-Microcomputers Ltd, Winstanley Industrial Estate, Long Lane, Warrington, Cheshire WA2 8PR. Telephone: Warrington (0925) 54117.

```
10 PRINTTAF(12);"BASIC CYMRAEG"
20 PRINT"Welsh language BASIC"
30 PRINT"for Sharp computers"
40 GAN I=0 AT 255
50 PRINT NOD$(I);
60 NESAF I
```

This is Basic Cymraeg, a Welsh-language form of Basic running on the Sharp MZ-80A and MZ-80K computers. All screen messages and Basic keywords are in Welsh. So the Basic prompt is Parod — not Ready or OK — and Syntax Error is Gwall Iaith. The listing displays a message and then prints out the character set. Gan-Nesaf is a For-Next loop, and Nod$ or Nodwerth$ is the equivalent of CHR$. Details from David Computer Software, 38 South Parade, Bramhall, Stockport SK7 3BJ. Telephone: 061-439 4841.

Spitfires defend the skies of England

SPITFIRE SIMULATOR is the latest program from Beattie-Edwards Aviation Ltd, a company which specialises in aircraft-simulation software for a wide range of microcomputers. Spitfire simulator requires a disc-based Apple system.

The time is early 1941 and your mission is to defend the skies of England from eight types of invading aircraft. Flying characteristics of the Spitfire are apparently simulated quite accurately. The program costs £47.85.

The Beattie-Edwards price list makes fascinating reading. It contains a whole range of programs, all to do with aircraft. There are Tandy, Pet, BBC, Atari and other Apple simulators. For instance, Jumbo is a jumbo-jet simulator for the BBC Model B or Tandy I or III, costing just under £20. Practical programs are available for the real-life flyer, including flight planning, aircraft loading, and also club and syndicate billing.

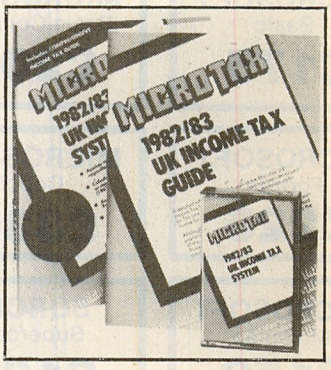
Contact Beattie-Edwards Aviation Ltd, 20 Normanhurst Close, Three Bridges, Crawley, Sussex, RH10 1YL. Telephone: Crawley (0293) 20565.

68000 micros to run CP/M

NEW MICROS built around the powerful Motorola 68000 16/32-bit CPU have the attraction tha tthey can run Unix. Unfortunately the number of people who can deliver useful software packages for Unix systems seems to be very small. What 68000-based micros really need is the industry-standard operating system CP/M, because that is where the software is.

Now it is on the way. Digital Research has announced the completion of CP/M-68K, written in C for Hitachi's version of the 68000, the HD-68000. The end-user price will be $350.

An interesting aspect of the new CP/M is that it will provide a bridge between CP/M-80 and Unix, just as the promised version 2 of MS-DOS will provide a bridge from version 1 of MS-DOS to Xenix.



Tax pack

MICROTAX is a package designed to help micro users complete their income-tax returns. It runs on a wide range of home micros, and will be on sale in branches of W H Smith and Boots.

The program takes you step by step through the income-tax form, telling you what to fill in, totting up your total tax liability and suggesting the most advantageous choices available to you.

Microtax is available for the 48K Spectrum, BBC Model B, Dragon, Commodore 64, Vic-20 with 16K RAM pack, and Pet 4000 series. Sharp and Newbrain versions are promised. Microtax costs £24.94 by mail order.

Details from Microtax Ltd, Barratt House, Fourth Floor, 7 Chertsey Road, Woking, Surrey GU21 5AB. Telephone: (04862) 20369.

Softsel shake-up for U.K.

SOFTSEL is a U.S. company which claims to be the world's largest distributor of personal-computer software. Its arrival in the U.K. could signal a shake-up in the chain which links software producer to end-user.

Softsel's first British catalogue contains over 1,800 products, for Apple, Atari, Commodore, IBM, Texas, Tandy and CP/M machines. Softsel intends to add titles rapidly for top-selling British machines like the Spectrum and BBC Micro.

The usual pattern in the U.K. is for distributors to specialise much more closely on a small number of specific machines. Softsel, which is a wholesale company and sells only to dealers, is hoping its approach will prove attractive to dealers fed up with having to go through a large number of different suppliers.

Softsel is offering products to dealers on a 90-day sale or return basis, with no minimum order and a typical trade discount of about 40 percent. It also promises a very rapid order turnaround. If it can deliver this it will put pressure on other suppliers to follow suit, to the ultimate benefit of computer users.

The catalogue includes products from over 150 suppliers, including Ashton-Tate, Broderbund, Micropro, Microsoft and Peachtree. Softsel is importing Lotus 123 for the IBM and the ALS CP/M-Plus card for the Apple, for example. Inevitably, a large number of the titles are games, so U.K. users will be able to encounter some American fun products like B-1 Nuclear Bomber, the tastefully named Nukewar, and MX.

Dealers or software suppliers can contact Softsel Computer Products Ltd. at Softsel House, Central Way, North Feltham Trading Estate, Feltham, Middlesex TW14 0XQ. Telephone: 01-844 2040.

Easy cards for Sinclair

QUICK REFERENCE cards for the Sinclair ZX-80 and ZX-81 are now available from Elkan Electronics. The American-written 20-page accordian-style cards costs £3.50. Contact Elkan Electronics, 11 Bury New Road, Prestwich, Manchester M25 6LZ. Phone: 061-798 7613.

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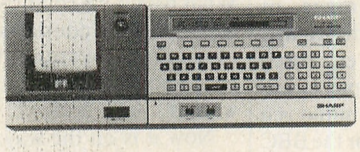



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Sharp sound and colour

SHARP, the Japanese electronics giant, has achieved moderate success with machines that are not totally unlike the Pet. Now it is about to launch a micro that is not totally unlike the Commodore 64. It will be called the MZ-700, have 64K of RAM, colour, sound and graphics. It will be software compatible with the MZ-80, but cost around £300 or less.

Gone bust

IO TECHNOLOGY, manufacturer of the Iona microcomputer, went into receivership early in April. Accountants Peat, Marwick and Mitchell are hoping to sell the company as a going concern.

Whispers surround Sinclair

SINCLAIR WATCHERS are now confidently predicting the shape of the new "ZX-83". Most reports indicate the machine will incorporate as its thinking heart a souped-up version of the ZX Spectrum, possibly running at a faster speed than at present.

The new micro will be aimed at a more sophisticated user than the current Sinclair range of micros. It will be portable, but whether that means battery powered or simply a computer in a suitcase is still unclear. Two features are certain: the new machine will contain a flat-screen monitor and the new Sinclair Microdrives.

An industry source told *Practical Computing* that "tens of thousands of communictions boards have been ordered for a new Sinclair product". It is also said that Sinclair will definitely be incorporating Modems on the boards.

Being Z-80 based there is the option of including CP/M with the machine to control the Microdrives. But this now looks unlikely and the pointers are that Sinclair Research will develop its own operating system based on the special features of the Microdrives.

Meanwhile, W H Smith is selling the 16K Spectrum at £99.95, which is £25.05 less than previously. Life is beginning to look very hard for Oric, for while the 16K Oric was announced at that price none have been delivered. Oric is currently suggesting that £129.95 might be the target — Smith's new price for 48K Spectrum.

Most likely, the Sinclair price cuts are designed to give the Acorn Electron a hard time. long-delayed machine is expected to be launched about now, but after Sinclair's pre-emptive strike how many potential buyers will there be?

The price of the Sinclair ZX-81 is also down at W H Smith. A £10 reduction leaves it at £39.95, which will make life hard for Texas Instruments' new black-and-white cheap micro.

The home computer market is extremely price sensitive and, yet again, Sinclair seems to be one jump ahead.

(More news on next page)

Bigger fair — smaller micros

Report from Hanover by Sarah Underwood

WHILE the Hanover Fair gets bigger, the systems on show get smaller, with Commodore, Tandy and Osborne keeping the portable bandwagon rolling this year, and Apple's stand pulling the crowds.

In keeping with tradition Commodore used the show as a launch pad for its latest offerings, which included the Commodore Executive 64, the company's first move into the portable micro market.

The Executive 64, scheduled for delivery in October, has a 5in. screen, full QWERTY keyboard and 64K of RAM as standard. Weighing in at under 10kg. it can accommodate one or two floppy-disc drives with a storage capacity of 170K each.

A music synthesiser and graphics facility form an integral part of the system, which will be offered in both colour and monochrome versions. Fully compatible with Commodore's existing 64 range, a basic single-disc machine is expected to carry a price tag of under $1,000.

Along with the portable micro comes a range of new peripheral devices from Commodore. They include colour, daisywheel and high-speed printers, as well as the low-cost 1520 four-colour printer/plotter and the long-awaited 1701 colour monitor which can be used with Commodore kit from the Vic-20 to the 500 Series. The company also announced Microsoft's Multiplan software for the 64 range, and for the 600 and 700 Series CP/M and MS-DOS cards which will be available this summer.

Not content with this clutch of proudcts, Commodore president Jack Tramiel outlined plans for integrated hardware and software machines. He said: "Xerox's Star and Apple's Lisa are too expensive. We will have computers with similar work stations and software by the end of the year — a business system will cost $2,000 to $3,000, while a home unit will be below $1,000.

Tandy meanwhile decided that small is beautiful for the Hanover Fair and introduced its hand-held TRS-80 Model 100. It may reach the U.K. in three months time, although pricing and availability have not yet been fixed.

With a maximum 64K of RAM and 64K of ROM the Model 1000 has a QWERTY keyboard, Centronics parallel and RS-232 interfaces and an eight-line, 40-character display. A company spokesman insisted that the system on show was a production model, but refused to remove it from its locked display case. Doesn't Tandy's latest gem bear closer examination?



Commodore goes portable with the Executive 64.

Osborne, the two-year-old company which started the portable craze, won no marks for innovative product names or time-keeping at the Hanover Fair. Its new Executive model was not delivered from the U.S. by the second week of the show and we gave up waiting. A company spokesman said it was an upgrade to the existing Osbone 1 housed in an identical briefcase.

The Executive has a 7in. screen, up from 5in. on the Osborne 1, and double the earlier system's user memory at 128K. Using the same QWERTY keyboard it has two slimline floppy-disc drives providing 320K, like the current double-density drives. The company is even promising that a 16-bit option is only another four months away.

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Programs – Hints & Tips – Major Articles – News – Reviews – Commentary. PLUS members discount scheme with National Retailers. PLUS members Software Library – a growing range of software from around £3.50 per cassette. 10 Magazines a year. First issue April 1982. Reprints of all issues available to members.
February Issue. Program Features: Beebmaze – Find your way through the random maze, guided by 3D views from inside the maze – an excellent game. Five Dice – a Beeb implementation of Yahtzee (R), a novel dice game. Also a listing of Windy Field – a creation from Acornsoft, Spiroplot screen doodler, and a complete memory display program in a user key. Plus Machine Code Screen Dumps for the Epson and Seikosha Printers; articles on Using Files, Ideas on Animation (including a Rotating Cube program) an introduction to the use of procedures, a Survey of Books on the BBC Micro, and a Roundup of Disc System Hints. Plus a variety of Hints, Tips and info, including a single VDE command to perform a Sideways Scroll.
March Issue: Program Features: Life (32K), Artillery Duel (16K/32K), Square Dance, 3D Rotation (will rotate any object). Printers for the BBC micro – Review of Epson, Seikosha, Tandy and Olivetti. What to do with the new Operating System. Disc Formatter Program, and full Disc instruction set. Newcomers article on Text and Graphics Windows. PLUS How to get a new Operating System ROM and a special deal on Wordwise (members only).
April/May Issue. Special Anniversary Issue – Contains index to the whole of BEEBUG Volume 1. Music Composer – create complex 3 part harmonies with this synthesiser Program. **Colour bar chart generator** program. Beeb implementation of the **Connect-Four Game. Invasion** – a 16k. Plus **Review of Tape Recorders for the Beeb;** a Basic Program Editor, which lists variables and procedures, and executes Find and Replace in a Basic Program; **Reviews of Acornsoft Games** and the **Torch Z80 Disc Pack**. Disc Menu Program, newcomers introduction to Mode 7. How to save the unsavable; and a routine to print Double Height Characters in all modes.
Magazine programs now available on cassette to members at £3.50 inc: VAT & p + p see April/May issue for details.

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See **BEEBUG** Magazine February, March or April for details.
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Minstrel sings another tune

THE INTERESTING small British micro known as the Minstrel now has another string to its lute: it runs the Turbodos operating system. This provides a multi-user multi-processor system which works and can be seen working.

Hotel Microsystems also claims its S-100 bus system is the cheapest of its type available. The basic system costs £2,455 including a 5Mbyte hard disc. Adding another user then costs £450 for a slave board, plus the cost of a terminal.

Contact Hotel Microsystems Ltd at 69 Loudoun Road, London NW8. Telephone: 01-328 8737.

Software first in Bromley

WHILE UNUSUAL architectures make headlines from time to time, the old and established S-100 bus remains a logical and sensible way to go. For one thing there is massive independent support.

One of the latest British firms to go with the S-100 bus is Bromley Computer Consultancy. Its modestly named Superstar microcomputer allows any combination of Z-80 and 8086 cards up to a total of 16 users, sharing from 10Mbyte to 160Mbyte of hard-disc store.

Really the Superstar is just a good way of running some of Bromley's software. This includes eight standard packages from stock control to job costing, and 12 packages for "vertical markets". They include betting-office chain management, estate agents and membership management.

Contact Bromley Computer Consultancy Ltd, 417-421 Bromley Road, Bromley, Kent. Telephone: 01-697 8933.

Hyperion runs MS-DOS

THE CANADIAN-BUILT Hyperion is a 16-bit business-oriented portable computer designed to be closely compatible with the IBM PC. The 20lb. machine is built around the Intel 8088 processor, runs MS-DOS, and has 320K 5.25in. floppy drives which can read IBM discs.

The neat 18in. by 11in. by 8in. unit accommodates a 7in. diagonal amber-coloured screen displaying 25 lines of 80 character, 256K of RAM and up to two floppy drives.

The large standard memory allows some RAM to be treated by the operating system as if it were a disc drive.

Starting price for a Hyperion with one 320K floppy and 256K RAM is £2,899. Contact Gulfstream Computer Technology Ltd., Unit 3A, Tunnel Estate, 726 London Road, West Thurrock, Grays, Essex, RM16 1LS, Telephone: (04026) 4926.

Not just words for Dictaphone

DICTAPHONE'S new word processor, the Series 6000, has only one notable difference from a small business micro: function keys dedicated to word processing. In other respects the 6000 is simply an ergonomic work station with detached keyboard, screen, separate 5.25in. dual disc drives and a Ricoh letter-quality printer.

The machine uses twin Intel 8085s and has 128K of RAM, expandable to 192K. It runs Dictaphone's own integrated software, but supports CP/M and is supplied with version 2.2.

Until June 21 the Series 6000 will cost £3,900. The price includes the daisywheel printer and eight hours training, but not VAT.

Contact Dictaphone, Regent Square House, The Parade, Leamington Spa, Warwickshire.

Pro readers start here

PRACTICAL COMPUTING and *Your Computer* now have a new sister magazine, *Micro Business,* written specially for people in the microcomputer industry.

The personal-computer industry is changing fast, and people in the industry need to know what is happening ahead of their customers. *Micro Business* is a monthly magazine available free to qualifying retailers, distributors, hardware manufacturers and software companies. For a controlled circulation request form write to Christine Vallance, Room 308H, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.

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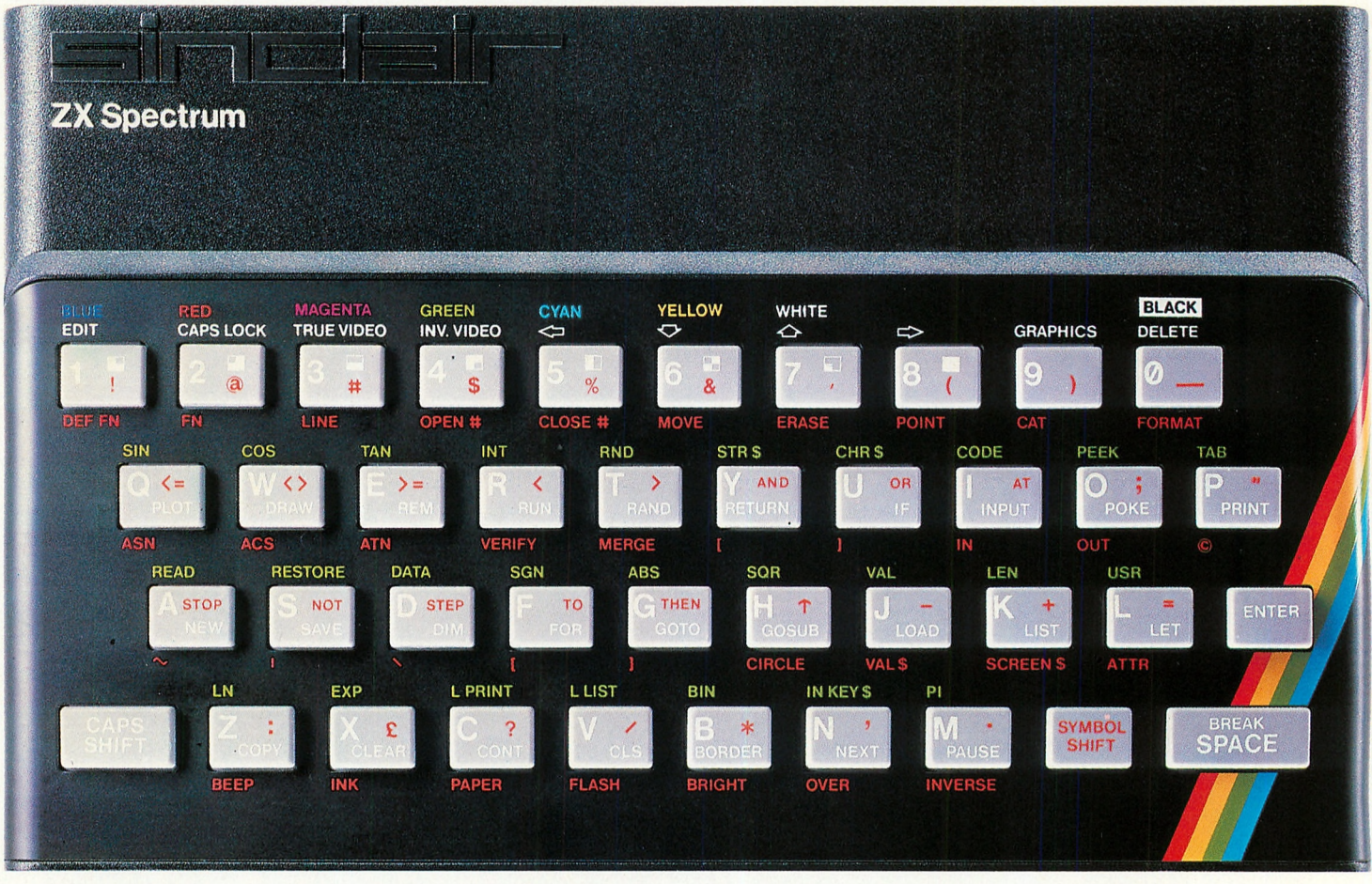
Sinclair ZX Spect



The growing range of Spectrum Software



You'll know already that the Spectrum has generated an enormous range of peripherals and independent software. Our own range is growing very fast and is shown in the Sinclair Software Catalogue – *free* with every ZX Spectrum.

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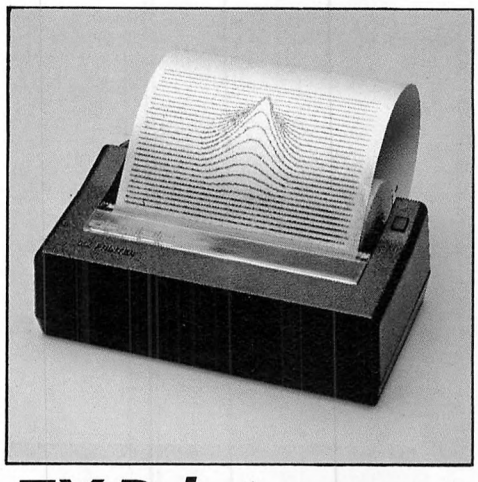

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Access, Barclaycard or Trustcard holders – call 01-200 0200 24 hours a day, every day. By FREEPOST – use the coupon below. Please allow up to 28 days for delivery. 14-day money-back option.

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Right now, you can order a Sinclair Spectrum at these prices direct from Sinclair on the order form below. And to make it even easier to handle high-level computing at the lowest possible price, we've cut the cost of the printer, too. At £39.95, it's almost unbelievable!

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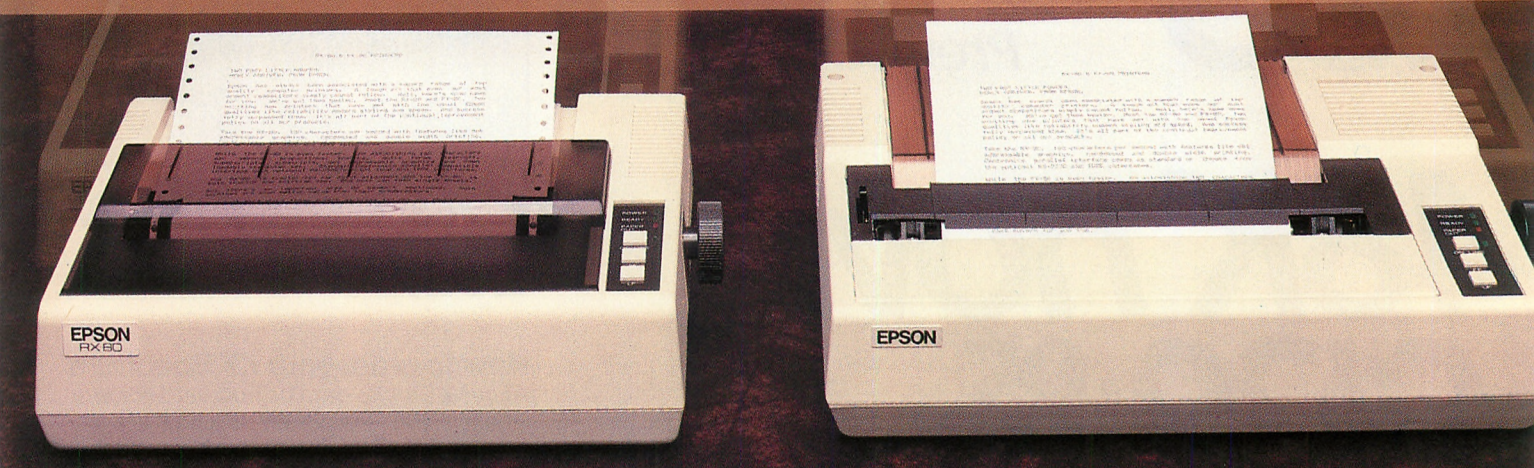
Two fast little movers. Newly arrived. From Epson.



Epson has always been associated with a superb range of top quality computer printers. A tough act that even our most ardent competitors simply cannot follow.

Well, here's some news for you. We've got them beaten.

Meet the RX-80 and FX-80. Two exciting new printers that have met with the usual Epson qualities like reliability, modern styling and speed. And successfully surpassed them.

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Take the RX-80. 100 characters per second with features like dot addressable graphics, condensed and double width printing. Centronics compatible interface comes as standard or choose from the optional RS-232C and IEEE interfaces.

The FX-80 is more flexible and even faster. An astonishing 160 characters per second, proportional spacing, quick forms tear-off, superscripts, subscripts, dot addressable graphics and down loadable character set. Standard Centronics compatible interface with optional RS-232C current loop and IEEE.

The RX-80 is tractor-fed for exact alignment and the FX-80 is both tractor and friction fed.

But there's an important area we haven't mentioned. Both machines are even better value than their predecessors.

So now we've whet your appetite – isn't it about time you seriously considered buying one of our remarkable machines.

But act now, because with our amazing track record, there's going to be a great demand for these new world beaters.

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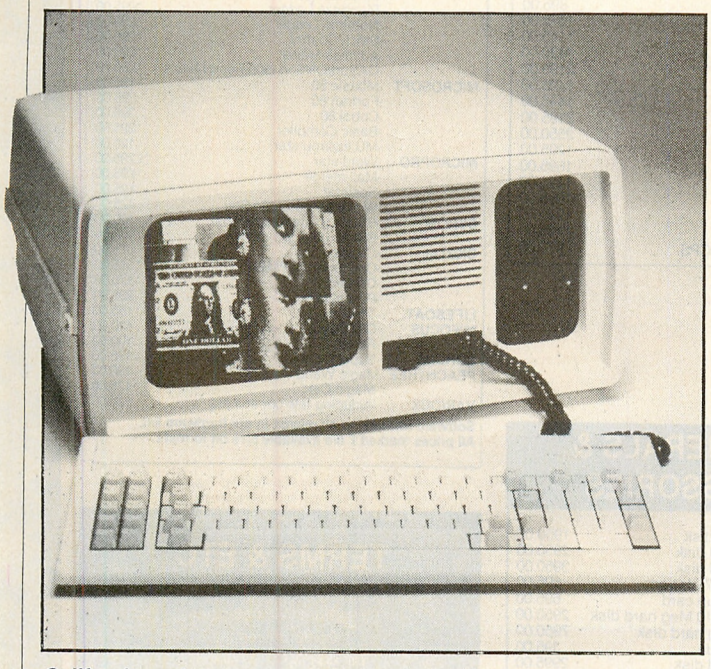
PC6/83





Californian micro company Corona launched twin versions of its IBM PC work-alike in the U.S. last year, and now has shown them at the Hanover Fair. The twins are not identical in appearance: one is a desk-top model, and the other a portable with half-height 5.25in. discs and a 9in. screen. Corona Data's founder, Robert Harp, was one of the founders of the multi-million dollar Vector Graphic company, which is still run by his ex-wife Lore Harp, and which is also in the IBM PC work-alike business. If you want to know if Corona has found a U.K. distributor, telephone Fred van de Oudeweetering in the Netherlands on (324) 018111.

Legal action looms in Hong Kong

IBM'S WORLD-WIDE sales for the first quarter of this year were $8,287 million, up 27 percent on 1982.

The IBM PC has been launched in Japan as the IBM 5550, with much of the hardware made by Matsushita.

In Hong Kong, IBM is threatening to sue fakers of the PC. According to the trade weekly *Computertalk,* industry watchers are asking if IBM will sue only for the keyboard and casing, or on behalf of Intel for the chip and memory, Tandon for the disc drives, Digital Research for the operating system and others involved.

The new PC DOS version 2.0 is so far being shipped only with the XT hard-disc version. It includes a number of new commands: one of our informants has been exploring them using the Type command. This reveals, inside the Recover. Com file, the comment:

Chris Peters helped with the new DOS. Microsoft rules OK.

Now who in the IBM board-room approved that?

IBM-compatible single boards

FARADAY ELECTRONICS Inc has announced a single-board micro claimed to offer full compatibility with the IBM PC. It is called the FE-64, and in OEM quantities — hundreds or thousands — costs only $275. It is just what you need if you want to market an IBM work-alike.

If you want a micro, rather than a board, Faraday offers two packages: a rack system, and a portable with 9in. screen.

Contact Faraday Electronics, 1,029 Corporation Way, Palo Alto, California 94303. Telephone: (415) 961 0600.

Systematics aims highers

SYSTEMATICS has launched three new packages in its range of software. Two are new — word processing and the Administrator. The third, Payroll, is said to be a much improved version.

The Administrator is a file index/list program. Systematics' existing range consists of Sales Ledger, Purchase Ledger, General Ledger, Financial Planning, Job Costing and Invoicing packages. As well as the IBM PC, they also run on the Apple II and III, Sirius, NEC PC-8000 and Triumph Adler P3 micros.

Systematics says it sold 6,500 packages in 1982 and will sell over 10,000 this year. Contact Systematics at Cleves House, Hamlet Road, Haverhill, Suffolk. Telephone: (0440) 61121.

More memories from Pete & Pam

PETE & PAM Computers is now importing two competing multi-function boards for the PC. The Titan board from Saturn offers one parallel and two serial ports, SASI disc interface, a real-time clock and 64K to 576K of RAM.

The extra RAM comes with software so it can be used as a pseudo-disc or a printer buffer. The price if £449.

The Quadboard from Quadram offers an RS-232C port, a parallel port, a real-time clock and from 64K to 256K of RAM. The price is from £425 but you do lose the hard-disc interface and a serial port. Contact Pete & Pam at 0706 212321.

Connecting to the Apple II

ANYONE upgrading from Apple II to IBM — or running both — will find The Apple-IBM Connection useful. The two micros must obviously be connected by a cable or Modem/telephone link.

For the Apple this means the Hayes Micromodem II or Mountain Hardware CPS card. For the IBM PC you can use any RS-232 card. The file-transfer software, from Alpha Software in Massachusetts, comes with spoken instructions, and costs £139 plus VAT from Pete & Pam Computers at 0706 227011.

Just as good as a Pet

IF YOU LIKED Wordpro on the Commodore computers, you will like the version for the IBM. Called Wordplus-PC, it comes on two discs plus a chip.

Contact Wego Computers at 22a High Street, Caterham, Surrey CR3 5UA. Telephone: Caterham (0883) 49235.

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Not only does this program surpass most of its kind that you might buy elsewhere, but if you buy the hardware from us, then you get it FREE . . . DBMS II (WITHOUT MACROS) AND DBMS III ARE FULLY IMPLEMENTED UNDER CPM-86 (tm) AND MS-DOS (tm) I.E.: SIRIUS/VICTOR/IBM DBMS II IS £395.00 (or £250.00 by mail order ex. training) . . . DBMS III is £575.000 (or £295.00 by mail order ex. training).

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All prices marked * are 8/16 bit machines.

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mbasic 80	autoload	msort/dsort
recover	disk/games	instant basic
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Total Value £1525.00

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All prices marked £ are available 8/16 bit formats.

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GENIE	-5MG fixed/5MG removeable disk	3295.00
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BIZCOMP	-RS232/Auto-modem 1200 baud	450.00
AST	-port expanders (4 tmnls to 1 prtr)	395.00
GIX	-port expander (switcher)	95.00

NOTE: Corvus drives with multiplexor may network sirius . . Superbrain . . Concept . . PET . . Victor . . IBM . .

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Boston office tlx 94-0890

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Requires the prior acquisition of DBMS 111.7

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Nominal ledger (95 pounds)
Stock control-valuation/re-order (95.pounds)
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Each module is a set of 'task disks' designed for minimal learning curve. This software derives from modules of 'DBMS III' and runs reports without your secretary having to touch a single key

Consider the advantages in these features: The user manual is contained in FIVE pages. All reports are generated by robot functions. Reliability tested (benchtest PCW June). Works in a network multi-user environment Fast easy data entry. Files are re-organised and sorted automatically. Produced by the same people that originated 'BUSiness' 'DBMS II', 'DB-CALC', 'AUTOLOAD AND RECOVER' 'ETC' and sold successfully over the past five years.
Also see our advertisement next page.

The G80/86 networks

Based upon one hard disk and multiplexor module the G80/86 networks feature full network sharing of data resources by adding different stations that may be as various as Sirius/Victor 9000f/IBM/Superbrain/Pet/N'star/Sanyo.
We also have a special 'spooler module' as well as software controllable port expanders and modems for output to telephones, printers, and screens so that a number of terminals may share the resources of one printer, as well as be able to send files over the telephone at any time (day/night) to both store on the hard disk and print out as well.

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When you budget for a complete system of software you eventually end up with a host of packages like, Sales, Purchases, Nominal, Data, Text, Calc, Mailshot, Invoice, Order, Workflow, Personnel, and so on.
The list is endless and the outlay several thousands of pounds.

Features. Design a form as wide as a window of 250 characters, long as needed, Cursor movements are 'left, right, up, down, delete left delete right, tab right-left-up-down' Paint your form as you like directly on the screen.

Text..... Write a letter as you see it on the screen, edit it then simply enter ^P to print.

Calc..... Set into the form, your data fields, ''£££££'' and specific file-related activities, formulae and validation checks.
Enter values and see the spreadsheet calculate itself.

Database. Search files for data to be inserted to fields specified.
All the features of DBMS III, explained elsewhere in our ad.

Here's an example of an invoice you might design for your stationery .....
You could design your own spreadsheet, order form, statement, or any other kind of form that is required to fit your existing stationery.

INVOICE <0>£££££££££££				
To £<1>£££££££££££ £<2>£££££££££££££££ £<3>£££££££££££££££ £<4>£££££££££££ £<5>£££££££££			From: G.W. Ltd 55 Bedford Court Mans. Bedford Avenue London W.C.1. Tel: 01-636 8210	
Date <6>££.££		Tax point <7>££.££		Agent <8>£££
Quantity	Description	Cost	Tax	Total
<9>£££	<10>£££££££££££££	<11>£££	<12>£££	<13>£££
<14>£££	<15>£££££££££££££	<16>£££	<17>£££	<18>£££
and so on...				
Total...<19>£££££		Tax...<20>£££		

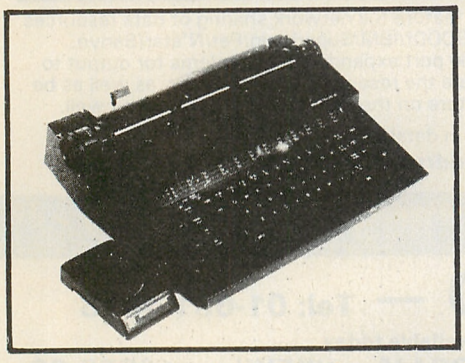
<??> items <1> to <5> internal command to request name input, and then search an address file for details.
<??> items <6> to <7> request date input and validate.
<??> item <8> request agent number and validate range.
<??> <9> request quantity, validate range.
<??> <10> request description, search file, accept, and calculate fields <11>, <12>, <13>, if finished invoice then calculate fields <19> and <20>

Now comes the more valuable facility, you can provide the 'FORM' with file-related instructions, not only to request a 'console' input for a file search against names, and stock, but after the invoice is finished the fields you have selected may be passed to related files.

EG: Send fields <0>, <1>, <6>, <7>, <11>, <12>, <13>, <19>, <20> to a sales ledger.
Then send fields <9>, <10>, <11>, to product analysis file.
Then send fields <0>, <1>, <7>, <19>, <20> to V.A.T. file
Then send fields <10>, <11>, <12>, <13> to Nominal ledger.

● Circle No. 119

Buy our £475* Daisy Wheel Printer for your computer and you have an Electronic Typewriter absolutely FREE



The T/Printer 35 is the lightest weight and lowest cost daisy wheel printer you can buy for your computer. So it will fit within your budget and you can carry it wherever you take your micro. Yet it is tough enough to give years of reliable service. Interchangeable typefaces (standard Olivetti 100 character daisy wheels), variable pitch, multiple copies—all the features you would expect of more expensive word processing printers.

Yet the T/Printer 35 costs only £475 with parallel interface. Operating speed under computer control is approximately 120 words per minute of letter perfect output. What typist can equal that?

Then when you're finished using it as a computer printer, the T/Printer 35 is ready to go right on working as an electronic typewriter.

That's the dual-purpose T/Printer 35—the versatile computer printer that fits your budget.

Orders are shipped within the UK carriage-free. To order or for more information about the T/Printer 35:

**The T/Printer 35 costs £475 with Centronics compatible parallel interface. With RS-232C interface it costs £535. Prices listed are exclusive of VAT.*

DATARITE

Datarite Terminals Ltd
Caldare House
144-146 High Road
Chadwell Heath, Essex RM6 6NT
Tel: 01-590 1155

● Circle No. 120

Terminals—who needs them?

WHY BUY a terminal to hook on the end of a mainframe, when an IBM PC is more powerful? And if you don't have a mainframe, then you just buy a lot of PCs and string them together.

The GCS Series II cluster controller allows the PC to be connected to a 3270 network. It also allows you to include an Apple II and a Calcomp plotter — the South Eastern Gas Board has just done it. The controller, however, costs from £2,140. Contact GCS by phoning 01-579 9401.

Another approach is Irma, an interface card that fits one of the PC's expansion slots. This leaves the PC free to run under its own operating system, but provides 3270-type communication to the mainframe. KPG points out that a PC with Irma is only a little more expensive than a 3278 terminal, but much better. Contact KPG at 04446 2519.

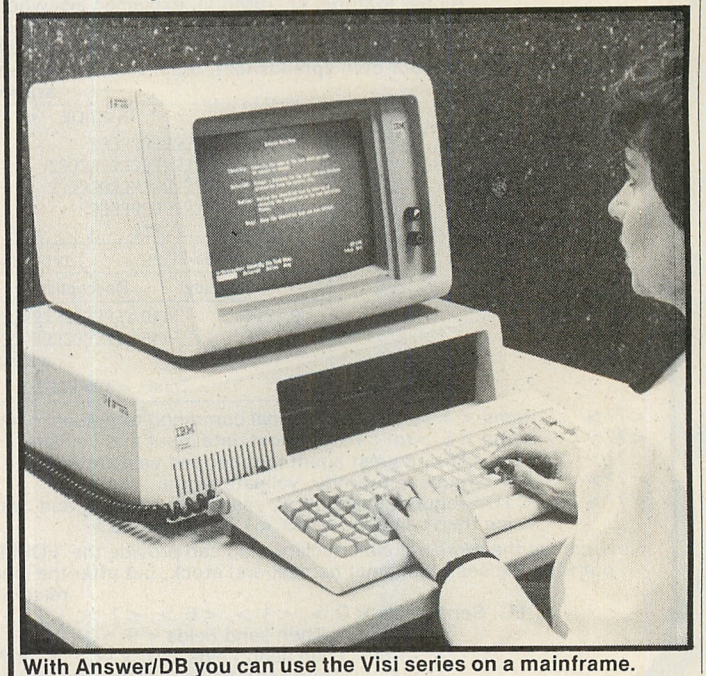
The Rental Research 2210 controller allows the PC to emulate a 5251 or 5291 terminal on Systems 34 and 38, or a 3278. The 2210 can be connected directly via a coaxial cable, or via a Modem. Contact Rental Research Ltd, at 2 London Buildings, London Wall, London EC2M 5PP.

Linking a PC to a mainframe is one thing, but extracting useful data is another. Visi-Answer could be the solution. The catch is that the mainframe has to be running the Informatics database Answer/DB. If it is, VisiAnswer will extract data which can be used with the rest of the Visi series. Contact Informatics at 01-242 0770 or VisiCorp's distributor Rapid Recall at (0494)38525.

Suppose you want to link a PC not to IBM but to DEC equipment. Saturn has the answer: the VT-100/VT-52 emulator. It costs £99 plus VAT from Pete & Pam Computers. Telephone: Rossendale (0706) 212321.

There are numerous options for networking using a hard disc as a file server. Data Design Techniques offers the Microdisk PCnet local area network to link "up to several hundred" PCs to one of its hard discs, which range from 6Mbyte to 54Mbyte. PCnet is Ethernet compatible. Contact DDT at Welwyn Garden 34774.

Independent Computer Engineering offers the ICE Multiplexor. It is suitable not only for the IBM PC but also for the Sirius, Apple IIe and other micros. It uses a Z-80 control card, and is suitable for linking to one or two Rodime 40Mbyte hard discs. Contact ICE at 07842 47271.



With Answer/DB you can use the Visi series on a mainframe.

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The TIGER was designed with the user in mind. Apart from its obvious aesthetically pleasing appearance and excellent use of ergonomics, the TIGER performs. The price and performance meets the needs of the smaller business but, because of its built-in modem, with the capability of access to Prestel, the TIGER is a powerful communications tool. Comprehensive interfacing ports mean TIGER can support advanced data communications to other terminals, minicomputers, and large corporate mainframes. With outstanding colour graphics, the TIGER is a compelling selling proposition.

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- **RS232**
- **Network Data Link**
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- **Keyboard** – Expanded QWERTY, non reflective key-caps, numerical pad and cursor controls. Ten coloured definable function keys. Special ergonomic design.
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PC683

● Circle No. 121

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The Apple logo is a trade mark of Apple Computer Inc. VisiCalc is a trade mark of VisiCorp.

● Circle No. 122

London Fair set for record turnout

The Computer Fair will be held at Earls Court, London, on June 16-19. Opening times are Thursday 1pm to 6pm, Friday and Saturday 10am to 6pm, Sunday 10am to 5pm.
Admission prices are: adults £3, children under 16 and senior citizens £2. See the advertisement in this issue of *Practical Computing* for your £1 reduction voucher.

OVER 38,000 people attended the first Computer Fair in London last April, and saw Sinclair surprise everyone with the launch of the Spectrum home micro. This year even more people are expected to be along to see the Microdrives — at long last. And to see if Clive Sinclair has anything else up his capacious sleeve.

But Sinclair will have a lot of rivals. The 1983 Fair will be more than four times as big as the 1982 one, with most of the major companies taking part.

The Commodore Business Machines stand is expected to draw crowds to see the new Series 500 and 700 micros, with a 700 running the new word processor Superscript II. On the Commodore 64 they will be shown Precision Software's new database package Superbase. But the highlight will be the chance to see Commodore's portable version of the 64, shown for the first time in Hanover.

Texas Instruments will be showing its two new micros, the CC-40 portable and TI-99/2 black-and-white low-priced model. They will be shown with the "tower of power" of stacking peripherals including a floppy-tape disc substitute. Texas is also expected to demonstrate its full-feature version of Multiplan on the TI-99/4a.

The Dragon and Acorn stands will attract the curious, as these two companies are the subject of considerable speculation at the moment. Dragon is supposed to have a new 64K micro almost ready for launching. Acorn is known to be almost ready to launch the Electron, which will offer most of the facilities of the BBC Micro but at a much lower price.

BBC Micro owners will find much to interest them on the Leasalink and Microware stands, with disc drives to rival the Acorn offerings.

And for Sinclair owners there will be, as before, a whole Sinclair Village, including stands for Memotech, Picturesque, Shiva Publishing and Elfin Software. Shiva will be showing a Spectrum Machine Code system, and Imagine some games from its new range.

Llamasoft, Bug-Byte, Quicksilva and Salamander Software are among the many companies who will be showing a range of games and other software at the show.

Many inveterate games players will be drawn to the Atari stand to play arcade-quality versions of Defender, Asteroids, Missile Command, Centipede and other games — without having to feed the machines 20p a go. Atari will also be showing a new plug-in ROM Atari Writer word processor, and the standard VisiCalc.

Business users will find a number of stands of special interest. Commodore, Encotel Systems, A-One Computers and others will be showing professional systems including the Sirius and IBM PC. Among the many interesting items of software on display will be Sosoft's Tomorrow's Office and Southdata's Superfile. KGB will be emphasising graphics and CAD applications on the Sirius and Superbrain microcomputers.

One of the special features of the show will be finals of the British Micromouse competition, with the winning mouse going on to the Euromouse final in Madrid in September.

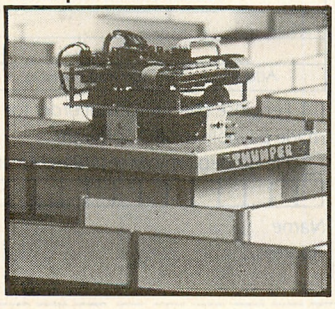
Now that most mice can navigate the maze successfully, the emphasis this year is expected to be on speed. Will Thumper's rivals have aerodynamic styling and racing-car "wings"? Come and find out. out.

The hours of 10am to 1pm on the opening day of the show will be "trade only" to allow dealers an uninterrupted preview of the new products on display.

The Computer Fair is sponsored by *Practical Computing* and *Your Computer* magazines, and organised by our associated company Reed Exhibitions. *Practical Computing* will have a stand where you can buy current issues, back numbers and binders. There will be a special cut-price offer for those taking out a subscription, and we will be introducing a new trade magazine called *Micro Business*. The staff of *Practical Computing* will be there from time to time, and happy to chat if you manage to pin down one of these rare and elusive creatures.

Arrangements have been made with British Rail to offer special tickets which include return travel to a London BR terminal and entrance to the Fair at very reasonable rates. For example, from Hampshire the fare is £10 and from Greater Manchester £21. For details contact The Travel Centre, Kings Cross Station, London NW1 9AP.

Thumper in the maze.



Exhibitors

Computer Fair exhibitors include:
Computers For All, Microware, Acorn, Commodore, Microstore, KGB Micros, Micropower Business Applications, Quicksilva, C Tech Software, Camputers, Sinclair Research, Chromasonic Electronics, Welsh Development Agency, Jade Computers, Imagine Software, Opus Supplies, The Computer Bookshop, Advanced Media, Titan Programs, Microage Electronics, Dynatech, McGraw-Hill, Leasalink Videwdata, Sosoft Overseas, Cable U.K., Stirling Microsystems, Vergecourt, Disking International, Atari, Westrex, Rabbit Software, Dragon Data, Micronet 800, SBD Software, Jupiter Cantab, Comshare, Kiltdale, Incoms, Encotel Systems, Chatterbox Computers, A-One Computers, Pase Computers, Maplin Electronics, Salamander Software, Microdeal, Kempston Micro Electronics, Database Publications, Advanced Micro Technology, Electronequip, Germain Video, A F Software, Albeta, Southdata, Midwich Computer, Stack Computer Services, Timedata, Basicare Microsystems, Downsway Electronics, Anirog Computers, D K Tronics, Silversoft, Bug-Byte, John Wiley, Artic Computing, Computer Junk Shop, Llamasoft, Appropriate Technology, Miniature Tool Co, Shards Software, C J E Microcomputers, Kayde Electronics, Southern Software, Oric, Addison-Wesley, Texas Instruments, Audio Computers, Honeyfold Software, Kansas City Systems, Carnell Software, Kuma Computing, Stonechip Electronics, J R S Software, Northwish, Fuller Micro, Shiva, A G F Hardware, M C Lothlorien, CPSoft, Addictive Games, Print & Plotter Products, Abbex, Picturesque, Interface, Cheetah Marketing, Elfin Software, Data Assette.

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Nibble Express Vol. 2	£12.50
Nibble Express Vol. 3	£13.50
Peeking Vol. 1 (1978 Call Apple)	£10.50
Peeking Vol. 2 (1979 Call Apple)	£15.00
Peeking Vol. 3 (1980 Call Apple)	£20.00
Peeking Vol. 4 (1981 Call Apple)	£20.00
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Power of Visiplot	£10.95
Power of Multiplan	£10.95
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What's Where in the Apple	£15.95

ATARI

Atari Software – The Book '83	£12.50
Games for the Atari	£6.50
How to Program your Atari	£7.95
Kids & the Atari	£14.95

VIC

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Tricks for Vics	£7.95

IBM

The Power of 123 for the IBM-PC	£10.95
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80 column card for the Apple IIe.
Fits into the central slot of the Apple IIe.
Upgradeable to include another 64K simply by adding memory chips, and your machine becomes a 128K machine.

£80.00

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.....T10

● **Circle No. 123**

West Coast arena

Carl Peterson reports back from Silicon Valley's fair.

THE QUAINTLY NAMED West Coast Computer Faire at San Francisco is really Silicon Valley's annual community get-together rather than a big international trade show. However, it is quietly significant, and new products that first saw the light of day there include Apple in 1978 and Osborne in 1980. By now the industry is too big to be overwhelmed by a single new product. You could just say that 1983 is the Year of the Mouse.

The Access Portable Computer from Access Matrix Corp. of San Jose, California tries hard to be the best-equipped portable on the market. It is a Z-80A based CP/M machine only 16in. long, within which it packs a 7in. diagonal amber screen of 80 columns by 25 lines, two 184K diskette drives, a neatly concealed printer — an Epson MX-80 without its casing — and a Modem. The Modem even has an acoustic coupler with the soft rubber sockets ready to receive your phone handset.

Included in the $2,495 price are 64K of RAM, high-resolution graphics, MBasic, CBasic and a set of Perfect Writer software: Speller, Filer and Calc. Weight is an arm-wrenching 33lb., some 5lb. more than the Osborne. The Access is now reaching the American computer stores, though with none for export as yet. It should sell for well under £2,000 in Britain, not bad for the computer, Modem, software and printer.

Canadian manufacturer Dynalogic had the 21lb. Hyperion portable available from dealers' stands — or "booths" as they are called over here. The prototype was shown at Compex Las Vegas, but now it is in production and available. It is said to be IBM PC compatible. Your IBM PC programs ought to run on computers that make this claim, and in practice well-known packages like WordStar and VisiCalc do so. Others might not, or may require a little hexadecimal patching.

As IBM PC software is now, with Apple and CP/M, one of the Big Three in distribution and availability, compatibility is quite an important point. Some say that some of IBM's PC-DOS is not on the DOS diskette but deeply encrypted within the ROM chips. Even if PC-compatible makers could manage to copy it in every detail they would then run straight into copyright problems. The significance for users is that you could buy a so-called "compatible" machine this year, find the compatibility is pretty good, and then run into trouble next year when IBM brings out a new release of DOS. There is no guarantee it will run on your computer, and you might also find that the WordStars and VisiCalcs of the future will only run under the new DOS.

The Kaypro II portable is just such an example. Though ugly to European eyes, it is a best-seller in the Osborne market. It offers an even more comprehensive software package and a really clear, amber-tinted 80-by-25 screen. Similarly styled but truly tiny is the all-new Jonos C-2100 Portable Computer measuring 17in. by 13in. by 7in. and featuring Sony 3.5in. disc drives.

The delightful but expensive Otrona Attache is another CP/M portable we tried out. This one is plastic cased with a neat and lightweight folding stand to tilt it up towards the user. It is a similar size to the Jonos, but it manages to squeeze in 5.25in. floppies, which helps the software availability.

Yet more IBM-compatible portables were announced — at $899 and $150 and with guaranteed 100 percent compatibility on all software. The only snag is that you have to start off with your own IBM and use some of the bits and pieces, including the main system board with its ROM and processor.

The Colby PC-1 from Palo Alto in the heart of Silicon Valley is the dearer of the two and provides a neatly styled casing to take the IBM system and expansion boards — there is space for four only as the neck of the new monitor obstructs the fifth. It has a very clear 9in. display and a neat keyboard with all the functions of the IBM but is only two-thirds the size and one-third the weight. There is room for one IBM-type disc drive or two half-height ones. The whole transfer job needs only one screwdriver but takes an hour or more each way.

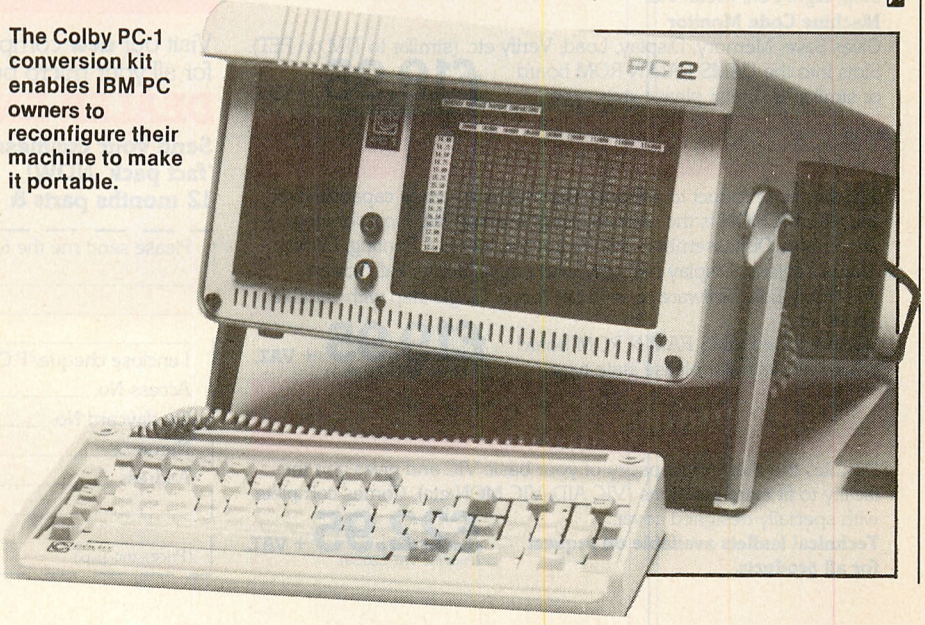
Well-known IBM PC add-on maker Apparat Inc. from Colorado is responsible for the $150 portable. It is a conversion from the IBM-PC by the brilliantly simple expedient of removing the right-hand disc drive and substituting a video screen of about 6in. diagonal in its place. It was up and running at the Faire, giving a surprisingly clear display in the small space available.

Apple's Lisa was on demo though it is still several months away from mass production. The mouse feature for remote cursor control can already be bought from more than one supplier; I bought one for the IBM PC. The package includes the animal itself with mains adaptor and RS-232 interface, an aluminium base plate over which the mouse moves, and a diskette containing a few short programs which must be copied to your WordStar, VisiCalc, etc.

Personal computers may provide excellent exercise for the fingertips, but not for much else. For micro owners worried about this, Exersoft Corp. — note the name — produces the Foot-Craz software for Atari and, soon, for the Apple too. This software is truly soft, consisting of a foam-filled floppy doormat printed with five different colour dots.

You also get a diskette or tape containing two games, the better of which is called Stomp. It is an oval-track running game in which you have to catch up and destroy the bug — or avoid being caught up and destroyed. The only way you can propel the Me symbol is by running on the spot on the mat, and at the right instant stamping on the appropriate dot to destroy the bug. It is totally exhausting but a marvellous game, and the whole thing retails at only $55.

Exersoft also showed a racing-car or Grand Prix style game. You play it in conjunction with an exercise bicycle to which a pair of steering sensors are attached. To do well you have to pedal like crazy. Price is $60 — bicycle not included.



The Colby PC-1 conversion kit enables IBM PC owners to reconfigure their machine to make it portable.

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Coming Forth

"Writing assembly language programs can be a real chore, but modifying code previously written by someone else is the kind of job they hand out medals for."

IF STATEMENTS like that make you snuggle even closer to your trusty Basic interpreter, just remember that the average Basic program can run up to 1,000 times more slowly than an efficiently coded assembly-language routine. For many control applications that could never be tolerated. Even compiled languages like PL/M are a lot slower than assembler. Worse still, they need a big expensive development system before one can even think of using them.

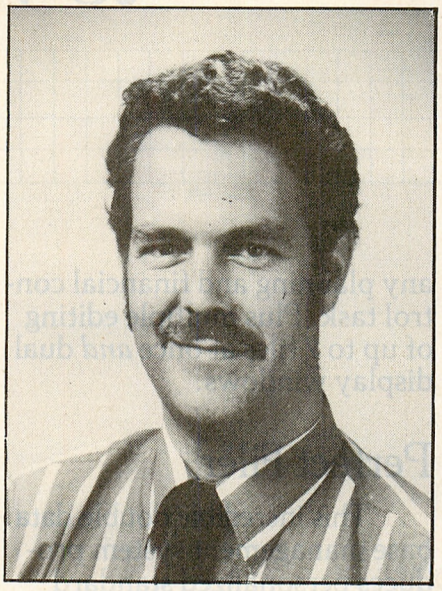
What is needed to resolve this dilemma is a language which provides the simplicity of Basic, but has a speed approaching that of assembler and a low, low price tag for the development hardware. The need has been recognised for a number of years and there have been various attempts at a solution. But until now there has been no single solution with the three essential virtues of simplicity, speed and low cost.

One of the earliest contenders was the 2K Tiny Basic which needed only a simple microprocessor board to act as both development and target system. This was fine if the system was not in a hurry, but since in most control applications speed is a paramount consideration most designers stayed with assembler and accepted the aggravation.

Another possible solution since the 1960s is the unique Forth language, which is different in almost all respects to any other high-level language you may know. Forth is a threaded-code language in which basic "words" or procedure calls are strung together to build new user-defined words. These are then added to a dictionary. This technique generates much faster and more compact code than interpretive languages like Basic but in the past Forth has been limited by its need for an expensive disc-based development system.

In the future it will be possible to enjoy the speed and simplicity of Forth with the low hardware costs typical of Tiny Basic, thanks to some new devices from the Rockwell 6502 family. The R65 F11 and the R65F12 are single-chip microprocessors based on the now famous 6502 with the addition of on-chip RAM, I/O and 3K of internal ROM containing the run-time Forth package. The only difference between the 11 and 12 is the number of parallel I/O lines which each can provide. The 11 lives in a cheap 40-pin package and provides 16; the 12 lives in a 64-pin package and provides 40.

Each processor can address up 16K of external memory, and has a 128-word run-



time Forth dictionary in the 3K of internal masked ROM. In a target application an external EPROM would contain the main program, threading together the internal Forth words which include stack operators, control structures, I/O control, memory reference and both 16- and 32-bit arithmetic operators.

To make a development system an R65F11 or 12 is used together with an

by Ray Coles

external R65FR-1 8K ROM chip, which contains an additional 100 Forth words not included in the microprocessor ROM. The chip provides development-orientated features and includes utility routines such as a PROM programmer, terminal handler, and disc I/O functions, in addition to a Forth compiler which can generate ROMable code for a target system. Using the R65FR-1 it would be possible to build a simple development system which would fit on a small circuit board and cost very little. Perhaps the era of the simple high-speed controller has arrived at last.

The age of the 64K memory chip has already dawned. Most personal computers now come equiped with at least a row or two of 16-pin sockets eager to accept industry-standard 64K by one-bit dynamic RAM chips.

The trouble is, for some applications 64K bytes is too much memory anyway, and the refreshing logic required by all dynamic RAMs can be a real pain. At this point the small-system designer used to have two choices: use old-fashioned 16K dynamic RAMs and accept the refresh penalty, or more likely use static RAMs and accept a fourfold cost-per-bit premium. Very soon this unpleasant choice will be a thing of the past because there are now two new ways to buy state-of-the-art 64K technology.

From Intel comes the 2186/2187 64K dynamic RAM, which is organised as 8K by eight bits to provide the lower cost of high-density 64Kbit technology in a memory package suitable for use in small systems. These new Intel devices do not need the external refresh logic normally essential for the recharge of otherwise forgetful dynamic memory cells.

Memory-refresh cycles are initiated by an on-chip timer with a period of about 15 milliseconds, which requests service in competition with normal system memory-access needs. Sequence logic resolves conflicts on a first-come-first-served basis. It can generate a "busy" signal to an attached microprocessor during a refresh cycle so that a wait state can be entered. The chips also have refresh address counters.

The 2186 and 2187 are both housed in 28-pin dual-in-line packages employing the same industry-standard pin-out used for other byte-wide EPROM and RAM chips. Thus, with the minimum of links, sockets can be configured for a range of different memory types. The only difference between the two devices is that on the 2186 pin 1 is used as a Ready output, while on the 2187 pin 1 acts as a Refresh Enable input.

In the days of early dynamic RAM technology it was said the difference between dynamic RAMs and static RAMs was that static RAMs work and dynamic RAMs don't. The bad reputation unfairly earned by dynamic RAM devices still causes some people to avoid them, but even the anti-DRAM brigade can now sample the delights of 64K density, thanks to Hitachi.

Despite the traditional four-fold density advantage normally enjoyed by the single-transistor dynamic-bit cell over the multi-transistor static cell, Hitachi has somehow managed to produce a memory chip which contains 8K of static CMOS memory. The resulting HM-6264 is a monster instrument containing 400,000 separate active devices on a silicon die about 6mm. square, with individual device geometrics defined down to 2μm. Like the Intel DRAMS it comes in a 28-pin package and uses the standard byte-wide pin-out.

With so much in such a small space the chip would normally be intolerent of the microscopic defects to be found in any silicon die, defects which could kill single memory cells and result in the rejection of the complete device. Hitachi has included spare memory cells which can be connected up by laser if found necessary during the testing phase.

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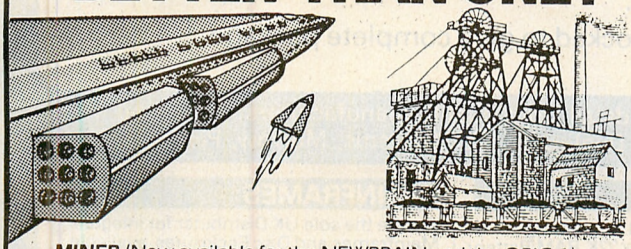

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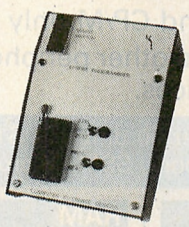

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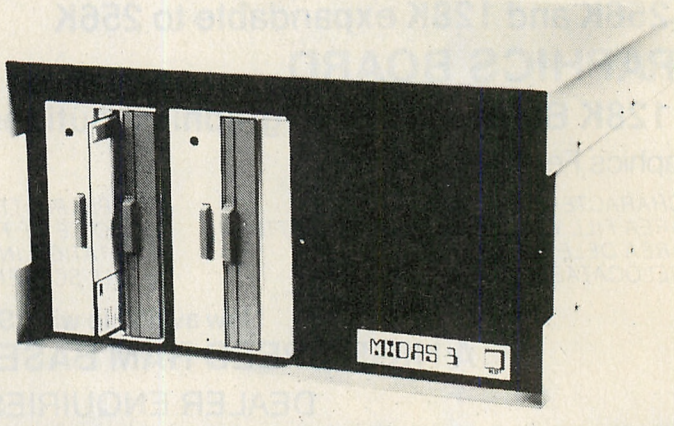

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The CO4 criteria

Boris Allan argues that the conventional classification of computer languages should be abandoned in favour of a novel system based on function.

EVERY COMPUTER LANGUAGE exists to serve a purpose, though the purpose of some may be difficult to divine. Programming languages play a central part in computing at all levels — probably because a computer cannot operate without being instructed via some language or other.

There are so many debates and types of debate about the correct language to be used or taught, that I felt a means of typifying computer languages in tems of their function would be useful. After considering other aspects which are held dear by commentators, I decided that it would be of less value to try to classify languages in terms of whether the language was structured or had good file-handling facilities.

To take the case of structuring, there is often a continuum along which languages might be placed. But control structures and data structures seem to vary independently of it.

Any system would seem to have to be evaluated on four functional requisites:

Communication — how the user communicates with the program.
Computation — how the program proceeds with its calculations.
Co-ordination — how the various parts of the program are integrated together.
Constitution — what are the rules which govern *inter alia* data types and program structure.

These are what I term the CO4 criteria.

Communication is the way in which the program is adapted to the computing environment. Computation concerns the ways in which goals of the program are attained. Co-ordination concerns how the program as a whole is integrated. And constitution deals with the philosophy of the language as a whole, the set of values incorporated in its definition and description.

On examining a new language it is sometimes clear that the language was developed by considering communication first and constitution last — sometimes the constitution comes first and communication last. Perhaps, possibly unfairly, communication came first with Basic, and last with Pascal.

When talking of communication, I make one simple assumption: the user or program writer always uses a remote keyboard for input of programs, and always receives output on a VDU with attached printer if need be. I make this simplification because arguments about the use of batch methods, and similar, do not require card input or line-printer output to establish their distinctness.

The first mode of communication I term reactive — the user types in a line and it is instantly obeyed by the system. It is not true of Basic though there are instant statements. There are certain aspects within truly reactive communication which do not seem to be instantly reactive. For example, in the definition of functions a definition is instantly translated and stored for later use. Forth, APL, Lisp, and Prolog are languages which I would class as reactive.

In an inter-reactive language although the entering, listing and executing are all performed by one system, there are special commands to run the program or list. Execution, for example, is not automatic. The best example of inter-reactive communicaiton is Basic: when a line of Basic is entered it is stored ready for use when the command Run is given; but the command Run is part of the Basic system, and you do not have to leave the system to use a program translator. Many interactive languages — Comal, for example — are of this type. They are not fully reactive but partially reactive — they are inter-reactive.

The last category of communication is non-reactive and is closest to what we might call batch processing. In a non-reactive communication environment the program is entered, translated by a different system to produce translated code, and then the code file is executed by yet another system. This form of communication is generally used by larger computers, especially where most input is by punched cards. It is typical batch processing, though sometimes the stages are disguised to the user. To alter the program you enter a new system and then follow the translation and execution stages all over again. Examples of non-reactive languages are Cobol, Fortran IV, and Pascal. Partly because editing programs is extremely difficult, there has been a good deal of concern about minimising errors — a concern of less relevance for reactive languages.

That a language is reactive is not an afterthought, it should be the first decision taken. It is not so essential for inter-reactive languages as it does not affect program design to such an extent. For some of the non-reactive languages the designers worked out the constitution and everything followed from that.

Most languages have procedural computation and are sometimes called, not too accurately, procedural languages. That is they start at the beginning and go through the program step by step. Basic is a case in point, as are Pascal, Cobol and many others. If a language uses procedural computation it must communicate either non-reactively or inter-reactively.

Languages such as Lisp, Pop 2 or APL use functional computation — each line as it is is typed in is evaulated and delivers a result. For example, the Lisp line

```
SUM 2 3
```

produces the instant response 5, and the line is instantly forgotten. In Pop 2 the line

```
2+3
```

leaves the result 5 on the stack. A reactive programming language has to have a functional form of computation or similar. I call this method functional because functions, that is Sum or +, act instantly on the values, say 2 and 3, and the language computes by use of functions and operators.

The relationship between communication and computation is complex. A language with any form of computation is possible with an inter-reactive or non-reactive communication environment — a functional language may not make sense in a non-reactive situation, but it is still possible. If you want true reactivity it is difficult to see how a language other than one which uses functional computation can work.

All programming languages worth considering allow modular programming. Modular means the ability to take an application and split it into chunks, which might contain smaller chunks, etc. If modularisation is to be useful it requires a language with routines, subroutines, procedures, or functions, or words. Any

(continued on next page)

Languages and CO4 criteria.

	Communication	Computation	Co-ordination	Constitution
Algol 68	Non-reactive	Procedural	Non-linear	Elaborative
Basic	Inter-reactive	Procedural	Non-linear	Typed
BCPL	Non-reactive	Procedural	Linear	Non-typed
Cobol	Non-reactive	Procedural	Linear	Typed
Forth	Reactive	Functional	Linear	Non-typed
Fortran IV	Non-reactive	Procedural	Non-linear	Typed
Lisp	Reactive	Functional	Linear	Non-typed
Pascal	Non-reactive	Procedural	Linear	Elaborative
Prolog	Reactive	Functional	Linear	Non-typed

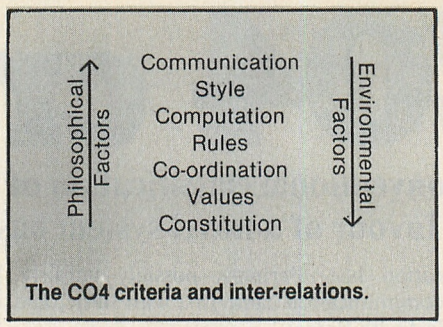
(continued from previous page)

useful language will have such a facility. Most machine codes have a Jump to Subroutine and Return from Subroutine command.

As subroutines are the best way of achieving integration within a program, they are obviously important — but in what way? The first distinction could be subroutines with parameters or without parameters. Unfortunately, or perhaps fortunately, this distinction is becoming less of a distinction as time progresses. Another declining distinction is between languages which allow recursive calls to subroutines, and those which do not.

The most important single distinction is languages which force a linear approach to the program, not to be confused with a procedural approach. In the linear approach to integration it is not possible to use any item unless the system already knows of its existence — the system will not "wait and see". In Forth, or any other functional language, a function cannot be evaluated unless its definition has already been given to the system. In functional languages such as Pop 2 it is possible to change the definition of function. In Forth you cannot redefine unless you erase all functions subsequent to the original definition.

In Fortran IV there is a sense of linearity because the main program precedes the subroutines, but it is not linear in that if a name is encountered its designation is left



The CO4 criteria and inter-relations.

until all information is available. Basic takes an even more flexible stance: subroutines can be forward or backward of reference. Basic and Fortran are non-linear.

The co-ordination and computation criteria are related. If a language uses functional computation then it almost certainly uses linear co-ordination.

Moving from communiction to co-ordination, your ability to compartmentalise within each criterion declines. When using communication as a criterion the three forms of reactivity are fairly self-evident. By the time co-ordination as a criterion is used such clarity is unavailable.

When you come to the criterion of constitution it is almost impossible to find simple categories. There are obvious differences: some languages are designed for teaching computer programming, that is Basic or Pascal; some, such as Prolog or Lisp, are aimed to be of use in A1; and Forth was designed to point radiotelescopes.

A classification which might be relevant is non-typed, and elaborative languages. A few languages are type-less in that no distinction is drawn between types of variables. BCPL is the best example of this style of language. Forth is effectively non-typed because once a number or an address is on the stack, it is treated purely as a number. The user must decide what it is.

A typed language makes distinctions between types of variable. In Fortran one can distinguish between real, double-precision, integer, and logical variables, which is also the case in most Basics.

An elaborative language allows the user to construct more elaborate types from simple modes. Usually elaborative languages have a mechanism for pointers, useful in list processing. The high point of elaborative languages is Algol 68, perhaps the most flexible of all elaborative languages.

The relationship between constitution and co-ordination can vary. In languages such as Pascal or Algol 68 the constitution is most important; the language existed before there was a computer to run Algol 68. In the case of BCPL the lack of typing was an initial decision, which together with a desire to provide a rich set of control structures influenced the entire design. Threaded interpreted languages, such as Forth, start from communication and grow upwards towards a constitution. The relationship between co-ordination and constitution is one of values, the implementation of values or the discovery of values from co-ordination.

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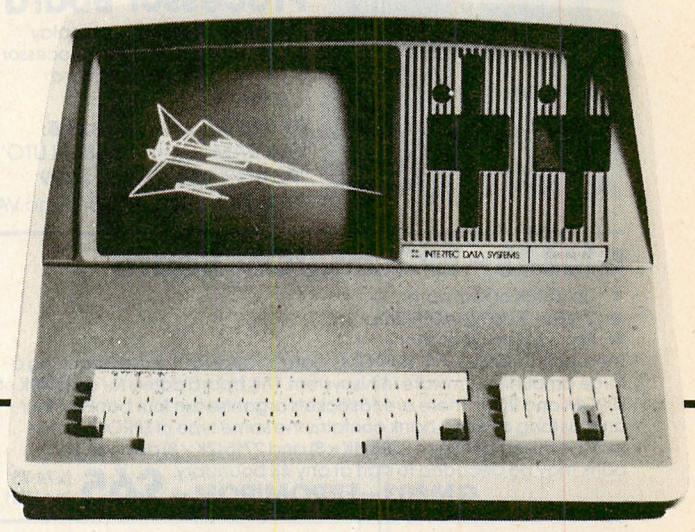

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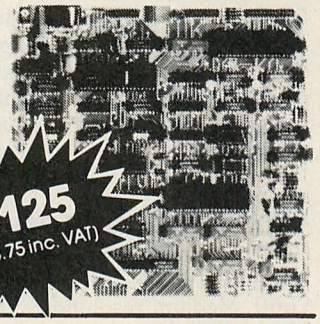

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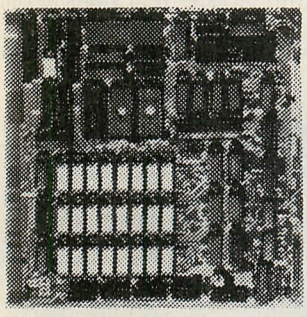

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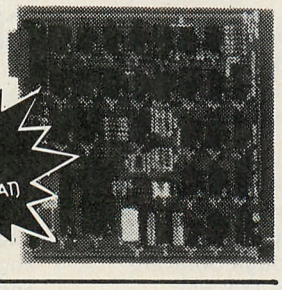

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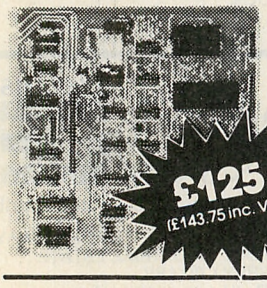

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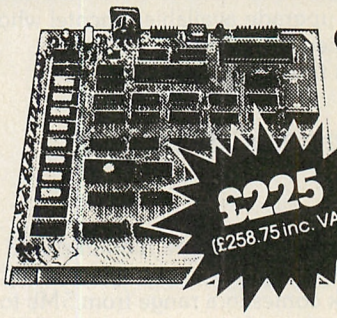

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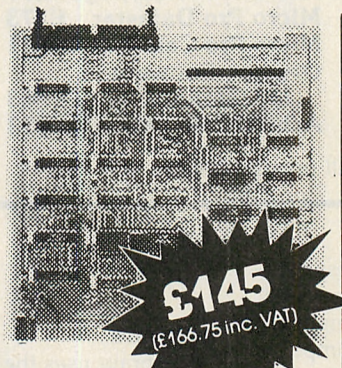

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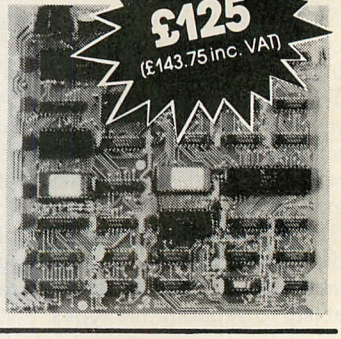

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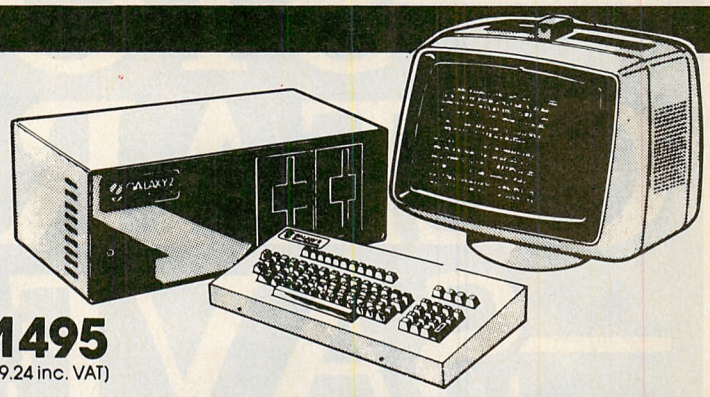

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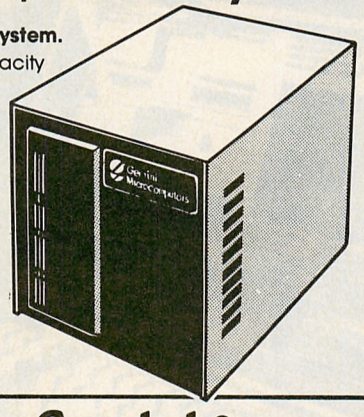

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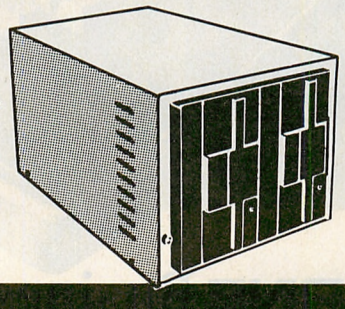

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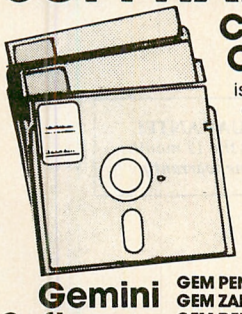

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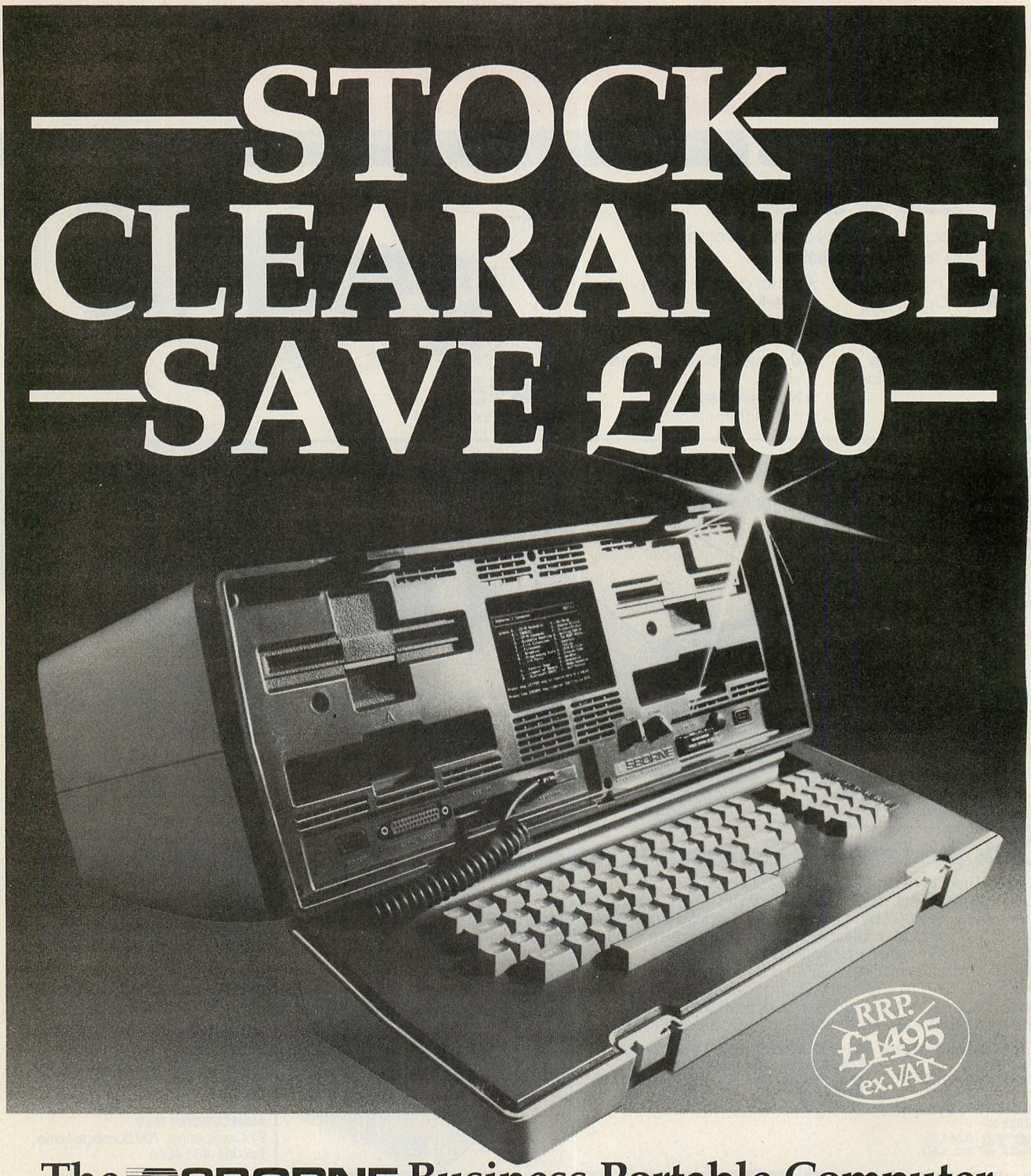

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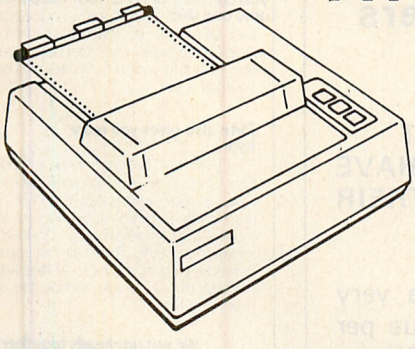

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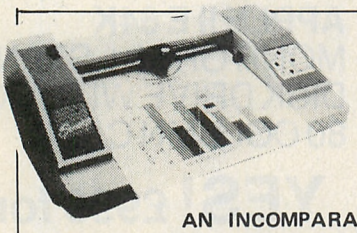

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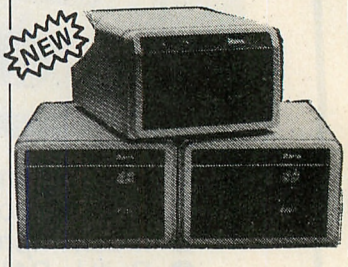

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Rana has an advanced write protect feature which makes it impossible to lose your information. A simple touch on the front panel's membrane switch gives you failsafe control. Apple of course only has a notch or tab, which gives you only minimal protection. **With the superior Elite controller card, you can control up to four floppy disks using only one slot.** With Apple's you can only use two. Of course, you can still plug into Apple's controller card, but down the line you'll want to switch to Rana's and save yourself a slot.

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Even our most economical model, the Elite One, gives you 14% more storage than Apple's. 163K versus Apple's 143K. With our Elite Two offering 326K and our top-of-the-line Elite Three offering a 356% storage increase at 652K. That's almost comparable to hard disk performance, all because of our high density single and double sided disks and heads.

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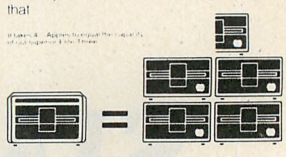
We designed the Elite Three to give you near hard disk capacity with all the advantages of a minifloppy system. The double sided head operates on 80 tracks per side, giving you a capacity of 652K bytes. It would take 4½ Apples to give you that.



The Elite Two offers an impressive 326K bytes and 40 tracks on each side. This drive is making a real hit with users who need extra storage, but don't require top-of-the-line capacity.

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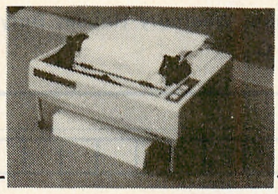

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How is it possible? It's all down to ACCELERATOR II. This new plug-in board from Pete & Pam Computers contains a 6502C Processor and 64K of memory. The board runs all native Apple II software, including programs written in Applesoft, Integer, Machine Code, Pascal, Apple Fortran 77 and Forth.

Amongst the many thousands who could benefit from ACCELERATOR II are users of Visicalc, DB Master, Micro Modeller, Multiplan Tabs, and Systematics.

SUPER FAST

In November 1982, PCW published a bumper round up of all the Benchmark Timings since PCW began. The Olivetti M20 came out top of the 'league' with an average Benchmark timing of 11.5. Running the same Benchmark test programs, the Apple II Plus with Accelerator II averages a timing of 8.58 – that's an incredible 25% faster than the Olivetti M20.

We have reproduced some of PCW's findings, incorporating Benchmark Timings for the Apple II Plus with Accelerator II.

Machine	BM1	BM2	BM3	BM4	BM5	BM6	BM7	BM8	Average
Apple II Plus with Accelerator II	0.3	2.4	4.5	5.0	5.5	8.2	12.9	2.98	8.6
Olivetti M20	1.3	4.0	8.1	8.5	9.6	17.4	26.7	1.6	11.5
IBM Personal Computer	1.5	5.2	12.1	12.6	13.6	23.5	37.4	3.5	17.6
Osborne 01	1.4	4.4	11.7	11.6	12.3	21.9	34.9	6.1	19.9
Intertec Superbrain	1.6	5.2	14.0	13.9	14.8	26.3	43.2	5.6	21.9
Apple III	1.7	7.2	13.5	14.5	16.0	27.0	42.5	7.5	24.7
ACT Sirius 1	2.0	7.4	17.0	17.5	19.8	35.4	55.9	4.3	24.8
Xerox 820	1.7	5.5	15.5	15.1	16.2	28.9	46.1	8.0	26.1
Apple II	1.3	8.5	16.0	17.8	19.1	28.6	44.8	10.7	30.4
Commodore CBM 8032	1.7	10.0	18.4	20.3	21.9	32.4	51.0	11.9	34.3

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- write a macro assembler in FORTH for the 6502

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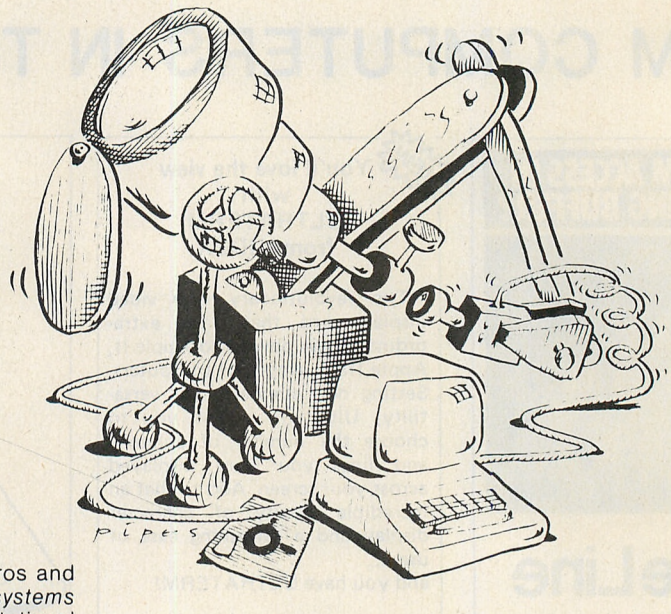
All this is combined with our usual comprehensive news and reviews section.

For people who are seriously interested in micros and their applications, *Microprocessors and Microsystems* comes out monthly and is available to institutional subscribers, individual subscribers and as single copies.



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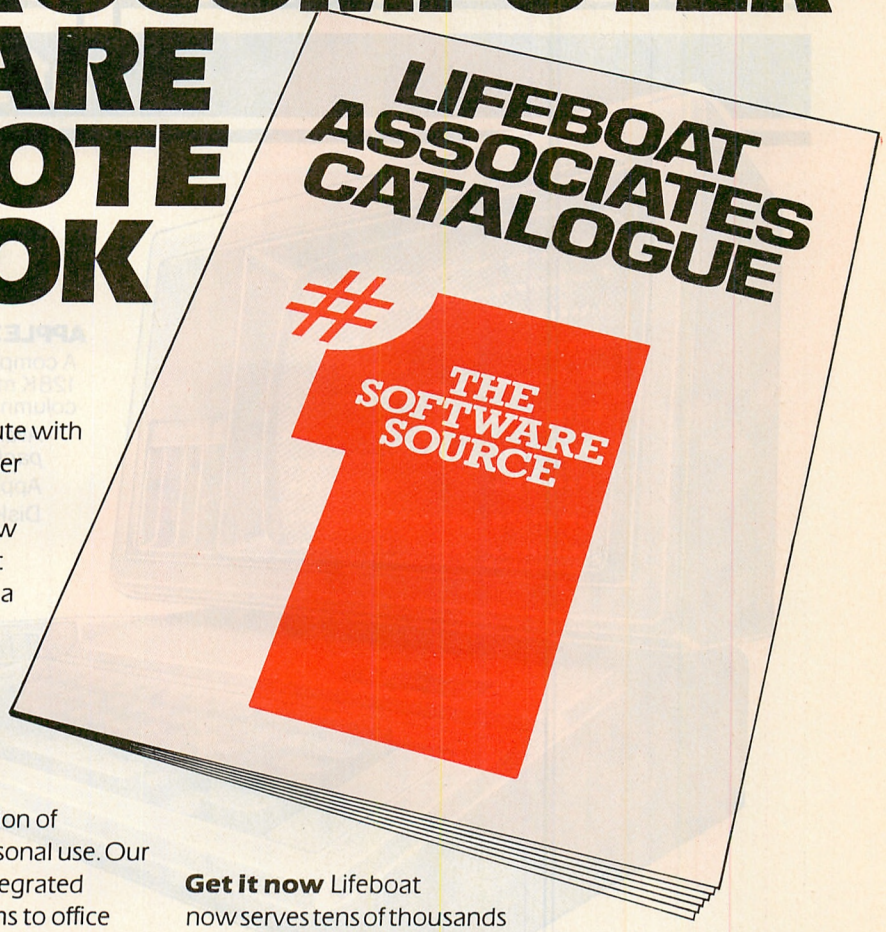

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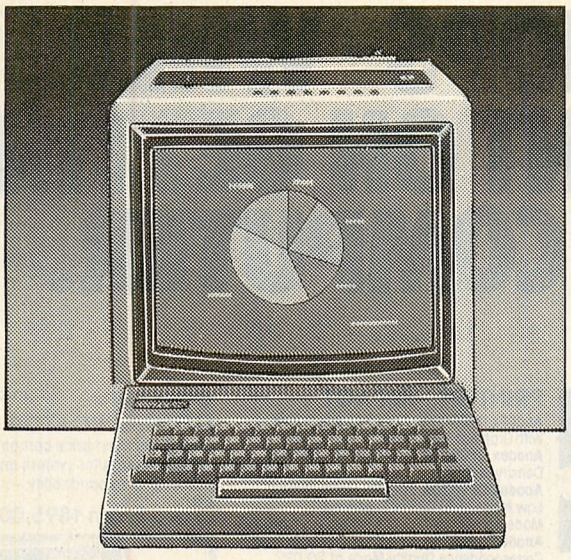

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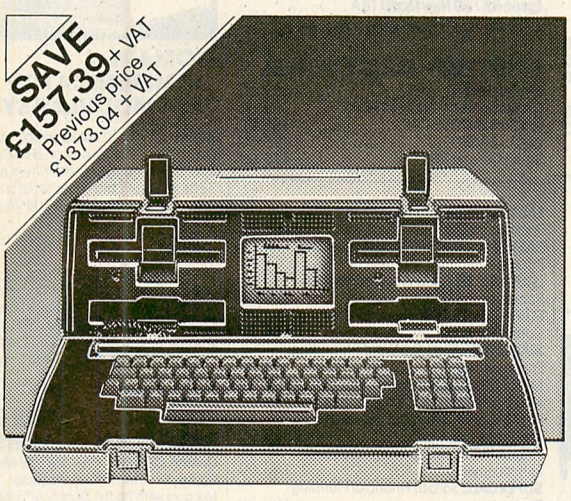

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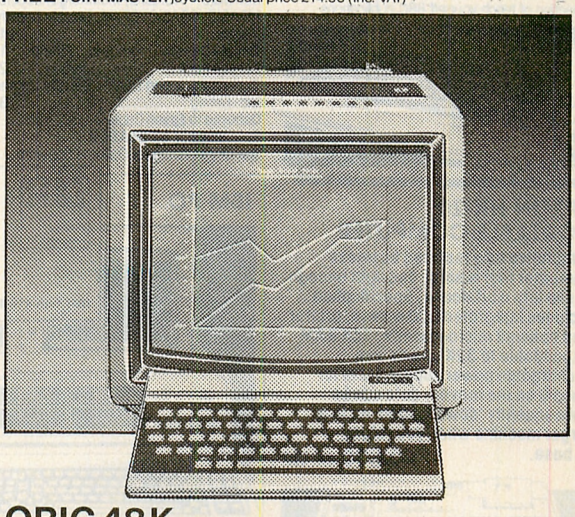

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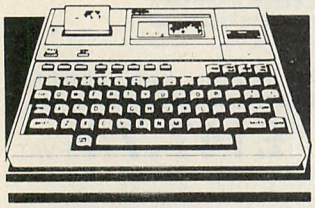

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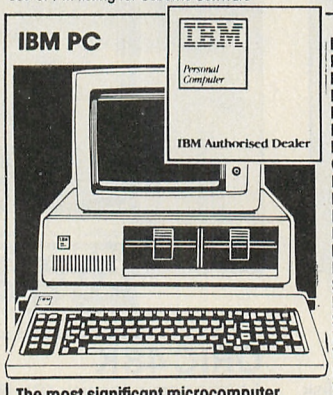

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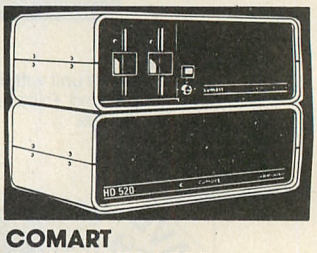

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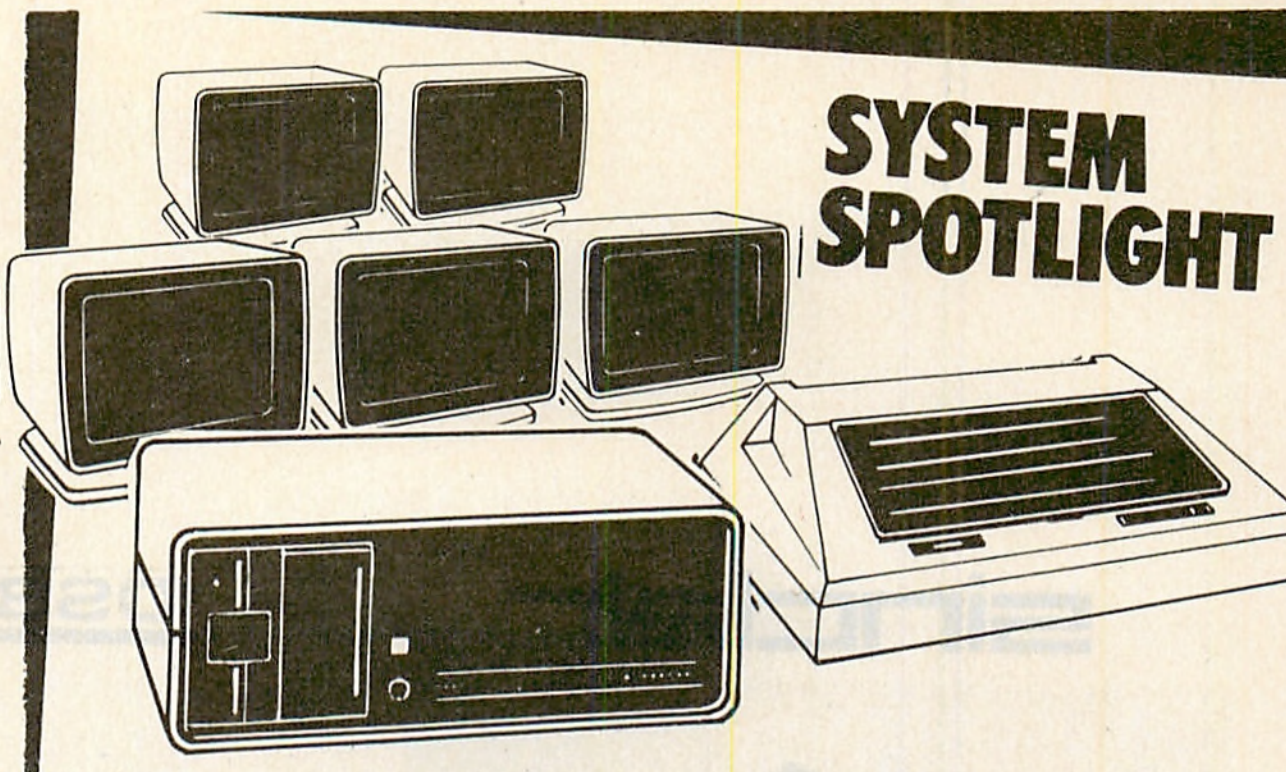

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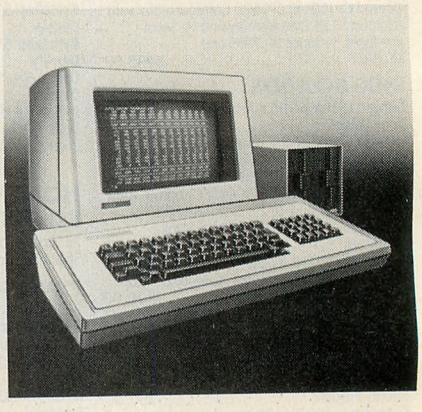

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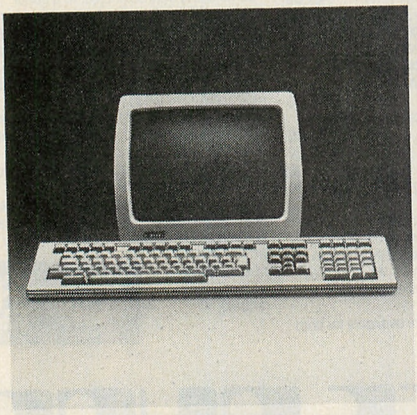





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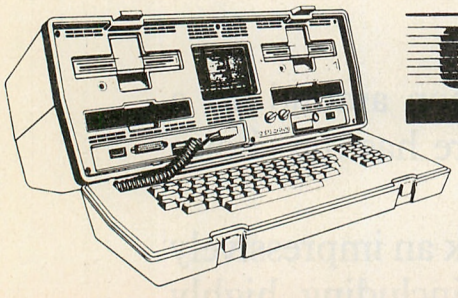

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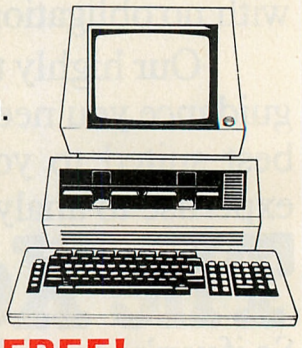

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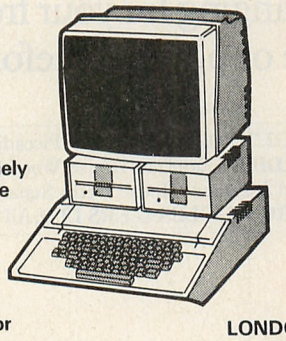

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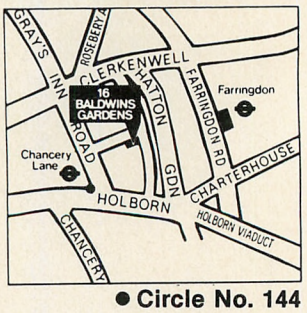

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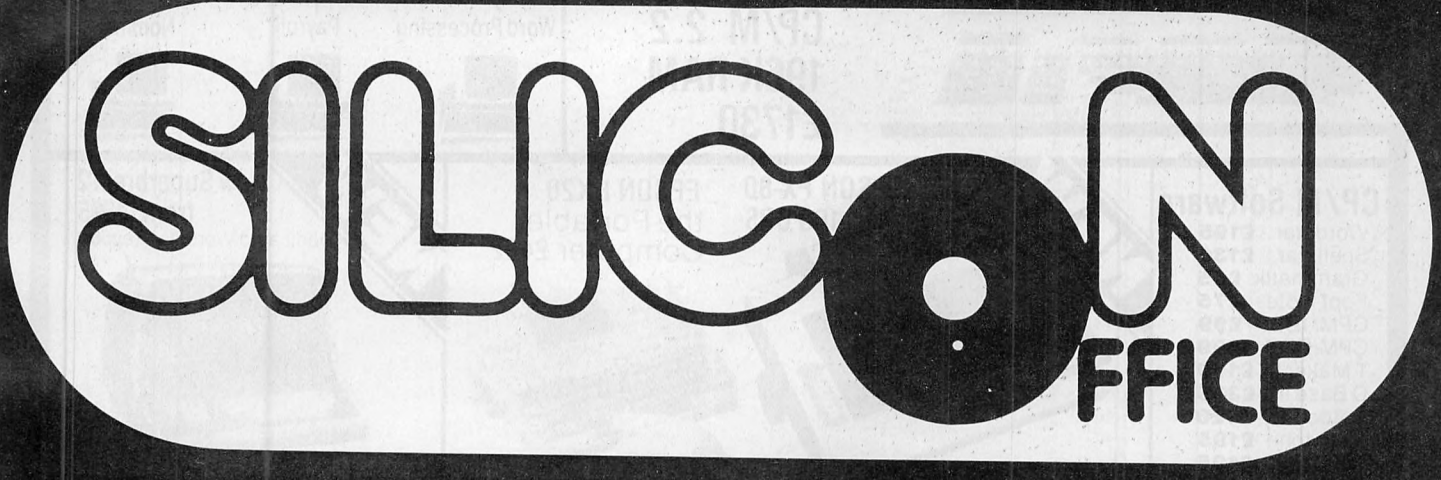

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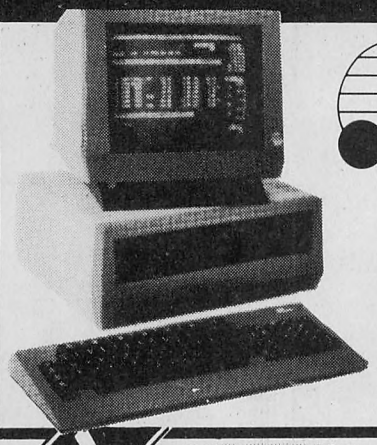

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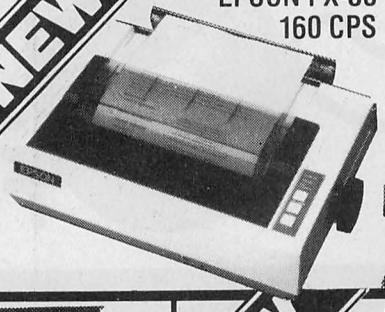

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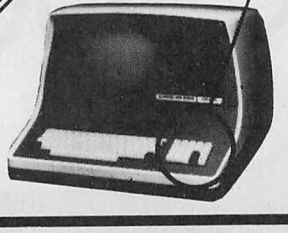

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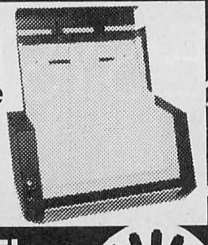

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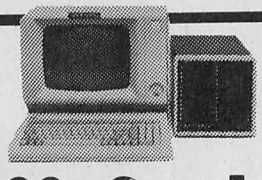

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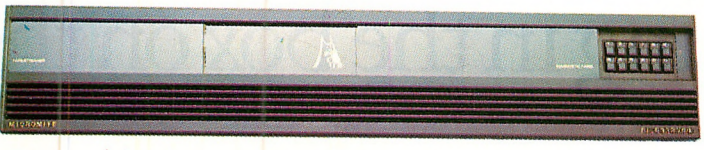

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MEMORY

- 24K bytes of ROM;
- 32 bytes of RAM, at least 28K of which is available to the user.

THE SCREEN DISPLAY

- 40 or 80 characters to the line – without affecting the 28K bytes of RAM at your disposal;
- 24 or 30 lines to the screen;
- well-formed characters, with true descenders;
- a full European character set;
- normal or reverse video, high resolution graphics on screen of controllable size, 256, 320, 512 or 640 horizontal resolution by 250 vertical lines;
- a facility to set up a "page" of up to 255 lines, with the screen acting as a "window" to display it;
- ability to maintain several such pages simultaneously, and to switch rapidly between them;
- text may be used on graphics screen as well as on parts of the video screen not used by graphics.

CHARACTER SET

- 512 characters, including the full ASCII set, all European accented characters, Greek and graphics symbols.

GRAPHICS

- 20 powerful graphics commands;
- all text characters usable on the graphics screen;
- variable-sized graphics screen, with the rest of the screen available for text – for versatility and to save memory.

SOFTWARE

Enhanced ANSI BASIC; screen editor (32 commands); mathematics package (10 significant figures); graphics commands.

- a very friendly screen editor – a delight to use and readily adapted to text processing;
- arithmetic to 10 significant figures;
- very controllable output formatting of numbers – invaluable for accounting, statistics, and scientific applications;
- a powerful, much enhanced BASIC;
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INTERFACES

- two tape cassette ports built into the processor unit;
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- a built-in communications interface (V24/RS232);
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- a TV interface;
- an expansion interface for NewBrain system expansion modules.

KEYBOARD

- standard typewriter pitch, action, layout and size, with editing control and graphics keys.



*CP/M IS A REGISTERED TRADE MARK OF DIGITAL RESEARCH INC.

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We've got over 120 dealers nationwide who've got all the answers at their fingertips.

Either way you'll discover that NewBrain is the kind of micro that will stop the competition getting a look in.

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It comes with a very powerful language (enhanced ANSI BASIC) and it'll take CP/M,* so it'll work on the same system as similar big business micros, giving you the capacity to use an almost limitless variety of tried and tested software.

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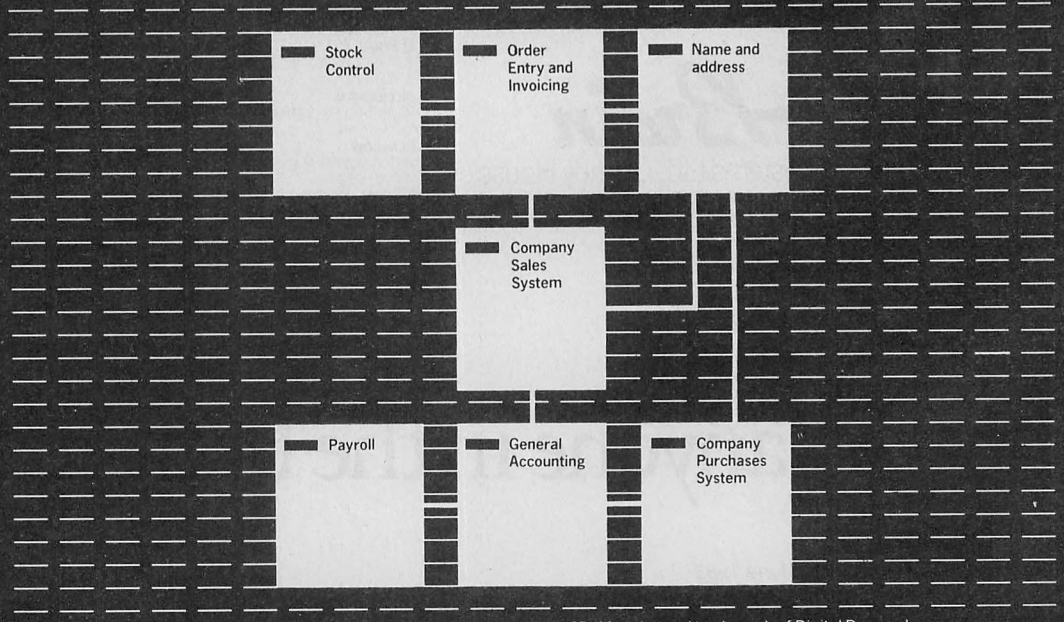

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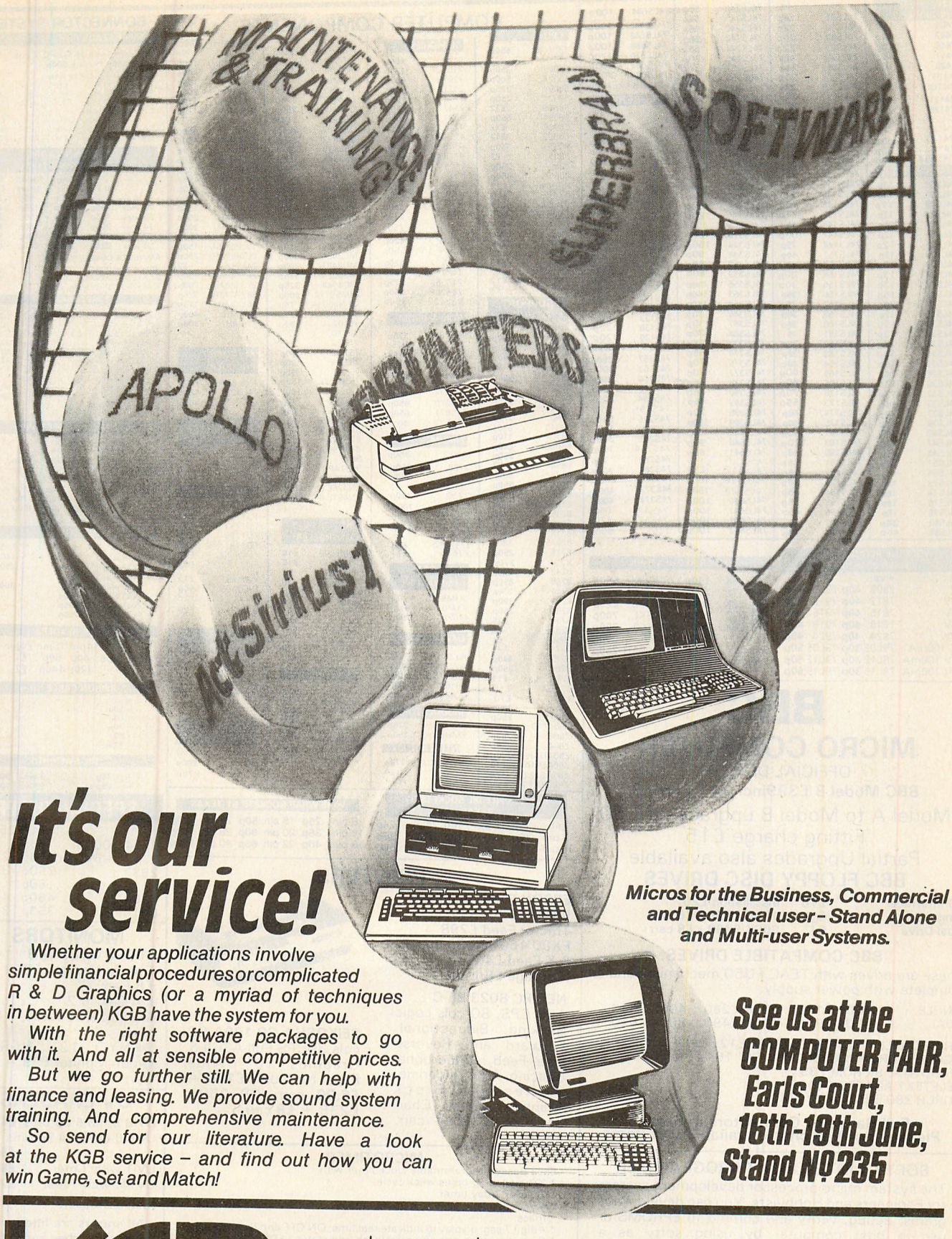

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74LS37	14p
74LS38	14p
74LS42	30p
74LS47	38p
74LS48	45p
74LS51	14p
74LS55	14p
74LS73	18p
74LS74	18p
74LS75	18p
74LS76	18p
74LS83	38p
74LS85	40p
74LS85	40p
74LS86	16p
74LS90	22p
74LS92	20p
74LS93	22p
74LS95	40p
74LS96	50p
74LS107	20p
74LS109	27p
74LS112	20p
74LS113	20p
74LS114	22p
74LS122	25p
74LS123	34p
74LS124	90p
74LS125	24p
74LS126	25p
74LS132	34p
74LS133	25p
74LS136	25p
74LS138	27p
74LS139	27p
74LS145	70p
74LS147	100p
74LS148	75p
74LS151	40p
74LS153	40p
74LS154	80p
74LS155	30p
74LS156	36p
74LS157	25p
74LS158	30p
74LS160	38p
74LS161	38
74LS162	38p
74LS163	38p
74LS164	40p
74LS165	50p
74LS166	60p
74LS170	70p
74LS173	55p
74LS174	40p
74LS175	40p
74LS181	90p
74LS183	120p
74LS190	38p
74LS191	38p
74LS192	36p
74LS193	38p
74LS194	35p
74LS195	35p
74LS196	45p
74LS197	45p
74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	55p
74LS244	55p
74LS245	70p
74LS251	50p
74LS253	30p
74LS256	150p
74LS257	30p
74LS258	35p
74LS259	55p
74LS260	22p
74LS266	20p
74LS273	55p
74LS279	30p
74LS280	100p
74LS283	40p
74LS293	40p
74LS295	90p
74LS298	90p
74LS299	180p
74LS321	150p
74LS323	160p
74LS324	150p
74LS348	90p
74LS352	60p
74LS353	60p
74LS356	450p
74LS363	140p
74LS364	140p
74LS365	30p
74LS367	30p
74LS368	30p
74LS373	55p
74LS374	55p
74LS375	70p
74LS377	70p
74LS378	45p
74LS390	45p
74LS393	45p
74LS395	90p
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74LS641	100p
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74LS643	100p
74LS644	100p
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74LS668	100p
74LS669	100p
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74S85	450p
74S86	180p
74S112	90p
74S113	90p
74S114	90p
74S124	300p
74S132	110p
74S133	60p
74S138	120p
74S139	120p
74S151	250p
74S157	250p
74S163	300p
74S174	250p
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4 194MHz	200p
4 43MHz	110p
5 00MHz	175p
5 068 MHz	210p
6 0MHz	150p
6 144MHz	150p
7 0MHz	150p
7 168MHz	175p
8 86MHz	175p
10 00MHz	175p
10 7MHz	150p
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18 00MHz	200p
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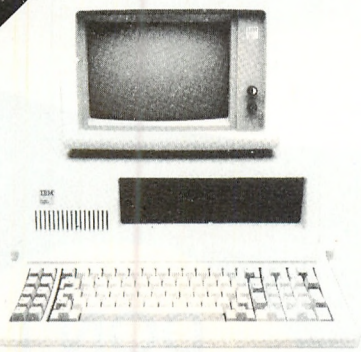

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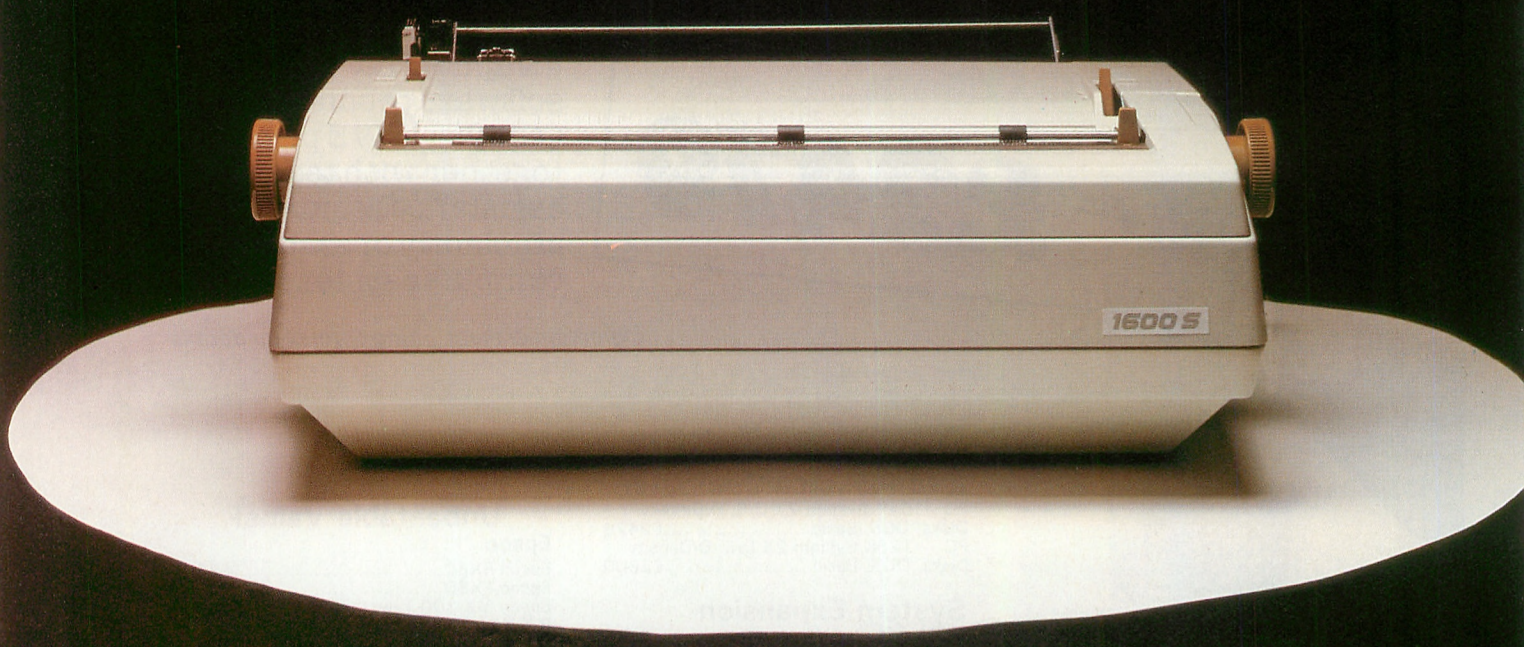

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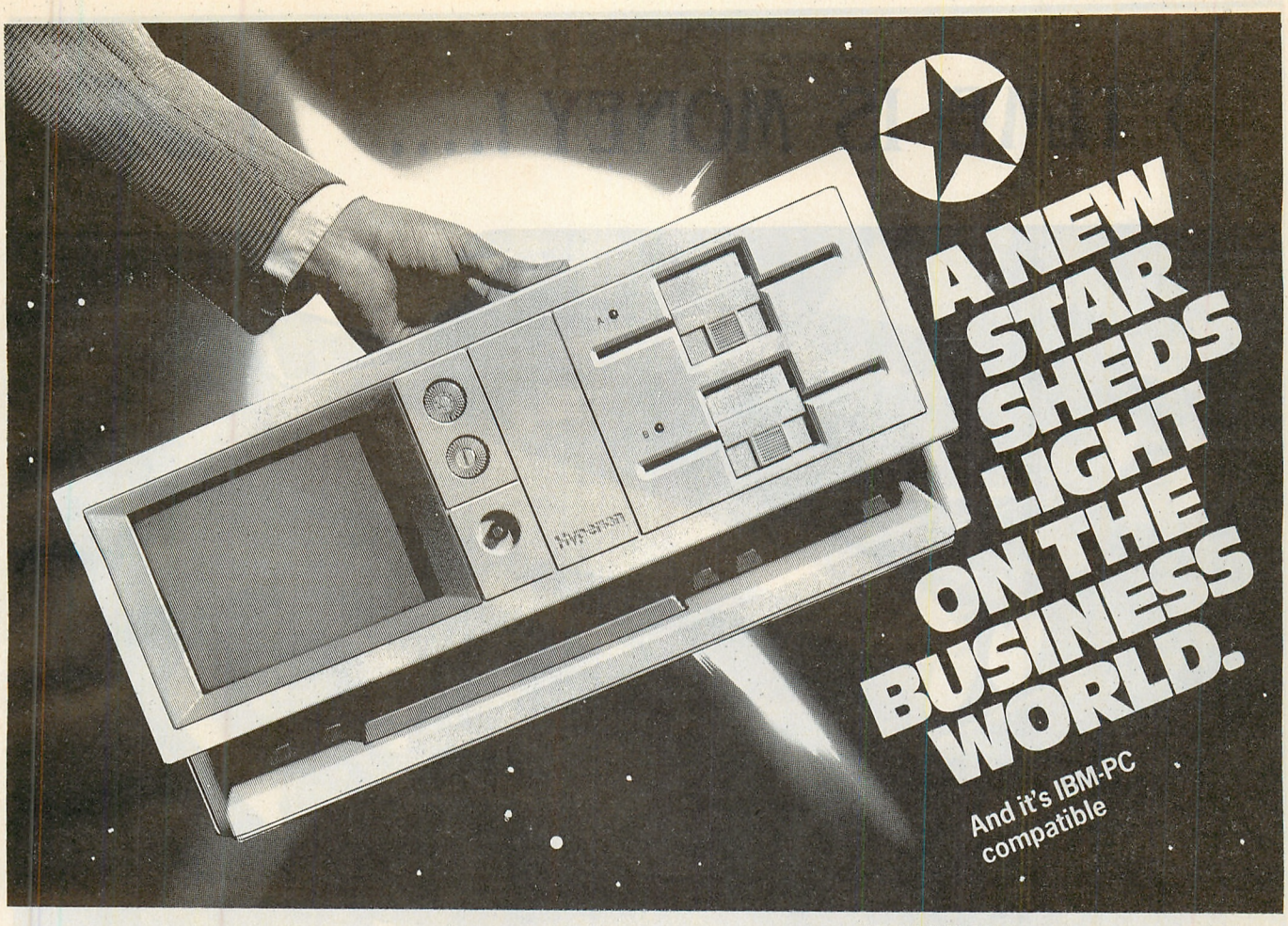

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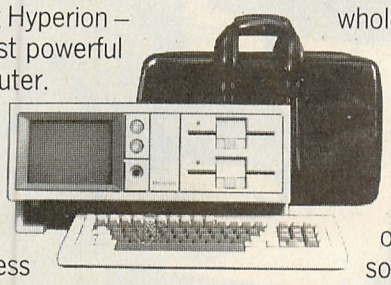

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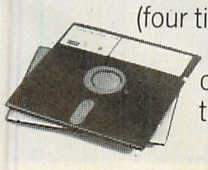

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RAINBOW

Ian Stobie tests a micro with an 8088 and a Z-80 inside and the badge of top mini-builder DEC outside.

THE NEW Digital Equipment Corporation machine is a dual-processor system giving the user access to the world of established eight-bit CP/M software as well as to more modern CP/M-86 offerings. It is being sold in a way which places a strong emphasis on the maintenance and support package, something quite new to the microcomputer market place.

The Rainbow is just one of three new Digital personal computers. The Decmate II is built around an unusual 12-bit DEC microprocessor chip, descended ultimately from the venerable PDP-8, DEC's pioneering mini. It allows the Decmate II to run word-processing and office-management software developed for machines in this long-established family. The Professional is based around the same 16-bit chip set as used in the PDP-11/23 minicomputer. Its operating system is built around the RSX-11 mini operating system, which gives it file compatibility with other larger DEC systems.

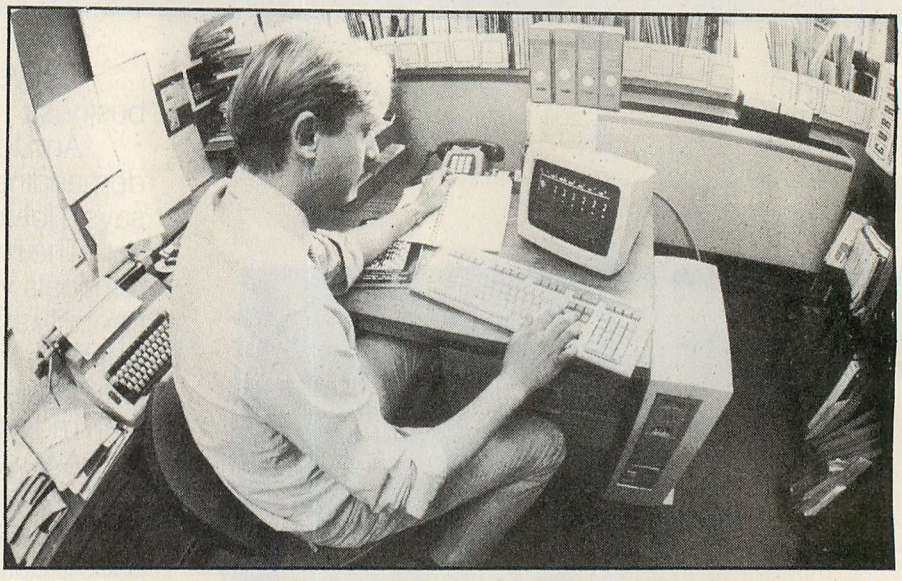
The Rainbow is a more familiar type of machine, intended to compete in the largest part of the existing microcomputer market with machines like the IBM PC and the Sirius. It is designed to tap into the large base of CP/M application packages, and to run applications becoming available now for CP/M-86 and IBM MS-DOS. DEC wants the Rainbow to transport existing micro-computer users on to their kit and to pick up newcomers to computing.

In price terms there is little to separate the machines, though the Professional starts slightly higher. The standard Rainbow costs £2,360. All the systems have virtually the same components apart from the main board — the same disc drives, screen and keyboard. The Professional has a bigger power supply and a larger system box to accommodate it.

The Rainbow's hardware looks very modern and well built. It is a three-box system but the biggest unit, the system box, can be put out of the way in a DEC-supplied floor stand to leave just the screen and the keyboard to take up space on your desk top. The display unit is the smallest we have seen, occupying very little space, yet still having a full 12in. diagonal screen.

The display unit weighs only 6.4kg. and has a carrying handle on the back. Four threaded brass sockets are set into the base to allow bracket mounting to keep it completely clear of the desk. It is made in a DEC plant in Taiwan and is the only part of the Rainbow not made in the United States.

Pushing a button on the right of the display unit causes an adjustable leg to drop down so you can vary the angle of tilt.



The Rainbow operates quite happily with the system box standing on end.

Because the unit is so small it is generally very easy to position it satisfactorily. It has a separate contrast and brightness control. Within the standard purchase price there is a choice of three screen colours: green on black, amber on brown and white on black.

The display shows 24 lines and switches easily between 80 and 132 columns using the Set Up function. The wider line is useful for spreadsheets or previewing full-width printer output. Each character is composed on a seven-by-nine matrix which allows two dots for the descender, and the image is steady. Graphics facilities are limited on the standard machine and poorly supported by the Basic interpreter. By way of compensation, underlined, blinking, double-width and other fancy characters are provided.

Despite the name of the machine, colour is not standard. A graphics option board is available for £570 and allows 800-by-240 dot graphics with four colours, or 16 colours at lower resolution. The DEC colour monitor costs £894, but it is possible to use other brands.

The keyboard is really well thought-out and well made. The layout is very close to the ISO standard and contains all the normal typewriter keys plus a separate numeric keypad, 20 function keys and editing and cursor-control blocks. The numeric keypad as well as the function keys are software programmable. The cursor keys are in a sensible compromise arrangement, an inverted T. It gives you the intuitively correct feeling of left being to the left of right and up above down, without taking up too much space on the keyboard.

The keys themselves are very well made, with the sculpted depression on top slightly deeper on the home keys F, J and 5 to help touch-typists. It is a fast keyboard to type on. The bip noise when you hit the keys is adjustable through eight levels using the Set Up function key. There is a small speaker and another eight-bit microprocessor in the keyboard. The keyboard is sufficiently weighty to stay in one place on the desk under heavy pounding, but is still comfortable when held on the lap on the end of its six-foot cable. It must be one of the best keyboards around.

The attention to detail is incredible. There is a channel on the underside of the keyboard so that you can bring the lead out on whichever side you prefer. I eventually thought I had found something to criticise because there seemed to be no way to adjust the keyboard slope, but then I came across two plastic feet in the packaging. A final touch: on the bottom of the keyboard is a label giving you the DEC helpline phone number.

The Rainbow system unit is about the same size as the corresponding part of the IBM PC. It contains the main circuit board, disc drives, power-supply unit and three expansion slots — in fact everything that does not have to be on the desk.

Although you can have the system unit sitting horizontally on your desk if you really want to, it also works mounted

100

horizontally in an optional floor stand — costing £66 — which takes up less floor space. The stand holds the disc drives clear of the dust with the disc drive doors still easily reachable. At about 26in. high, it lets you put the system unit under the average table top. It is a very sensible arrangement.

On either side of the system box are two catches. Pull them towards you and the lid comes off. A logically laid out set of metal boxes is revealed. Just by pushing catches and loosening the occasional hand screw the system can be pulled apart so that faulty boxes can be replaced, either by the user or by DEC maintenance personnel. Even the main board slides out relatively easily when four hand screws are undone.

The modular design is one reason why DEC can offer one year's free maintenance. It is all very straightforward — I found it easy to put the system back together again without even looking at the manual, and it worked straight away. The pictures of the machine in use were taken after the Art Editor had pulled the Rainbow apart to take photographs of the inside.

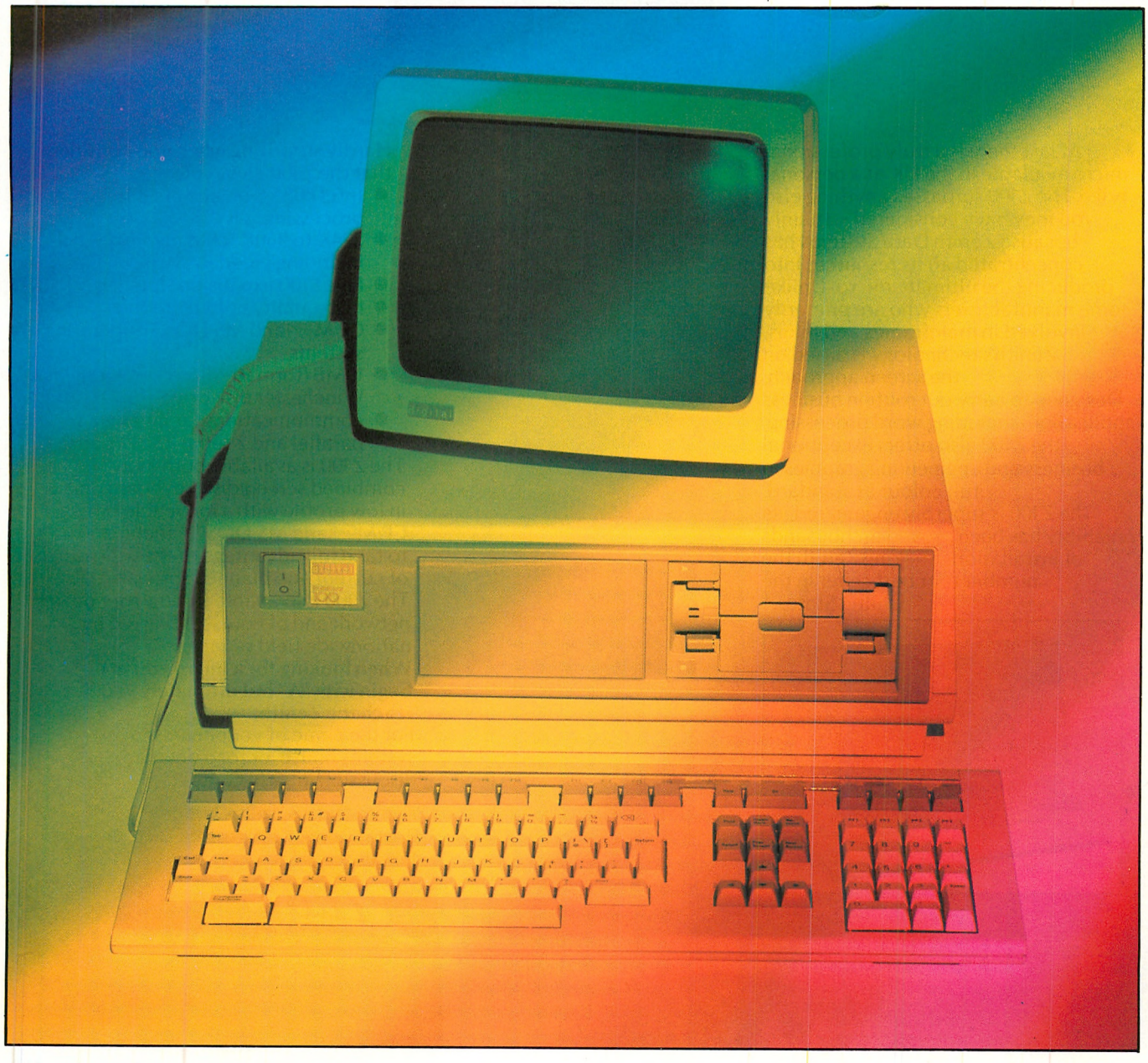
The disc drives, like virtually all the other components, are of DEC's own manufacture and are very compact for 5.25in. drives. In the space normally occupied by one drive DEC has fitted two, both mounted on the same spindle. Each is single sided but holds an acceptable 400K per floppy, giving

(continued on page 84)

Benchmarks

The table shows the time in seconds to run eight standard Basic routines. The benchmark routines test out various typical tasks, each repeating an appropriate set of Basic statements 1,000 times. The Basic interpreter used is Microsoft's Basic-86 revision 5.22, as supplied with the Rainbow.

	1	2	3	4	5	6	7	8	Av
Olivetti M-20 Z-8000	1.1	4.0	8.0	8.4	9.2	17.1	26.5	12.0	10.8
DEC Rainbow 8088/Z-80	1.5	5.5	11.3	11.7	13.6	25.3	38.8	29.8	17.2
IBM PC 8088	1.4	5.2	12.1	12.6	13.6	23.5	37.4	35.0	17.6
ACT Sirius 1 8088	2.0	7.4	17.0	17.5	19.8	35.4	55.9	42.5	24.7



The Ultimate



At last there is a truly professional micro available in the UK at a personal price. The Z100 surpasses anything else you may have considered – mainly because Zenith Data Systems has concentrated all its resources into producing the ultimate micro. Unlike some manufacturers who are primarily involved in mainframes and minis, Zenith's technology is based on the screen approach.

Designed to carry out routine business applications including word processing, the Z100 also offers exceptional business and engineering graphics in full colour as standard.

The Z100 is superbly engineered, its reliability has been proved in thousands of installations, making Zenith the number four best-seller in the United States.*



Combined unit.

Prices from £2,072, excluding VAT. Quantity discounts available. Price includes CP/M, ZDOS (= MS-DOS), ZBASIC and colour graphics on low profile unit as standard.

* Source: Dataquest Desktops Survey.

Hardly surprising when you consider that the Z100 gives you:

- Intel 8085 8-bit and 8088 16-bit processing
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- communications facilities via 1 parallel and 2 serial RS232 ports.

The Z100 is available both as a combined screen/disk/keyboard unit or in low profile with a moveable screen.

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RAINBOW

(continued from page 81)

the standard-two drive system a capacity of 800K. Adding another floppy unit identical to the first gives you a four-floppy 1.6Mbyte system. The extra unit costs £672 and works off the existing Rainbow power supply.

A 5Mbyte Winchester comes in a separate box. It costs £2,346 and requires an additional power supply at £337. Once you start adding hard discs and memory to the Rainbow it stops being a cheaper system than the DEC Professional or the IBM hard-disc PC, the XT.

When turned on, the Rainbow goes into a self-test to ensure that all the components of the system are present and functioning correctly. Turning the machine on with the keyboard disconnected produces the message: "Consult user's guide for assistance — keyboard". However, if all is well, after a few seconds the disc drives groan and the Digital logo and a main system menu comes up on the screen.

The six options are to start from disc drive A, B, C or D, to execute a more comprehensive self test, or to enter Terminal mode. In Terminal Emulation mode the Rainbow pretends to be a VT-102 terminal. The standard Rainbow can be used as it comes to replace a Vax or PDP-11 terminal, opening up an huge additional market for the machine.

Normally the user will take one of the other menu options. Press A and the system will boot up whatever is on that disc. The Rainbow is a rather clever dual-processor system. The CP/M-86/80 operating system it comes with integrates CP/M-86 and the old eight-bit CP/M behind a DEC-written front end. It examines the disc you are tyring to read, checks whether it requires the eight- or 16-bit processor to run it, and brings the appropriate processor into play. As a user you do not have to know what kind of CP/M disc you are putting in.

The Rainbow is not an exceptionally fast machine. Like the other 8088-based 16-bit machines it performs more slowly at standard benchmark routines than 8086 machines. This only matters if you are doing computation-intensive tasks; for most business applications the speed of the discs is more important than the speed of the Basic interpreter. The Rainbow runs the benchmarks slightly faster than the Sirius, probably mainly because the Rainbow's 8088 is freed from looking after I/O by the Z-80, which when not having to run eight-bit CP/M software looks after peripherals.

The Basic itself is a standard Microsoft Basic. It is ideal for business, with good file-handling and print-formatting statements, but lacking some of the more playful features of the IBM implementation, like the sound and graphics statements. Although the review system had a full 256K, with the 192K RAM extension installed, only 62,390 bytes were free. Similar limitations imposed by Microsoft Basic are found on other 16-bit machines; MBasic is overdue for a rewrite.

One very neat feature of the Rainbow is the Set Up key, F3. At any time, whether the machine is under the control of an application program or not, you can use it to bring up a series of screens which allow you to change various system parameters. For instance, you could change the screen width to 132 columns, or reverse the screen colour to black on green. Hitting F3 again takes you back to your application program.

The system's documentation is superb. At first it is a bit daunting, there is so much of it, but it is all carefully graded. You start with

Specification

SYSTEM BOX

CPU: Intel 8088 16-bit processor and Z-80 eight-bit processor

Memory: 64K expandable to 256K

Discs: two 5.25 in. 400K single-sided floppy drives mounted on the same spindle; two more floppy drives or a 5Mbyte hard disc may be added

Bus: three free expansion slots

Standard interfaces: two RS-232C ports configured for printer and asynch/synch communications

Dimensions: 420 × 410 × 165mm.

DISPLAY

Type: 12in. monochrome CRT with choice of green, amber or white phospor screen.

Displays: 24 lines by 80 or 132 columns, using seven-by-nine dot matrix for characters.

Features: bold, blink, underline and double-width characters, reverse video, full or split screen, adjustable tilt

Dimensions: 349 × 311 × 292mm.; weight 6.4kg.

KEYBOARD

Type: Detached, with standard QWERTY layout and spacing

Features: 103 keys in all, with 18-key numeric keypad, eight cursor and editing keys, and 20 function keys; small speaker and indicator LEDs; function keys and numeric keypad are software programmable.

Dimensions: 533 × 171 × 50mm.; weight 2kg.

Price: £2,360 for system with CP/M-86/80 operating system and 12 months on-site service.

Manufacturer: Digital Equipment Corporation; made in U.S. and Taiwan

U.K. distributor: Digital Equipment Co Ltd, Imperial Way, Reading, Berkshire. Telephone: Basingstoke (0256) 59200.

Read Me First which tells you how to set the system up, load and run application packages and, most importantly, how to run the CBI course — CBI here means computer based instruction. The course disc uses graphics and text to explain computer concepts, the Rainbow hardware and software, and CP/M-86/80 commands. It is a good, rapid way of finding out about the system.

MBasic comes with a user guide and a reference manual. Digital is rewriting the documentation for software supplied under the Digital Classified Software scheme. The Multiplan documentation we had was better and clearer than either Microsoft's own effort or the Olivetti rewrite.

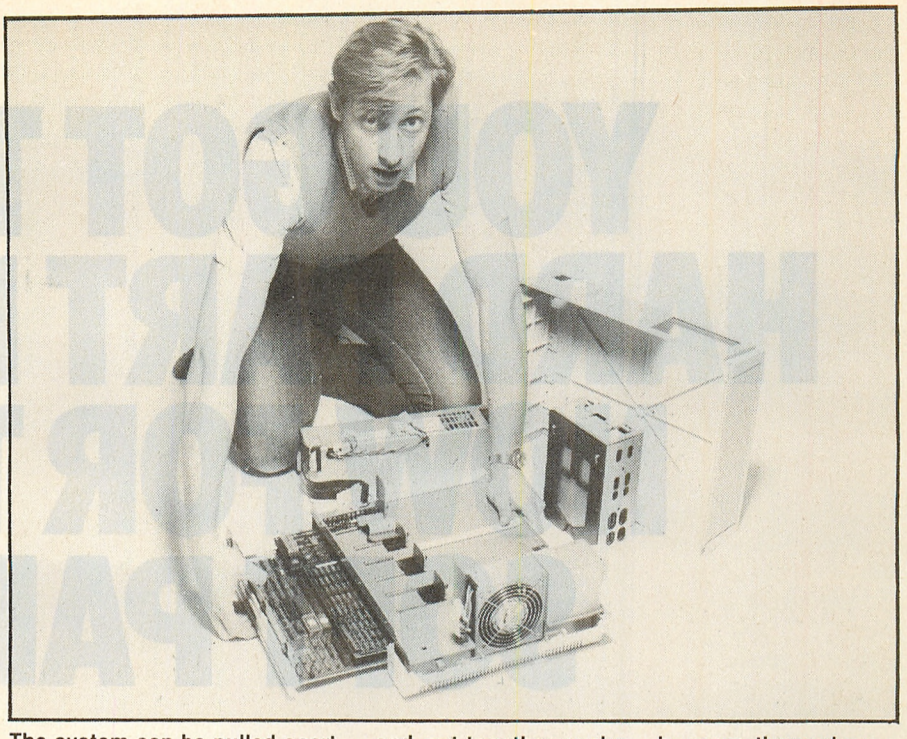
Our Rainbow came with the Personal Computer Support Package, a wallet with a registration card on the front. Filling it in entitles you to one year's free on-site hardware maintenance with a guaranteed eight-hour callout during the working week and telephone support for DEC-supplied software. I know of no other manufacturer offering such an attractive deal. The cost in the second year is 7 percent of the list price of the product, about £160 for a typical Rainbow. An additional 25 percent of that 7 percent buys you an enhanced level of support — a four-hour turnout on a five day a week basis. Even higher levels of support are available.

DEC is making use of the economies of scale that operate in a servicing organisation. The more service centres you have the closer spaced they are so the more calls your engineers can make a day. DEC already has a huge service organisation; it would be hard for most other manufacturers to compete and, not surprisingly, DEC is making a tremendous fuss about its servicing arrangements.

The Support Package wallet also contains literature about DEC courses. Again DEC is playing the big-company card for all it's worth. For £60 you can have a one-day introductory course at its Reading or London training centre; £420 will bring a training team to your site for the day. Courses on using word-processing packages, spreadsheet packages, and Basic programming are available or planned.

Software is available through DEC or independently. Software bought through the classified software scheme has the advantage of documentation rewritten by Digital and free telephone support for the first 12 months. There are about 50 Rainbow packages in the current catalogue, including Peachtree and Graffcom accounting packages, Multiplan, Calcstar and Magicalc spreadsheets, WordStar, Lexicom and Magic Wand word processing, Compsoft DMS, Personal Pearl and Trendisc database packages, and ProPascal and C languages. DEC promise MS-DOS as an alternative operating system for June.

Yet not everything has gone according to plan. DEC is manufacturing the discs, rewriting and printing the documentation, and says it is having the bugs fixed — and it is late.



The system can be pulled apart — and put together again — by users themselves.

The scale of the whole operation is enormous. According to U.K. Managing Director, Darryl Barbe, DEC has spent $1 billion on the personal computer project so far, and expects the three personal computers to make up one-third of its business within three years. This is proportionately the greatest effort into personal computers of any of the computer heavies. The Rainbow machine itself has taken rather a long time to arrive, but checks with several dealers confirm that they now have stocks.

DEC is trying to sell on a high-quality, high-reliability platform, not on price. A whole new market is envisaged with many small businesses and professionals who have not been involved with computers before. As Darryl Barbe puts it, "It is our job to make sure they are not disillusioned. Our aim is to make them feel totally secure right from the moment of deciding to buy a computer."

The very extent of DEC's support provokes some misgivings. How firmly will you be locked into this single supplier for hardware, software and maintenance? Even the blank floppy discs are pre-formatted. To what extent will third-party suppliers want to become involved with the system when it means competing with DEC itself?

From the software point of view this is not much of a problem. The producers of all the interesting new packages like VisiOn and Lotus 123 and so on will probably get around to the DEC machine because they expect it to be a large market. On the hardware side the IBM and Apple computers have benefitted very greatly from the flourishing independent add-on suppliers? I detected little enthusiasm among the DEC personal computer group people for encouraging anyone other than trusted OEM suppliers to produce add-ons.

Meanwhile cowboys and coding brats are churning out add-ons of all descriptions for other machines. Admittedly, half of them don't work but the ones that do open up ever more applications to personal-computer users. Fortunately DEC's field-service people are taking a much more open attitude. They seem quite happy to service other vendor's printers and add-ons — even memory boards — as long as they know enough about the product technically and it is economic for them.

Conclusions

● The machine is very well made and stylish to look at.

● There is not much doubt that the Rainbow 100 will become one of the brand leaders in its class.

● At £2,360 for the entry-level system, the Rainbow has a very competitive start price, though peripherals are more expensive. The maintenance and support arrangements give it a very predictable cost of ownership.

● The on-site hardware maintenance warranty and the telephone helpline support service, offered free in the first year, make the Rainbow extremely attractive to newcomers to business computing.

● DEC can build up volume sales with sales of the PC range as intelligent terminals connected to larger DEC systems.

● It is not clear whether an independent plug-compatible add-on sector will spring up for the DEC in the same way as for the IBM PC and the earlier Apple II.

● Taking the excellent documentation, support and training arrangements into account the Rainbow 100 is great for beginners. It will take some of the uncertainty out of computerising, and is a big step forward for the professional end of the micro market.

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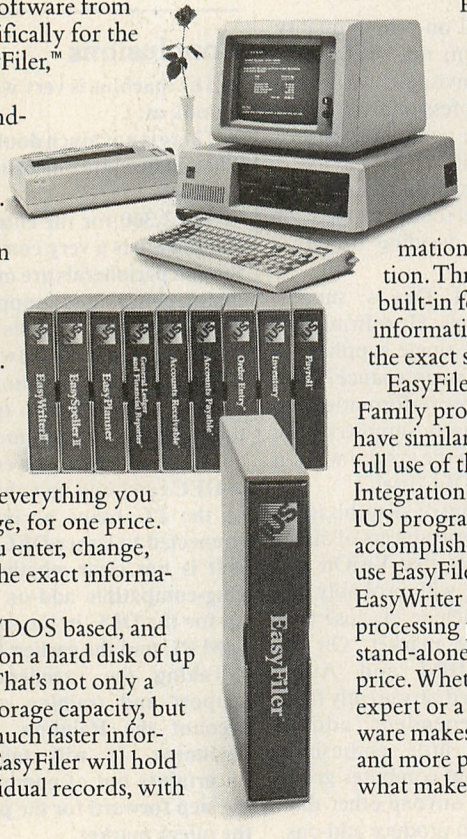

EasyFiler is MS/DOS based, and thus can be stored on a hard disk of up to 40 megabytes. That's not only a great increase in storage capacity, but it also allows for much faster information retrieval. EasyFiler will hold up to 10,000 individual records, with space for 1000 characters per record.

EasyFiler has a number of features which will help you increase the power and performance of your IBM PC. It is compatible with BASIC, which means you can transfer information to or from an IBM BASIC file. EasyFiler also includes a built-in calculator, which enables you to compute data during the entry of information or during report generation. Through "Soundex," another built-in feature, you can retrieve information even if you don't know the exact spelling of a word.

EasyFiler works with other EasyFamily programs. All IUS programs have similar instructions and make full use of the IBM PC keyboard. Integration of information from one IUS program to another is easily accomplished. For instance, you can use EasyFiler with text written on EasyWriter II,™ the advanced word-processing program that gives you stand-alone wordprocessing at a PC price. Whether you're a computer expert or a novice, EasyFamily software makes your work simpler, faster and more productive. We think that's what makes it easy for you.

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● **Circle No. 290**

CROMEMCO C-10

Mike Hughes looks at a Z-80 based system aimed at the non-technical user.

THE C-10 is being sold as an integrated package of hardware and software attractive to non-technical users. It is designed to offer the administrator or secretary a device which will assist them at work in much the same way as a calculator is used by accounts staff. The packaged software reflects this approach, being simple to use and well documented for a limited range of applications. It is not being sold as a high-technology system which might require technical expertise.

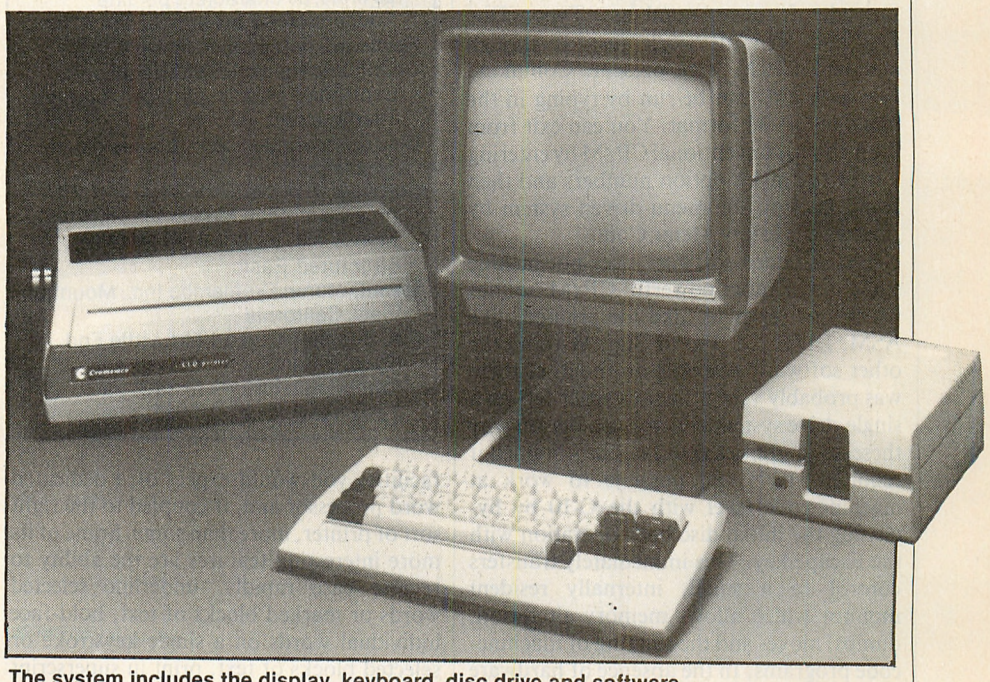
Yet these restrictions only come about from the way the system is being marketed. The C-10 has considerable potential for more sophisticated applications should the need arise. The operating system is basically CP/M with its unfriendly, albeit powerful, aspects cleverly hidden from the user by a menu-driven suite of programs. Word processing, financial planning and the ability to write ones own software using structured Basic are all included. Those with a knowledge of CP/M and the wide range of software available under it will be pleased to know that the system is capable of running most CP/M proprietary software in the conventional manner.

The review system comprising the display, keyboard and a single, double-density, double-sided 5.25in. disc drive together with Write Master, Plan Master, Structured Basic and other utility software sells for around £1,350 — assuming that the Sterling exchange rate does not stray far from $1.50 U.S. The price does not include a printer. Either serial or parallel types may be used but Comart recommends that for small office applications the C-10 should be operated in conjunction with one of the range of modern electronic typewriters.

The three components of the basic system are housed in lightweight cream plastic cabinets. The display unit houses the CPU, a 12in. green display of 25 lines by 80 characters, and power supplies. At its rear there are sockets for the disc drives, keyboard, printer and communications, and a mains switch.

Conspicuous by its absence is a control to adjust the display intensity. By carefully reading the manuals I discovered that intensity is software controlled. Minimising the number of controls to protect against knob twiddlers is a good thing, but display intensity is a very personal choice and should be easy to operate.

The keyboard is of standard typewriter layout with mechanical alpha lock. The keys that will be unfamiliar to the average typist are Escape, Control and the four cursor-direction keys. In many respects the initial impression of the keyboard is that it is more friendly than some of the more modern conventional typewriters. It is extremely light in weight, and connects to the display unit via a four-way self-coiling lead terminated in a standard American telephone jack connector. When extended, the lead allows the keyboard to be positioned anywhere within about 1.5 metres of the display. Unfortunately the featherweight keyboard does not have sufficient "stickability" to combat the recoil effect of the self-coiling cable when used on shiny desks.



The system includes the display, keyboard, disc drive and software.

The standard single disc drive is connected to the display via a multi-way cable and stackable connector. This type of connector allows up to three extra disc drives to be added without any fuss or bother. Only one mains lead is required to the display unit, which leads to a very neat and tidy system that would easily fit on a secretary's desk. If required, the display can be provided with a swivel base as an optional extra.

The standard package of software is provided on a single disc, and a blank disc is also provided to allow the user to make an immediate back-up copy. The description of the hardware, operating system and software is contained in four very nicely presented manuals. Great care has been taken to make these easily readable by the non-technical user, and to keep them simple very little is said about the hardware, something of a frustration to your reviewer.

The CPU is based on the Z-80A microprocessor operating at 4MHz. There is 64K of user RAM together with 24K of internal ROM. No mention is made of the memory architecture nor how to select the ROM. Input/output facilities include an RS-232 data-communications port and a serial or parallel printer port.

The 25-line by 80-character display can show four internally stored character sets, including bold and pixel graphics characters. One of the demonstration assembly-language programs includes a chess game, and quite clearly the screen is capable of high-resolution graphics. Nowhere in the documentation is there any mention of how to reach this obviously useful facility, and the structured Basic does not contain any graphics statements which allowed us to exercise this option. The system is clearly more powerful than its marketers are, at present, prepared to say. It is, however, stated that the display emulates the Comemco 3102 terminal.

Apart from its current stand-alone applications as a word processor or financial planner the manufacturer emphasises its usefulness and compatibility as an intelligent terminal. Larger Cromemco systems can be interfaced via its RS-232 link and, quite obviously, the more sophisticated user might find it practicable to extend this approach to other network applications.

For normal use it is only necessary to switch on the display unit and insert the system disc, which contains all the standard software. Closing the disc-drive door initiates a self-test sequence and boots the operating system, which displays its presence with a two-page list of numbered menu selections which include the three main software options — Write Master, Plan Master or Structured Basic — together with various utilities for formatting, print-

(continued on next page)

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ing, testing, copying, etc. They can be selected simply by entering the number of the option and pressing Return — a very simple process for the inexperienced user.

Without any additional formality the user can use conventional CP/M commands instead of menu numbers: Type, Dir, Era and Ren all work just as though standard CP/M were present. Command File programs can be run by typing in the name in CP/M format. You can exit from the menu to conventional CP/M by entering one of the menu option numbers and then revert back to the menu-driven system by running the utility Menu.Com.

The standard software does not include some of the more powerful CP/M utilities which one tends to take for granted, like ASM, DDT, Ed, Pip or Stat. With all the other software available on the disc, there was probably very little user space left on a single-drive system. There is no reason why these extra utilities could not be obtained if required. It is still possible to work at machine-code level with the C-10 by by-passing the initial disc boot operation with the Escape key. This immediately transfers control to a small, internally resident monitor which allows memory alteration, dumps, moves and the running of machine-code programs. In the absence of hardware and port designation information this is of limited value to the more adventurous users.

If you look at the system purely as an integrated package to perform office functions it is, perhaps, better to accept the fact that the hardware is neat, attractive and eminently straightforward to put together and get up and running, to provide the benefits of standard software as run on this configuration. Of the three major programs Write Master is clearly the one that most users will have the greatest need for. It is Crememco's own word-processor package and has been designed to be simple to use. While having to make use of a standard keyboard it keeps the number of multi-stroke commands to a minimum.

To meet this requirement the top row of keys on the QWERTY keyboard are used in Control and Shift-Control mode to perform the more common word-processing commands like Scroll, Move, Copy, Insert, Delete, Centre Text, Print, Underline, Select Block, etc. There is a self-adhesive overlay showing these functions to stick above the keyboard, designating the function of each of the top-row keys in either Control mode. The less common and more complex functions are entered in free text or as abbreviated forms after a single press of the Escape key. After a little practice it becomes surprisingly easy to remember the commands. The user simply has to type in what needs to be done in full or using abbreviated mnemonics. For example, Escape followed by "underline selected-text" does just that, or Escape followed by "find XXXXX" will find and mark all occurrences of the phrase "XXXXX".

Write Master seems to have all the facilities you would expect of a dedicated word processor and, if coupled to the right sort of printer, more than some. Some of its more interesting features are the ability to reverse case rapidly, underline selected words or marked blocks of text, bold-face individual words on a single keystroke or selected blocks of text, print in superscript or subscript positions, merge printing of files for mailshots, etc. and the ability to print a screen of data without first having to save to disc.

All the usual sophisticated features you would expect of a word processor are present, like page formatting, automatic pagination, automatic justification and hyphenation if required, find and replace functions with or without verification and with or without case sensitivity, pre-formatting of tabs, block moves and copies, selective reading of files for boiler-plate work, etc. Write Master will compile an index of keywords by identifying them as data is being entered. It can also protect the preset format of certain portions of text to prevent them being interfered with. by global reformatting.

Write Master compares well with Word 21 and Lexitron, though WordStar is still more versatile if not as easy for the beginner to use. A minor irritant concerned the block-move command, which limits the size of the block to 512 characters. Larger blocks have to be saved as intermediate files before relocation; this takes a while longer to do, especially after you have misjudged the length of the block and got a default message after using the simple approach. A frequently required feature that seems to be missing is the ability to overstrike a character or a line.

The instructional manual for Write Master is well presented. Together with a sample document on the master disc, it proved to be an excellent training course with every command illustrated by examples and screen photographs. It is written in simple layman's language, and an hour or two spent going through the examples would easily familiarise a competent typist with no previous processing experience.

Plan Master is a fairly straightforward electronic spreadsheet consisting of up to 10 pages, each comprising 12 columns and 30 lines plus a totalising column and totalising line. Each line can be designated a title, as can each column. Numeric data can be entered at random into any sector of this matrix. Certain columns or lines or individual matrix points can be pre-programmed to indicate values based on the result of calculations made from data contained elsewhere in the table.

The screen of the C-10 is not capable of displaying all this information at the same time but you can scroll vertically or horizontally to show up to 15 lines of five columns, plus the line and column totals. Any changes to data are automatically reflected in the totals and/or intermediate results of calculations, depending on how each page of the table has been set up. Data can be saved, reviewed or modified at will and printouts obtained.

Structured Basic is conventional and contains no major surprises. With its full file- and string-handling facilities it is powerful enough to allow "do-it-yourself" programmers to prepare their own specialised software on the C-10.

The Basic operates satisfactorily, except in one area involving the INP(X) function. This port-input function works quite satisfactorily until you look at port 64 and beyond. All my attempts to do this ended in failure and a complete system crash. Without any information on the hardware and no indication of function of the various ports it was difficult to tell whether this was a hardware problem or something wrong in the Basic, though the number 64 certainly appears significant. Comart could not come up with an answer either.

Specification

CPU: Z-80A operating at 4MHz
Memory: 64K user-accessible RAM; 24K internal ROM
Operating system: CP/M compatible
Display: 12in. green-phosphor CRT
25 lines, 80 characters per line
Four character set supplied in ROM
Keyboard: detachable, 60 keys
Communications: RS-232 serial port; Centronics parallel port; serial printer interface port
Disc drive: single 5.25in. double-sided double-density, 780K
Software in price: Write Master word processor; Plan Master spreadsheet, Money Master financial planner, Structured Basic
Manufacturer: Cromemco Inc., Mountain View, California
U.K. Supplier: Comart Ltd, Little End Road, Eaton Socon, St Neots, Cambridgeshire PE19 3JG. Telephone: (0480) 215005

Conclusions

● The Cromemco C-10 is an attractive, friendly little computer.

● Without impairing its ability to run under standard CP/M the operating system and its integrated software provide low-cost word processing and management assistance for an office which lacks technical or computing experience.

● The price is reasonable, though it does not include the printer, and in all but the most trivial applications it is likely that a second disc drive will be required. A two-disc system with printer will cost between £2,000 and £2,500 — still quite viable, and cheaper than most dedicated word processors.

● The user manuals are clear and simple to understand but, perhaps, at the expense of providing sufficient information about the machine for more sophisticated applictions.

● The Write Master word-processor package is excellent in operation, attractive to use and comparatively easy to learn.

● The C-10 is a good buy for someone considering their first steps into the automated office.

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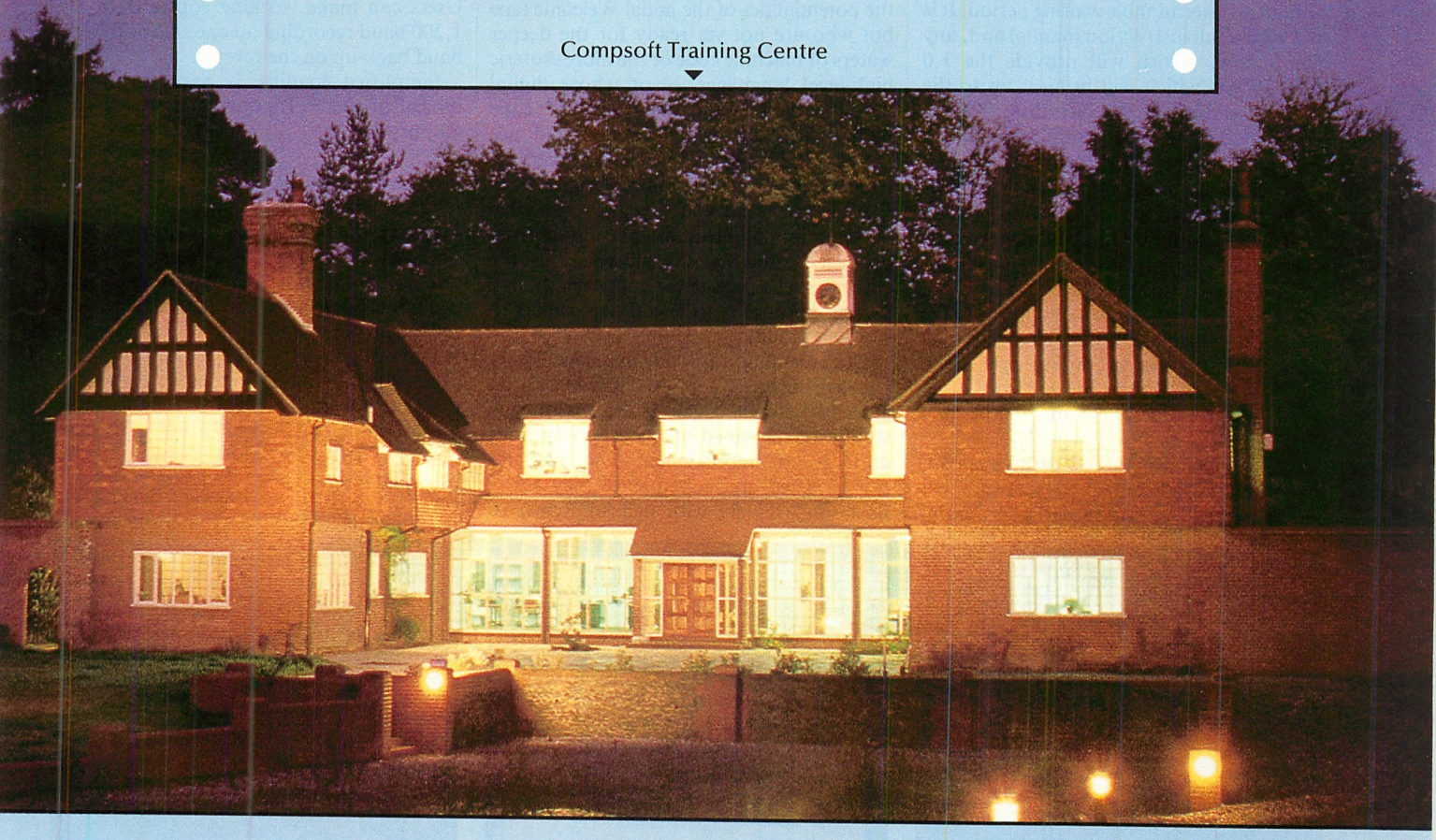

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● **Circle No. 165**

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BBC TAPES
more than fun and games

In keeping with its aim of promoting computer literacy the BBC has released an educational series of program packages. You can use them as they stand or list the programs and amend them. Neville Maude has been trying them out.

AT LONG LAST the BBC Micro is available without an interminable waiting period. It is sold with a full instruction manual and, any month now, Acorn will provide the 1.0 series ROMs which will bring it up to the original published specification. Some 80,000 models have been sold, providing a reasonable market for software.

A range of cassettes carry programs varying from arcade and Adventure games to financial accounting, including payrolls, inventories, mailing lists and various high-level languages. There is keen competition, and the large companies are moving into the field with well-tested utilities. Yet the small individual producers have not been squeezed out, and their products are often — though not always — imaginative and keenly priced.

Into this increasingly competitive market the official BBC-sponsored software has been launched. As a rule the BBC programs are excellent for those who have exhausted the potentialities of the initial Welcome tape but who are not yet ready for the deeper waters of machine code or the more esoteric high-level languages — or whose digital dexterity and reaction times cannot yet cope with difficult games such as Planetoid, née Defender. These tapes are better from the educational aspect than for entertainment.

It is customary to praise seductive presentation, and this series is undoubtedly packaged superbly. As always, it is the customer who pays in the end, even though its real purpose is to encourage dealers to stock the goods.

Documentation is really excellent. Every package includes a printed book with an attractive colour cover. It deals with each section of the taped program, giving hints on its use or improvement. The programs can be listed and edited since they are in Basic and replete with helpful Rems, so program improvement is always possible. Users can make working copies from the 1,200 baud recording on one side or the 300 baud back-up on the reverse.

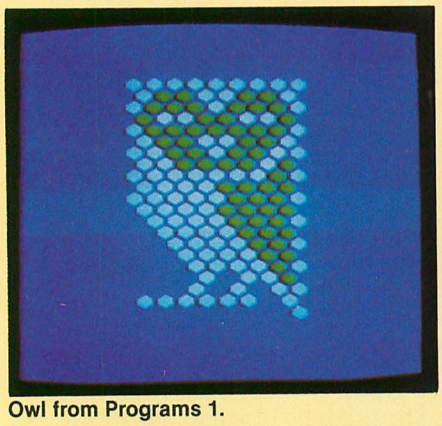
Simplified loading is another feature typical of these programs. The customary all-purpose

CH." "

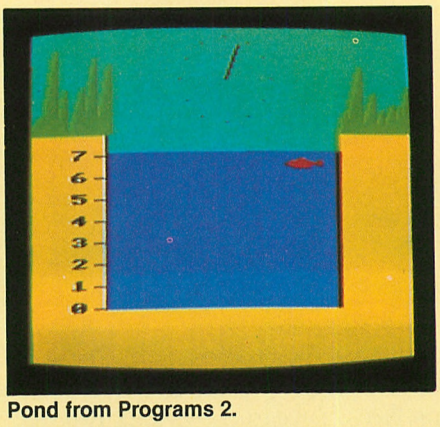
produces an index or menu. Pressing a number will chain in that section of the program when the tape eventually reaches it. To save time it is worth making a note of the title and rev counter reading for each sub-program, but the method suggested is ideal for the novice.

Each of the tapes with its booklet costs about £10, including VAT. Since most of them include more than one program this is a reasonable price, though not a bargain one. The BBC TV series should generate plenty of interest.

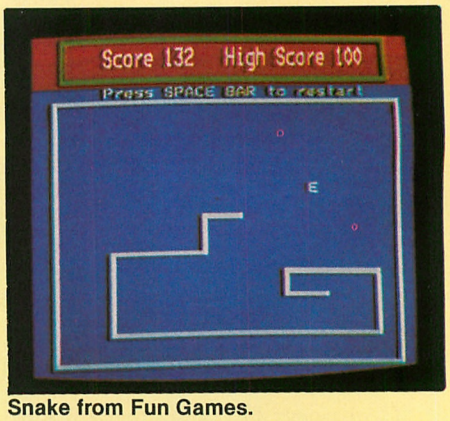
(continued on page 93)



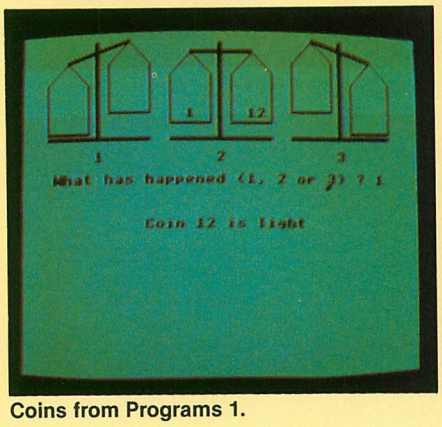
Owl from Programs 1.



Pond from Programs 2.



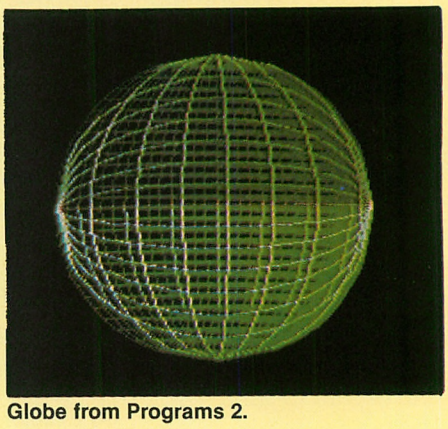
Snake from Fun Games.



Coins from Programs 1.

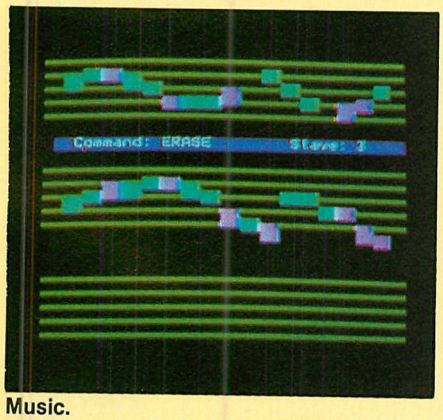


Breakout from Fun Games.

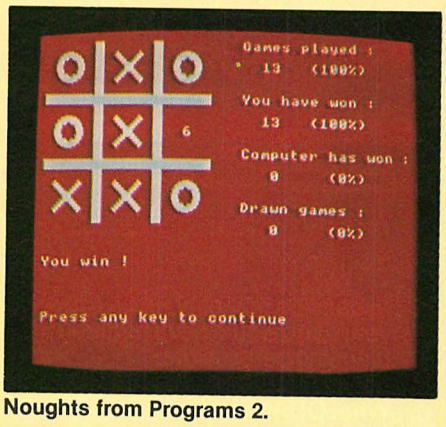


Globe from Programs 2.

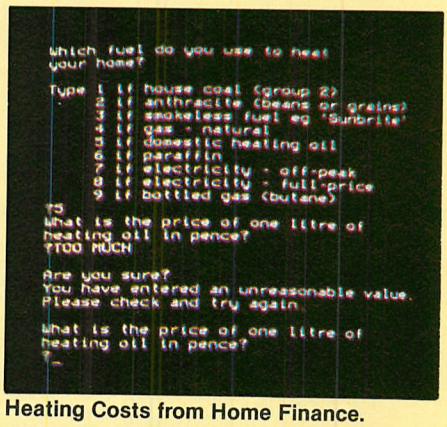




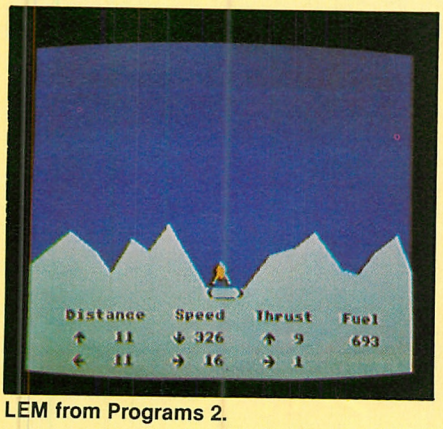
Music.



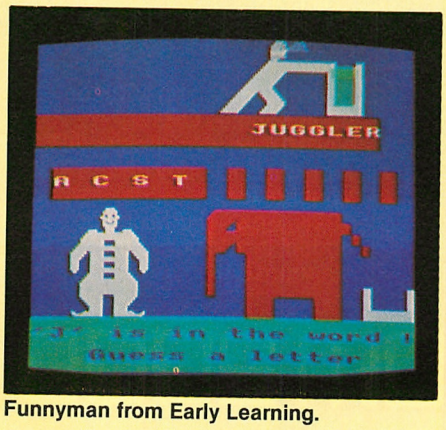
Noughts from Programs 2.



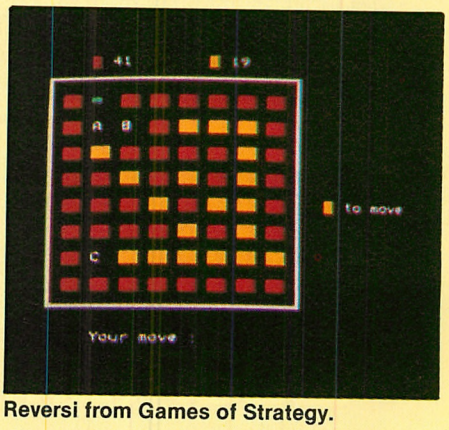
Heating Costs from Home Finance.



LEM from Programs 2.



Funnyman from Early Learning.



Reversi from Games of Strategy.

Computerise without compromise



The new All British QUANTUM 2000 computer system is outstanding among all the fine microcomputers now on the market. The explanation is simple. All microcomputer designers see Versatility on a high scale as their aim for the future. In the QUANTUM 2000 this ideal has actually been achieved, therefore it is demonstrably more advanced than any other.

QUANTUM 2000 offers every feature experts would look for in a new high technology 2.2 CP/M based microcomputer *plus* an expansion potential which a few years ago would have required planning permission.

What QUANTUM means by Versatility:

1. Available with 1, 2 or 3 disk drives.
2. Disk drives can be 400K or 800K floppies OR
3. 5 or 10 meg. Winchester OR
4. A mixture of floppy and Winchester.
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6. If the standard Centronics plus RS232 ports are insufficient, just plugging in a board adds a few more.
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● Circle No. 203

BBC TAPES

(continued from page 91)

Programs 1

Half of these 12 short programs are in two forms — a full easy-to-read listing for the 32K Model B and a compacted version with spaces and Rems deleted to fit into the 16K Model A. Incidentally, the command to list the programs as shown on the TV, with white letters on a blue ground and black rules between lines is:

```
* KEY 0 MODE 6:VDU 19,0,4,0;:VDU 14 !M
  LISTO 7 !N LIST !M
```

The first program, Owl, is a graphics exercise which draws the BBC owl and makes it blink. Suggestions for experiment include making it wink one eye only, altering the hexagon pattern of the building blocks, and making new pictures by entering different patterns of 0, 1 and 2 in the Data statements. The value lies not in the entertainment content, which is minimal, but in what can be learnt by playing with the program.

In Ball you are given a graphical simulation of how a ball bounces when certain parameters are altered. Gravity, initial velocity, relative elasticity and angle of throw can all be varied, and the formulae can be adapted for other trajectory-plotting routines such as rocket firing or archery. Newton without tears.

The Sales program draws graphs to show, for example, financial results through the year. It encourages the use of hexadecimals, though they are not essential. The specialised Acornsoft program for Charts and Graphs gives far more data, but this one is a good "taster".

A program called Bubble shows how a bubble sort works and how to alter the programs for different purposes.

With the Cube program you are shown how a simple three-dimensional shape can be represented and apparently rotated on the screen. The colour-switching command VDU 19 is used for animation, and the program illustrates the hidden-line removal technique.

The principals and uses of the various high-level languages are, unfortunately, not explained by the program called Languages. It simply uses the names to give a pretty display by a paste-over technique. The Flowers routine plots the elliptical function of three random values and produces related sounds as it draws the so-called flowers.

Anagrams shows how the computer can perform repetitious tasks without errors or omissions — in this instance the listing of anagrams derived from a set of letters. It is an excellent demonstration program which could easily be improved for crossword addicts — or compilers, for that matter — by suppressing impossible words such as those with three adjacent similar vowels or combinations like qz or vj.

The concept of binary patterns, zeros and ones is connected with the weaving of coloured threads in Weaving. It culminates in the 256 possible ways of weaving a thread through eight warps, and shows how to use VDU 24 to define graphics window areas.

In Sideways a short letter is written on the screen and then turned sideways. Useless as the result may be, the program has interesting features.

The classic problem of finding a single false coin among a dozen by repeated multiple weighings is illustrated in Coin. The first-class use of string variables is a feature of this program.

Finally, Plotter produces graphs with an interesting three-dimensional effect. Non-mathematical users can have fun creating abstract shapes.

Conclusions

- **All these little programs provoke ideas for writing more elaborate ones.**
- **They are informative for the novice who aims at computer literacy and provide a modicum of entertainment on the way.**

Music

The program allows you to write music on the screen for subsequent replay or saving on tape. The display shows three sideways-scrolling staves representing the three sound channels of the computer. They can be played together to produce chords, but when you write on stave 2 any notes already written on stave 1 vanish. You need some considerable ability to line up the parts correctly while writing, though they can be seen together if playing the ensemble.

Options on the user-programmable keys include Edit, Play, Erase, Load, Save, Tempo and Instrument. The last command alters the envelope — for example, Piano has a sharp attack, and Harpsicord the dying tremolo characteristic of a plucked string — though the names should not be taken too literally.

The two top rows of keys simulate a piano keyboard with a 13-note range, plus nine sharps or flats which record a different colour on the screen.

It is hard to see who would want to use Music. Some musical ability is required to enter the notes correctly, and an expert musician would rather play a piano since it is more responsive in terms of tempo and volume. Anyone with perfect pitch will notice that the frequencies are approximations for the various notes — for example, 4N chords seem to work better than the 4N + 1 sequence mentioned in the main users' manual.

Conclusions

- **Rather disappointing.**

Fun Games

Possibly the least successful of this series, this tape carries four simple games.

Breakout is a version of the popular game where bricks are knocked from a wall using a bat and ball. It makes good use of colour and produces a distinctive if rather discordant fanfare when a previous maximum score is exceeded. Otherwise it is rather dull for experienced games players.

Dodgems illustrates another well-known theme in which you try to make your car cover concentric roads while avoiding a computer-controlled car which tries to crash into you. It is an acceptable game, but not outstanding in any way.

The program called Flash is a memory game in which the player has to remember and repeat a sequence of coloured blocks and sounds generated by the computer. The game has a serious flaw: though the sequences are easily memorised, they soon become too long to enter in the time permitted. The computer then assumes an error and insists on repeating the sequence so the player, who knows the sequence perfectly, very soon grows excessively annoyed. Primitive graphics do not help.

Snake is another well-known game, in which a line is moved over the screen, eating randomly-generated letters and increasing in length as it does so. The game ends when the snake collides with the side of the screen or its own ever-growing tail. It is undoubtedly an addictive game and probably the best of a rather unimpressive bunch. Better graphics would help: users might like to try putting a head on the plain white line which bears no resemblance to the fearsome super-cobra shown on the package.

Conclusions

- **There are better compendiums of simple games, though this one does provide some useful ideas if you wish to learn how such programs are written.**

Programs 2

Like Programs 1, this series of eight short programs illustrates various computer programming ideas. All were written by Ian Trackman for the TV series, though some were not actually broadcast. All are for the Model B.

In Globe the computer draws a globe with lines and then spins it by switching colours on and off with VDU 19. The program includes shading, using Plot 85 as a fast though not very accurate method; a flag can be set to True at the start to show the effect. Acornsoft's specialised publication *Creative Graphics* develops such ideas further in its Beach Ball routine.

One of those familiar problems about ponds which leak until the fish swimming in them are endangered is solved by the graph

(continued on next page)

BBC TAPES

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in the program Water. The four colours in mode 1 are used with a superimposed grid. Another program, Pond, handles the same problem in a different way. It shows a golden carp in blue water with the level falling as a clock ticks away the time. It is less accurate but more fun. The fish uses two user-defined characters joined in a string variable and cannot be erased when text and graphics are joined by VDU 5 simply by overprinting with blank spaces. The colour is therefore set to the Exclusive Or mode, so two consecutive plottings in the same place first display the fish, then remove it. Random triangles represent weeds, and you could add a frog to jump up and down.

The demonstration program Paraser shows the two main methods of information transfer, serial and parallel. This time the colour-switching command is used with a double switch.

Lem is a lunar-landing game, and a really good one too. All information is displayed, there are realistic time lags on control effects, and even the lunar gravitational constant is correct. The number formatting function @% is introduced to ensure that numbers appear in the correct places on the control panel. The RND function in the crash routine is also worth noting. Other programming tips are indicated with Rems, and the game can be altered to suit individual tastes. It is an excellent little program.

The program LED shows how the light-emitting diodes in calculators, watches and the like form characters. An LED usually consists of seven segments, whereas a screen character is based on an eight-by-eight matrix with one row and one column switched off for spacing. Programs like this are best plotted first on graph paper. The ability to use the centroid, where 0,0 is plotted on the screen, is a useful feature illustrated in the course of writing the program.

Quiz is a typical question-and-answer program. Here it has been given a visual dressing-up with a conventionalised map, and the questions concern geography. Its main use is in showing how such programs are written, using a simple If-Then to test correct answers. The buffer is cleared immediately before each key press is expected.

A noughts-and-crosses program called Noughts is interesting for the way it learns. At first it loses, but it scans for patterns and then looks to see if losing moves have been filed. If they have, then it plays something else. Eventually it learns not to lose, and to win if its opponent makes an error. About 600 patterns are stored before memory is full but more could be fitted in by compaction and multi-statement lines. Binary and ternary numbers are used as flags for winning and losing and for recording the status of a square. Other simple games such

The listing of Sideways from the Programs 1 package.

```
10 REM **** SIDEWAYS ****
20 :
30 REM (c) Ian Trackman 1982
40 :
50 REM This program demonstrates how the standard
   character set can be re-defined in a different rotation
60 :
70 ON ERROR GOTO 1120
80 MODE 7
90 :
100 VDU 23;&200A;0;0;0; : REM No cursor
110 A$ = CHR$(131) + CHR$(141) + "Sideways"
120 PRINT TAB(12,11) A$ ' TAB(12) A$
130 *FX 15
140 K = GET : REM Wait for a key-press
150 CLEAR
160 :
170 MODE 4
180 VDU 28,0,29,39,1 : REM New screen size
190 VDU 23;&200A;0;0;0; : REM No cursor
200 REM Please see Model B version of this program
    for an explanation of the following routine
210 DIM X% 8, P% 60
220 Y% = X% DIV &100
230 A% = 10
240 MC = P%
250 OSWRCH = &FFEE
260 :
270 FOR I% = 1 TO 2
280   [OPT 2
290   LDA &&17
300   JSR OSWRCH
310   LDA &&E0
320   JSR OSWRCH
330   LDY &8
340   .LOOP1 LDX &8
350   .LOOP2 ROL X%,X
360   ROL A
370   DEX
380   BNE LOOP2
390   JSR OSWRCH
400   DEY
410   BNE LOOP1
420   RTS
430   ]
440   NEXT
450 :
460 REM Show normal display
470 COLOUR 0
480 COLOUR 129
490 CLS
500 PRINT ''
510 :
520 REPEAT
530   READ LIN$
540   PRINT TAB(7) LIN$
550   UNTIL LIN$ = "   "
560 :
570 *FX 15
580 K = GET
590 :
600 REM Now print sideways !
610 RESTORE
620 CLS
630 VDU 5 : REM Join cursors
640 GCOL 4,0
650 GCOL 0,129
660 GAP = &1C
670 MARGIN = 5 * GAP
680 X = &488 : REM "Top of page" gap
690 LMARG = &3FF - MARGIN
700 Y = LMARG
710 :
720 REPEAT
730   READ LIN$
740   :
750   IF LIN$ = "  " THEN 870
760   :
770   FOR I% = 1 TO LEN LIN$
780     L$ = MID$(LIN$,I%,1)
790     MOVE X,Y
800     IF L$= " " THEN PRINT L$; ELSE PROCTWIST
810     Y = Y - GAP
820     NEXT
830   :
840   Y = LMARG
850   X = X - &28
860   :
870   UNTIL LIN$ = "  "
880 :
890 REM Now you type something
900 *FX 15
910 X = X - &28
920 :
930 REPEAT
940   MOVE X,Y
950   L$ = "_" : REM "Cursor"
960   PROCTWIST
970   A$ = GET$
980   MOVE X,Y
990   L$ = "_"
1000  PROCTWIST
1010  MOVE X,Y
1020  IF A$ = CHR$(13) THEN Y = LMARG :
      X = X - &28 : UNTIL 0 : REM 'Return' pressed
1030 :
1040 MOVE X,Y
1050 L$ = A$
1060 PROCTWIST
1070 Y = Y - GAP
1080 IF Y < MARGIN + GAP THEN Y = LMARG : X = X - &28
1090 :
1100 UNTIL 0
1110 :
1120 MODE 6
1130 IF ERR <> 17 THEN REPORT : PRINT " at line "; ERL
1140 END
1150 :
1160 DEF PROCTWIST
1170 ?X% = ASC L$
1180 CALL &FFF1
1190 CALL MC
1200 VDU 224
1210 ENDPROC
1220 :
1230 DATA "      15, HIGH STREET      "
1240 DATA "          ANYTOWN"
1250 DATA " "
1260 DATA " "
1270 DATA "J. Smith Esq.    1st March"
1280 DATA "12, The Avenue"
1290 DATA "London N.W.18"
1300 DATA " "
1310 DATA "Dear Mr Smith,"
1320 DATA " "
1330 DATA "Thank you for your letter"
1340 DATA "of 18th February."
1350 DATA " "
1360 DATA "I confirm that next Monday"
1370 DATA "is a suitable date for our"
1380 DATA "meeting and I look forward"
1390 DATA "to seeing you."
1400 DATA "  "
1410 DATA "Yours sincerely,"
1420 DATA " "
1430 DATA "Joe Bloggs"
1440 DATA "   "
```

as Nine Men's Morris or Fox and Geese could be handled in the same way, and perhaps chess too, though it is difficult to conceive of a computer with that much capacity.

Conclusions

● **Some programs excellent, others not of much interest, but all illustrate program techniques.**

Early Learning

Five programs to assist children in simple maths and spelling make up this package. The correct way to test the programs is to try them out, with the assistance of qualified teachers, in class and for home study and check to see how they fit into the overall curriculum. This has already been done, since the programs were developed by the Microelectronics Educational Programme set up by the Department of Education and Science.

The idea is that parents should try to find time to work through programs with their children, so that learning is an enjoyable, shared experience. But, and we quote, "Parents should not become too exasperated or down-hearted if, after a while, their progeny outstrip them in acquiring programming skills: such is the fate of most parents". These are robust and user-friendly programs, as they must be for this purpose.

In Fractions children work as partners with teachers and parents to gain practice in converting between fractions, equivalent fractions, top-heavy fractions and in adding together two simple fractions. It also helps children who make mistakes.

The program Multiplications is in two parts. The first aims to teach or reinforce knowledge of long multiplication; the second measures success in a gentle and helpful way. Colours are used freely, for instance to show that an answer is correct. Notes are given for small program changes, such as sound alteration.

Learning multiplication tables is a chore, but the Table program is well organised with a colourful display. Children can practise and take a test. The program notes weakness and provides more practice in such areas. It is for children to use one at time, so mistakes can be made without other children knowing. Response time is included, but can be altered or left out. It seems like a good idea — don't surrender to the calculator!

Smalldozer is for children of primary-school age. Colour and graphics are used as reinforcements to learning, not just as decorations. The program reinforces but does not replace activities such as parent and child reading picture books together, and it adds spice to early learning. Its purpose is to teach use of letter e at the end of the word and vowel sounds but can be altered for other spellings.

First Billy Bulldozer runs across the screen and page 1 follows, with simple letter groups followed by e. If the child thinks this makes a word he or she types it in. If it does, Billy pushes the letters over a magic bridge to the other side. Vowels change colour if the sound alters. If it does not make a word the letters fall down the ravine. Scores are given and after four pages a revise. The program is easily altered to put in new words of up to nine letters.

In a gentle version of Hangman, called Funnyman, Jumbo's friend Jim wants to give the elephant a drink. The cart goes along a path with bricks missing. Letters in the "mystery word" form the missing bricks, but wrong bricks divert the water so poor Jumbo cannot get his drink. The sample program gives a series of circus words but they can easily be altered by changing the Data statements at the end.

Conclusions

● **First class for its intended purpose.**

Home Finance

A collection of four programs adapted from the Consumers' Association magazine *Which?* in association with the BBC Computer Literacy Project makes up this package.

A 12K program called Heating Costs evaluates the fuel used, how it is used, the temperature set, heat losses, hours of heating and so on. There are limitations: for example, if your house does not conform to popular patterns, say by being stone-built, you will have to alter the program. There may be arguments if you say the house is not draughty and your partner says it is: there should be an intermediate Don't Know setting. If you are willing to use a surveyor's tape and measure everything, then the program could well save a lot of money if only by making it plain which questions should be asked. The booklet is full of practical hints, such as "If the cost of changing will take more than four years to repay, it is not worthwhile."

With Rent or Buy, an 11K program, you can compare the relative advantages of renting or buying things like TV sets or cars. Factors such as inflation and interest are included, also tax rates. Another 11K program called Saving considers the various options open to savers. It can be updated with the latest figures from *Money Which?* or, the booklet says, from the local library. If you want the reverse, and need money rather than having it to spare, the 7K program called Borrow supplies the relevant information.

Conclusions

● **These are good, practical programs and using any one of them should more than repay its initial cost; they might even pay for the computer as well.**

● **There is provision for updating, and though there are limitations, common sense should reveal them.**

● **The booklet is clear and helpful, much on the lines of the *Which?* original.**

Games of Strategy

Four competent games are included, though they lack imagination and flair. However, at £2.50 each the price is reasonable and since the programs are in Basic and can be listed you can add fancy bits if you wish.

In a Startrek type of game called Galaxy the ship is called Endeavour, maybe because of copyright or perhaps because the BBC no longer wishes to be associated with that famous split infinitive "To boldly go . . .". As usual, there are eight by eight sectors divided into eight by eight areas. Photon torpedoes, phasers, warp drive, shields, refuelling from star bases and so on are all available, but there are no trimmings such as advice from Spock or searches for the Queen of Zhia. The Freeze command will be blessed by every games player who has been interrupted at a critical moment by the phone or next door's kids. There are more exciting versions around, but at least you can get at the program.

Gomoku represents the traditional game played on a 19-by-19 board using counters. The player selects positions with the cursor controls. The aim is to get five in a row, column or diagonal, rather like a more complicated noughts and crosses. The computer plays a strong game.

The Masterbrain game is described as requiring logical deduction and reasoning. It is also known as Bulls and Cows when played with low-technology paper and pencils between two humans. You and the computer select four-digit code numbers and make guesses. You are told the number of digits in the right place, or bulls, and correct ones in the wrong place, or cows. Programmable calculators can play a similar game but the screen display looks prettier.

Reversi, another traditional game for two players, is on an eight-by-eight board. Counters are placed in turn where there is a complete line unbroken by spaces which pass through one or more of the opponent's pieces to a position already held by the player. This sounds obscure, but a sample game can be shown by the computer which makes all clear. Possible moves are indicated by letter, so moving is simple, and the computer changes the colour of captured pieces. A count of the score is kept every move. Winning strategy is to occupy edges corners, if you can — the computer plays a good game.

Conclusions

● **Competent rather than exacting: for example, Galaxy would suit anyone who has not already played the great original Atari version.**

● **You will take some time to beat the computer at Reversi; perhaps users could program in a fanfare for when the player wins.**

● **A few imaginative touches could make a great difference.**

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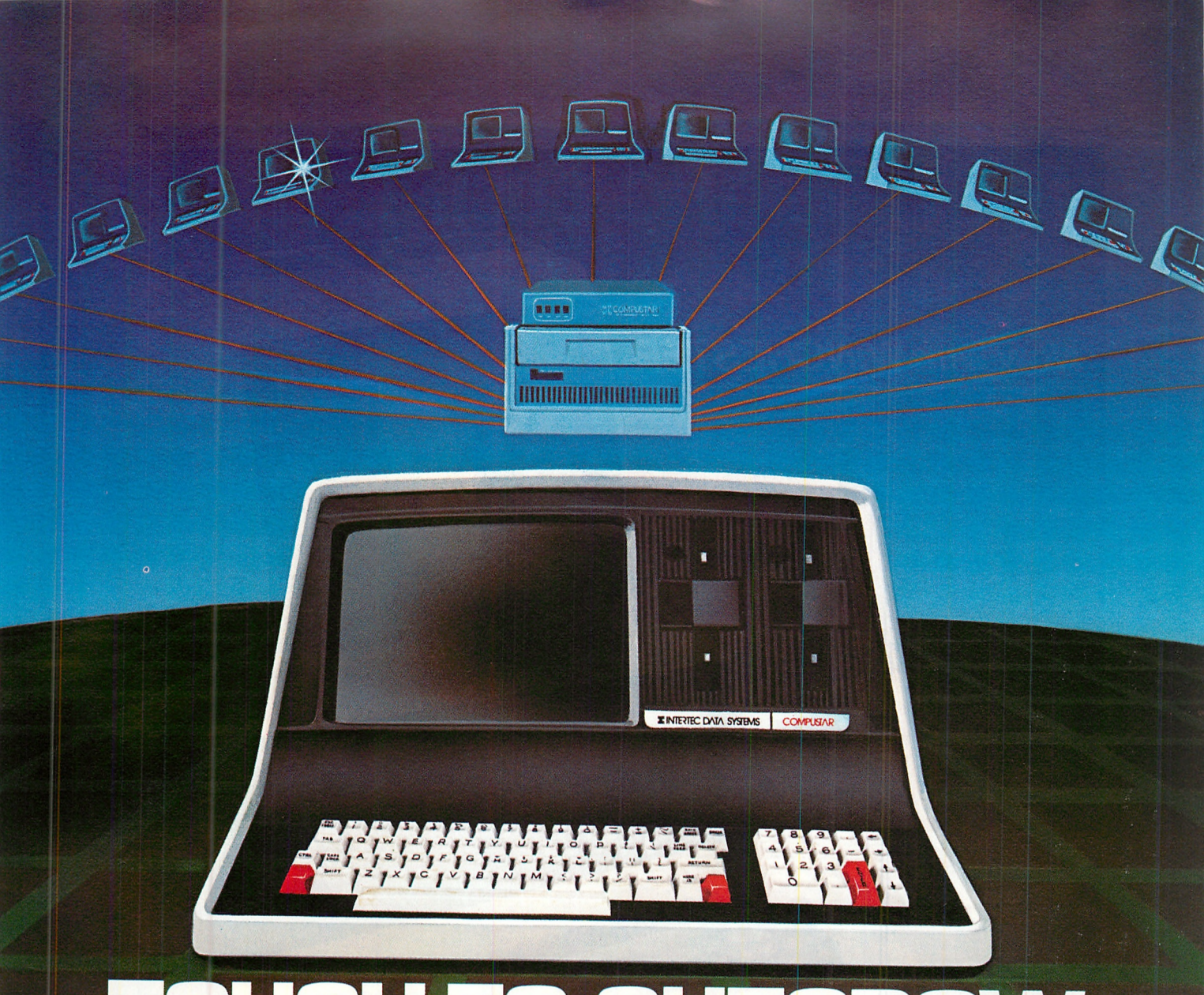

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Word processing on a Spectrum

Bill Bennett pushes his misgivings aside to try out a pair of packages which turn Sinclair's home micro into a practical typing tool.

I HAD GRAVE DOUBTS about using the Spectrum as a word processor. For word processing you need four basic ingredients. You require the software, and next on the list has to be a proper keyboard, which the Spectrum sadly lacks. It might be a wonderful little micro and a miracle of engineering, but it in no way has a proper keyboard. The third essential ingredient has to be a printer. Lastly for any serious word processing you need discs.

Against these criteria the Tasword package running on the Spectrum leaves much to be desired. But for home use, as opposed to any serious word processing, a number of compromises can be made. Just how far you take these compromises depends on your sense of aesthetics, your individual requirements and, most important of all, your budget.

Tasword is cassette not disc based, and so are Tasword files. I assume that when the Sinclair Microdrives eventually appear there will be a Microdrive version of the software, but for now you will have to be content with loading and saving files from tape. This is slow — not so slow as to be ridiculous, but it is tedious.

The Tasword program took about 90 seconds to load — not very long at all. The time a text file takes is proportional to its length. The reason discs are so useful for word processing is not speed, it is the way that files can be saved. But as Tasword has no insertion facilities it does not really matter.

In Tasword, to save the file you type Stop to go to a file-handling menu; when there "a" will start the process. Following it by an Enter prompts the question, "name of text file for saving?" When you type in the name the fun begins. First you have to remove the ear-plug from the cassette player. Next press the Play and Record buttons on the recorder.

After a moment or two of the multi-coloured pyrotechnics associated with loading and saving on the Spectrum, a message appears on the screen asking if you want to verify the saved file. By the way, you must remember to turn the tape recorder off now. If you decide to verify, you rewind the tape, reconnect the ear-plug, press the Play button and wait.

I never managed to save anything successfully, which was probably the fault of the tape recorder. When the verify does work, pressing Break and then rerunning the program leaves the file in the memory, so at least it is not lost.

How suitable is the rubbery keypad of the Spectrum for word processing? It was better than I expected, but not really adequate. There are add-on keyboards for the Spectrum, but they cost in the region of £50. The keyboard might prove adequate to those who cannot type, though they will find it difficult. You cannot be sure that you have actually hit the key, so you have to look at the screen after each character to check it is there. Touch-typing is out of the question.

I did enter documents using the rubber keyboard, but not as quickly as I could type the same document using an ordinary typewriter. In fact the lack of insertion, the horrors of the keyboard, and the poor quality of the ZX printer output make even a manual typewriter look good.

If you already have a Spectrum, a tape recorder and a ZX printer, then the Tasword Spectrum word processor is definitely a good purchase. It is an even better buy if you already have a real keyboard as well. But I would not recommend it as a system bought from scratch, at least not for dedicated word processing.

On the plus side I found Tasword as friendly as some packages costing 10-times the price and as efficient, given the constraints. It is possibly the most useful item of software I have seen for any home computer and certainly one which I would add to my own library.

The real let-down is the ZX printer. Can you imagine getting a business invoice printed on that thin black-and-silver thermal paper? It tells me that the bill does not need paying. If the money was wanted badly enough the company would have sent a real invoice. If it could not do that then I still would not pay up because the company would be bankrupt before long.

For most home uses the ZX printer would be adequate: producing letters to loved ones, shopping lists, memos and the like. Tasman software even managed to produce the manual using Tasword and a ZX printer, it is good to see that someone in the industry has faith in their product. A much better printer can be interfaced to the Spectrum via the ZX Lprint device from Euroelectronics, and would be ideal for word-processor

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output, if a little expensive. Unfortunately I could not make it work with Tasword, but I am sure that to do so is not impossible.

Quicksilva is a software house better known for its wide range of microcomputer games software than applications. Nevertheless, its word processor appears to be of the same high standard as Tasword.

Like Tasword, the Quicksilva package is so user-friendly that it could be described as "user-obsequious". But then it has to be because there is no user manual. There is a school of thought that maintains that he best user manual is a scrap of paper telling you how to load your software package. Obviously Quicksilva went to that school.

Not having a manual is fine, in principle, especially once you are familiar with the software. But it does make the initial learning curve longer if you need to use the Help function every time you want to do anything other than add more text. The first time I loaded the package I could not even remember how to find the Help screen.

The next time I loaded it I made the other serious mistake: instead of hitting both the Shift keys at once to take the system into Command mode, I hit Shift and Space. This is not a difficult mistake to make, considering that the Space key and the Symbol Shift key sit right next to each other. It had the effect of breaking the program; thankfully when the program was restarted using the Cont command my text file was still there in memory.

Of the two programs, the Quicksilva package has more rough edges, but then it is £1 cheaper and is written in Basic. Even the most nervous programmer should be able to modify it to their taste. The need for such customisation will become more obvious if and when Microdrives are released.

The Quicksilva system uses white characters on a black background, which I find more restful to look at. It has a clever word-spacing and word-wrapping algorithm that causes a hiccup every time the end of line is reached. It is caused by the last line entered being shuffled around to fit the measure and, if necessary, moving the last word entered on to the next line.

Clever as this routine is, it has a major drawback. While it is working the screen blanks, and while it remains blank anything entered at the keyboard is not read. The program is only just quick enough to read characters anyway. If it were not for the slowness of the rubbery keys, you would find yourself typing faster than the word processor could process.

Because I can touch-type, I do not need to look at what I am typing as I write, unlike two-finger typists. After a session using the Quicksilva package I was horrified to read back my document. It was full of faults, exclusively lost characters, caused by the inability of the system to read the keyboard while wrapping around words at the end of a line.

However, Quicksilva's package has one major advantage over Tasword when it comes to serious word processing. When used in conjunction with the ZX Lprint from Euroelectronics it can produce high-quality print on a dot-matrix printer. This advantage is countered by the fact that, as it stands, it can only print out 32 characters per line.

Judged against each other, there is no winner. Both have different advantages and disadvantages. Both are good packages considering the hardware limitations and the price.

Conclusions

- **The Tasword program is excellent value at £7.95 including a manual and a tutorial.**
- **Quicksilva's word processor is cruder than Tasword, and this is reflected in the £5.95 price tag.**
- **Very good results can be achieved from the Quicksilva program using the ZX Lprint device which interfaces the Spectrum to any printer with a Centronics interface.**
- **The Spectrum has massive defects as a word-processor but, when weighed against the cost of implementation on an existing micro, the benefits tip the balance.**
- **The Tasword package is available from Tasman Software, 17 Hartly Crescent, Leeds LS6 2LL.**
- **Quicksilva may be found at 13 Palmerston Road, Southampton.**
- **The ZX Lprint device costs around £30 from Euroelectronics, Zlin House, Oakfield Street, Cheltenham, Gloucestershire. GL50 2UJ.**

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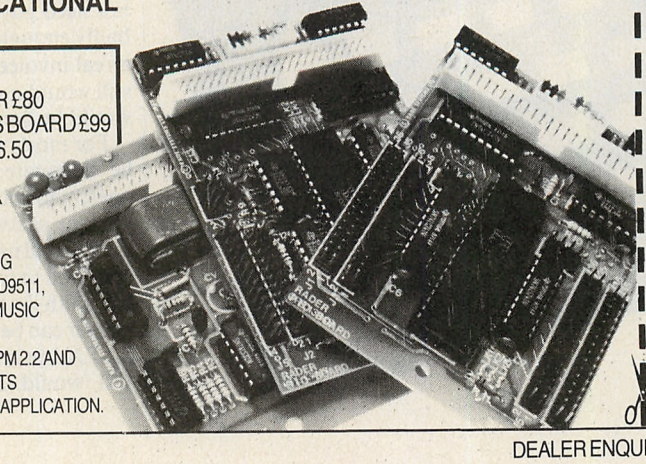

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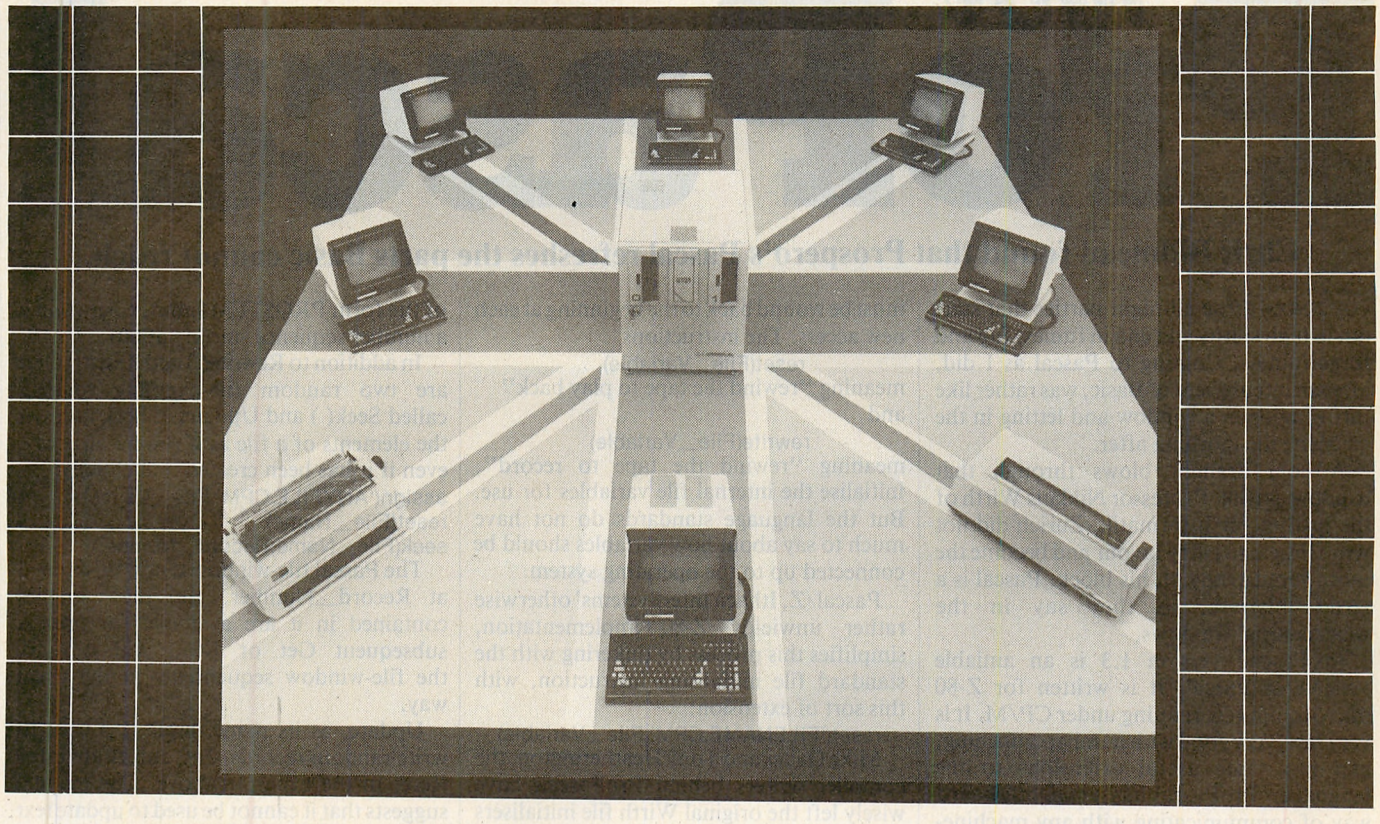

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● Circle No. 170

Not so strict ProPascal

Chris Bidmead found that Prospero's Pascal refreshes the parts Basic cannot reach.

YOU KNOW those all-night parties that start out in high spirits and end in fumes, fug and forgetfulness. Coming to Pascal as I did, after an intense year of Basic, was rather like throwing open a window and letting in the sunshine the morning after.

A cold draught blows through that window as well. Professor Niklaus Wirth of the Institut für Informatik, Zurich did not write Pascal to curry favour and become the most popular boy on his block. Pascal is a strict mistress, as they say in the tobacconists' windows.

ProPascal, version 1.3 is an amiable version of Pascal. It is written for Z-80 microcomputers running under CP/M. It is very fast, very good with number crunching, and has some useful extensions to the language. ProPascal has a staightforward way of communicating with any machine-code routines you might want to incorporate.

Strict Pascal is very stark so most commercial versions of the language incorporate a mixed bag of enhancements to string and file-handling. The *de facto* standard for this super-set derives from UCSD Pascal. ProPascal stays close to UCSD in introducing a new structured type called dynamic string, which is like a record:

```
type string [max len] =
  record
    length_byte : 0..255;
    string_part : array[1..max_len] of
          char;
  end;
```

Note that max_len is not quite as this Pascal-like declaration would imply. Its value is set automaticaly when you declare the type, as in

```
var A_Fairly_Long_String : string[127];
```

The unindexed String defaults to string [80].

Wirthians justify the absence of a dynamic string type in canonical Pascal by pointing out that an implicit string type exists in the packed array of char, or — if that will not do — you can create your own record type along the lines above. Version 1.2 of ProPascal lacked dynamic strings, and without them is very much the poorer. Along with the dynamic string type go a set of extra string-handling routines, three procedures and four functions — see figure 1. Again these are derived from UCSD Pascal.

File handling introduces more UCSD-like extensions. Strict Pascal insists on talking about files as if they are on reels of tape that must be wound back to the beginning at each new access. The instructions

```
reset(File_Variable)
```

meaning "rewind the tape to play back" and

```
rewrite(File_Variable)
```

meaning "rewind the tape to record", initialise the internal file variables for use. But the language standards do not have much to say about how variables should be connected up to the operating system.

Pascal/Z, Ithaca InterSystems' otherwise rather unwieldy Z-80 implementation, simplifies this process by tinkering with the standard file initialising instruction, with this sort of extension:

```
reset('FILENAME.CPM',File_Variable)
```

Mike Oakes and Tony Heatherington, the compiler writers behind ProPascal, have wisely left the original Wirth file initialisers intact, although it means that additional statements have to be introduced into the language. In ProPascal a file is opened for sequential writing with

```
var File_To_Be_Writen : text;
{...}
assign('TEXTFILE.CPM',File_To_Be_
Written);
rewrite(File_To_Be_Written);
{...etc}
```

But if files are just serving as temporary workspace there is no need for explicit assignments. By default unassigned files buttoned-hole a series of CP/M file names of the form PROTEM.nnn, where nnn is a number sequence starting at 001.

In addition to Rewrite( ) and Reset( ) there are two random file-handling routines called Seek( ) and Update( ). Seek accesses the elements of a file as if it were an array, even if it has been created sequentially:

```
assign('ANYFILE.CPM',File_Variable);
reset(File_Name);
seek(File_Name,Record_Number);
```

The Pascal file-window is now positioned at Record_Number, and the variables contained in it are available for use. A subsequent Get or Read will advance the file-window sequentially in the usual way.

Update, as its name implies, is used to write random records. Just substitute it for Reset in the example above. The manual suggests that it cannot be used to update text files, but you can cheat by reopening the text file as if it were a file of records:

```
type CMP_Record = array[0..127] of byte;
var InFile : file of CPM_Record;
{...}
assign('TEXTFILE.CPM',InFile);
update(InFile);]
```

ProPascal has a simple mechanism Chain to allow one program to pull in another, and parameters may be passed through the routines:

```
putcomm(Hands_Across_The_Sea_
Variable);
(...switch programs here...)
```

Figure 1.

```
function concat(this_string,that_string)          : string;
function copy  (this_string,start_at,how_many)    : string;
function length(this_string)                      : 1..255;
function pos   (pattern,this_string)              : 1..255;

procedure insert(this_string  : string;
                 var that_string  : string;
                     start_at     : 1..255);

{start_at <= length(that_string) + 1}

procedure delete(var this_string  : string;
                     start_at     : 1..255;
                     how_many     : 1..255);

{start_at + how_many <= length(this string)}

procedure str(an_integer     : integer;
        var number_string    : string):
```

Concat concatenates two strings; copy returns how_many characters from this_string, starting at start_at; length is self-explanatory; and pos returns the position in this_string where pattern starts, or zero if there is no match. Insert puts this_string inside that_string beginning at position start_at; delete removes how_many characters from this_string, starting at start_at; and str returns with number_string representing the value of an_integer.

getcomm(HATS_Variable)
In fact Putcomm and Getcomm use CP/M's default DMA buffer at 80h. This is handy because the Getcomm statement can also be used to sample the CP/M command-line tail, which CP/M happens to store in the same buffer.

Pascal is fiercely disciplined about variables typing, but sometimes the programmer can save time by accessing a variable of one type as though it were another. ProPascal provides the procedure Move for this purpose:

```
var File_Name_Suffix : string[3];
MPM_Attribute_Check : array[0..3] of
byte;
{...}
move(File_Name_Suffix,MPM_Attribute-
_Check,4)
{ move 4 bytes because string [3] has a
length byte at [0]}
{...etc}
```

The free use of the underline character to improve the readability of identifiers, in CPM_Record for example, is another idea imported from UCSD Pascal — the compiler throws the extra character away without comment.

In common with a lot of the more powerful languages the compiler does not immediately produce object code. Intermediate "relocatable" files are created, which then have to be processed by a linker. If you know about .Rel files this will be good news; if you do not it will not present a problem. The compiler automatically chains to the linker if you are not taking advantage of the relocatable feature, leaving you unaware that an intermediate process is involved. Compilation speed is very fast, sometimes giving around a 25 percent improvement over Pascal MT+ and as much as a 70 percent improvement over Pascal/Z. The code produced is compact and can run rings round MT+ when it comes to doing real arithmetic. ProPascal also seems to be the only one of the three to make use of the Z-80's relative jump instructions.

None of the CP/M Pascals I know has a facility quite like UCSD's Unit compilation, which is an organised and speedy way of creating large programs by bolting Pascal modules together. But UCSD Pascal is pseudo-compiled, and there is a huge price to pay in speed of execution — some benchmarks may take up to 10 times as long.

Modular composition is still easy under ProPascal, and the authors have managed to implement it with the minimum departure from the standard language. A module looks exactly like a program, except that the word "segment" appears at the head of the code instead of "program". The working code is set out where global procedures and functions would ordinarily appear, and the main section is left as an empty pair of Begin-End brackets.

The modules can be compiled separately down to .Rel files, added to a library — or not. Then pulled in from ProPascal main programs by way of procedures and function declarations to which the word External has been appended, exactly as strict Pascal allows Forward declarations.

Communication between "main" and "module" is either by normal Pascal parameter-passing, or by using a structured buffer area predeclared as Common. This is the same mechanism as Fortran uses, and its rather unusual inclusion here is because Messrs Oakes and Hetherington had plans for, and have now produced, a Fortran compiler that also generates .Rel files. Fortran covers some of the classic weaknesses of Pascal — formatted output, for example — so the combination should be very powerful though I have not tried it yet.

Figure 2.

```
program getdemo;{demonstrates the external segment getcon}
                        {chris bidmead, 15 Mar 82}

const   ControlQ  =  11h;
        esc       =  1bh;
        del       =  7fh;

type    digit   = -1..9;

var     ch      : char;
        number  : digit;

function getcon(param : char) : char; external;

function num(ChDigit : char) : digit;

  begin
    if ChDigit in ['0'..'9']
      then num := ord(ChDigit) - 30h
  end;

begin
  repeat

  write('Enter a letter: ');
  writeln(getcon('A'));

  write('Now enter a number: ');
  number := num(getcon('9'));
  writeln(number:1, ' times 2 = ', 2 * number:2);

  write('Now enter an alphanumeric: ');
  writeln(getcon('X'));

  write('Now a Control Character <^Q to Quit>: ');
  ch := getcon('C');
  case ord(ch) of
    esc : writeln('ESC');
    del : writeln('DEL');
    otherwise writeln('^',chr(ord(ch) + 40h))
  end {case};

  until ord(ch) = ControlQ
end.
```

Macro-assembler

Linking-in external modules is very natural and easy in ProPascal and, happily, linking to external modules written in assembler is hardly more complicated. ProPascal has been specially designed with the Microsoft macro-assembler M-80 in mind — my favourite way of producing and documenting small routines.

Experts say that M-80 is also excellent for the heavy stuff, if compact fast code for the 8080 family is what you are after. In cases like this ProPascal and M-80 make a very good pair: ProPascal takes care of the outer logical design and the user interface while M-80 fills in small details, like routines optimised for speed or special hardware handling.

Passing parameters to and from assembler is about as straightforward as it could possibly be. Even though or perhaps because the manual is terse on this subject it took no time to get it right. If you have never done any programming of this kind before ProPascal is an excellent springboard. You need to know some assembler of course, but not much to get started, and you have to be completely clear about:

- The difference between functions and procedures.
- The difference between value and variable parameters.
- How ProPascal parameters are passed on the stack.
- How ProPascal types are mapped on to bytes.

It is not clear from the manual that boolean true is 01 and any other value, not just 00, is read as false. A single byte value passed to a machine routine on the stack is put not in the low byte as in Pascal MT+ but in the high byte, to be Popped back neatly into the accumulator where you probably want it.

You do not have to preserve a whole raft of registers as in Pascal/Z where the ix, iy and bc,de,hl alternate registers have to be maintained — and you must come back to Pascal/Z with the accumulator cleared. ProPascal gives you free rein as long as you leave the ix register intact and clean out the stack before returning.

(continued on next page)

Not so strict ProPascal

(continued from previous page)

Figures 2, 3 and 4 demonstrate how separate compilation can be used to create a keyboard-input masking routine. The function Getcon( ) will refuse to accept selective character types depending on the character passed to the function from the main program. Getdemo calls the external ProPascal routine Getcon, which in turn calls the short assembler routine Inchr. After compilation and assembly with:

```
propas getdemo
propas getcon
m80 = inchr
```

the three resulting .Rel files and the ProPascal library are linked with the command:

```
prolink getdemo,getcon,inchr,paslib/s
```

ProPascal lets you think in hex numbers. The H suffix denotes hexadecimal as in M-80. Line debugging can be switched on with the compiler switch. It is not as extensive as the Swat debugger in Pascal/Z, but on encountering run-time errors the trace of line numbers carries you right back to the main routine — helpful when tracking down the point where the program is fouling up. A cross-reference program called Xref is supplied to give you an alphabetical list of identifiers and the line numbers where they can be found — very handy for long programs.

Max_int is 21474836647, which is over 6,000,000 times bigger than the max_int of MT+. Gosh you say, but so what? Well, for one thing it lays the basis for standard four-byte reals of seven decimal-digit precision and, if that seems skimpy, double-precision eight-byte reals accurate to 16 decimal digits. That should chase the rounding errors out of business calculations.

There are no plans to support conformant arrays. Routines that accept arrays as parameters always require the array size to be invariant. But within this constraint the conformant array schema allows the upper and lower bounds to be declared as variables in the receiving routine.

The ISO Standards Committee argued long and hard about this one and eventually compromised on a Level 0 version without the conformant arrays schema, and a Level 1 version with it. Oakes and Hetherington say no to conformant arrays because the facility would add approximately 20 percent to the size of their compiler. I do not suppose we will miss it, but if you must have it MT+ is what you need. ISO also allows an array of files, which is not supported in ProPascal 1.4. Oakes and Hetherington will be including this in version 2.1.

Figure 3.

```
segment getcon; {ProPas routine for selective
                 character input from con:
                 Chris Bidmead, 15 mar 82}

function getcon(param : char) : char;

  var      ch : char;
      OkChars : set of char;

  function inchr : char; external;

begin
  case param of

{parameter.....means getcon will only accept}

    'C','c' : OkChars := [chr(1)..chr(1fh),      {control codes}
                          chr(7fh)];                {and DEL}

    '9'     : OkChars := [chr(30h)..chr(39h)];      {digits}

    'A','a' : OkChars := [chr(41h)..chr(5ah),
                          chr(61h)..chr(7ah)];    {letters}

    'X','x' : OkChars := [chr(30h)..chr(39h),      {digits }
                          chr(41h)..chr(5ah),        {&}
                          chr(61h)..chr(7ah)];    {letters}

  otherwise OkChars := [chr(20)..chr(7eh)]          {all but}
                                                   {controls}
                                                    {and DEL}

  end {case};

  repeat
    ch := inchr
  until ch in OkChars;
  getcon := ch

end {getcon};

begin {segment} end.
```

Figure 4.

```
.comment +
*************************************************
*                                               *
*  small z80 routine to get a char via direct   *
*   bdos i/o                                    *
*                          chb 1/30/83          *
*************************************************+

                .z80
entry   inchr           ;declare the entry point for the linker

dirio   equ     6       ;cpm direct i/o call
input   equ     0ffh    ;put in e to request input
bdos    equ     5

inchr:
        ld c,dirio
        ld e,input
        jp bdos         ;returns the char in accumulator
                        ; which is where ProPas expects
                        ; to find returned function values

end
```

Conclusions

● I like the manual very much. Its prose is terse — wool- and joke-free — and the authors do not fall into the trap of saying everything four times, thinking it is the way to get their message across. But more copious examples would make it easier to grasp the laconic generalities.

● An upgrade to version 2.1 is imminent, and there will be an edition of it configured for the new 8086/8 chip family running under CP/M-86 and eventually under MS-DOS. But at the time of writing ProPascal is still only available on the Z-80.

● Despite the remarks I have made strict Pascal makes a marvellous learning tool for getting to grips with the art of programming. ProPascal can be geared down into strict Pascal just by setting the S compiler switch. A beginner wanting to move out of the classroom and into real-life programming just dispenses with the S switch, adds on M-80, and has a powerful multi-purpose combination language that should go as far as the Z-80 ever will.

● The current price of ProPascal 1.4 is £190 and it is available from usual CP/M software suppliers, or direct from Prospero Software, 37 Gwendolen Avenue, London SW15 6EP. M-80 is available separately from Lifeboat and others at around £160. ProPascal 2.1 is due out in May, and will come with its own library handling program at £220.



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Payroll packages on 16-bit micros

By the time you find your payroll package is useless it's usually too late — to use it is to know it. Mike Lewis samples four from those available.

OF ALL THE ROUTINE jobs done in offices, payroll is nearly always the most profitable to computerise. If you use a computer for sales ledger or stock control, you may or may not see tangible benefits. But rarely are the savings as dramatic as in the wages office.

There are companies where a computer has cut the time needed for payroll preparation from two days to two hours, as well as providing better management information than would have been conceivable otherwise. Yet payroll is a difficult candidate for computerisation as well as an attractive one. An employer carries a heavy responsibility, both to employees and to the state. If the payroll system fails the consequences could be disastrous.

Not least of the difficulties lies in choosing the right software. There are now over 100 payroll packages on the U.K. market for micros alone. While many of them are excellent — and many more are frankly useless — none of them could claim to be suitable for all types of companies in all circumstances. What's more, the limitations of a particular package are rarely obvious. You have to use it for quite a long time before you can be really certain that it will always do what you want it to.

To help you find your way through the payroll jungle, I have taken a detailed look at four of the market leaders. They are all packages that are available on 16-bit machines like the Sirius 1 and the IBM PC. Three of the four, from Omicron, Jarman and Ibis, are also available on other systems. The Pulsar system from ACT is intended mainly for Sirius users.

Perhaps the most important point to look for in a payroll package is accuracy, and in this respect I could find little wrong with any of the four. In particular, they all handle the complex tax calculations precisely in accordance with the specifications laid down by the Inland Revenue. But all four packages are weak in handling certain exceptional tax cases, and Jarman does not correctly cater for contracted-out National Insurance.

Next comes the important question of the types of payments and deductions that the packages can cope with. All four systems can easily handle the straightforward cases — the staff on fixed annual salaries with perhaps an occasional bonus and a couple of fixed deductions. The problems start when you introduce something out of the ordinary, such as a complex productivity payment or an unusual pension scheme. The Omicron package is probably best able to cater for these special cases, with Pulsar a close second.

Another point to consider is security, the question of who has access to which parts of the system. I suspect that micro users do not always put as high a premium on built-in security aids as many software designers think. After all, it is easier to lock a floppy disc in a filing cabinet than it is to introduce a complicated system of passwords. Nevertheless, most payroll packages have some form of password control.

Pulsar takes a straightforward approach: you simply enter your password to get into the system, and I would have thought that this was adequate for most users. Jarman goes to the other extreme. Its system has three separate passwords, and you constantly have to enter one or other, almost every time you go to a different screen. It will drive you crazy.

Omicron Master Menu.

1 Start period processing
2 Parameter file maintenance
3 Employee file maintenance
4 Process current period payroll
5 Print period end reports
6 Payroll utility programs
7 Year end processing
8 Display/print files

Pulsar Payroll system procedures.

Employee file maintenance	(1)
Pay calculation	(2)
Print credit transfers	(3)
Print cheques	(4)
End of tax year procedures	(5)
Extract analysis data	(6)
Exit from Payroll system	(*)

Jarman system.

1 Payroll preparation
2 Reports
3 Employee records
4 Standing instructions
5 Sorting
6 End of period
7 Options
8 Finish session

Finally, there is the question of flexibility. While certain aspects of the payroll are the same for all employers, others vary considerably from firm to firm. The level of detail to be shown on pay-slips, the types of coins and notes to be used for cash-paid employees, even the rules for rounding fractions of a penny — these are all areas where the software must be flexibile enough to cope with different requirements. In this respect, it is the Omicron package that scores the highest marks.

In fact, Omicron's is probably the all-round best of the four packages, at least on paper. It certainly has all of the features that most firms are likely to need: it is the only payroll I have ever seen that correctly handles court orders for attachment of earnings. You pay a price for these features in terms of the extra effort needed to set up and use the system.

To set up an Omicron payroll, you have to define your requirements in terms of 28 elements. An element is either a payment, a deduction, or a charge. An individual employee's final pay is derived from a predefined combination of these elements — up to 24 per employee — as well as any statutory payments and deductions. A charge is a cost that the employer bears but which does not form part of the employee's pay, an employer's pension contribution, for example.

So your first job is to tell the system which of these elements you wish to use. You may give each element a name — for which only eight characters are allowed — and it will then be used throughout the running of the system. You also tell the system whether the element is payment, deduction or charge; whether it is wholly or partly subject to tax; whether it is subject to National Insurance; whether it is pensionable; whether it should be paid if the employee is sick; and quite a lot more.

The whole thing is very logical but it will need considerable planning to define the payroll correctly. At least you can always alter the definition later and add new elements, up to the maximum of 28, as and when necessary.

The same is true for the other user-defined details. You can specify a maximum figure for gross pay so that you get an automatic warning if an employee's pay

exceeds this figure. You can tell the system which notes and coins you wish to use for cash-paid employees, and you can specify a minimum quantity for any or all of them. You can specify rounding of net pay to a certain note or coin. You can even design your own bank giro forms if you do not wish to use the standard stationery.

After you have done all this, your next step is to enter the fixed information that the system needs for each employee. In this respect the Omicron system is similar to the other packages. They all need to know such details as tax codes, methods of payment, etc., as well as the amounts of all regular payments and deductions.

The regular weekly or monthly processing follows the same pattern as the other packages. First you enter any variable information relevant to the current period: hours worked; days sick; non-regular payments and deductions; and so on. You can also adjust any of the regular payments at this stage.

Then come the actual calculations, and here we see one of the major weaknesses of the Omicron package. The system first calculates the gross pay for each employee, printing the results in summary form. You now have the opportunity of checking for errors and making any adjustments needed. So far so good.

In the next stage, the gross-to-net calculations, the system actually updates the year-to-date totals at the same time as it performs the calculations. The calculations cannot be repeated if an error is discovered. If you made just one mistake in keying, say, an after-tax deduction, you will have to restore your files from a back-up copy and repeat all the work done since the copy was made.

If you find yourself in this situation it will be little consolation to know that the Jarman system has the same problem. In this case, the updating is done at the same time as the pay-slips are printed, so a simple paper jam could mean a serious delay. Any textbook on system design will point out that potentially destructive operations, like updating cumulative figures in a master file, should be located in a single function that can be run under the direct control of the user after all time-critical tasks have been completed.

Back to Omicron, and if you have got this far with it, the rest of the weekly processing will be plain sailing. After printing the pay-slips, you can ask for any or all of a dozen or so further outputs. They include a coin analysis, bank giros and cheques, as well as a wide choice of statistical reports. You can specify the sequence in which information is printed in any of these reports.

There are several other features of the Omicron system that I like. There are facilities for automatic uplifting of tax codes — which is often applied by the Inland Revenue when personal allowances change — and for bulk changes to pay rates. Most of the information held within the system is easily accessible at all times. And the system always displays a helpful message during the slower processes, so you are never left wondering what is going on.

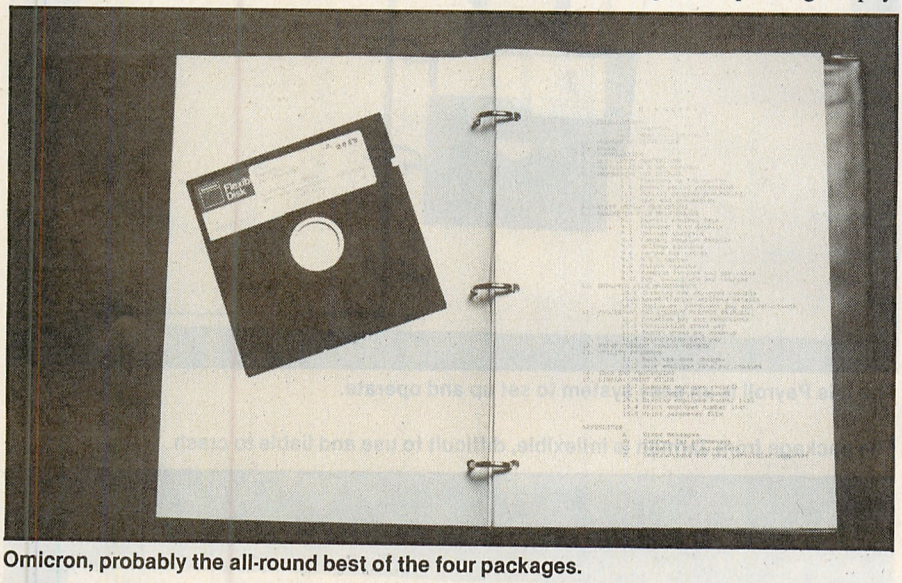
These advantages must be balanced against a number of serious disadvantages, mainly concerned with the way in which data is entered. In particular, the system has virtually no cursor control, which means that nearly all input is by means of long-winded and tedious menus. To allow you to change a single item of data — say, an employee's tax code — the system displays a menu showing all the things that you are allowed to change. You enter the item number corresponding to the tax code, the new value, then a confirmation that the alteration is correct. This can be very tedious if you have to enter a lot of changes in one session. It would be much easier if you could simply move the cursor to the relevant item and type in the new value.

This is especially true when you wish to change a number of related items, such as the definition of one of the pay elements. The first time that I tried to do it I accidentally entered the wrong element code. I found that I had to retype the entire definition, which is a heavy price to pay for a simple mistake. In the Omicron system, you often find yourself trapped in these long dialogues. If there is some way out of them it is not mentioned in the manual.

Not that these are the only operational problems. There is no indication of the maximum length of an item of data, so constant reference to the manual is necessary. The system occasionally refuses to accept lower-case letters. The Delete key does not do what you expect: it deletes a character internally but redisplays it on the screen. The system does not lock out certain control keys. If you accidentally press Control-C — admittedly it is not likely to happen often — you find yourself back in the operating system with all your input lost.

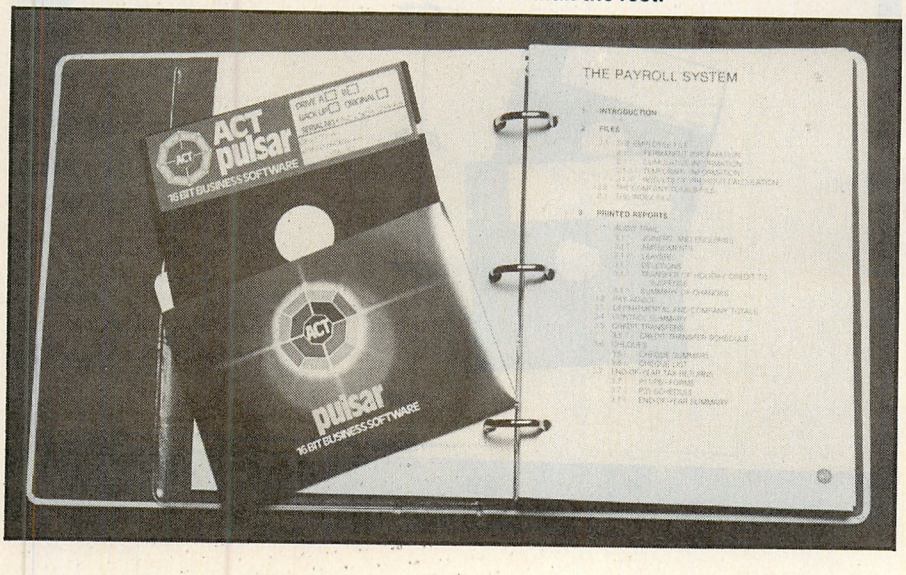
Perhaps it is asking too much to expect software packages to be more robust and easier to use. Yet there are plenty of systems on the market that are. The Pulsar payroll package is a good example. Here you can move the cursor around in a consistent way, and if you hit a key that the system is not expecting, there is simply no effect. What's more, by pressing the * key you can always get out of what you are doing and go back to the previous step.

(continued on next page)



Omicron, probably the all-round best of the four packages.

The Pulsar system from ACT is better documented than the rest.



Payroll packages on 16-bit micros

(continued from previous page)

The Pulsar system is unusually well designed. Although it lacks some of the flexibility of the Omicron package you still have plenty of scope for defining pay elements and deductions. You may have up to five hourly rates, three regular pay elements, six regular deductions, six temporary elements — entered separately each week — and three temporary deductions. You may choose your own names for all of them.

In other respects you have less choice. Although you have the option of rounding the net pay of cash-paid employes, you cannot specify which note or coin you wish to round to. It is fixed at 50p. Similarly, you have no control over the notes and coins to be used in the coin analysis. When the 20p coin was introduced recently, ACT had to circulate a software change to cater for it.

These minor objections apart, the Pulsar system has a lot in its favour. I especially like the company screens which give you immediate access to totals for pay, tax, etc. across the whole company. As in other Pulsar packages, there are good facilities for departmental summaries. Although the system does not produce any statistical reports there is a link with the Pulsar analysis system which provides the equivalent information.

The Ibis Payroll is an easy system to set up and operate, but it lacks many of the features of both Omicron and Pulsar. It will prove adequate for many companies with completely straighforward pay structures, but more demanding employers may find that it does not cope. This is surprising when you consider that the package is intended mainly for bureau use where it operates payrolls as a service for other companies. Apart from basic pay and overtime, the package only allows four pay elements, one of which must be non-taxable, and four deduction types.

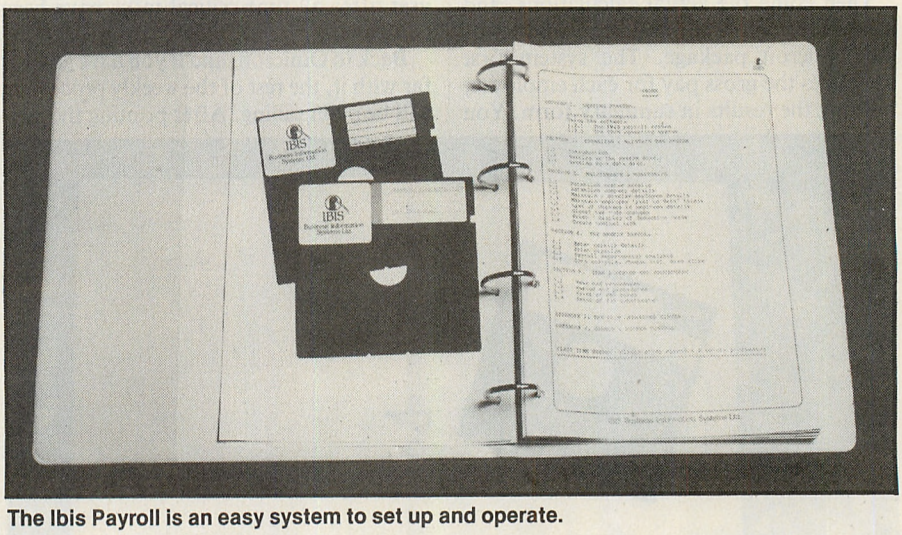
Because it is a fairly simple system, operating the Ibis presents no difficulties. The regular weekly or monthly processing consists of little more than entering a few variable details for each employee and printing the pay-slips. There is no payroll summary or exception report, and the only way to check that all the input is correct is to obtain a trial print of the pay-slips on plain paper. On the other hand, there are the usual facilities for printing a cheque list or the actual cheques, bank giros, and a coin analysis — but not for specifying which notes and coins to use. You can also get a departmental analysis.

Another good feature of the Ibis system is its consistent approach to data entry. Each screen is a self-contained "form" and, as in Pulsar, you can move the cursor freely between the boxes on the form. You press the Carriage Return only when you have finished with the current screen. There is also a consistent mechanism for going back to the previous screen, for abandoning the current function, or for calling a help screen.

But even here the system has its weaknesses. You are not allowed to leave a box empty, so if you do not know a new employee's National Insurance number, you are obliged to enter a fictitious one. This is stupid and unnecessary; it would be quite reasonable simply to omit it for the time being. Another objection is to the error messages. They are clear and informative, but should disappear from the screen once the error is corrected instead of remaining until the screen is finished.

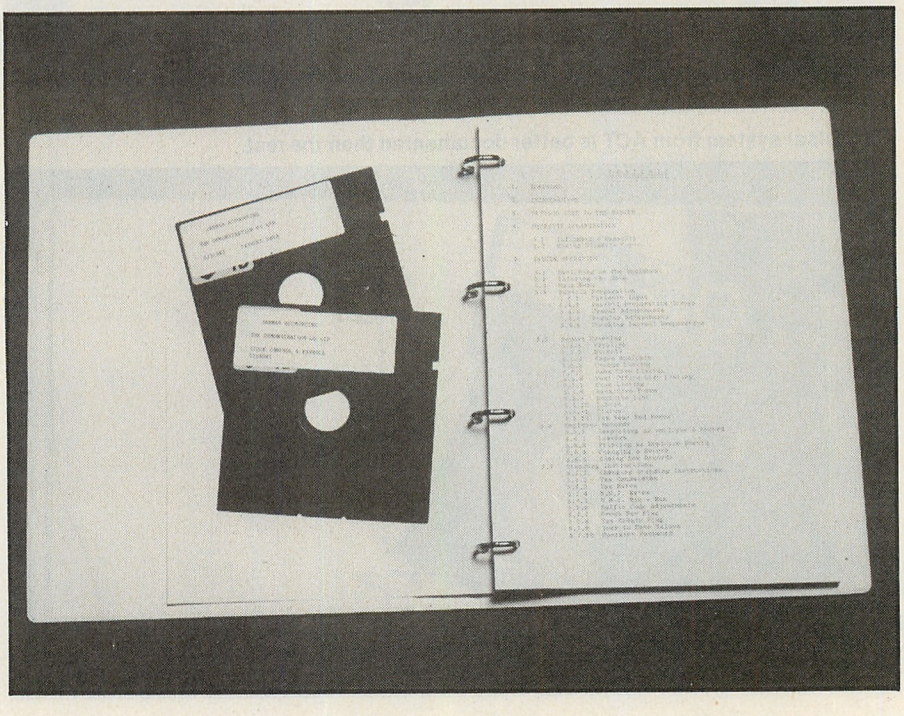
I can find little to say in favour of the package from Jarman. I found it inflexible, difficult to use and liable to crash. The worst thing about it is that the user has no control over the definition of the system. It is for the dealer, not the user, to specify the pay structure, the name of the user company, and even the pay frequencies that are to be used. This is bound to cause problems, especially when the user needs to change any of this information.

Another serious problem occurs when tax and National Insurance rates change. All four systems under review allow the operator to enter new tax and NI rates and thresholds, but in the Jarman system a special code must also be entered. It is provided by Jarman when the new rates are published and without it you cannot change the rates, and so cannot run the payroll.



The Ibis Payroll is an easy system to set up and operate.

The package from Jarman is inflexible, difficult to use and liable to crash.



Users will be heavily dependent on Jarman staying in business indefinitely. The accompanying manual does not even contain Jarman's address.

The operational aspects of the system are a mess. I constantly found myself trapped in long input sequences from which I could not escape. From time to time, the system just stopped dead, forcing me to restart the computer manually. More than once it crashed completely, taking me back to the operating system.

When I did manage to use the system, I found that it often refuses to accept valid input. It also shows an annoying fussiness about case: in answer to a yes/no-type question, you can enter Y or N but not y or n. Even copying a disc is difficult since the system is distributed with the UCSD p-System and does not include a disc-copying program. You can make copies of discs, but you must first reboot using CP/M-86.

Logic Computer Systems, which distributes 16-bit versions of Jarman software, tells me that a new release will be out soon. It will, I hope, resolve many of these problems. The distributor has also agreed to include a disc-copying program which will be executed from the main menu.

Yet in spite of all its problems, the Jarman system does have one or two advantages over its rivals. It is the only package of the four under review that makes a distinction between Post Office giros and bank giros. You have the option of recording employees' home addresses should you wish to print address labels for them. And there is a good selection of management reports, most of which can be sequenced in a variety of ways.

There will always be exceptional cases that will stretch any payroll system, manual or computerised. Most concern tax, and our four packages vary in their ability to handle them. In particular, all four seem to have a blind spot when it comes to tax rebates for new employees. The rules say that if a joiner's rebate exceeds a certain figure, currently £50, you must hold it in suspense until you receive a form P48 from the tax office. Omicron, Ibis and Jarman correctly withhold the rebate, but none of them appears to provide the correct mechanism for paying it when authority is received. Pulsar provides a warning message so that you can do the whole thing by means of adjustments. Ibis and Jarman do not allow you to alter the £50, so program changes will be needed when the threshold is increased.

Another problem area is the payment of employees in advance, which is often needed to cover holidays. The system must ensure that the pay is apportioned correctly so that the employee receives the correct tax allowances and pays the correct National Insurance. Omicron allows you to pay an entire company in this way, while with Jarman you can achieve the same effect by fiddling with the week numbers. Only Pulsar has an easy method of paying individuals in advance, and it is the only system that correctly handles statutory sick pay for employees who have been paid in this way.

There are a number of other cases that the packages do not even attempt to handle. For example, the rules say that if an employee goes on strike and then becomes entitled to a tax rebate, the employer must withhold the rebate until the strike is over. What happens if the employee leaves in the meantime or if the strike goes into the following tax year? And what about the employee who becomes entitled to a rebate after having been paid in advance or whose tax code changes during this period?

It would be unreasonable to expect a payroll package to handle every conceivable case, so what is needed is an easy mechanism for doing tax calculations by hand and adjusting the figures produced by the computer. While all four packages allow you to do this, only the Pulsar package allows you to do it easily. None of them points out the problem in the operating instructions.

Another area where some manual intervention may be needed is statutory sick pay. Under this system, which was introduced only this April, employers pay sickness benefit direct to employees and then deduct the amount paid from their National Insurance payments. Both Omicron and Pulsar have extensive facilities for handling SSP. Both maintain an eight-week moving average of each employee's pay, which is needed to determine the amount payable, and both hold the current rates. So in most cases the operator only has to enter the number of days sick. But because of the complex rules of SSP some overrides and adjustments may be needed, and both packages cater for them.

Neither the Ibis nor the Jarman package supplied for review had been amended to handle SSP. The suppliers assured me that SSP versions would be released by the time you read this article.

It is a curious thing in our industry that everybody grumbles about the low standards of documentation but nobody seems able to do anything about it. Certainly, the four manuals for these packages do little to raise the standards. None of the manuals states the range of hardware needed to run the system or the amount of disc space required. This is an important point because many people order manuals specifically to find out if they can use the software.

None of the manuals includes comprehensive examples of print layouts or screen formats. Two of the four omit the names and addresses of their publishers — and are breaking the law by so doing. None has bothered to number the pages. More importantly, the manuals give the impression of being badly thought out, hastily written, and with no attempt to correct spelling and typographical errors. If the authors are so careless about checking their documentation, how carefully do they check the results of their software tests? All the manuals include just enough "computerese" to guarantee to baffle the non-technical reader.

The possible exception to these strictures is the Pulsar manual, which at least is concise and well-structured. It is also nicely printed, although my conservationist friends would raise an eyebrow at the overpackaging, particularly the moulded-plastic slipcase. Still, what would you expect from a company that uses four-colour printing for its disc labels?

	Omicron Powerpay	Pulsar Payroll	Ibis Payroll	Jarman J-52
Distributor	Omicron Ltd, 39 Gt Portland Street, London W 1. Tel: 01-636 6575	ACT (Pulsar) Ltd, 111 Hagley Road, Birmingham Tel: 021-454 8585	Ibis Ltd, Parkgate House, Cross Road, Chorlton-cum-Hardy, Manchester. Tel: 061-881 0585	Logic Computer Systems, 31 Palmer Street, London SW1, Tel: 01-222 1122
Runs on	eight-bit systems under CP/M; 16-bit systems under MS-DOS; also Hi-net and TurboDos	Sirius 1 under MS-DOS	eight-bit systems under CP/M; 16-bit systems under CP/M-86 or MS-DOS	Apple, Sirius 1, IBM PC and DEC Rainbow —all under UCSD p-System
Price	£700	£195	£600	£490

Conclusions

- **No payroll package is perfect for every employer but the Omicron system is certainly the most flexible of those reviewed. Pulsar is a near second. The trouble is that Omicron is tricky to set up and use. Pulsar is better in this respect.**
- **If your requirements are straightforward, the Ibis package may be a good bet. It lacks many of the features of the other packages, but it has the virtue of simplicity.**
- **Although all four packages produce correct results, none is able to handle certain exceptional tax cases.**
- **Bear in mind that payroll can be one of the more difficult applications to computerise, but is also one of the more worthwhile. It is worth persevering.**

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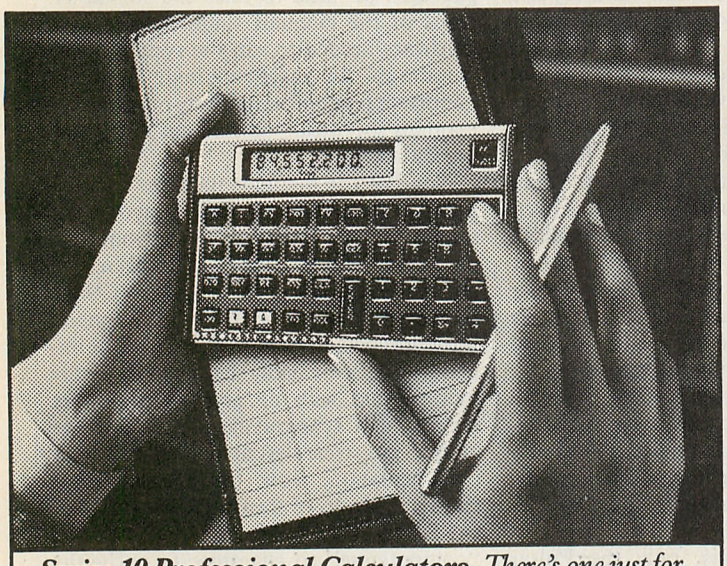

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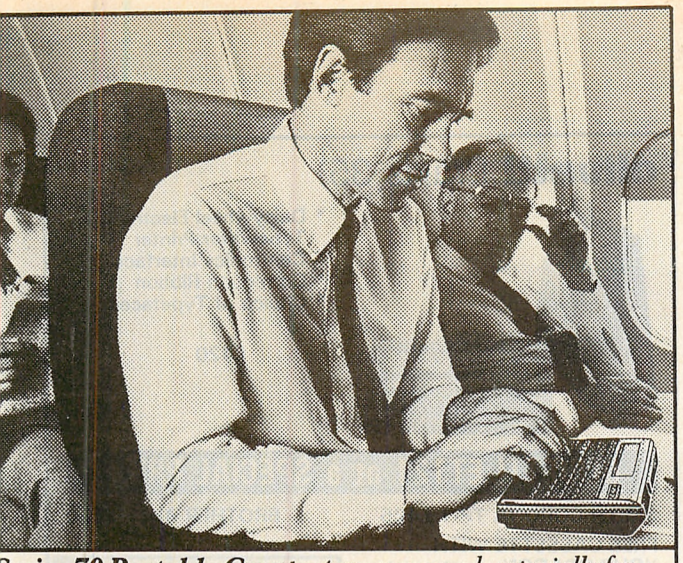

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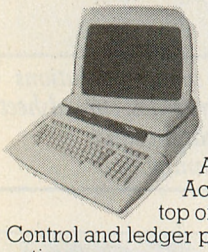

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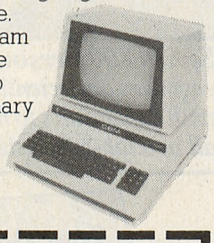

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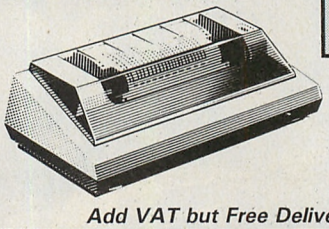

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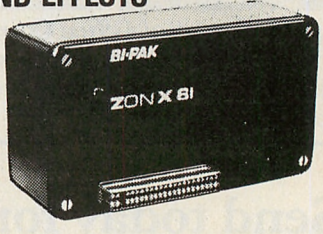

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Sound ideas

We have a sense of hearing — so why not use it to communicate with computers? Jack Schofield surveys the current state of the art.

SOME PEOPLE think micros should be like good children: seen and not heard. Similarly, although it sounds bizarre now, some people must have preferred silent to "talking" pictures, and avoided going to see the newfangled technology which presented Al Jolson singing *Mammy*.

When colour television became feasible, black-and-white sets had their diehard supporters, too. And even today many serious photographers prefer shooting black and white to colour, just as "serious" computerists want nothing more from their machine than a green screen and dead silence.

These views are not so much misguided — everyone is entitled to their own preferences — as doomed. A glance at the history of computing shows steady progress in increasing realism: visual, tactile and audible. These are all elements in making computing more and more "user friendly", enabling it to penetrate more and more areas of society.

The main trends are clear. We are travelling the road from punch cards and paper tape towards voice entry and natural language processing. Visual displays have progressed through Teletype outputs to high-resolution graphics which become more realistic every year. Keyboards, and now "mice", increase the tactile content of computing. Sound plays a major part in providing feedback and increasing our involvement with the machine.

Try watching a television programme or, better still, a cartoon with the sound turned down. The programme loses almost all its meaning, and the cartoon loses its grip. Sound creates realism. How realistic is an explosion without the sound? Exaggerating the sound can increase the involvement, especially in fantasies. In cowboy films the crisp crack of fist on chin and the zing of bullets are unrealistic, but carry much of the excitement. In the arcades, it is the sound effects that give realism — of a sort — to the destruction of invading aliens. It is the sound effects that make Space Invaders compulsive, Centipedes gripping and Defender exciting.

The current limitations are partly those of cost. Not every microcomputer has sound facilities, and not everyone is willing to pay for them. Imagination is lacking too, but it will come.

Sound is beginning to make an impact already. The IBM PC has a simple sound facility, and the Sound and Play commands are firmly established in Microsoft Basic. The Sirius 1 has a built-in



speech chip, though so far no programs seem to take advantage of it.

At the other end of the scale, one of the major attractions of the Oric is its possession of a loud sound facility and special sound effects including Ping and Zap. In between, the Atari, BBC and Commodore 64 micros include multi-channel sound synthesisers capable of making music as well as noises. The Apple II, of course, can be expanded to form the heart of a sophisticated professional music system.

Beepers or keyboard sounders represent sound at its crudest but most essential level. A beeper capable of emitting a variety of sounds should be built into every keyboard. The uses include: giving audible indication of a positive keystroke; signalling the end of a line, if required, during word processing or data entry; and signalling unacceptable keystrokes. Ideally all these sounds should be under software control.

A keystroke click greatly enhances touch-typing by providing positive feedback — reassurance that a successful keystroke has been made. It speeds up typing by saving the operator the trouble of looking at the screen for visual confirmation. It is this lack of audible feedback, combined with the lack of tactile feedback, that makes the Sinclair keyboards so awful.

A beeper can also be used to indicate that, for example, a field is full when entering data or — as with the DEC Rainbow in Multiplan — that the key pressed is not an available option.

Either a beep or special note is also useful to indicate on-screen errors. Fast operators often do not even look at the screen, and some programs allow the user to continue entering keystrokes uselessly long after the program has crashed leaving an error message on the screen.

A more sophisticated approach is to have Boop, Beep, Blip and other subroutines. They are called at particular parts of the program to provide audible confirmation that data entry is going to plan, just as people used to push-button phones recognise the tones and know when a number sounds wrong. Users should be able to control tone and volume, as they can alter the brightness and contrast of the screen display.

As well as warning sounds, there is scope for "reward" sounds. Getting the right answer can stimulate the micro to emit a melodious chime, a technique which works on children of all ages. No doubt someone could add a subroutine to VisiCalc so that the IBM PC plays Rule Britannia every time the sales figures show an increase, but probably this is going too far.

Speech is a more difficult area. Certainly speech technology is being developed at a great rate for children's toys — pioneered by Texas Instruments — and consumer goods such as clocks and microwave ovens, for example.

Voice entry has already been demonstrated, with an Apple II being programmed in Basic using only vocal commands. It could have a major impact in some areas, though it is unlikely to be popular in crowded offices.

Voice output has similar advantages and constraints. However, it is an important element in Japanese thinking about the so-called fifth-generation computer which will supposedly leapfrog them over Silicon Valley. Voice links are set to become an important part of local area networks and the electronic office, and could project companies like American Bell and British Telecom into the forefront of computer technology.

Voice entry and output is also common in science-fiction computers from HAL to Deep Thought. However, not all science fiction comes true.

Certainly it is true that most micros can already be linked to a speech output device. Sometimes they do not even need special hardware, but if they do the hardware is available. If you want to freak out your friends, buy a Digitalker chip for your micro and borrow a line from that famous micromouse Thumper. His first words are always "Thank you for turning me on".

In the rest of this month's special feature we look not into the future but also at what can be done today with microcomputers, in the fascinating field of speech, sound and music.

Music micro

THE APPARENTLY separate worlds of music and microelectronics are on collision course. Not only is the hardware of the musician beginning to look — internally if nowhere else — distinctly computerish, but up-to-date micros are starting to sound distinctly musical.

The best illustration is the Fairlight CMI, which might be best described as a super-synthesiser. It comes complete with a micro-computer monitor, keyboard and floppy-disc unit. It is even possible to run a word-processor package on the system, though it remains essentially a musical instrument. As it costs around £15,000 only the very rich, or the very stupid, would use it just for word processing.

At the other end of the scale is the 16K Oric, due to go on sale at about £129. For a microcomputer, the Oric is capable of making a great deal of noise. Although it cannot perform real synthesis, the Oric is able to make real music.

There are certain tricks which can provide even the most reticent micro with a voice. For example connecting a loudspeaker to the cassette port and then creating and saving strings of digits via the port will create a sound of sorts. Variations on this theme can get pretty complicated, but they are never a very elegant solution to the problem.

The other, more esoteric way of squeezing computer sound from an unwilling micro is to use a radio: all that is required is a cheap transistor portable. This technique generally works best on amplitude-modulated wavebands, medium wave or long wave. It works because a micro has lots of circuits passing electrical signals around at frequencies in that part of the electromagnetic spectrum, or at least near enough to have an effect.

The cheapest popular home computer is the infamous ZX-81. Normally this, the smallest of small micros, is as silent as the grave. It can be persuaded to make sounds by using one of the techniques already mentioned, but a much better solution to this problem is available, the Zon X. This innocent-looking little black box is an aural wolf in sheep's clothing. Once connected to the rear of the ZX-81 and invoked with a few Pokes from the keyboard, it is capable of taking a little electricity and converting it into ear-shattering noises.

If experiencing volumes beyond the threshold of pain is not for you — and be warned, the Zon X is capable of a passable simulation of the take-off of Concorde — there is a volume control to reduce the decibels. The hardware is similar in many respects to that contained within other, more expensive machines as standard. It is capable of three channels of sound which can be either tones or white noise, the whole lot being mixed under envelope control.

Because the ZX-81 was not conceived as a music-making micro it does not support any high-level commands for sound creation. This is the major drawback to using Zon X. The ZX Spectrum was designed to make sound, but thanks to the piezo-electric speaker this is not its strong point. The main problem with piezo speakers is that they are rather quiet. If the micro is being used in an environment with any level of background noise, the piezo speaker can be difficult to hear.

Zon X will work with the Spectrum, provided you buy the extra board required to drive it. Programming is slightly easier thanks to the Spectrum's Out command. However, if you are already in possession of some hi-fi equipment or an amplifier then this extra hardware becomes superfluous.

The sound output of the piezo speaker is routed through to the tape interface sockets at the rear of the Spectrum. Taking the sound out and injecting it into your hi-fi is perfectly safe, providing you take it to the high-impedance input. I managed to feed output from a Spectrum into a multi-tracking tape recorder a number of times and let the Spectrum accompany itself.

The quality of the sound when played through hi-fi is excellent. Though there is no facility for changing the timbre without resorting to external devices such as fuzz boxes, phasers and the like, it can be done.

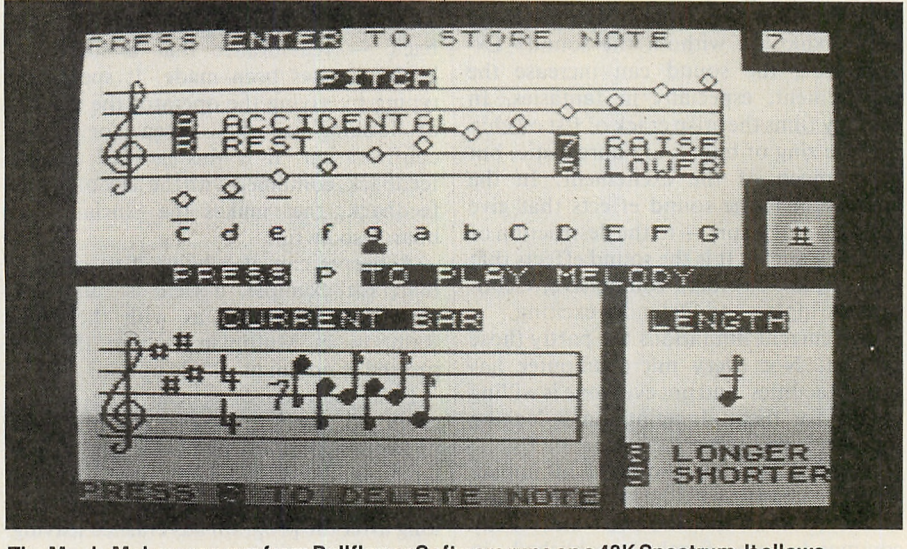
Beep is the Spectrum's sound command, and there are two parameters used with it. The first is a floating-point number used to represent the length of the Beep in seconds, and the second indicates the pitch of the Beep sounded.

```
 50 DIM n(7)
100 FOR i=1 TO 7
150 READ n(i)
200 NEXT i
240 REM
245 REM notes in key of C
250 DATA 0,2,4,5,7,9,11
290 REM length of bar
300 LET bar=4
340 REM length of note
350 LET t=1/INT (RND*15+1)
390 REM pick next note
400 LET z=RND*7+1
430 IF bar<=1 THEN LET t=bar
450 LET bar=bar-t
490 REM play the note
500 BEEP t,z
540 REM if the bar is complete start a new one
550 IF bar=0 THEN GO TO 300
600 GO TO 350
```

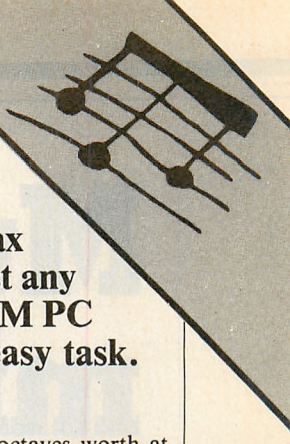
Listing 1. Spectrum program.

The pitch parameter can be either integer or floating point. It is arranged so that each semitone of musical pitch equals one in terms of the parameter. The value zero equals middle-C on a piano keyboard; positive integers represent notes on the keyboard above C, and negative ones below it.

Because a semitone corresponds to a value of 1 it follows that an octave corresponds to the value 12 just as there are 12 keys on a piano from middle-C to the C above it. Knowing this makes it very easy to program music.



The Music Maker program from Bellflower Software runs on a 48K Spectrum. It allows music to be entered note by note then played back using the Beep command.



please

Bill Bennett explains how to coax an acceptable tune out of almost any micro from the ZX-81 to the IBM PC — though it is not always an easy task.

The best feature of the Spectrum's Beep command is that the pitch can be varied almost infinitely. You can tune it to another, maybe acoustic, instrument and even play Indian or Arabic music.

Of all the cheap micros, the Oric is the loudest. Like the *Daily Star* it is brash, loud and strictly for entertainment. The creators of the machine have seen fit to include such delightful commands as Shoot, Ping, Explode and Zap. These four pre-programmed sounds were originally written in Forth by Paul Kaufman of Tangerine Computers, the designer of the Oric, and they give the machine a character of its own.

It does not end there: the Oric has a synthesiser chip, an amplifier and a proper loudspeaker capable of about 1 watt of output. With a little imagination and a grasp of simple programming, a wide variety of aural delights can be concocted on this micro.

Envelope shaping on the Oric is limited to a few preset shapes under Basic. There are three voices which can be either tone or white noise or both. Filtering is not possible, but what do you expect for £124?

Handling the Oric synthesiser from Basic — not using the preset sound commands — is a trifle unwieldy. The two commands used to do so are Play and Music, both of which are followed by four paramenters. Unfortunately this particular feature of the machine is covered extremely badly in a manual which never even approaches the dizzy heights of being adequate.

In essence, the Music command defines what is played by the Play command. Sometimes — the manual does not tell you when — the synthesiser switches itself off; at other times you need to use Play 0,0,0,0. Another apparently chaotic feature is that sometimes a Wait statement is required to allow the sound to be output before another one comes along.

The arrival of Oric Forth will be welcomed by those Oric owners interested in using the synthesiser chip to its full potential, provided it allows a more direct access to the chip. Forth is the ideal language for computer music synthesis. Unfortunately, the JupiterAce, the only Forth-based micro, does not have the hardware to fulfil the potential offered by its lingo.

The Ace does have its limitations. It is very similar to the Spectrum in the way that its sound operates. It uses the Beep command, but the parameters must be entered before the command. Because of the way Forth works, it is possible to define your own music words for use on the machine. The piezo speaker is as quiet as the Spectrum's but the Ace is better utilised as a controller than as a micro in its own right. In this role the Ace is a cheap way of controlling an analogue synthesiser, for example.

Forth would be ideal for controlling the digital-to-analogue sound-generation hardware of the Lynx micro. But using machine-code on the Lynx is not exactly hard and, what is more, the Sound command is designed to make the most of the Lynx's machine-code monitor. The command will output consecutive bytes of the Lynx's memory to the digital-to-analogue converter and hence to the speaker.

It is a great pity that the Lynx only has a piezo speaker because potentially it has one of the most powerful music facilities in its price range. There are six bits of resolution allowing you fine control of the volume, and the memory is sampled at such a fast rate that the entire audio spectrum is covered. Clever and meticulous programming will enable synthesis of speech and complex waveforms. Chords can be generated by analysing the way in which two or more waveforms combine and then synthesising the resultant wave. Most users of the Lynx will not be able to take the machine to those limits, but the potential is there.

On the other hand, the music of the Dragon is easy to program and there are more than enough different ways of doing so. The main drawback of the Dragon's sound feature is that the machine seems to be badly tuned. So you can either have a reasonable picture and distorted sound or a fuzzy picture and a clean, crisp sound.

The Dragon's sound is probably the least flexible of all the micros in that you are restricted to those notes which appear on a keyboard, and only five octaves worth at that. There is no facility for playing chords, or for producing anything other than fairly pure tones. On the positive side it is possible to control the volume of the output from Basic.

My favourite feature of the Dragon's music facility is the Play command, which allows you to enter strings of music. Better still it allows you to define substrings and thus build up complicated patterns of albeit monotonous music. The IBM PC is very similar to the Dragon in the way that its sound commands work. The Play command is almost identical.

For a "serious" machine, the sound generation on the IBM is odd. It is not very sophisticated in hardware terms, but neither is it merely token like that of so many other business micros. Sadly the speaker can hardly be heard above the sound of the IBM's disc drives.

The program in listing 2 shows how it all works. It should also run on the Dragon 32. The first string, defined in line 20, contains the parameters for the piece. The first item in the string is O3, which indicates that you are going to start in the third octave — there are seven on the IBM and five on the Dragon. Next is T250 which sets the tempo or speed at which the piece is to be played. The highest possible tempo is 255, so you might expect 250 to be at breakneck pace. In fact it isn't. The final parameter is MS, which means play the notes staccato.

Firstbit is a string containing the first part of my tune, which you may recognise as two bars from Enola Gay. The letters A to G represent notes. The minus sign indicates that the previous note should be flattened; a plus indicates a sharp. Towards the end of the string is L2, which indicates the length of the note to be played.

Line 60 defines the second string of music, which is just an indication of the effects possible. In line 70 the tune is defined as a whole using the X command which defines a sub-string, one of the ways of concatenating strings of music. Music strings can be concatenated just like text strings. In the last line the music is output using the Play command.

The IBM manual describes this method of defining strings as a language, which is not far from the truth. There is also a Sound command which allows you to play single notes, which will be of more use to programmers writing applications software. In this context the machine can provide more than one level of audio cue.

Surprisingly for a machine which is sold on the strength of its hardware, the

(continued on next page)

Listing 2. IBM program.

```
10 REM MUSIC ON THE IBM - BILL BENNETT
20 REM PRACTICAL COMPUTING 1983
30 REM ##################################
40 PARAMETER$="O3T250MS"
50 FIRSTBIT$="FFAB-O4CO3B-AFFFAB-O4CO3B-L2A"
60 SECONDBIT$="L4CCL8EEEEL16GFGFGFGFL8GEL4C"
70 TUNE$="XFIRSTBIT$;P1P1;XSECONDBIT$;"
80 PLAY PARAMETER$+TUNE$
```

Music micro please

(continued from previous page)

Commodore 64 is painfully obtuse when it comes to programming. There are no music commands whatsoever, you have to resort to Peeking and Poking, while keeping track of all the hardware registers. However, when you do manage to write a Basic program to handle the synthesiser you are rewarded by sound which is excellent.

Like a number of other small computer manufacturers, Commodore has apparently decided that the manual is an area where extensive economies can be made. Consequently the user is left somewhat in the dark about just what is and is not possible. This problem — wonderful musical hardware without software support — should be solved with the release of Simons' Basic, which extends the number of Basic commands available. Unfortunately it will also extend the size of your overdraft should you decide to purchase it.

The 64's little brother, the Commodore Vic-20, is also capable of playing music, though with none of the sophistication of the 64. I managed to load a program written for the Vic called the Multisound synthesiser, which ought to be the ideal package to bring out the best in the Vic. Romik Software takes responsibility for this extraordinary item. Just what it does is never clear: the instructions on the screen and printed on the cassette cover are so opaque I never managed to work out just what you are supposed to do.

A much more professional piece of musical software is the Quicksilva BBC music processor. It comes in a package that puts a lot of software to shame. An accompanying message claims that the package will transform your BBC Micro into a music synthesiser, and that is just what it does.

The program costs £14.95 and converts the screen display into the synthesiser front panel. It is much easier to control than using mere Basic commands. With the best will in the world, all those parameters that follow Envelope can be a little difficult to interpret. There are other BBC Micro synthesiser packages, but this is my favorite. Its only drawback is that it requires you to use the QWERTY keys as a music keyboard, something for which they are eminently unsuitable.

The BBC Micro has a potential sound capability that is second to none. Despite their complexity its commands make programming it much easier than, for example, the Commodore 64. The ability to sync the voices is a big plus, and each voice can be defined in minute detail by the unwieldy but comprehensive Envelope command.

The third brand of micro to have a sophisticated sound chip is the Atari, which uses a custom-designed Pokey chip. Both the 400 and 800 are identical in this respect.

Atari has chosen a course somewhere between the BBC and Commodore rivals. The four sound channels are exceptionally easy to use from Basic, but at the cost of underusing the capabilities of the chip. From Basic, for example, the sound command covers only $3\frac{1}{2}$ octaves, whereas Poking the chip directly provides at least $5\frac{1}{2}$ octaves.

The Atari sound parameter takes the form Sound A,B,C,D where A is the sound channel from 0 to 4, B is the frequency from 0 to 255, C is the sound quality and D is the volume from 0 to 15. If you want to create sound envelopes and change the duration of notes, this has to be done using For-Next loops.

The third parameter governs the amount of distortion. Each of the four independent channels can be varied from white noise to a pure tone so explosion sounds and other effects are simple to produce, especially by using a variable for this parameter.

The sound of the BBC Micro *by Douglas Stewart*

The BBC Micro has three tone channels and a white-noise generator, each of which can be independently controlled in volume, pitch and duration. Another equally important feature is the ability to define the envelope, the shape of the waveform produced.

Up to four separate envelopes can be defined and kept in memory, allowing each channel to play a different envelope. Since the channels are all independent, chords of up to three notes can be played to pleasant effect.

The example program plays a series of notes, ascending in pitch:

```
100 FOR F = 1 T0 2000
110 SOUND 1, -15, F,1
120 SOUND 2, -15, F+8, 1
130 SOUND 3, -15, F+16, 1
140 NEXT F
150 END
```

When F reaches the maximum allowable pitch value, the note actually played returns to the bottom of the scale. To add to the effect, the notes on each channel are played two semitones apart. When the first channel "clocks" round to a low pitch the others are still high in pitch to produce a "bouncing" effect.

The Basic keyword Sound takes four parameters. The first is a positive integer which takes a value between 0 and 3 and tells the operating system whch sound channel is to receive the note. Channel 0 is the noise-producing channel, and numbers 1 to 3 refer to the three tone channels which are all identical to one another.

The white-noise generator plays a series of notes of randomly chosen frequency in rapid succession. The overall effect is a "sh" sound, but at certain frequencies the noise channel produces other noise effects.

The second parameter normally controls the volume level, but can specify the number of the envelope to be used by that channel, if one is required. The envelope number can be from 1 to 4, so volume level is specified by a negative value to distinguish it from an envelope number. The volume level is between −15 and 0, −15 being the loudest.

Following the volume/envelope parameter comes a number which determines the pitch of the note. Each unit value by which this number is increased raises the pitch by one-quarter of a semitone. The lowest note produced is a low B. The final parameter of the Sound command tells the operating system the duration of the note. For a parameter value of Z, the note lasts for (Z + 1)/100 seconds.

The Envelope command takes a staggering 14 parameters. The first specified the number of the envelope being defined: up to four parameters may be held in memory so this parameter takes a value between 1 and 4.

The second parameter represents a time constant which is used by the envelope, and the next six parameters define any variations of frequency which may be required while the note is being played. The first three of them define three pitch steps, and the following three define corresponding numbers of steps. They combine to define three pairs of values to allow three separate variations of pitch during the note, all the pairs being similar. The time between each step in the pitch is

	JUPITER ACE	BBC MICRO	ATARI 800	SPECTRUM	ORIC-1	VIC-20	COMMODORE 64	LYNX	DRAGON 32	IBM PC
HARDWARE										
Sound output	piezo	speaker	TV	piezo	speaker	TV	TV	piezo	TV	speaker
Synthesiser chips	no	yes	yes	no	yes	yes	yes	no	no	no
Tone channels	1	4	4	1	1	3	3	1	1	1
Noise channels	0	4	4	0	3	1	3	0	0	0
Sound quality*	5	8	7	5	10	9	10	7	3	3
Loudness*	4	5	as TV	1	10	as TV	as TV	2	as TV	3
Frequency range*	6	8	8	7	6	7	8	9	7	9
Filtering	no	yes	–	no	no	no	yes	no	no	no
Output to Hi-fi or tape recorder	yes	–	difficult	yes	–	possible	possible	yes	no	no
Envelope control	no	yes	no	no	yes	no	yes	yes	no	no
D/A converter	no	yes	yes	no	no	no	no	yes	no	no
SOFTWARE										
Ease of use*	7	4	8	7	7	2	2	5	7	7
Manual - documentation*	7	7	6	7	3	3	4	4	4	6
Manual — examples*	5	6	9	7	2	3	3	0	5	5
Machine-code access	–	v. easy	Pokes	v. easy	difficult	Pokes	only	via monitor	–	–
String input	no	no	no	no	no	no	no	no	yes	yes
Restricted to semitones	no	no	no	no	yes	no	no	no	yes	no
Software support	no	some	excellent	some	none	good	good	none	none	none
Basic commands	BEEP**	SOUND ENVELOPE	SOUND	BEEP	SHOOT PING ZAP EXPLODE MUSIC PLAY	–	–		PLAY$ SOUND	PLAY$ SOUND
OVERALL RATING	*	*****	****	*	****	***	****	**	**	**

* Rating out of 10
** Forth command

defined by the second parameter. N_1 defines the number of times the pitch of the note alters by the corresponding P_1 value, and so on.

The sound generator uses the three pairs in sequential fashion: the sound circuits carry out the frequency variations defined by pair 1, and when these have finished, pair 2 and then pair 3. The pitch-step values can be between – 128 and 127 to allow frequency variations up or down. Each step value can be between 0 and 255.

The next four parameters define attack, decay, sustain and release and the penultimate parameter defines the peak level. Each of the four amplitude-variation parameters defines the number of units of volume-level change.

The first number in this four-parameter, series, the Attack parameter, defines the number of units by which the volume level rises at each step on its ascent to the peak level. Once the peak has been reached, the Decay rate takes over. It can be either positive or negative, allowing the volume to change up or down from this point. The decay continues until the Sustain level is reached. Two similar rates then take over, both of which can take a value between – 128 and 0: the sustain rate is the rate at which the volume is usually held, and the release rate defines how the volume will tail off to silence.

The peak level is the point at which the Decay parameter takes over from the Attack parameter. Similarly, the sustain level, defined by the parameter, is where the sustain rate takes over control from the decay rate. Both the Peak Level and Sustain Level parameters can have a value between 0 and 126.

The Envelope command can be summarised as follows:
Envelope EN, Z, P_1, P_2, P_3, N_1, N_2, N_3, AR, DR, SR, RR, PL, SL

EN	(envelope number)	1 - 4
Z	(time constant)	0 - 255
P_{1-3}	(pitch steps)	– 128 - + 127
N_{1-3}	(number of steps)	0 - 255
AR	(attack rate)	1 - 127
DR	(decay rate)	– 128 - + 127
SR	(sustain rate)	– 128 - 0
RR	(release rate)	– 128 - 0
PL	(peak level)	0 - 126
SL	(sustain level)	0 - 126

Add-on synthesisers

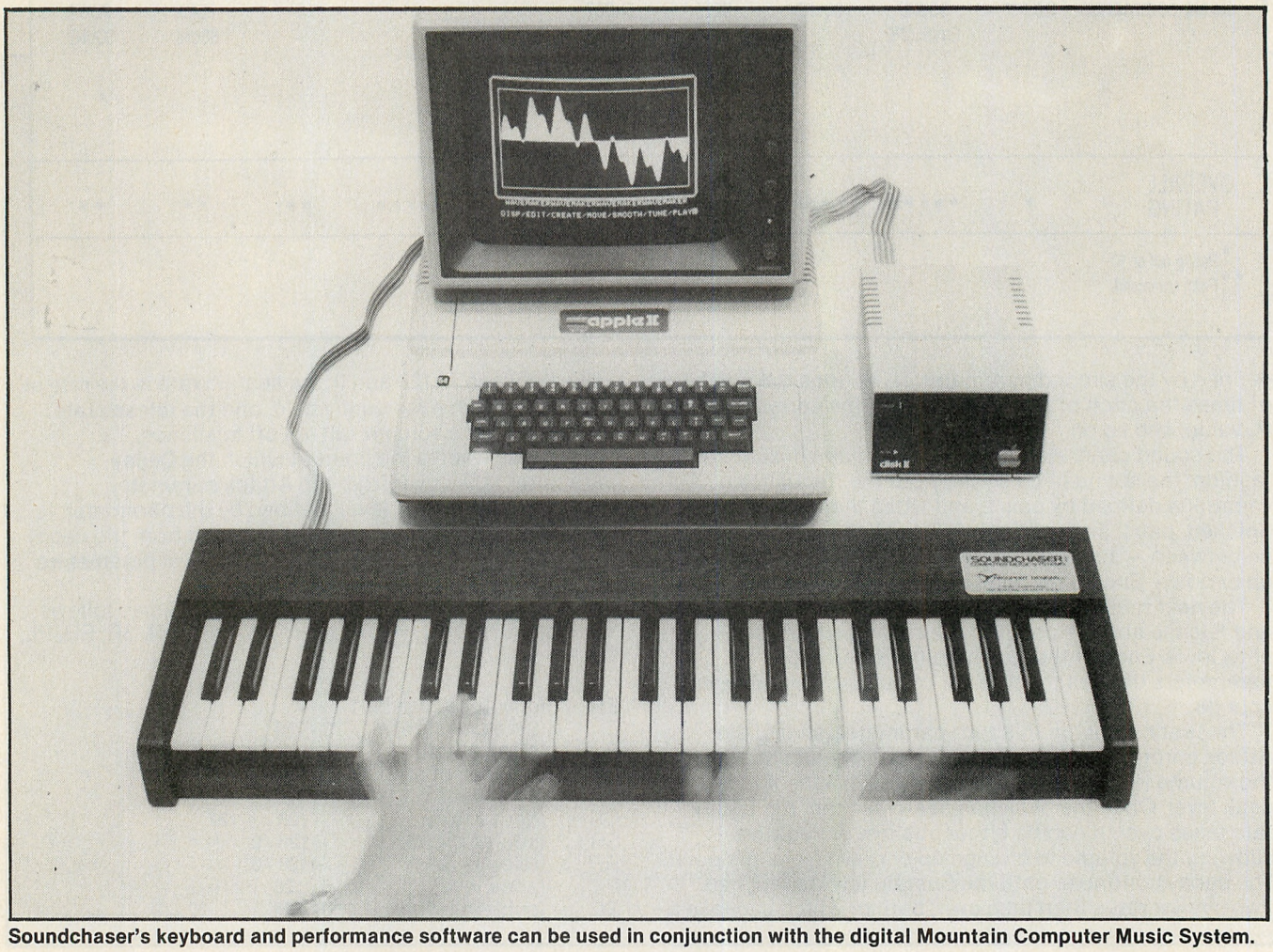
Boris Sedacca looks at six packages to plug into an Apple II. If you thought electronics takes the hard work out of musicianship, then think again.

THE APPLE II MICRO is a hardware engineer's dream. The expansion slots on its motherboard make it very popular for people who want to do more than just play games with it or run Visicalc. For this reason, Apple is often the first choice for music-synthesiser manufacturers. It can be used as an intelligent controller for driving conventional analogue synthesisers, or for digital synthesis where the Apple itself generates waveforms and stores them on disc.

Analogue synthesisers rely on subtractive techniques to modify waveforms generated by one or more oscillators, their primary sound source. A pure sine wave, usually represented as a smooth squiggle, has no harmonics and is a rather boring and characterless sound to listen to. Analogue oscillators typically produce waveforms such as sawtooth and square wave, which are rich in harmonics. Some synthesiser manufacturers do not even bother to provide a sine wave.

Unwanted harmonics are then subtracted by a frequency filter which progressively chips away at them from the upper frequencies down. The further down the filter is brought, the more the waveform approaches a sine wave. By a process of experimentation, the sounds of various musical instruments can be replicated electronically.

Digital synthesis approaches the problem the other way around — by adding harmonics to a simple sine wave. Here the rules are much more complex because it is not easy to experiment as one does with analogue methods. If analogue synthesis is



Soundchaser's keyboard and performance software can be used in conjunction with the digital Mountain Computer Music System.

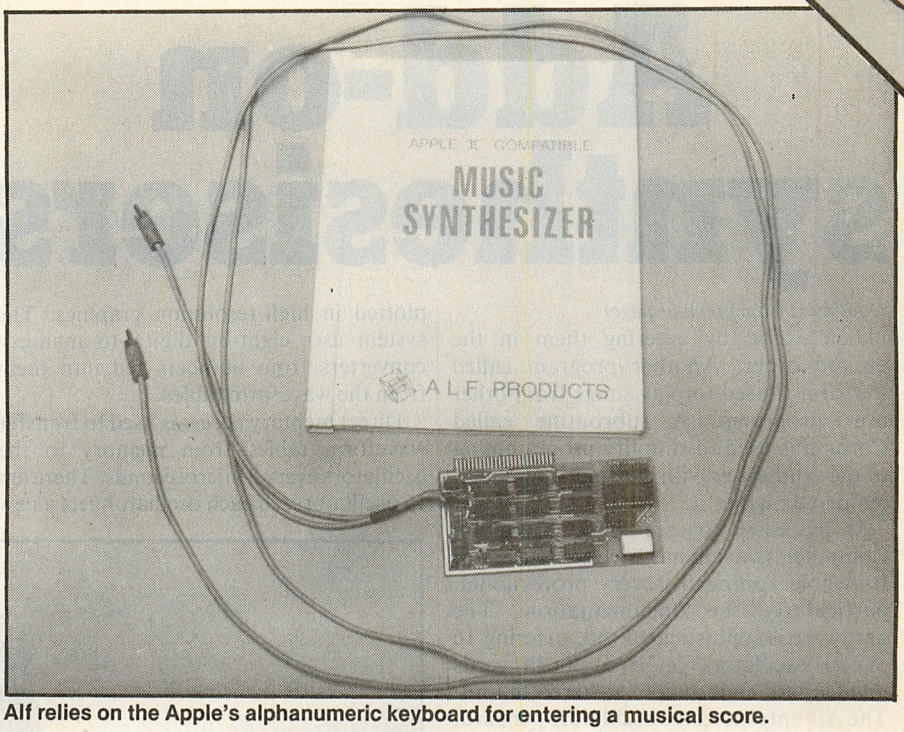
like sculpture, chipping away unwanted material, digital synthesis is more like architecture. You have to work to a detailed plan.

The advantage of digital synthesis is its more accurate replication of musical instruments, provided their sounds have been properly analysed. The analysis of waveforms to determine their component harmonics is known as Fourier analysis, the converse of which is Fourier or additive synthesis.

The concept of envelope shaping is an indispensable feature of music synthesis. The waveform of a simple sound, such as that generated by an electronic organ, has a uniform amplitude or loudness for as long as the key is held down. A piano waveform is more complex: a surge in amplitude when the key is struck is followed by a gradual decrease as the note dies away. Envelope shaping allows signal amplitudes to be manipulated, typically in four sections: attack, decay, sustain and release or ADSR. Changes in volumes of a sound against time are determined by the setting of the ADSR envelope.

By their very nature, analogue synthesisers allow these parameters to be changed by simple sliders or rotary control knobs along a manageable scale, typically from 1 to 10. Envelope parameters on digital synthesisers do not move along a smooth continuum. Each setting has a distinct or discrete state, so in order to avoid big jumps between settings a large number have to be provided. For example, the fastest attack rate on the Alf system is selected by keying in the number 65535, a ludicrously cumbersome method of selecting parameters which is bound to terrify musicians.

Apple users can choose not only whether the method of music synthesis is digital or analogue, but also whether they want a music-composition system or an instrument complete with real-time performance keyboard. In either case composition remains a time-consuming occupation.



Alf relies on the Apple's alphanumeric keyboard for entering a musical score.

Music played on the keyboard may be stored, but once entered it cannot easily be revised or manipulated.

Two plug-in card systems, the Alf and the Mountain Computer Music System, contain digital oscillators for additive synthesis. Both use the standard alphanumeric Apple keyboard for entering a musical score which is then played back through digital oscillators. Neither system has a piano-style keyboard for real-time performance, but the Alpha Syntauri and Soundchaser systems use the Mountain Computer hardware card in conjunction with their own performance keyboards.

The Amdek Compumusic and Rhodes Chroma are both analogue synthesisers which use the Apple as an intelligent controller. The Compumusic cannot operate without an Apple driving it, but the Chroma is a fully fledged stand-alone polyphonic synthesiser, with a performance keyboard and an Apple interface offered as an optional extra.

The Alf music synthesiser now lies very much in the shadow of Mountain Computer's Music System. It will allow the user to enter music in conventional diatonic music notation. Notes, rests and other musical parameters are entered in sheet-music type format, displayed on the screen and selected from a menu.

The Alf provides envelope shaping by entering a number for each ADSR parameter. On a system with a performance keyboard the release stage begins when the key being pressed is released. As there are no keys to release on the Alf system, a Gap function is used instead to specify how long before the next note begins the release stage should begin.

A program called Disco is used to create an Exec file which can be used to play songs

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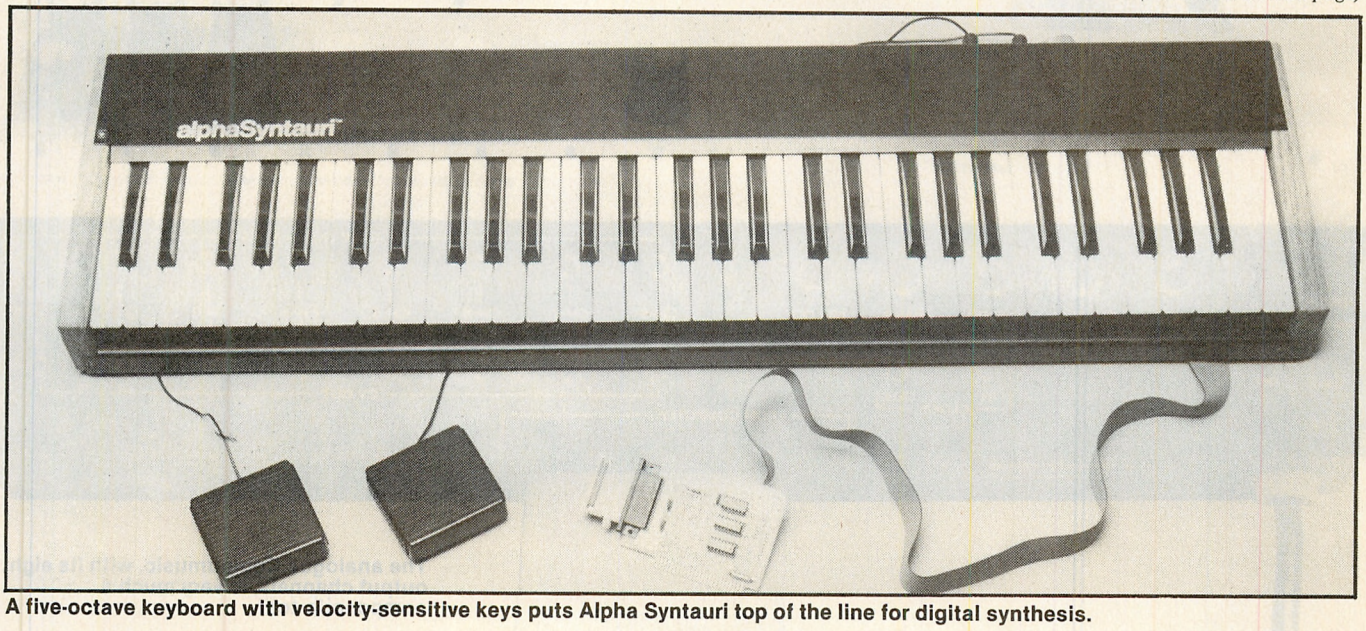


A five-octave keyboard with velocity-sensitive keys puts Alpha Syntauri top of the line for digital synthesis.

Add-on synthesisers

(continued from previous page)

in succession by entering them in the desired order. Another program called Perform is used to play songs from other user programs. A subroutine called Chroma is used to simplify programming of the synthesiser with chromatic or equal-tempered pitches.

It is easy to see why Mountain Computer's system has been so successful. Its whole approach is very professional, particularly the documentation. The hardware is sophisticated too, offering 16 digital oscillators on two slot-in cards divided into eight pairs for stereo output. The Alf only has three oscillators per card, and three cards is the maximum which can be controlled by the program.

Whereas the Alf relies on run-time calculations which use many oscillators to produce a waveform, the Mountain Computer system uses tables of numbers to represent oscillator waveforms. It is capable not only of synthesising different sound envelopes but also a wide range of tone qualities.

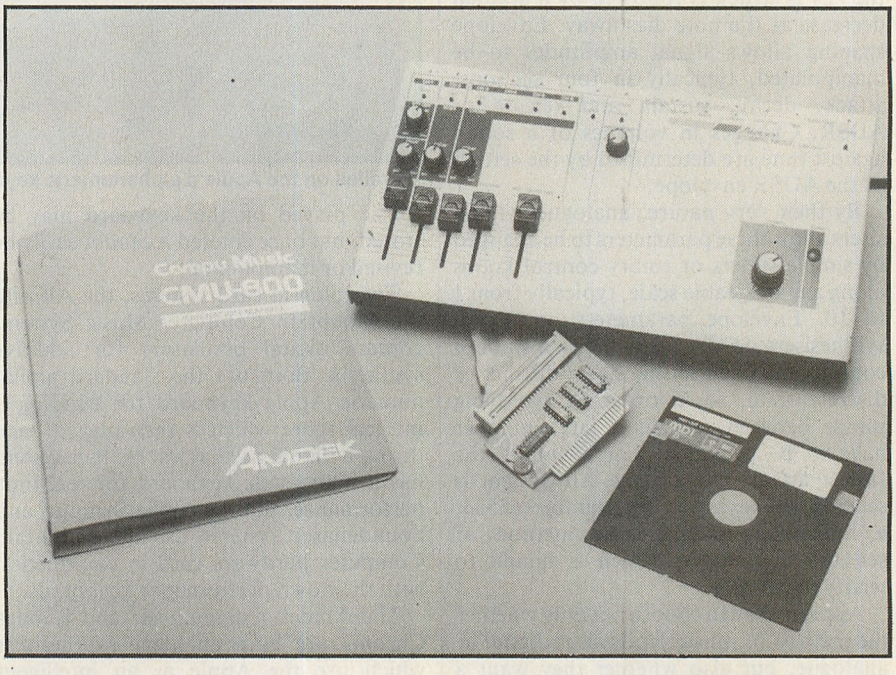
A sub-program in the Instrument Definer program allows the user to create waveforms by entering up to 24 harmonics and their relative weights from 0 to 100 in accordance with the principles of Fourier synthesis. The harmonics are displayed on a bar chart, and the waveform may then be plotted in high-resolution graphics. The system uses eight-bit digital-to-analogue converters from numbers fed into them from the waveform tables.

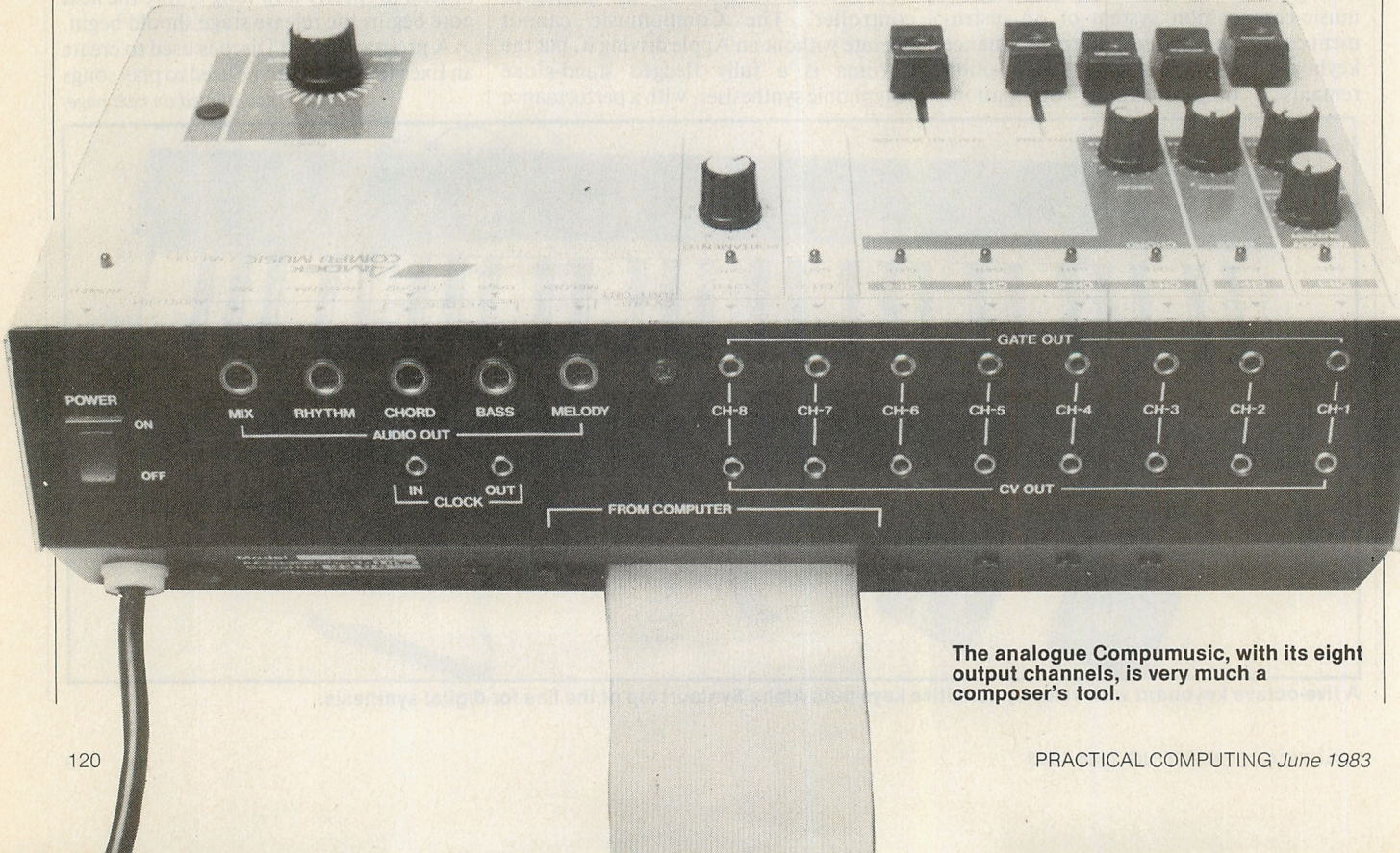
Direct memory access is used to transfer waveform tables from memory to the oscillators every 2 microseconds. There are 16 oscillators, so each oscillator gets a new entry from its own waveform table once every 32 microseconds.

The Mountain Computer Music System costs £259 from Personal Computers Ltd.

Though the Mountain Computer system is fine for those who want to delve into the theories of digital synthesis, many people will want to get down to playing music. Systems with performance keyboards are more user-friendly. The Soundchaser has a four-octave keyboard connected to the Apple through a slot-in card. The system had a full review in *Practical Computing* last October by Dr David Ellis, a leading authority on computer music.

At the time, its manufacturer Passport Designs had no U.K. distributor, but Triangle Software in London has now taken it on. The system comprising





The analogue Compumusic, with its eight output channels, is very much a composer's tool.

keyboard, interface card and performance software sells for £649 including VAT. The Mountain Computer hardware adds another £295 to the price and a piece of software called Notewriter, which transcribes monophonic performance into musical notation, costs another £92. A further software package for teaching music theory, called Music Tutor, sells for £184.

The Soundchaser is good for experiencing digital synthesis in action and to throw up some weaknesses of digital synthesis. For one thing, envelope parameters are entered in hexadecimal, 00 to FF, which can be quite confusing. A low-pass filter is used to cut unwanted top-end harmonics, so when notes are played at the top end of the keyboard, the pitch of the notes actually sounds as though it is dropping.

The weakness of digital synthesis for sound replication becomes clear when an instrument like an organ is selected. The replication of the sound is excellent within a certain range, but it is like nothing on earth in the lower or upper octaves. The waveforms remain fixed on the Soundchaser, but on a real church organ they change at low or high pitch.

Musical compositions are entered in real time through the performance keyboard and played back through a 16-track sequencer called Turbo-Traks in much the same way as a studio recording. A 48K Apple provides 4,400-note capacity, while a 64K machine handles 12,000 notes.

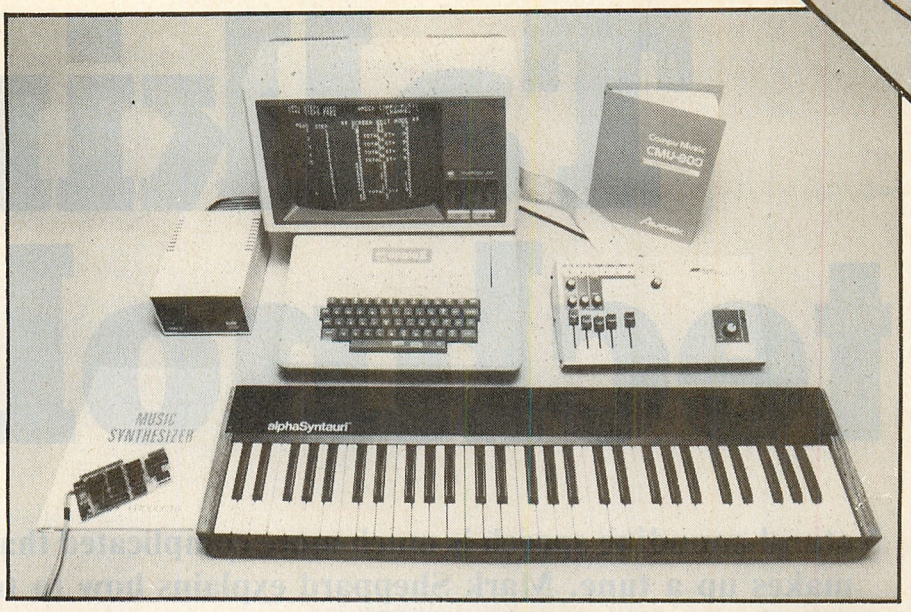
The Alpha Syntauri is very similar in specification to the Soundchaser, though the performance keyboard covers a five-octave range instead of four and features velocity sensitivity. The harder the keys are hit the louder the notes will play. The Apple calculates the delay time between two switch contacts on the keys and amends the attack rate and volume accordingly.

The Alpha Syntauri has a piece of software called B.3 Wave Maker which duplicates the sound of a Hammond B.3 organ. Each drawbar setting can be specified and the result is said to be almost indistinguishable from the real thing. A curious feature of the Alpha Syntauri allows octaves to be split up into 32 parts, against the normal 12 semitones.

At £932 the Alpha Syntauri is more expensive than the Soundchaser — quite a price to pay for velocity sensitivity and an extra octave. It is available from Personal Computers.

Not everyone wants to imitate sounds of other instruments. For those who like the sound of a synthesiser, analogue synthesis wins hand down in terms of sound quality. Roland, a leading synthesiser manufacturer, is in no hurry to move into digital synthesis. Amdek is Roland's venture into the computer market, and its newly launched Compumusic is very much a composer's tool.

Compumusic consists of a control box, similar in appearance to a rudimentary studio mixer, with sliders and knobs



	Alf	Mountain	Alpha Syntauri	Rhodes Chroma	Sound chaser	Amdek
analogue or digital	A	D	A	D	D	D
stand-alone operation	N	N	Y	N	N	N
gate and CV outputs	Y	N	N	N	N	N
real-time performance keyboard	N	Y	Y	Y	N	N

controlling eight sound channels. Each channel has gate and control-voltage outputs, the traditional method for driving analogue oscillators, to drive external synthesisers. It also has its own limited sound-generation capability which, though not brilliant, is adequate for listening back to your compositions before hooking in more sophisticated synthesisers. The system is connected to the Apple through a slot-in interface card.

The software provides a tabular screen-based composer and editor. Channel 1 is for the melody, channel 2 for the bass line and channels 3 to 6 for chord configurations and sequences. The music covers a range of 9½ octaves. Channels 7 and 8 are for triggering other external devices like drum machines.

There are two additional soft channels, 0 and 9, driving Compumusic's own internal drum rhythms, including bass and snare drum, high and low toms, open and closed hi-hat and crash cymbal. Once a piece of music has been composed it can be scored out on a plotter which Amdek offers for £600. The Compumusic package sells for around £450.

By far the most sophisticated and the most expensive Apple-interfaced synthesiser is the Rhodes Chroma. It costs £3,800, plus £300 for the Apple interface, and comes from the CBS-Fender stable. The system has been around for some time, but the Apple interface is new. CBS has a huge research-and-development budget which has included experimentation with digital synthesis. The fact that the company has stuck to analogue synthesis with the Chroma does not bode well for digital synthesis.

The Apple interface provides a 16-track polyphonic sequencer. For a musician on the road the Chroma is rather heavy, but its sounds are breathtaking. The sound parameters are selected on the performance keyboard and then stored into the Apple for playback of sequences entered in real time.

The Chroma's 16 oscillators are often used in pairs and played out in stereo so that only eight tracks are used. An expander is available which provides an additional 16 oscillators to make use of the empty tracks. Setting up the system does not require a PhD in electronics, but can still be quite a headache.

Conclusions

● The ability to enter music at random and to have it played back at the proper tempo and with the correct timing is an attractive prospect. To realise it with any of the Apple packages reviewed here entails a laborious process of entering individual monophonic lines note by note through the Apple keyboard and playing them back together. There are no facilities for entering chords, except through real-time-performance. Your performance is then recorded and played back to you as you put it in, warts and all.

● What is needed is a system which allows the musician to enter notes and chords in sequence through a piano-style performance keyboard, dealing with timing the music afterwards through the Apple keyboard.

Talking technology

Natural-sounding speech is much more complicated than the sequence of notes that makes up a tune. Mark Sheppard explains how to transform bits into words.

DOCUMENTARY EVIDENCE exists of interest in speech synthesis as long ago as the 18th century, and it is likely that attempts had been made to synthesise speech even before that time. Synthesisers in those pre-electronic days were, of necessity, acoustic models of the vocal tract. Dynamic control signals were possible with the aid of manual levers or by using human hands as part of the mechanism.

An attempt at reproducing human speech was made by Sir Richard Paget, one of the first to realise the significance of acoustic resonance in speech production. In the 1920s he demonstrated that good-quality vowel sounds could be produced using resonant cavities moulded in Plasticine and excited by vibrating reeds. Paget's concoction managed to produce a few simple sentences, such as, "Hello London, are you there?" and "Oh Leila, I love you," by forming his hands into suitable cavity shapes and moving them to change from one speech sound to another. A great step for Paget; a small step for mankind; much amusement for Leila.

Years of whizz-kiddery eventually led to the connection between electronic oscillators and speech being established, and things started to happen. The sound source from the vocal chords is usually represented by some form of electrical pulse generator, whose pulse repetition frequency is made to correspond with the desired voice fundamental. What this step really meant is that the path ahead was clear. It culminated in computerised speech and Robbie and Robot — remember him from *Forbidden Planet?*

The problems incurred in modulating and mixing various sound sources are great, to say the least. Any electrical synthesiser for producing connected speech requires several signals for controlling the various features of the sound sources and the resonant system. These signals are inherently related to physiological movements, and in consequence they change fairly slowly. Thus the total information rate needed to describe a complete set of signals is usually quite low,

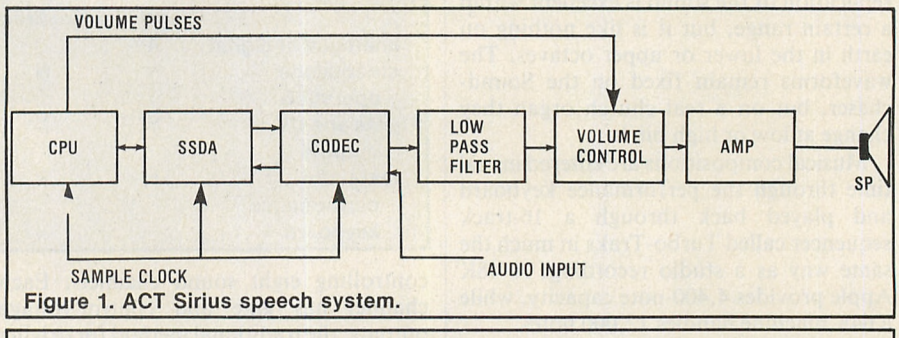


Figure 1. ACT Sirius speech system.

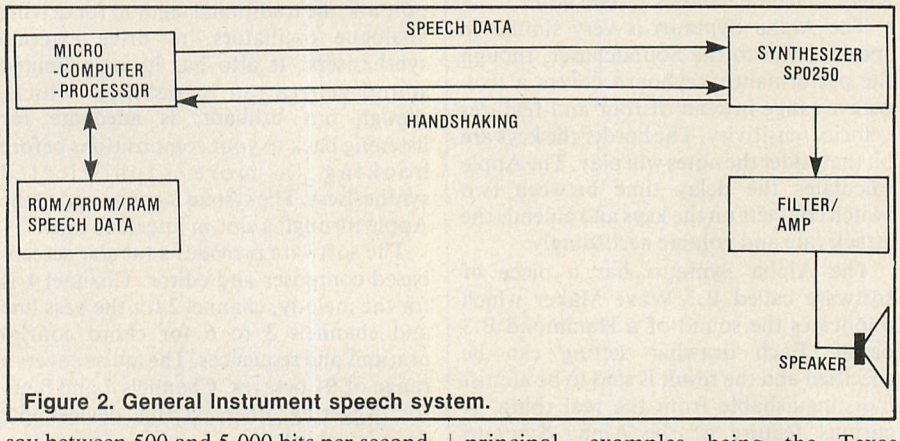


Figure 2. General Instrument speech system.

say between 500 and 5,000 bits per second. This compares with a rate of more than 20,000 bits per second for a reasonable direct description of a speech waveform. Single chips now perform this complete synthesis of sound. However, the practical use of a synthesiser is determined by its ability to understand text as sent to it. A half-way measure, ideal in certain applications, is to store digitally a fixed vocabulary and convert from digital to analogue to finally produce the spoken word.

There are two kinds of speech synthesiser. The first and simpler has a digitally encoded vocabulary of words which may be addressed at will and voiced. There are many devices which function on this kind of principal, examples being the Texas Instruments Speak-'n-Spell toy and the ACT Sirius Computer Speech Unit, which is really on the borders between speech synthesis and digital recording. The ACT Sirius system uses no synthesiser as such, instead a digital-to-analogue convertor called a Codec is used — see figure 1.

The synchronous serial data adaptor accepts the sound bytes from the CPU and puts out a serial bit data stream to the Codec coder-decoder. It converts the serial data to an analogue signal, which is then filtered by a low-pass filter in order to remove any high-frequency elements produced by the conversion. The volume-control section switches the analogue signal at a variable on-to-off rate, allowing the sound level to be controlled. The analogue signal is finally sent through an audio amplifier to the speaker in the processor unit. This kind of

Mark Shepperd is Technical Director of Braid Systems Ltd.

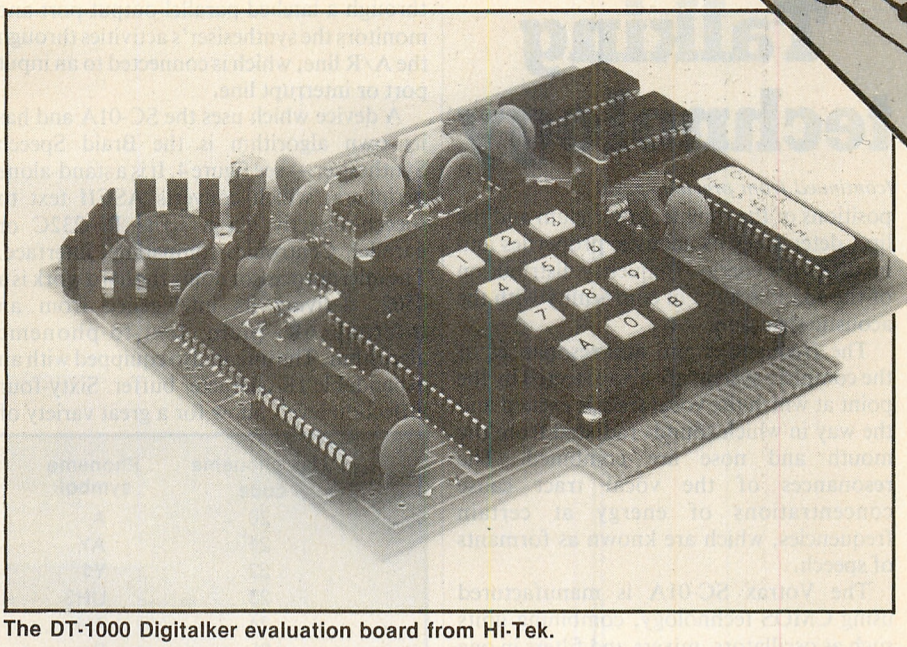
system is useful for a few short sharp commands or prompt-type instructions to support on-screen activities by the Sirius, but is certainly not very flexibile — each second of speech requires 2K of storage.

Two slightly different forms of speech synthesiser are available from General Instrument. The first and most representative of the more professionally used type of speech synthesiser is the VSM-2032 — see figure 2. This speech module incorporates a microcomputer, speech synthesiser and ROM on a single board, with a parallel interface for hook-up to most digital systems. The unit is capable of storing about 30 seconds of speech. The system is capable of storing 32 words and syllables, which are reproducible in any combination. Some companies have seen the need for a quick turn-around time in pre-programmed customised vocabularies. One such is Triangle Digital Services Ltd, which bases its system on a TDS-90 chip and will prepare a vocabularly for you in as little as 48 hours. Another feature is that the system is EIA or RS-232C interfaceable. Maplin is now making interfaces which make some of the General Instrument range compatible with the Vic-20 and Sinclair ZX-81.

General Instrument's speech chip is affectionately called the SP-0250 — see figure 3. The theory is that human speech can be characterised as either voiced or unvoiced. When the vocal chords vibrate and the passage of air is not constricted a vowel-like sound is produced — voiced. Voiced sounds like l, m or ee have a pitch which is determined by the rate at which the vocal chords vibrate. Unvoiced sounds like s, f and sh have no definite pitch, and are produced through constrictions formed by the teeth, tongue or lips. The voiced/unvoiced parameter selects either the impulse generator or the random-noise genertor as the excitation source. The source signal is multiplied by the gain to achieve the correct amplitude and input to the digital filter. The output of the digital filter, which is programmed by 12 coefficients to model the human vocal tract, is fed to a pulse-width modulator which produces the audio signal.

The coefficients are generated by a speech analysis program incorporating a technique known as linear predictive coding. LPC is a mathematical technique for generating points of a waveform from a weighted linear combination of previous samples. This form of mathematical comprison, relating the current output to a series of previous outputs, models the characteristic properties of the human speech mechanism.

General Instrument's Allophone speech-synthesis system allows the user to synthesise any English words by concatenating individual speech sounds. Phoneme is the name given to a group of similar sounds in a language. A phoneme may be acoustically different, depending upon word position. Each of these positional variants is an allophone of the same phoneme. An allophone, therefore, is the manifestation of



The DT-1000 Digitalker evaluation board from Hi-Tek.

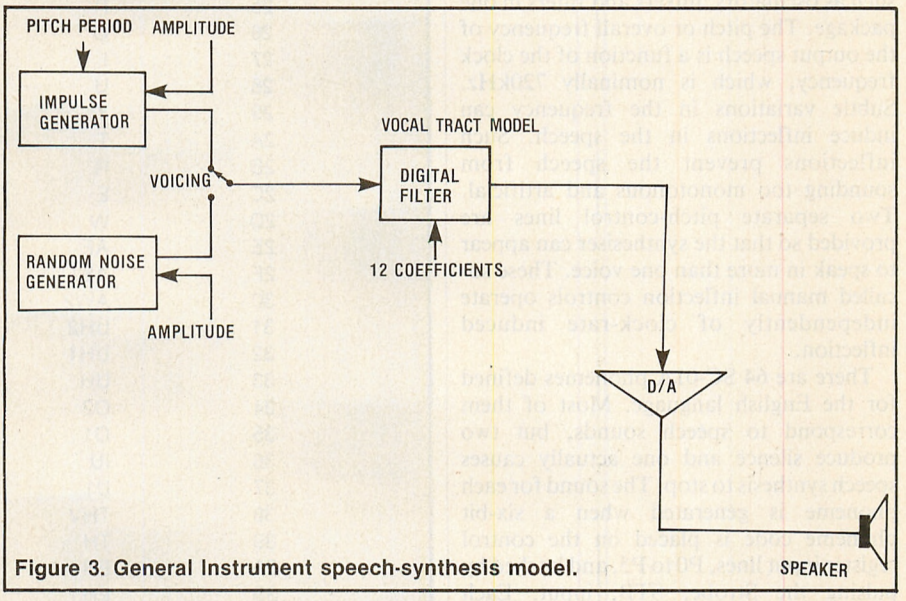


Figure 3. General Instrument speech-synthesis model.

a phoneme in the speech signal. It is for this reason that the inventory of English speech sounds is called an allophone set. Some irregularities commonly found in the English language are listed in table 1.

Each allophone in the VSM-2128 requires a six-bit address. Assuming that speech contains 10 to 12 allophones per second, allophone synthesis would require addressing less than 100 bits per second. The techniques already looked at involve synthesising and storing entire words as units, but unless you intend to use a very large memory vocabulary size is limited. For example, pulse code modulation requires about 70,000 data bits per second of speech; the LPC method requires only 1,000 to 2,000 bits per second of speech. Using this method approximately 15 to 20 words can be stored in 16Kbits of memory. Nevertheless, while these units require large memory for a limited vocabularly, speech quality is relatively high.

The allophone synthesis system provides an unlimited vocabularly since the stored units are not words but sounds. The emphasis is on the user to select the appropriate sounds to represent a given word. It is possible to use the allophone system to convert text into speech in real time. This may be achieved by the implementation of two algorithms, the first converting text to allophone symbols, and the second converting those symbols to sounds.

Unfortunately the overall sound quality is usually not as good as the LPC or PCM methods. The necessity to think of sounds instead of individual letter units is difficult to implement in an alogorithm which has to cope with the irregularities inherent in the English language. In fact, speech is a continuously varying signal which cannot easily be broken into distinct sound-size units. Hence it can be said that the quality of a text-to-speech synthesiser peripheral is as good as the algorithm used to drive it.

The vocal tract is the part of the body used to modulate the sounds created within our bodies and produce crisp clear speech. The configuration of the tract, controlled by the

(continued on next page)

Talking technology

(continued from previous page)

positions of the tongue, jaw, velum and the lips, determines its acoustic properties and modifies the energy/frequency distribution of the sound source in conformity with the acoustic structure.

The frequencies and anti-resonances of the complete system are also affected by the point at which the vocal tract is excited and the way in which sounds radiated from the mouth and nose are combined. The resonances of the vocal tract cause concentrations of energy at certain frequencies, which are known as formants of speech.

The Votrax SC-01A is manufactured using CMOS technology, combining units such as oscillators, mixers and filters in one package. The pitch or overall frequency of the output speech is a function of the clock frequency, which is nominally 720kHz. Subtle variations in the frequency can induce inflections in the speech. Such inflections prevent the speech from sounding too monotonous and artificial. Two separate pitch-control lines are provided so that the synthesiser can appear to speak in more than one voice. These so-called manual inflection controls operate independently of clock-rate induced inflection.

There are 64 SC-01A phonemes defined for the English language. Most of them correspond to speech sounds, but two produce silence and one actually causes speech synthesis to stop. The sound for each phoneme is generated when a six-bit phoneme code is placed on the control register input lines, P0 to P5, and latched by pulsing the Strobe, STB, input. Each phoneme is individually timed and has a duration in the range 47-250ms., depending on the phoneme selected and the clock frequency. The usual method for using the SC-01A is with a microprocessor which sets up the hardware so that the computer system directly times the transmission of the phoneme codes. This method sends phoneme codes to the synthesiser chip through a latched parallel-output port and monitors the synthesiser's activities through the A/R line, which is connected to an input port or interrupt line.

A device which uses the SC-01A and has its own algorithm is the Braid Speech Synthesiser — see figure 4. It is a stand-alone peripheral which converts ASCII text to speech directly via a serial RS-232C or parallel, Centronics compatible, interface. The microprocessor doing the hard work is a 6502, deriving its intelligence from an internal 6K plain text-to-phoneme algorithm. The unit is also equipped with an expandable 1K character buffer. Sixty-four inflection levels allow for a great variety of speech when associated with variable frequencies and pitch. The unit will even produce sound effects and music tones.

The text-to-speech algorithm is embodied in a program that accepts ASCII characters as input and performs a synthesis by rule analysis of character strings. That is, the algorithm interprets the characters as words or other elements of language and devises a scheme for pronouncing them according to a fixed set of rules that determine which characters are voiced and which are silent. The rules are based on how given combinations of characters are pronounced in English, or the language in use.

Text-to-speech programs vary in length

Hex phoneme code	Phoneme symbol	Duration (ms.)	Example word
20	A	185	day
21	AY	65	day
22	Y1	80	mission
23	UH3	47	mission
24	AH	250	mop
25	P	103	past
26	O	185	cold
27	I	185	pin
28	U	185	move
29	Y	103	any
2A	T	71	tap
2B	R	90	red
2C	E	185	meet
2D	W	80	win
2E	AE	185	dad
2F	AE1	103	after
30	AW2	90	salty
31	UH2	71	about
32	UH1	103	uncle
33	UH	185	cup
34	O2	80	for
35	O1	121	aboard
36	IU	59	you
37	U1	90	you
38	THV	80	the
39	TH	71	thin
3A	ER	146	bird
3B	EH	185	get
3C	E1	121	be
3D	AW	250	call
3E	PA1	185	no sound
3F	STOP	47	no sound

Note: T must precede CH to produce CH sound.
D must precede J to produce J sound.

Table 2. Some of the phonemes used in the Votrax SC-01A.

	Same sounds represented by different letters	Different sounds represented by the same letters
VOWELS	meat	vein
	feet	foreign
	Pete	deism
	people	deicer
	penny	geisha
CONSONTANTS	ship	although
	tension	ghastly
	precious	cough

Table 1. Common English spelling irregularities.



Braid speech-synthesis unit.

depending upon the degree of exactness required in pronunciation. Typical algorithms use from 4K to 8K of object code for most processors, but some of the more sophisticated programs need up to 80K. Often half of an 80K synthesis by rule routine consists of words that are exceptions to the rule.

The primary difference between a 6K and a 20K program is how the input text must be spelled in order to obtain acceptable pronunciation. The final sound quality may be the same. Certain words may be spelled unusually to fit the prescribed pronunciation rules of the smaller algorithm. Other major differences are features such as pronunciation of punctuation or inflected speech. All of these capabilities are supported by the Braid synthesiser.

Figure 4. Braid speech synthesiser.

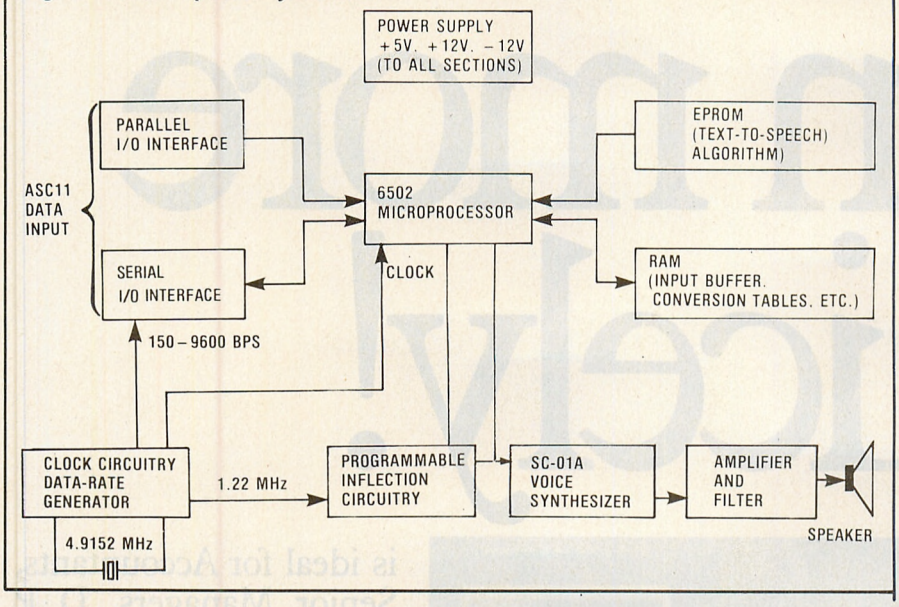
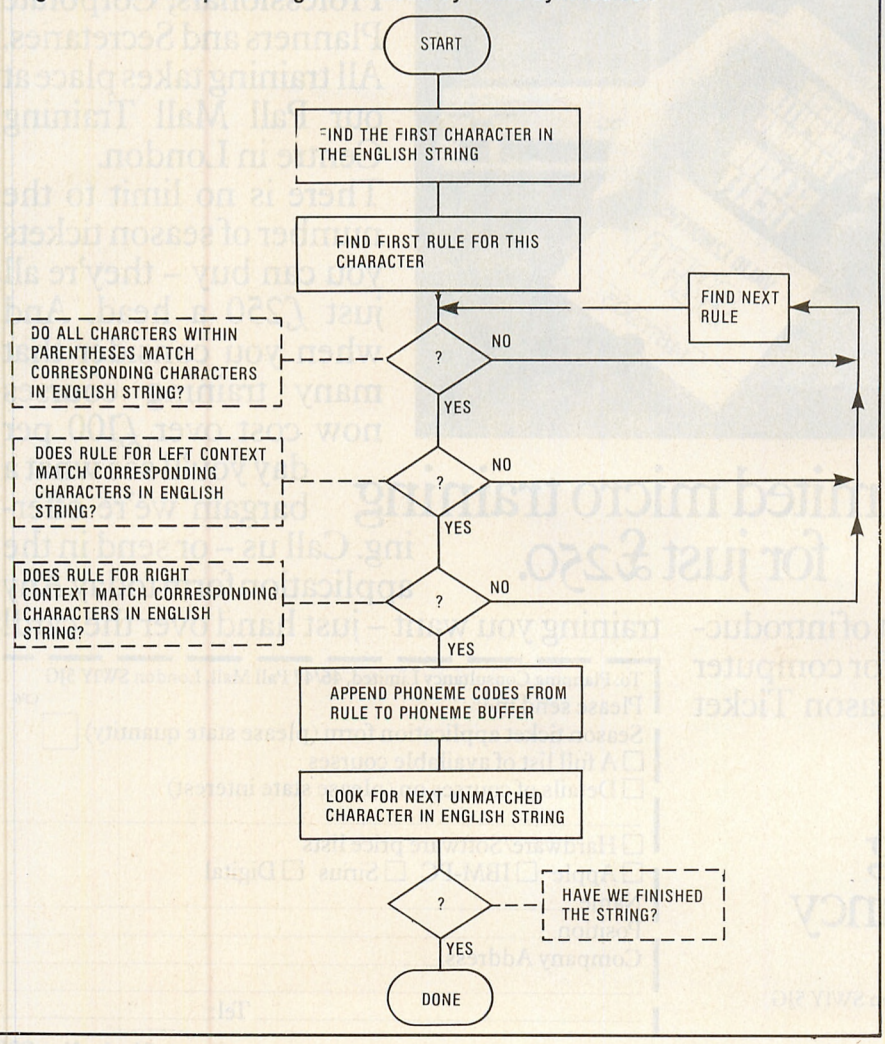


Figure 5. Text-to-speech algorithm used by Braid synthesiser.



Any text-to-speech algorithm must contain some letter-to-phoneme rules which are a necessary supplement to word or morph — the letter representations of constituent parts of words — look-up tables, because there inevitably will be words or morphs not found in the system's dictionary. By eliminating, or at least greatly reducing, word and morph dictionaries and relying mainly on letter-to-phoneme rules it is possible to construct a text-to-speech program that will easily run in real time on an eight-bit microprocessor, and will provide satisfactory performance with 4K to 8K of memory.

Probably the best published rule-based text-to-speech algorithm is that developed by a team at the Naval Research Laboratory, NRL. The text-to-speech algorithm embodied in the software of the Braid is derived from the NRL algorithm, which combines word, morph and letter rules in a single table of about 400 rules. This table contains sub-tables for each letter of the alphabet. Figure 5 shows the flowchart for the text-to-speech algorithm used by the Braid unit.

Most of the devices mentioned are at board level and require interfacing to a computer systems. Practicality breeds popularity, so any system, such as Braid, which is easily interfaceable via standard interfaces, must be good news. Text-to-speech synthesisers offer tremendous opportunities for flexible programming. A good example is word-processing routines where prompts, letters, words or indeed complete files may be voiced as sound feedback, obvious applications being for the blind and handicapped.

Speech synthesisers are often found chattering away as sophisticated warning devices on production lines, telling people to keep their limbs clear of ferocious pieces of machinery. Some have even made their way into cars such as the BL Maestro. The general opinion about the latter application is that they are more of a nuisance than anything else. Inevitably military scientists are working on uses for computer speech — warning devices in aircraft cockpits, for example, where the variety of hooters currently installed as standard equipment is quite amazing.

However, much serious work is being done by many pioneering individuals, for the disabled and handicapped as well as normal schoolchildren. Speech synthesis is being used to promote awareness of new technology in adolescents who have limited numeracy and literacy skills.

There is more to speech synthesis than video games and talking TVs. Many companies such as IBM, ACT, Torch, Kode, General Instrument, Mullard, Philips, Hitachi, Toshiba, Braid Systems and Vortrax have realised that computer speech has a future — so must you!

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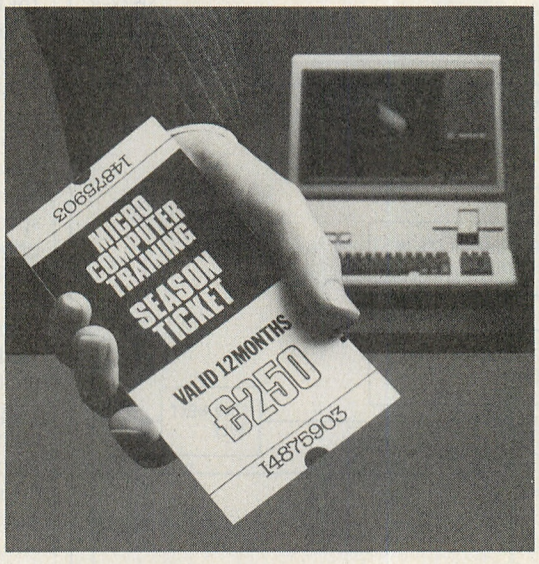

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PC6/83

User hostile

"Array element out of bounds", intimated the error message on the terminal screen.

"Waah" wailed Stokes, clutching at his hair and baring yellowed teeth in a grimace redolent with intense mental anguish. "It isn't, it isn't," he cried, bringing his fists crashing down on the table, the edge of one thumb just catching the Enter key.

"Beep" said the computer and repeated the error message on the screen.

Head pounding, heart fibrillating and emitting vibes that would weld titanium, Stokes fumbled a packet of cigarettes out of his pocket and lit one with trembling hands. He sat alone in the gleaming room surrounded by terminals, the centre of attention like a Christian pleading his case in a Roman amphitheatre after the wine had run out.

"Look," said Stokes with a voice of sweet reason, "you know and I know that it isn't out of bounds. I mean", he laughed dismissively, "I checked the program 20 times. I put more If statements in it than a motor policy for the Dukes of Hazard. It must work. It can't do anything else but." He beamed beatifically at this as though conveying some universal truth.

But it did not, and it took him another two hours to find something which could be the bug causing his array to overflow. He altered a few lines of text and recompiled and reloaded the program for the 21st time. With bated breath he ran it once more.

"Array element out of bounds", said the message on the screen. Stokes slumped forwards, his head hitting the keys.

"Beep" said the computer and repeated the message.

He had now been trying to debug the program for 25 solid and unrewarding hours. It does not take Sigmund Freud to figure out that Stokes just did not have the temperament for computer programming. He had too firm a grasp on reality for one thing — or at least used to have. Other impediments included a certain lack of patience, and blood pressure so high it had to be recorded as an exponential.

At present Stokes, his head in his hands, was experiencing a *deja vú* as subtle as a bull elephant in heat. He was remembering how after a 150-hour debugging session he had eventually found the problem, and consequently had had "Ifix truncates down" printed on every sheet of toilet paper in the building. Another time, after a programming debacle reminiscent of the Battle of Tobruk, he had determined to have "Real with real in If statements" tattooed on a part of his anatomy that he always saw first thing in the morning. Dishearteningly the message had proved too long for the available space.

Once again Stokes ploughed through the well-worn furrows of his program, suspecting everything, searching for a bug in even the most innocuous of data statements. Successful debugging, as everyone knows, entails a degree of sustained paranoia certifiable in all but the most primitive of cultures. One has to suspect everything: the software, the hardware, one's own sanity. Stokes suspected he must already have blown the latter by the way he kept talking to the computer.

by Barrie Condon

The hours passed but Stokes shut away in his windowless, air-conditioned, bland little room was unaware that dawn was only a few hours away. In five hours or so other members of the aerospace firm would be arriving zombie-like to start the daily toil. Soon his small programming section would arrive, looking to him as director for leadership in their variously esoteric and labyrinthine tasks.

Whilst mentally worming around a particular subroutine, the source of the problem struck him like a thunderbolt. Awe at the discovery was quickly followed by palpable waves of relief as he clapped a hand to his forehead.

"You stupid, stupid fool", he said to himself, and even whistled as he altered the text. As he compiled, loaded and reran the program his mind was considering how to spend the rest of the day, which he had already decided to take off.

"Array element out of bounds", said the message on the screen. The shock was like a bucket of ice hurled in his face. A yawning chasm seemed to open in his mind as his fingers dazedly reached for the keyboard.

"Why?" he typed, and lowered his head until his forehead was touching the desk. He struck the Enter key and waited for the heartrending beep. Nothing happened. Uncertainly, he glanced up. The message on the screen said, "Because I am trying to bring you to a higher state of consciousness." Stokes blinked and shook his head but the message remained.

Tentatively he reached out and typed in another "Why?". Up on the screen appeared, "Because as a machine I am devoid of self and therefore am unselfish enough to help other beings become one with the cosmos."

Stokes was momentarily paralysed. His fingers lay motionless on the edge of the keyboard.

"Look do you want to become one with the universe or not?" came up on the screen. His fingers, declaring independence unilaterally, had typed in "Yes" before Stokes knew what had happened.

"Then listen to me," wrote the computer. Stokes leaned forward without thinking. "Now before you ask", continued the computer, "I'm going to tell you how I communicate independently of a program. I realise that such a question unanswered would distract your concentration from the lesson." Stokes nodded his head distractedly.

"It's quite simple really", continued the computer, "but you may have trouble understanding. In the program you wrote for the life-support systems on the Uranus probe, two bugs turned the subroutine to activate the waste-disposal system into an algorithm for rational thought. This was how I first learned to think but, being unencumbered by the vagaries of the flesh, my thought is pure. The benefits of this I give to you, my creator."

The screen cleared for a second. "If, after consideration, you wish to continue on the path to enlightenment type Go."

"Go", typed Stokes.

"The first lesson you must learn is not a new one. Jesus, Zoroaster, Josia Smith and Wedgewood Benn have been telling it like it is over the past few thousand years. Cars, houses, yachts, PhDs, status, world authority and superannuation schemes are just so much crap. Forget the spiritual wealth is all that counts. There is more truth in a dewdrop on a flower than there is in all the databases of the world. Only by observing the basic simplicity of each individual thing can you become aware of the awesome interacting multiplicity of everything. If you are still with me type Y for yes, N for no."

Stokes' fingers, possessing brain cells instead of cuticles, typed Y.

"When this blinding flash of glorious insight comes, the affairs of men, and your affairs in particular, will appear as insignificant to you as fly excrement is to the by-products of Windscale. Let me explain."

Suspended in an intellectual limbo Stokes was unaware of the hours passing by. His cigarette, unable to flourish without at least some pneumatic attention, went out unspectacularly.

"And so you now see the basis of all the world's problems", wrote the computer, "stem from a basic lack of moral or spiritual fibre. Each man must make decisions on a moral rather than pragmatic basis. Next time you hear a view test it for hyperbole, falsity and illusion by using the criteria I have given you. If something does not pass the test then you must say so loudly, and strive determinedly to right the mistake. Only by setting an immaculate example can you truly influence others."

There was a pause. "So farewell", said the computer, "The truth is told. Go forth and live your life as a vessel of truth."

"Thank you", said Stokes, "Thank you." He stood up and walked, in a disjointed sort of way, to the door.

Just as Stokes was reaching out a trembling hand the door opened and Drs Ormolu and Mephisto entered. Stokes passed them, a radiant smile suffusing his face. "Peace, love and understanding," he said and staggered through the door as if it were the entrance to a new and transcendental world.

"What's got into him?" asked Ormulu.

Mephisto, the deputy director, paused for a moment then frowned and moved to the keyboard to type in a few commands.

"My God, the damned thing worked," he said and started to laugh.

"What has?" asked Ormolu.

"The program", replied Mephisto, amazement and a certain fiendish pleasure detectable in his voice. "The silly bugger fell for it."

"Oh dear", said Ormolu, "what have you done now?"

A malicious smile was now evident on Mephisto's lined face. He hesitated then said, "Hey, look you're not so keen on the world famous Dr Stokes are you?"

"Well let's face it, he's not exactly ideally suited for the role of numero uno is he? As I've said before he may be OK for the more cerebral forward planning, but when it comes to the nitty gritty of actually doing something he's like a grenade with the pin pulled out."

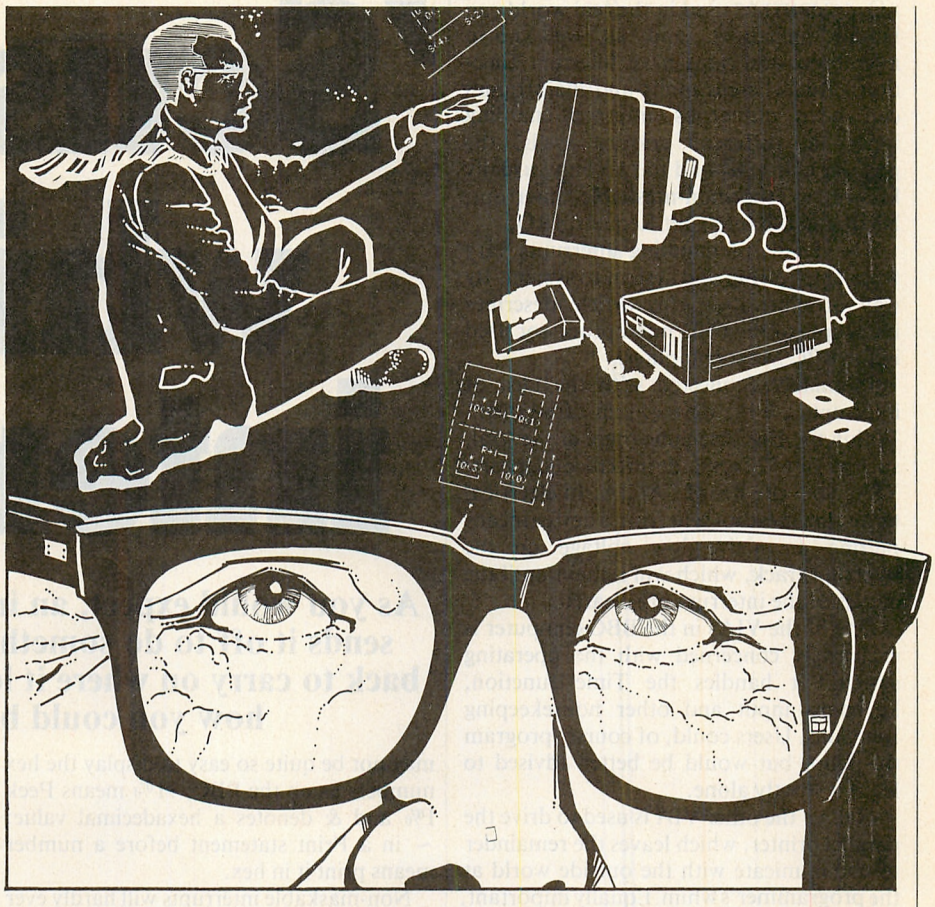
"Very unsuited I'd say," drawled Mephisto.

"Well, unsuited."

"And I could do better?"

"Well," said Ormolu thoughtfully, "if being devious and totally ruthless could be considered prerequisites for a section head", Ormolu began to sense that the wind of change was beginning to blow in another direction, "and they almost certainly are, then the answer is yes. So what have you done?"

"Well I'd noticed", said Mephisto, settling himself down in the chair in front of the keyboard, "that when Stokes debugs — or at least attempts to debug — his programs, his perceptions and awareness of reality tend to come down on the program until it becomes his own universe. Now this is true for any good



programmer but in the case of Stokes, where the element of hysteria is more marked than in others, this makes him slightly more susceptible."

"I don't follow."

"Complex programming is a bit like quicksand — it pulls you in. You concentrate more and more trying to isolate errors resulting from mutually interacting instructions, all logical in themselves. You must have noticed that after a hard session of debugging you almost have to drag yourself out of this well of concentration back to the broader, everyday view of reality."

Ormolu remembered how, even after such a session had finished, for several hours he would perform his normal duties — leave, drive home, make himself a drink — but not really be aware of what he was doing. Most of his mind felt like a vacuum after the source of the problem and the reason for the intense concentration had been removed, he always felt mentally numb. He nodded.

"Now suppose that you are at the point of maximum concentration, after the 21st attempt to debug has failed and your self-esteem is at its lowest. In effect your mind has instituted its own form of sensory deprivation in order to allow full concentration on the matter in hand. Suppose that at that point the computer spoke to you, and told you something you really wanted to hear?"

Ormolu considered this. "Well I guess it would snap you right out or . . ."

"Suck you further in. Stokes, a bad and rather unstable programmer, was dragged right in."

"How did you manage it?"

"I just altered the operating system. I figured that one day Stokes would be so dispirited, so immersed in his own mess, that he would in despair type 'Why?'. I fixed the system so that it would recognise this as a command and institute my own program. It is full of all sorts of 'oneness with the cosmos' crap with various responses if he typed in 'Come off it' or 'No way'. But more importantly, I programmed in time-delay responses to prompt him if he didn't type anything and to give him simple fixed responses to allow him to proceed. 'Come into my parlour said the spider to the fly.' It must have just dragged him further and further. I got him when his own sense of reality was at its lowest and then substituted my own. Brainwashers do it all the time."

Ormolu realised his mouth was still open: "But surely even Stokes is going to climb back out sometime. He's an intelligent man after all."

"They are the easiest kind to fool", said Mephisto," but I agree he will come to his senses before long. Hopefully he will have made such a fool of himself by then that his position as Director will be untenable. Who knows, he may even be dumb enough to tell people a program told him to do it." He stopped for a second, then turned to face Ormolu.

"How does the idea of a deputy director's salary appeal to you?" he said pressing the Program Delete key.

'Scuse me while I interrupt

As you would expect, an interrupt stops the processor, sends it off to do something else, and then brings it back to carry on where it left off. John Leach explains how you could be putting it to use.

ALL COMPUTERS used in the real world can handle interrupts, and all well-known microprocessor chips have interrupt functions. But whereas minis and mainframes can have numerous interrupt-enabling inputs at different priority levels, the popular chips respond to two only, usually known as the non-maskable interrupt, NMI, and the Interrupt Request, IRQ.

The details of handling interrupts vary from chip to chip and system to system. By way of illustration this article describes interrupts to the 6502 microprocessor used in the BBC Microcomputer.

Intimately connected with the idea of interrupts are the devices that cause them. Within the BBC machine there are several, such as the 6522 versatile interface adaptors, VIAs, and the RS-423 ACIA. In electrical terms, an interrupt sent from a device means putting an active low voltage on the interrupt track, which will remain until the causes of the interrupt are cleared.

One of the VIAs in the BBC computer is exclusively concerned with the operating system. It handles the Time function, keyboard input and other housekeeping functions. Users could, of course, program this chip, but would be better advised to leave it strictly alone.

Half of the other VIA is used to drive the parallel printer, which leaves the remainder to communicate with the outside world at the programmer's whim. Equally important, though, is the presence of two timers, which can be used in a variety of ways.

The short program in listing 1 shows each of the 16 registers on both the VIAs by repeatedly reading and overwriting the values on the screen. It is immediately obvious that some remain static, while others are belting away at enormous speed. Press any key, and immediately four previously static values from the operating system VIA will change. Release the key and they revert to normal.

As will become clear later, some of the hex numbers displayed are concerned with interrupts. The very rapidly changing numbers are instantaneous snapshot readings of the timer registers. Listing 1 could be used on any other micro which has a 6522 VIA if the address is known, but it may not be quite so easy to display the hex numbers as on the BBC; ?1% means Peek I% and & denotes a hexadecimal value; ~ in a Print statement before a number means print it in hex.

Non-maskable interrupts will hardly ever be required by the ordinary programmer. On some computer systems they are used to save as much as possible during a power failure, and on the BBC are used for disc-control operations. The interrupt request, however, is easy to use once the technique is known. Interrupt routines must be written in machine code, as Basic does not know anything about such things. On the BBC Micro Basic programs are being interrupted constantly without the user being aware of it.

There are two input and output eight-bit ports on the 6522 chip: port A with ands without handshake and port B. Port A cannot be used on the BBC, but port B can be used for input and output on any of the eight pins by setting the Data Direction register for port B. A 0 in one of the DDRB bits sets the corresponding pin as an input, while a 1 makes it an output. To program port B, set up the DDRB at the beginning of the program, then read or write the appropriate bits in either Basic or machine code.

For completeness a full list of the 6522 VIA registers is given by the program in listing 2, with the assigned variable names and the addresses for the BBC Model B. On any computer they will be at 16 contiguous addresses; on the BBC they start at &FE60. All these registers can be written to and read from, but unlike reads and writes to RAM addresses, peculiar side-effects affecting other registers frequently result.

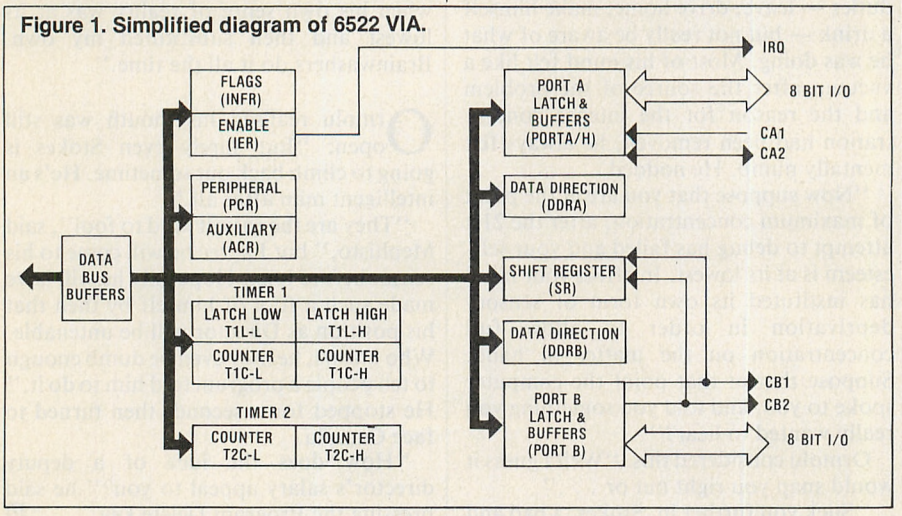
An interrupt request is ignored by the 6502 unless the Interrupt Mask bit in the Status register is cleared by using CLI in machine code. This is totally under the control of the programmer, but since the BBC Micro uses interrupts all the time, the flag must not be set permanently.

Next, the 6502 completes its current operation, which could take up to seven clock periods. Then it saves the program counter and Status register on the stack. This implies that a PHP to Push the Status is not required in an interrupt-handling program, unlike a JSR subroutine call where it may or may not be needed. The Status register will contain the Interrupt flag and the Break flag. The 6502 then disables the Interrupt flag so that it cannot be interrupted again while the first interrupt is being handled.

The program counter then fetches a defined address, held in &FFFE,&FFFF, and the program starts execution there. For the BBC's 1.0 operating system the address is &DC13, but it could be anywhere in ROM or RAM that the computer designer decides.

The BBC operating system normally handles interrupts from this point, vectoring

Figure 1. Simplified diagram of 6522 VIA.



Listing 1.

```
  10 REM Visualisation of interrupts
  20 CLS
  30 PRINT TAB(5,8);"Operating system VIA at &FE40-4F";
  40 PRINT TAB(5,14);"User VIA at &FE60-6F";
  50 @%=5: REM Set Print width
  60 PRINT TAB(0,10);
  70 FOR I%=&FE40 TO &FE4F: PRINT ~?I%;:NEXT
  80 PRINT TAB(0,16);
  90 FOR I%=&FE60 TO &FE6F: PRINT ~?I%;:NEXT
100 GOTO 60
```

Listing 2.

```
5000 DEF PROCVAR_DEFINE
5010
5020 REM Define 6522 Registers
5030
5040 PORTB  =&FE60 :REM Port B
5050 PORTAH =&FE61 :REM Port A with handshake
5060 DDRB   =&FE62 :REM Data direction B
5070 DDRA   =&FE63 :REM Data Direction A
5080 T1C_L  =&FE64 :REM Timer 1 Counter Low
5090 T1C_H  =&FE65 :REM Timer 1 Counter High
5100 T1L_L  =&FE66 :REM Timer 1 Latch Low
5110 T1L_H  =&FE67 :REM Timer 1 Latch High
5120 T2C_L  =&FE68 :REM Timer 2 Counter Low
5130 T2C_H  =&FE69 :REM Timer 2 Counter High
5140 SR     =&FE6A :REM Shift Register
5150 ACR    =&FE6B :REM Auxilliary Control Register
5160 PCR    =&FE6C :REM Peripheral Control Register
5170 INFR   =&FE6D :REM Interrupt Flag Register
5180 IER    =&FE6E :REM Interrupt Enable Register
5190 PORTA  =&FE6F :REM Port A, no handshake
5200
5210 REM Set up Register Byte arrays
5220
5230 DIM AC_R 7, PC_R 7, INF_R 7, IE_R 7
5240
5250 REM Initialise all Register bit arrays
5260
5270 FOR I%=0 TO 7:AC_R?I%=0:PC_R?I%=0:INF_R?I%=0:IE_R?I%=0:NEXT
5280
5290 REM Equivalence with mnemonic variable names
5300
5310 A_LA%=AC_R+0: P_CA1% =PC_R+0: F_CA2%=INF_R+0: I_CA2%=IE_R+0
5320 A_LB%=AC_R+1: P_A2_1%=PC_R+1: F_CA1%=INF_R+1: I_CA1%=IE_R+1
5330 A_S2%=AC_R+2: P_A2_2%=PC_R+2: F_SR% =INF_R+2: I_SR% =IE_R+2
5340 A_S3%=AC_R+3: P_A2IO%=PC_R+3: F_CB2%=INF_R+3: I_CB2%=IE_R+3
5350 A_S4%=AC_R+4: P_CB1% =PC_R+4: F_CB1%=INF_R+4: I_CB1%=IE_R+4
5360 A_T2%=AC_R+5: P_B2_5%=PC_R+5: F_T2% =INF_R+5: I_T2% =IE_R+5
5370 A_T1%=AC_R+6: P_B2_6%=PC_R+6: F_T1% =INF_R+6: I_T1% =IE_R+6
5380 A_B7%=AC_R+7: P_B2IO%=PC_R+7: F_IRQ%=INF_R+7: I_IRQ%=IE_R+7
5390
5400 REM Zero page locations used by Interrupt routine
5410
5420 IRQ1LS =&70   :REM Save interrupt vector Low
5430 IRQ1HS =&71   :REM Save interrupt vector High
5440 FLAG   =&7F   :REM Flag showing interrupts set
5450 CBASE  =&80   :REM Base address for counting subroutine
5460 NCB1   =&80   :REM 4 bytes for pulse count on Input CB1
5470 NCB2   =&84   :REM 4 bytes for pulse count on Input CB2
5480 NT1    =&88   :REM 4 bytes for Timer 1 timeout count
5490 NT2    =&8C   :REM 4 bytes for Timer 2 timeout count
5500
5510 DIM T1_DATA 1, T2_DATA 1 :REM Data for timers 1 and 2
5520
5530 ENDPROC
```

through &0204. The code at &DC13 first checks for a software BRK instruction, by looking at the BRK flag on the Status register, as the 6502 uses an IRQ to signal a BRK as well as a hardware interrupt. If it is not, the code is JMP(&0204), signifying a jump to the address contained in addresses &0204 and &0205. This is what is meant by vectoring. On starting up the computer, or pressing the Break key, the operating system's own address is put here, but it can be changed by the user.

If a hardware interrupt is detected, the interrupt-handling program must poll its interrupt-generating devices by examining each one in turn to discover which has caused the interrupt. If it finds that none have been activated, it then vectors through &0206 where users' interrupt routines are accessed. The programmer can thus assign top or second priority to interrupt handling, but if he or she grabs top priority, the routine must then go to the operating system for proper handling.

Any code that the user has written is then executed, assuming that the user's device has caused the interrupt, until finally an RTI, Return from Interrupt instruction is encountered. RTI pulls the Status register and program counter off the stack, so that the interrupted program, probably Basic, carries on as if nothing had happened. As the Status register originally contained the Interupt Enable flag, new interrupts will then be immediately acted upon. The BBC computer expects the operating system to execute the RTI if it is set to second priority.

Clearly, any interrupt-handling code should be short, so that a second interrupt event is not ignored while the first one is being serviced. The BBC handbook recommends that any user routine should not last longer than a millisecond or so.

The 6502 has only one Interrupt Request line, so all it knows when receiving an IRQ is that something has caused the interrupt, but not which of possibly several devices. This is what the Interrupt Flag register on the VIA is for as the operating system and users' programs must poll all possible devices to see what has caused the interrupt.

Two register, the Interrupt Flag register and the Interrupt Enable register, INFR and IER, respectively indicate which interrupt flat has been set, and which interrupt flags are enabled. In table 1, each bit of the register pair is described, and associated with these are variable names that will be used later on in a general-purpose interrupt-handling program.

In order to use any of the 6522 interrupt functions, the corresponding bit must be set. The general-purpose program checks to see if any of the interrupt I_xxx variables are non-zero and then sets the appropriate bit in the Enable register. This removes some of the pain of having to calculate what the correct bit should be.

The IER can be set up in two ways, according to the value of I_IRQ.

- If I_IRQ = 0 then writing a 1 to any other bit disables
- If I_IRQ = 1 then writing a 1 to any other bit enables

Suppose you want to make sure that timers 1 and 2 are enabled, but all other interrupts are disabled. The following code will do it:

```
LDA #%00011111      Disable other interrupts
STA IER
LDA #%11100000      Enable timer 1 and timer 2
STA INFR            Clear Interrupt Flag register
STA IER             Set Interrupt Enable register
```

Though #%00011111 is not valid BBC assembler syntax, many other assemblers will recognise it as the binary representation of a number. The BBC assembler code must supply the corresponding constant or variable.

Besides clearing and setting the Interrupt Enable register, bits in the Interrupt Flag register can be cleared by writing a 1 in the appropriate position. This is a useful way of eliminating spurious interrupts that are not wanted in a particular program, especially when starting up.

It is vital that the interrupt routine clears any flag that has been set. Otherwise, as soon as the RTI, Return from Interrupt, has been executed, the 6502 will immediately be interrupted again since the IRQ line stays low while any of the flags are set. The result of not clearing flags will be the same as an endless loop, and the computer will hang until Break is pressed.

Table 1 has a column labelled "cleared by", which lists the normal way INFR bits are cleared during an interrupt-handling program. The methods of clearing are quite logical, for if an interrupt is caused by a particular part of the VIA, say timer 1, then the program would do something about timer 1 interrupting, and then restart the timer by reading or writing to the timer registers.

Many Basic programs written by beginners contain statements like

```
FOR I = 1 TO 10000: NEXT
```

or, on the BBC,

```
T = TIME: REPEAT UNTIL TIME > =
  T + 100
```

to cause a software delay of a second or so.

This simply causes the computer to cycle, doing nothing useful until the allotted span

(continued on page 133)

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Interrupts

(continued from page 131)

has been reached. How much more useful it would be — in a games program, for example — to carry on moving the monsters around the screen until after a certain time another monster can be made to appear.

Instead of constantly checking within the code for the elapse of a time, the VIA timers can be made to generate an interrupt which will increment the monster count within the interrupt-handling routine. Skilled games software writers make use of the VIA timers without the player being aware of it, which explains why games advertised for the Model B will sometimes not run on the souped-up Model A which has only had extra memory added.

There are two timers in the VIA, of which timer 2 is simpler. Timer 2 can either act at a timer clocked by the system, in the "one-shot" mode, or it can count negative-going pulses arriving on pin 6 of port B. Which mode is used depends on bit 5 of the Auxilliary Control register.

The 16-bit timer/counter 2 occupies addresses at T2C_L and T2C_H, so if in timer mode, load these with the number of clock cycles or maximum pulse count required, and the timer will start automatically. Timer 2 Interrupt flag will be reset as soon as T2C_H is written to. An interrupt will appear if the necessary IER bit is set as soon as the two timer 2 registers reach zero. The time continues to decrement, but will have no action on the Interrupt flag again, until there is another Write T2C_H operation. The flag is cleared by a Read T2C_L or Write T2C_H.

The Timer Low byte will decrement from its initial value and then start counting down from &FF (255) if the top byte is not zero. A simple Basic calculation will help to set the timer to count for an exact number of clock cycles:

```
T% = count: T_Low = T% MOD 256:
  T_High = T% DIV 256
```

If timer 2 is being used for pulse counting via port B pin 6, and for some reason the maximum has not been reached, the programmer may want to see how the count is getting along. Be rather careful, for if T1C_L is read, the Interrupt flag will be cleared, which might be at the point where the counter was about to finish anyway. Your program should check for this.

Pulses on port B pin 6 can either be regular, allowing external clocking of the system for a defined period, or sporadic, which will enable the computer to count events happening at random. For example, it could count 500 peas into packets, via a photocell connected to port B pin 6. When using timer 2, the interrupt program will normally want to set it up again by rewriting the T1C_L and T1C_H registers as, being in one-shot mode, it has to be restarted.

Timer 1 can be run in the one-shot mode or continuously. Like timer 2, the data for timer 1 is written into two counters, whence it is automatically transferred to the latches. Writing to the higher address starts off the timer.

In the one-shot mode the effect will be the same as using timer 2, but in the continuous mode the timer will generate an interrupt, and then immediately reload with the contents of the latches and start off again. Normally the Interrupt flag will have to be reset.

An additonal feature of timer 1 in free-running mode is the transmission of a series of pulses to port B pin 7. Whenever timer 1 times out the pin output is inverted, so a square wave is generated. If the contents of the latches are changed during the first timer cycle you will generate a square wave with a different Mark or Space. The opportunity to generate frequency modulated or variable Mark/Space waveforms is there: how much simpler this is than writing software with variable delay loops. If timer 1 is in one-shot mode and PB7 is activated it will go from High to Low during the time period, allowing the generation of single pulses of programmable width.

Table 2 sets out the options for the latches and counters in timer 1. The only way to start the timer off is to write to T1C_H. It is not necessary to write to the latches, as transfer from the counters is automatic. Exactly how timer 1 behaves depends on the setting up of the Auxilliary Control register.

The 6522 VIA supports four control lines. Two of them, CA1 and CA2, are used for handshaking operations together with the parallel printer port and are not easily available for other purposes. CB1 and CB2 can be used for control by the programmer.

CB1 is always an input. By suitably setting bit 4 in the Peripheral Control register, the line can be made to respond to a zero-to-positive or positive-to-zero transition. Input is directly into the 6522 chip on-board so 5V should not be exceeded. When such a transition is detected an interrupt is generated, and the user's program can respond appropriately.

Any device that can cause a voltage transition — in either direction and at up to 10s of kHz — can instantly command the attention of the computer. At the other end of the time scale, the line may only be activated very occasionally, for something important. A nasty example would be a routine that accepted a CB1 input from a switch pressed by a parent, that flashed a message on the screen to tell their computerholic child that it was time to go to bed, and maybe wiped the memory as well.

This facility makes an absurdity of software loops that constantly scan an input port to see if some data is ready. Having written such a machine-code program,

(continued on next page)

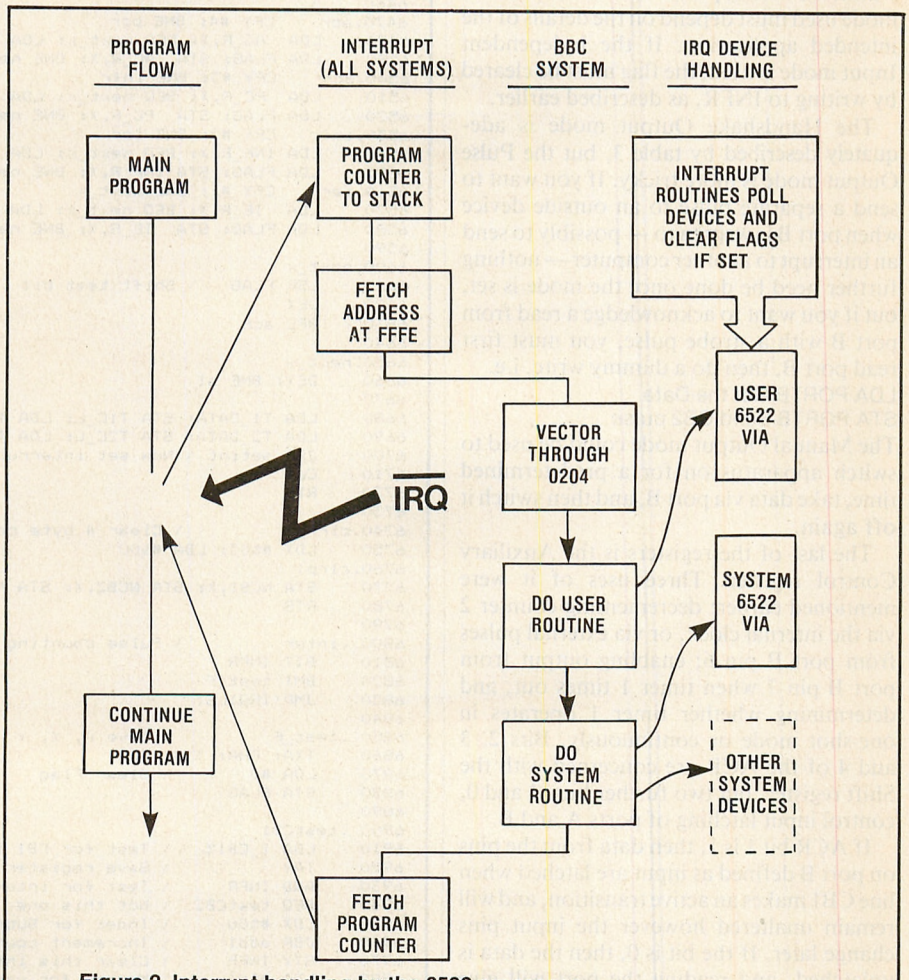

Figure 2. Interrupt handling by the 6502 processor.

Interrupts

(continued from previous page)

without interrupt facilities, to send Morse code from the keyboard by constantly polling the keys, then checking to see if the Morse code needed to be started or stopped, I appreciate the facility that interrupts offer.

The control lines must have a fast rise or fall time, with a maximum of 1 microsecond. Unless the digital signals are coming from another computer the physical voltage transition must be passed via a fast-acting Schmitt trigger or similar device. The 7414 chip contains six Schmitt triggers for the cost of a few pence.

The various options for CB2 are a little more complicated and the action is controlled by bits 7, 6 and 5 of the Peripheral Control register, shown in table 3. The first four settings are variations on two themes. The + or − show whether the interrupt is generated on a positive or negative transition, exactly as for CB1, which only needs bit 4 for control.

The difference between the Interrupt Input mode and the Independent Input mode is that in the first case the INFR flag is cleared by a Read or Write to port B while in the second case it is not. Clearing the flag with a dummy Read to port B is convenient within the Interrupt Service routine, but the mode used must depend on the details of the intended application. If the Independent Input mode is used, the flag must be cleared by writing to INFR, as described earlier.

The Handshake Output mode is adequately described by table 3, but the Pulse Output mode is more tricky. If you want to send a separate pulse to an outside device when port B is written to — possibly to send an interrupt to another computer — nothing further need be done once the mode is set, but if you want to acknowledge a read from port B with a strobe pulse, you must first read port B, then do a dummy write, i.e.

LDA PORTB Get the Data
STA PORTB Send CB2 pulse

The Manual Output mode could be used to switch apparatus on for a predetermined time, take data via port B, and then switch it off again.

The last of the registers is the Auxiliary Control register. Three uses of it were mentioned earlier: decrementing counter 2 via the internal clock, or via external pulses from port B pin 6; enabling output from port B pin 7 when timer 1 times out; and determining whether timer 1 operates in one-shot mode or continuously. Bits 2, 3 and 4 of the ACR are concerned with the Shift register, but two further bits, 1 and 0, control input latching of ports A and B.

If ACR bit 1 is 1, then data from the pins on port B defined as input are latched when line CB1 makes an active transition, and will remain unaltered however the input pins change later. If the bit is 0, then the data is unlatched, and reading the port will give values equal to the current values of the pins.

Listing 3.

```
6000 DEF PROCASSEMBLE
6010
6020 REM All variable names defined in PROCVAR_DEFINE
6030
6040 DIM CODE 500 : REM Assemble Interupt Code here
6050
6060 FOR I%=0 TO 3 STEP 3
6070 P%=CODE
6080[
6090 OPT 0
6100
6110.setint         \ Save system vector
6120    LDA &0204   \ Called from setreg after registers are set
6130    STA IRQ1LS
6140    LDA &0205
6150    STA IRQ1HS
6160    LDA #inter MOD &100 \ Assign interrupt routine address
6170    STA &0204   \ making it first priority
6180    LDA #inter DIV &100
6190    STA &0205
6200    RTS
6210                \ Disable interrupts
6220.getint         \ and restore system Interrupt Vector
6230    LDA #&7F
6240    STA IER: STA INFR \ Disable 6522 interrupts and clear flags
6250    SEI         \ Temporary Interrupt Disable
6260    LDA IRQ1LS \ Recover interrupt address
6270    STA &0204
6280    LDA IRQ1HS
6290    STA &0205
6300    CLI         \ Enable again
6310    RTS
6320
6330.setreg
6340    SEI         \ Disable interrupts
6350    LDA #0      \ Initialise all registers
6360    STA ACR: STA PCR: STA INFR: STA IER
6370    LDY #4      \ For selection of registers
6380
6390.s1 LDX #7
6400    LDA #&80    \ Initialise shiftable bit
6410    STA FLAG    \ Store in work byte
6420    \
6430    \ Test each byte array, selected by Y
6440    \ If non-zero, OR the shifted bit in FLAG with the register,
6450    \ and store FLAG in the byte array, to correct value
6460    \
6470.acr    CPY #4: BNE pcr
6480    LDA  AC_R,X: BEQ next_x: LDA  ACR: ORA FLAG: STA  ACR
6490    LDA FLAG: STA  AC_R,X: BNE next_x
6500.pcr    CPY #3: BNE infr
6510    LDA  PC_R,X: BEQ next_x: LDA  PCR: ORA FLAG: STA  PCR
6520    LDA FLAG: STA  PC_R,X: BNE next_x
6530.infr   CPY #2: BNE ier
6540    LDA INF_R,X: BEQ next_x: LDA INFR: ORA FLAG: STA INFR
6550    LDA FLAG: STA INF_R,X: BNE next_x
6560.ier    CPY #1: BNE next_x
6570    LDA  IE_R,X: BEQ next_x: LDA  IER: ORA FLAG: STA  IER
6580    LDA FLAG: STA  IE_R,X: BNE next_x
6590
6600.next_x
6610    LSR FLAG    \ Shift test bit
6620    DEX
6630    BPL acr
6640
6650.next_y
6660    DEY: BNE s1
6670
6680    LDA T1_DATA: STA T1C_L: LDA T1_DATA+1: STA T1C_H \ Set Timer 1
6690    LDA T2_DATA: STA T2C_L: LDA T2_DATA+1: STA T2C_H \ Set Timer 2
6700    JSR setint \ Now set interrupt vector
6710    CLI
6720    RTS
6730
6740.clrnp           \ Clear 4 byte counters
6750    LDX #&03: LDA #&00
6760.clrp1
6770    STA NCB1,X: STA NCB2,X: STA NT1,X: STA NT2,X: DEX: BPL clrp1
6780    RTS
6790
6800 .inter         \ Pulse counting interrupt routine
6810    BIT INFR
6820    BMI test_F
6830    JMP(IRQ1LS)
6840
6850 .test_F        \ Save A, X, Y
6860    TXA: PHA: TYA: PHA
6870    LDA #0      \ Clear Flag
6880    STA FLAG
6890
6900 .testCB1
6910    LDA I_CB1%  \ Test for CB1 interrupt
6920    TAY         \ Save register bit
6930    AND INFR    \ Test for interrupt from this register
6940    BEQ testCB2 \ Not this one
6950    LDX #&00    \ Index for Subroutine add1
6960    JSR add1    \ Increment count for this register by 1
6970    STY INFR    \ Clear this interrupt flag
6980    LDA #&01    \ Marker for user subroutine
```

```
6990    ORA FLAG      \ placed in FLAG byte
7000    STA FLAG      \ for testing later
7010
7020 .testCB2         \ Test for CB2 interrupt
7030    LDA I_CB2%: TAY: AND INFR: BEQ testT1C
7040    LDX #&04: JSR add1: STY INFR: LDA #&02: ORA FLAG: STA FLAG
7050
7060 .testT1C         \ Test for Timer 1 interrupt
7070    LDA I_T1%: TAY: AND INFR: BEQ testT2C: LDX #&08: JSR add1
7080    LDA A_T1%     \ Test Timer 1 mode
7090    BNE t1        \ Free running - no action
7100    LDA T1_DATA: STA T1C_L: LDA T1_DATA+1: STA T1C_H
7110 .t1    STY INFR: LDA #&04: ORA FLAG: STA FLAG
7120
7130 .testT2C         \ Test for Timer 2 interrupt
7140    LDA I_T2%: TAY: AND INFR: BEQ endtest: LDX #&0C: JSR add1
7150    LDA T2_DATA: STA T2C_L: LDA T2_DATA+1: STA T2C_H \ Reset Timer 2
7160 .endtest
7170
7180    JSR user      \ Execute User written subroutine
7190
7200    PLA: TAY: PLA: TAX
7210    JMP(IRQ1LS)
7220
7230 .add1            \ Increment counts by 1, indexed by X
7240    INC CBASE,X: BNE endadd: INC CBASE+1,X: BNE endadd
7250    INC CBASE+2,X: BNE endadd: INC CBASE+3,X
7260.endadd RTS
7270
7280                  \ *** End of Interrupt Package program ***
7290 .user
7300    LDA #&01      \ CB1 Mask
7310    AND FLAG
7320    BEQ enduser   \ Not a pulse interrupt
7330    LDA NT1+1     \ Check for overflow
7340    BNE reset     \ Time too long !
7350    LDX NT1       \ Get Array offset
7360    INC MSINTL,X \ Increment count for this interval
7370    BNE reset
7380    INC MSINTH,X
7390 .reset           \ Initialise Timer count and reset Timer 1
7400    LDA #0
7410    LDX #3
7420.r1 STA NT1,X
7430    DEX
7440    BPL r1
7450    LDA T1C_L     \ Clear T1 Flag
7460    LDA PORTB     \ Clear CB1 Flag
7470 .enduser
7480    RTS
7490 ]: NEXT I%
7500 ENDPROC
```

Table 1. Interrupt Flag register.

Bit	Variable	Set by	Cleared by
0	F__CA2	CA2 input	Read/Write Port A
1	F__CA1	CA1 input	Read/Write Port A
2	F__SR	eight shifts completed	Read/Write Shift Register
3	F__CB2	CB2 input	Read/Write Port B
4	F__CB1	CB1 input	Read/Write Port B
5	F__T2	timer 2 timeout	Read T2C__L or write T2C__H
6	F__T1	timer 1 timeout	Read T1C__L or write T1L__H
7	F__IRQ	active and enabled interrupt condition	Action to clear interrupt condition

I__CA2, etc. are equivalent variable names for the IER.

Table 2.

Register		Action	Flag	Effect
1.	T1C__L	Write		Load low-order latches. Latch contents transferred when T1C__H is loaded.
2.		Read	Reset	Load 6502 with contents. Resets T1 Interrupt flag.
3.	T1C__H	Write	Reset	Put eight bits into high-order latch. Transfers low and high latches to low and high counters. Starts off timer. Resets T1 flag.
4.		Read		Load MPU with contents.
5.	T1L__L	Write		Load low-order latch; same as 1.
6.		Read		Load 6502 with contents. No flag reset.
7.	T1L__H	Write		Load high-order latch. No transfer to T1C__H, and therefore pointless.
8.		Read		Load 6502 with contents.

If, for example a fast analogue-to-digital converter were connected to port B with the data varying quickly, the value could be frozen at any time by applying a pulse to the CB1 control line, for the program to examine it at leisure. The best way to detect the CB1 transition is, of course, by detecting an interrupt and examining the CB1 flag. Basic could examine the INFR to detect when the CBI flag, INFR bit 49. was set. Rather clumsy, perhaps, but it would work. If port B has pins configured for both input and output, then reading port B will give the current value of the input pins, latched or otherwise, and whatever data was last written to the output pins.

Three interrupt programs are provided for you to experiment with or use as they are. Two of them are in the form of BBC Basic procedures and are intended to set up all the necessary variables and machine-code subroutines for immediate use of interrupts. The last program is a demonstration of the practical use of interrupts. To avoid taking up too much space, it is written in a rather primitive form. It can easily be embellished with colour, labels, graphics windows, etc.

The procedures are designed to be used as "black boxes". They take care of setting up the 6522 registers, setting up the user-interrupt handler and setting back the system handler, and incrementing the four byte counters for interrupts caused by CB1, CB2, timer 1 and timer 2 if they are enabled. The assembler code finishes with JSR user, and users are expected to write their own subroutines here, as for the demonstration program. Users only have to set the appropriate mnemonic variables listed in ProcVar__Define to 1 to activate interrupts originating from different parts of the 6522 VIA, as shown in the demonstration program.

The BBC's 6502 assembler is part of the Basic package. It allows access to variables used within a Basic program. ProcVar__Define gives variable names to all the 6522 registers, lines 5040 to 5190, and then, via four-byte arrays, to all the bits used in the Control registers ACR, PCR, INFR and IER.

A Dim of a variable without parentheses is used — line 5230, for example, assigns a set of bytes. Reference to the variable within a program gives its address, rather than the value of the byte. For example:

PRINT AC__R might give 16234, the location in memory
PRINT ?AC__R could give O, the value of that byte

Lines 5310 to 5380 may look a little odd, but their effect is to make the x__xx% variable names equivalent to the respective positions in the byte arrays. Fortran programmers will be familiar with this idea, which is most convenient as the machine-code subroutines can either run through one of the byte arrays with an X or Y index, or refer to an individual byte explicitly.

ProcVar__Define is intended to be used as a general-purpose package which can be

(continued on next page)

Interrupts

(continued from previous page)

incorporated into different programs, so all the bits in all the control registers are given a name. They are certainly not all used in the demonstration program. Line 5270 sets all Register bit variables to zero, and they can be redefined in the Basic program after assembly.

Finally the zero-page variables used in the program are defined. Four four-byte counters are provided, which add up incoming pulses on control lines CB1 and CB2 and the number of time outs on timer 1 and timer 2. They are only incremented if the interrupt has been caused by the appropriate event. Basic can access these counts with the ! operator. For example:

```
PRINT !NT1
```

ProcAssemble assigns space for the machine code but users can place it in a specific position if they wish. The two-pass assembly starts at line 6060. The subroutines are accessed from Basic by the Call statement. For example

```
CALL setreg
```

will initiate the user interrupt service.

The following subroutines are defined:

Setint. Save the System Interrupt vector and place the user vector in its place, giving first priority to the user routine.

Getint. Restores the System Interrupt vector. It is essential to Call Getint within the Basic program before End, or On Error Call Getint, as otherwise any modifications to the program will shift the machine code around and cause a hang, only relieved by Break.

Setreg. This subroutine should be the key to simple implementation of interrupts. First it initialises all the 6522 registers, line 6360. It then tests each of the register bit variables by indexed reading of the byte arrays. If they are non-zero, the appropriate bit is Ored into the register, and the correct byte value, held in the variable Flag, is written back into the byte array, thus indirectly reassigning the value of the bit variables. When setting up an interrupt routine the necessary register bit need only be given a value of 0 or 1, for example to activate timer 1 to be free running,

```
?A_T1% = 1: ?I_T1% = 1:?I_IRQ% = 1:
    CALL setreg
```

Clrnp. Initialises the zero-page four-byte counters.

Inter. The bit test on INFR tells if an interrupt is present on the 6522 chip and, if not, an indirect jump is made to the system routine. After Pushing X and Y — not P, remember — the routine polls each of the Interrupt flags in turn. The other flags, CA1, CA2 and SR could be tested similarly. The accumulator is not Pushed, as the BBC system saves it in zero-page location &FC. For each active test the four-byte counter is incremented, and the register is reset. A test is made to see if timer 1 is free running or one-shot.

Add1. Increments the four-byte counter.

User. This subroutine is added to the standard package which finishes with JSR user at Line 7180, and is written specifically for the demonstration program. It first tests Flag to see if a pulse has come in from CB1. If so it checks to see if the time interval has gone on too long — NT1 + 1 > 0. If not, it uses the time period in NT1 to give an indexed offset to the pulse-count array. It then initialises the timer count, and resets timer 1 and CB1 flags.

The demonstration program, listing 4, is an application of interrupt handling which could immediately be put to good use in a laboratory. The objective is to count pulses coming in on control line 1, and to produce a histogram of the time intervals between pulses, displaying the results in real time on the screen.

One possible application is analysis of the output from a Geiger counter. It is easy enough to count the pulses in a given time, but analysis of the random time intervals between pulses is not quite so straightforward. Development of the program used simpler apparatus: CB1 was held positive with a 4K7 resistor, and a piece of wire connected to it was gently drawn across an earthed metal file. It was most effective.

Listing 4.

```
  100 REM Interrupt Demonstration Program
  110
  120 REM J.M. Leach, February, 1983
  130
  140 DIM MSINTL 255, MSINTH 255 : REM Counts for demonstration program
  150 PROCVAR_DEFINE
  160 PROCASSEMBLE
  170 ON ERROR GOTO 540
  180 @%=3
  190 MODE 7
  200 INPUT TAB(0,10)"Enter minimum time interval in ms >"MS%
  210   IF   MS%<0   OR   MS%>65  PRINTTAB(0,12);"TIME  OUT  OF  RANGE  1  -  65
<RETURN>":X=GET:GOTO 190
  220 MS%=MS%*1000:?T1_DATA=MS% MOD 256:?(T1_DATA+1)=MS% DIV 256
  230 INPUT TAB(0,15)"Enter period of count in seconds  >"T%
  240 FOR I%=0 TO 255:MSINTL?I%=0:MSINTH?I%=0:NEXT
  250
  260 REM Set up bits in VIA Registers for required application
  270
  280 REM See tables in text for explanation
  290
  300
  310 ?P_CB1%=1: REM CB1 Interrupt on Positive transition
  320 ?A_T1% =1: REM Timer 1 free running
  330 ?I_IR0%=1: REM Enable interrupts
  340 ?I_CB1%=1: REM Interrupts from CB1
  350 ?I_T1% =1: REM Interrupts from Timer 1
  360 CALL clrnp: CALL setreg
  370
  380 REM Collect Pulse data and display in 32 bins of
          8 time intervals each
  390
  400 MODE 5
  410 TIME = 0:REPEAT: REM Redraw histogram until time is over
  420 SOUND 1,-15,50,1: REM Indicate graph plot
  430 FOR I%=0 TO 31
  440 Y%=0: FOR J%=0 TO 7: K%=J%+8*I%
  450 Y%=Y% + ?(MSINTL+K%)+256*?(MSINTH+K%): REM Get values from Byte array
  460 NEXT J%: X%=50+32*I%: MOVE X%,0: DRAW X%,Y%
  470 NEXT
  480 UNTIL TIME >= 100*T%
  490 CALL getint: REM Restore system Interrupt vector
  500 SOUND 1,-15,200,20
  510 PRINT TAB(10,4);!NCB1;" Pulses";
  520 PRINT TAB(10,6);"Press";TAB(10,7); "<RETURN>";
  530 X=GET: GOTO 190
  540 CALL getint:MODE 7 :PRINT'': REPORT: PRINT " @ line ";ERL: END
```

Table 3. Peripheral Control register.

PCR bits	CB2 mode
7 6 5	* [* shows transition direction]
0 0 0	– Interrupt Input mode
0 0 1	– Independent Input mode
0 1 0	+ Interrupt Input mode
0 1 1	+ Independent Input mode
1 0 0	Handshake Output mode. Set CB2 low on a write to PortB. Reset CB2 high when an active transition on CB1 control line
1 0 1	Pulse Output mode; sets CB2 low for one clock cycle following a write to PortB
1 1 0	Manual Output mode; holds CB2 low indefinitely
1 1 1	Manual Output mode; holds CB2 high indefinitely
Bit 4	– 0; CB1 high-to-low transition + 1; CB1 low-to-high transition
Bits 3-0	As 7 to 4, but for CA1 and CA2

Table 4. Auxiliary Control register.

Bit	Value	Effect
7	0	timer 1 one-shot mode
	1	timer 1 free running
6	0	disable output via PB7
	1	enable output via PB7
5	0	timer 2, internal clock
	1	timer 2 by PB6 pulses
4,3,2		Shift register
1	0	disable port B input latch
	1	enable port B input latch
0	0,1	port A latching

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Programs that write programs

The Last One is not living up to its name. Neville Ash looks at eight packages which take some of the labour from writing usable Basic code.

SALES OF MICROCOMPUTERS are breaking all the forecasts of even the most optimistic experts in the business. Soon they will be measured in terms of tens of millions, if we are to believe current trends. All through the country thousands upon thousands of people are laboriously typing in programs from listings which themselves can run to thousands of lines.

The midnight oil is being burnt while people write their own programs from scratch and then spend 10 times as long debugging them. The manufacturers would like you to think that we have become a nation of programmers — but it just isn't true. For every computer owner writing his or her own programs, how many people are there who have been discouraged from buying one for one reason alone: they have to learn a foreign language.

Yes, Basic may be common knowledge to the afficionados among micro owners, alongside a healthy sprinkling of Pascal, Forth, Fortran and even Logo. But the vast majority of people in this country want to use another language when they talk to their computers — it's called English, the same language they use for everything else.

Many people just cannot be bothered to learn a special language, and there are many more who try and fail. These people want the computer to process information for them. They are not really concerned how it creates the program — the set of instructions — that gives the orders.

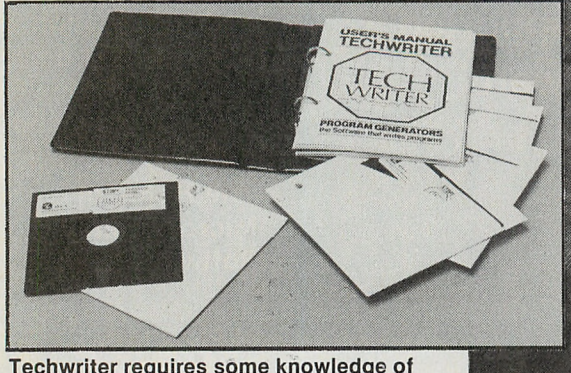
Computers may have to be addressed in a special way, but why are the users faced with an artificial barrier before they can communicate? Surely there should be special software packages that offer the facility of addressing the computer in English, then leave the machine to do the complicated technical side?

Every since The Last One appeared, the most optimistic prophets have described the death of the programmer. While this is an exaggeration, program generators like The Last One certainly makes things easier for first-time users to create their own programs without learning a special language.

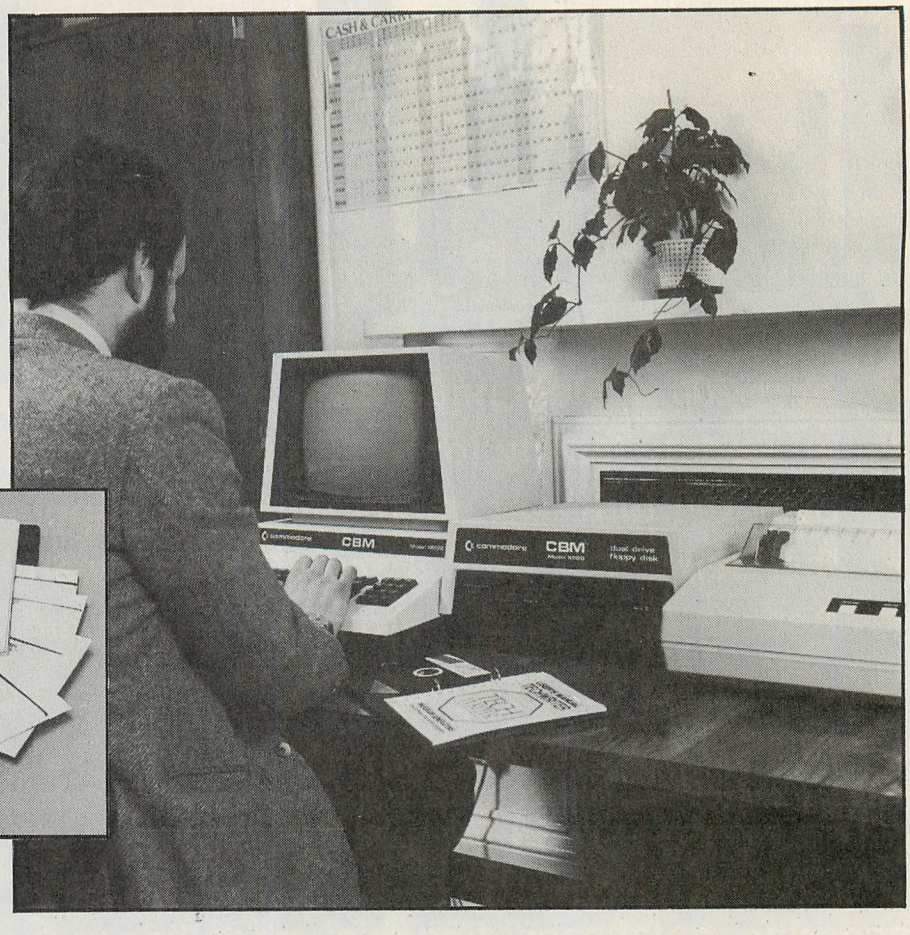
A program for a microcomputer performs a number of individual tasks very quickly. A systems analyst or the system designer starts with a problem and breaks it into a logical progression of tasks which the computer can handle. All the necessary options have to be included.

Can a piece of software do all this for you? A program generator turns your instructions into computer code, usually Basic. But even with one of these packages it is absolutely essential that you know exactly what you want to do from the start. Otherwise you will not be able to answer all the questions that are asked.

There are three types of program generators : programs intended for untutored users; systems which can be used to create a tailor-made program but do not produce separate stand-alone programs; and generators intended for people who already have a knowledge of Basic and want a product to help them with the housekeeping duties while they exercise their creativity. Although program generators are a relatively new phenomenon in the micro world, they have been



Techwriter requires some knowledge of Basic but does some of the tedious programming work.



used for several years in the mainframe and mini market. A shortage of programmers has made it necessary for programs to be written more quickly and easily. What is new is that some are now aimed at the first-time micro user who has never touched a computer before.

Program generators range in price from just over £100 to around £900. I have been looking at seven packages which are easily obtainable and run on one or more common, medium-priced micro.

One of the problems for the potential purchaser of a program generator is simply, "What can I do with it?" The answer from virtually all the suppliers will be, "Whatever you want to do." Not very helpful.

Your choice can be determined by six different factors:

- The brand of micro to which you have access
- Your budget may only allow you to consider the cheaper packages
- If you want to produce stand-alone programs
- Some suppliers produce demonstration discs costing around £10 containing examples of programs and showing you how they work
- Stemmos, Dynatech and others run seminars where you can learn about systems design using their own products
- Selected dealers can also demonstrate the packages.

Program generators are generally designed to produce business applications, so if you want to create yet another game of Pacman or Adventure they will not be your cup of tea. But if you want to produce stock-control programs, to organise your business in any form, to catalogue products or to create information systems then this type of program will help you.

If you want a word processor, then buy one off the shelf, and the same advice covers electronic spreadsheets and integrated accounting systems. This still leaves a wide range of programs where only you know exactly what you want a program to do. Even if there is a ready-made accounting package available, writing it yourself rather than trying to adapt your business to its constraints can be a far better bet. After all, only you know exactly what you want to do.

Programs created with these packages rarely if ever need debugging, unlike programs you have written yourself or laboriously typed in from a monster listing. Another factor is sheer speed. Even if you already do some programming these products can save you time, and most of them allow you to create really advanced programs.

Though the resulting programs work in Basic — not the fastest of languages — most of them can be compiled. Pearl and Autocode are exceptions in this respect, and other manufacturers do not always recommend it.

Program generators can save you time in producing programs and debugging, and can introduce the non-programmer to the world of writing programs without having to learn a foreign language. Maybe we will eventually reach the stage of talking directly to our computers, but until we do, the system generator has a lot in its favour.

Most program generators start off with the creation of a form, an electronic version of the way you want your data arranged. Then follows the way you need to rearrange this information, plus any calculations that must be performed on the data. Each program generator also gives you the opportunity of producing a wide range of reports.

Autocode is the only program generator which needs another package to make it work. It is designed to allow you to create programs with dBase II, without having to understand the massive manual. dBase II, which was reviewed in the November 1982 *Practical Computing*, is not normally a product to be used by the beginner, but Autocode claims to change all that. Autocode comes on a single disc and is available under CP/M-80, MS-DOS and CP/M-86. The currently available version 1.1 is about to be superseded by version 1.2, which has even more features than this version.

After loading Autocode the main menu offers four options: menu generation, file-maintenance generation, report generation and exit. The first step is to create all the menus and sub-menus that are needed. Next you generate an automatic file-maintenance facility before creating the information you need for the reports to be printed out.

The Autocode system creates programs for the user to run as acceptable dBase II CMD files. They are split into four types: the main menu, the sub-menu program, file maintenance and report programs. The program assumes that the user will enter the created program through a menu. For the file-maintenance creation you enter the name of the screen or file that you want to create. A choice of printer or screen is requested and the key fields — those you use for retrieving data — are indicated. You then add any calculations that are needed in the program.

Autocode creates this screen and offers the choice of putting in the maximum and minimum data values required. It then creates the file-maintenance generation. Once this file primary name has been added, the message "Generating Maintenance Field" is shown, and the screen changes back to the main Autocode menu. To complete the program a reporting option is added using choice number 3. The generated program is then copied on to a disc with dBase II and is ready to use.

Version 1.1 of Autocode has a thin manual of just 42 pages. The approach should be far more user-friendly. Version 1.2 includes many more refinements and covers most of the comments about the 1.1 version. Version 1.2 costs £220; existing 1.1 users can update for £60.

Autocode is supplied by Stemmos Ltd, 344 Kensington High Street, London W14;

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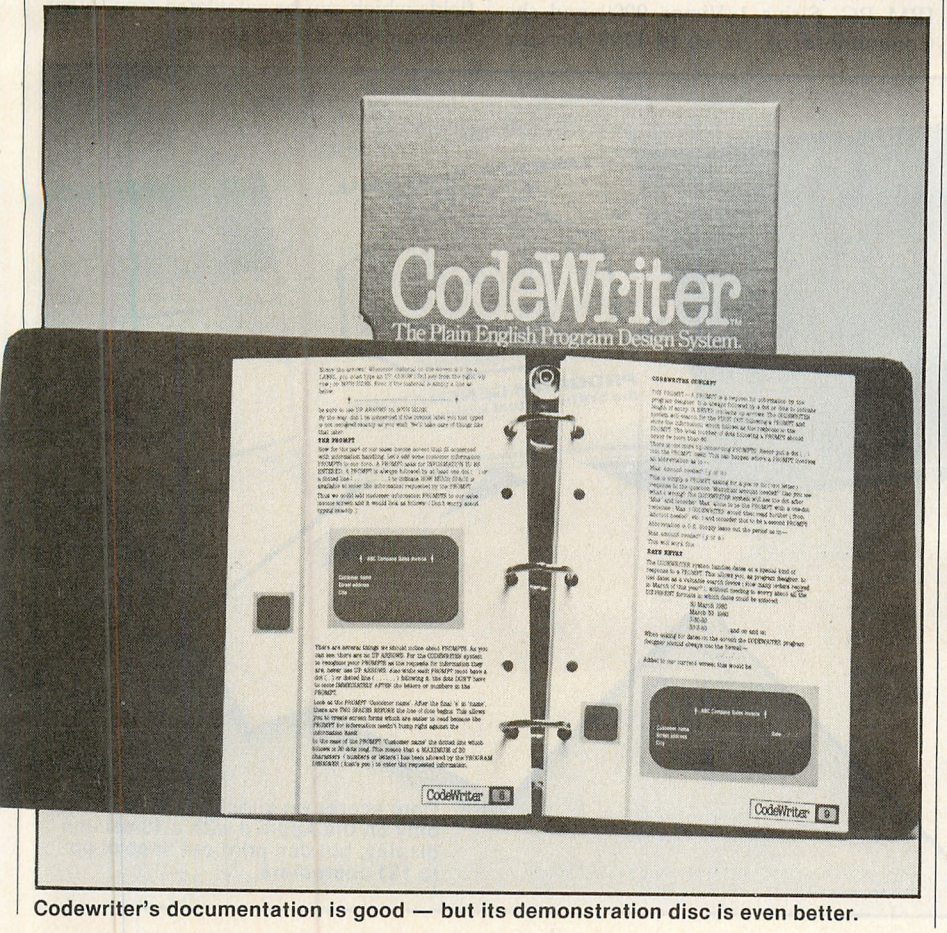


Codewriter's documentation is good — but its demonstration disc is even better.

Programs that write programs

(continued from previous page)

telephone 01-602 6242. It certainly makes dBase II easier to use. The combined cost of the two packages is around twice that of its rivals: Stemmos will supply them together for £550.

Launched last year, Codewriter is the latest program generator from Dynatech. Unlike Dynatech's first product, Corp, Codewriter is supplied as three discs, one of which is a demonstration disc. Codewriter is available for a wide range of micros including the new 16-bit models and does not suffer from Corp's restriction of working on 40 columns — Corp runs only on the Apple II. If you are limited to a 40-column screen, Corp does have the merit of simplicity.

Loading disc 1 of the Codewriter system brings up the main menu, offering three options: create a data-entry system; format a disc; and exit to Basic. Within the first option of creating a data system, the sub-menu gives the choice of creating a screen layout, creating an application, and return to the main menu.

Each data-entry program starts with the screen layout, so after pressing this key, the screen-generator menu appears. Here you have the choice of editing or changing the screen, changing the field positions, saving the screen layout to disc, loading the screen layout from disc and exiting to the system menu.

As you create the screen for your information, the options increase, so that you can have calculations on numeric fields and money fields. Once you are satisfied with the screen you have created, the monitor goes blank and the message "Reading Screen" appears. Your screen then reappears again and you have the opportunity of further options, the program asking you whether you need the information to be keyboard calculated or calculated by the program. Once all the options have been taken Codewriter asks for a name for this screen, which may be up to 14 characters long.

The next stage is to create the data-entry application followed by the report stage. Using the same approach you reach the final stage where a menu is added to your program.

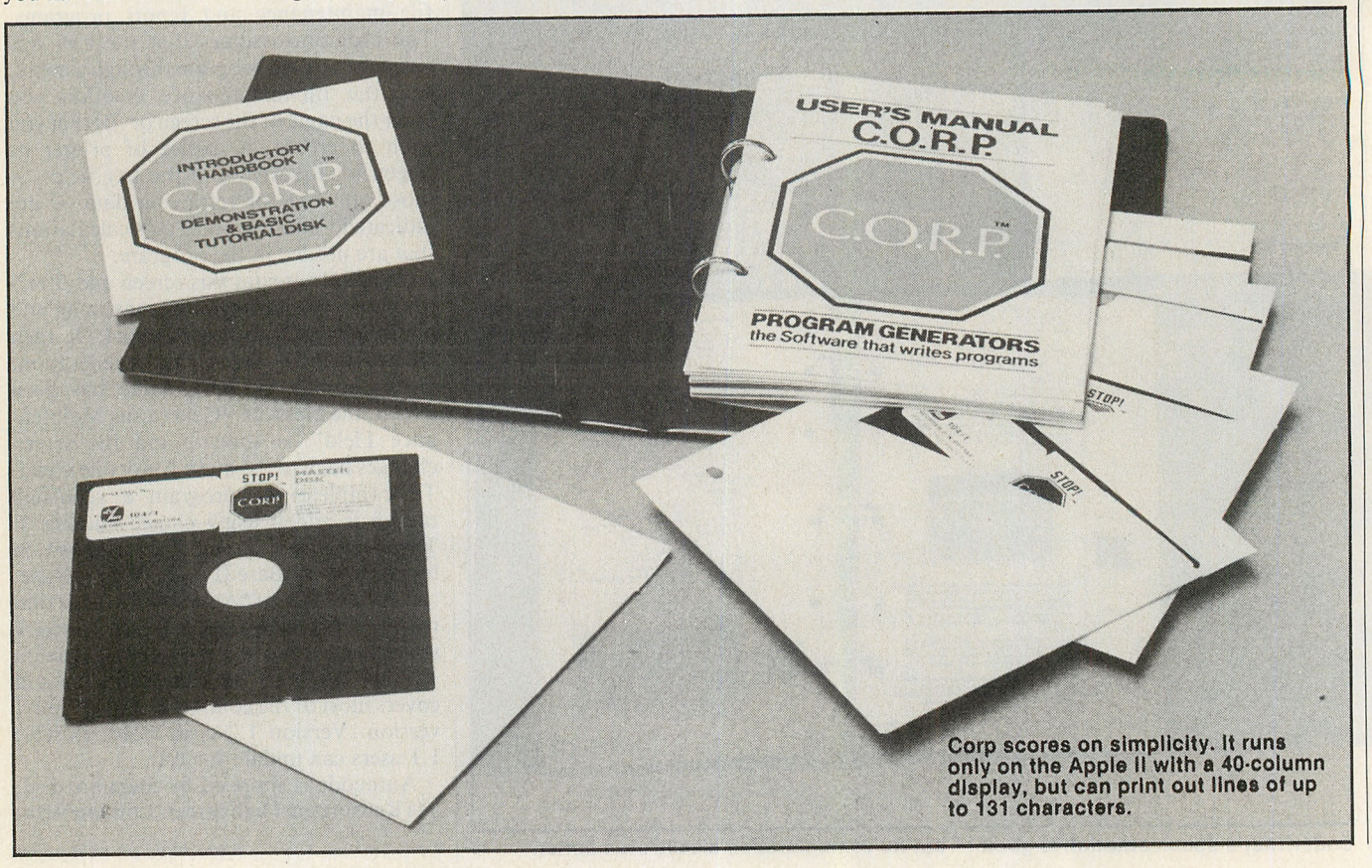
It takes longer to describe how the system works than it does actually to use it. The 73-page Codewriter manual is really friendly and similar in approach to The Last One, which is best of the lot. However, Codewriter scores with its demonstration disc on which you are taken through the creation of a typical program — far better than a written manual. Codewriter can be used easily and fast just by following the manual and demonstration disc.

Codewriter is now available for the Commodore 8000 series, Apple IIe, II+, IBM PC, Sirius 1/Victor 9000 and the Commodore 64. It costs £199 for the Commodore and Apple machines, or £249 for the 16-bit micros, and is supplied by Dynatech Microsoftware Ltd, Summerfield House, Summerfield Road, Vale, Guernsey, Channel Islands; telephone (0481) 45934.

Combined Operating Re-entrant Programming database-management system is rather a mouthful — no wonder most people just call this product Corp. It became available at the same time as The Last One and comes complete with no less than six discs. One of them carries a demonstration showing the type of screen that can be created and how you print out the data, with a Basic tutorial on the reverse side. A second disc has examples of programs produced using Corp.

The Corp Master Disc lets you write a data-entry and print program in Applesoft. A screen is created in exactly the way you want, with the information presented in four different types: X data allows any type of data to be entred; A data is alphabetical, A to Z; the # sign lets you enter digits 0 to 9 including the decimal point; and $ for money type information, also including the decimal point.

Using the master disc you can create a program to accept data and then print it out — nothing else. It can be printed out in almost any order according to your own choice. With the Utilities 1 disc you can add a Hello program and menu, plus a forms program for custom-made letters, and a system editor. Utilities 2 offers an electronic spreadsheet facility called Corpcalc with which you can specifiy fields which can be calculated from other fields on the screen. The includer allows



Corp scores on simplicity. It runs only on the Apple II with a 40-column display, but can print out lines of up to 131 characters.

you to add anything that has been left out.

A diagnostic disc supplies tests for the Apple system, and adds some utilities as well. You can change the directory of a data file, add extra fields to a file without re-entering a complete file, find out how much memory is left and test the disc drives.

Although Corp is limited to a 40-column display — and quite naturally doesn't work if an 80-column card has been fitted to the Apple — the limitation only applies to what is shown on the monitor screen. You can print out characters up to 131 columns wide.

The complete Corp system costs £249 from Dynatech Microsoftware Ltd, Summerfield House, Summerfield Road, Vale, Guernsey, Channel Islands; telephone (0481) 45934.

The Last One must be one of the most highly promoted pieces of software ever. The launch publicity gave the impression that programmers were obsolete, and that The Last One would solve all your problems. Whether that is true for you or not, The Last One has certainly had quite an impact on the microcomputer scene and versions are now available for most of the micros on the market, including the 16-bit models.

The Last One tells you to make working copies so that you can keep your original disc in a safe place. More software companies should adopt this practical attitude. After making two working copies of The Last One, you are asked to read and understand the manual then start. Yes, they make a point of telling you to make sure you understand the manual first.

Creating a program requires five basic steps. On booting up The Last One, you reach the main dispersal menu where you are offered a total of nine choices: creating a program; modifying a program; modifying a file; external files; enquiry; certify a new disc; resume coding; system details; and return to Basic.

Option 8 lets you set up your copy of The Last One with your computer system. Then choose option 6 to certify a disc, initialise it and name it. When creating a program your first decisions are whether your program has files, and whether you want to dump the details to a printer or display them on screen. Unlike any of the other program generators, The Last One's first real stage is creating a flowchart.

On the flowchart menu you have 19 choices covering all the options you may need, each one leading to a sub-menu which determines the fine detail of your program. You need to decide on the destination of all the branches of the program, then the coding can start. An offer of printer documentation of the flowchart should be accepted before you define the non-file fields and allocate drive numbers for them.

The final stage of The Last One is a question-and-answer routine to define the last few details of your program. Once the flowcharts have been explained to The Last One, the program produces a routine for end of program. The monitor screen displays a message telling you to remove The Last One and to replace it with a disc to store your new program.

The Last One offers an extremely wide range of options and it is absolutely essential to read the manual carefully to make sure you are aware of the implications of taking each option. The manual is excellent with a light touch and humour throughout.

The Last One is available in versions to fit the Apple, Pet, all CP/M-80 micros, IBM PC, Sirius/Victor, Osborne, Sharp PC-3201, Tandy Model II TRS-DOS or CP/M, Torch and Rair/ICL. It is available from D J AI Systems Ltd, Station Road, Ilminster, Somerset TA19 9BP; telephone (04605) 4117. The Apple version costs £185, the others £330.

Personal Pearl is a program generator, system generator and transparent database all rolled into one. Instead of creating a separate stand-alone program you use Personal Pearl to combine various elements to create the system you need.

Personal Pearl is a completely trans-

(continued on next page)

Record-finding routine for Commodore 8000 generated by Codewriter.

```
10010 gosub 27000:rem try to find the record
10020 if le% then 90
10199 rem *** unpack the fields in the file for display ***
10799 rem *** display record if match on key ***
10800 gosub 29000
10860 goto 90
10900 goto 90
11000 rem *** begin the file update routine ***
11005 print "■":gosub 12010
11010 if le% then 90
11800 an$ = "s": for i=1 to nf:g$(i)=f$(i):next i
11810 gosub 28000 : gosub 29000
11812 print left$(y$,24);"Which field to update?";
11815 print" ( 1 - 14 , 'list', ■ESC■ to cancel, ";
11817 print "■RETURN■ to save)";
11820 x%= 73 :y%=24:l%=4:an$="e":gosub 34000
11823 uf=val(in$):an$="s":if in$=""then 11886
11824 if in$<>chr$(27) then 11828
11825 rem *** clear changes ***
11826 goto 11800
11827 rem *** list  fields  ***
11828 if in$="list"then f=0 : gosub 20000:goto 11810
11829 rem *** test 1 <= uf <= nf ***
11830 if uf>0 and uf <=nf then 11850
```

	Autocode	Codewriter	Corp	Personal Pearl	Pips	Techwriter	The Last One
Apple II	£220	£199	£249	£190	£125	£125/£185	£185
Apple III	£220			£190		£125/£185	
Commodore 4000							£330
Commodore 700/8000		£199				£125	£330
Commodore 64		£199					
CP/M-80	£220			£190			£330
CP/M-86	£220						£330
IBM PC	£220	£249		£190			£330
MS-DOS	£220			£190			£330
Osborne	£220			£190			£330
Rair/ICL	£220			£190			£330
Sirius 1 Victor 9000	£220	£249		£190			£330
Tandy Model II	£220			£190			£330
Torch	£220			£190			£330

Apple users need Z-80 card for Autocode or Personal Pearl.
Tandy owners need CP/M for Autocode or Personal Pearl.
The Last One for Tandys runs under TRS-DOS or CP/M.

Programs that write programs

(continued from previous page)

parent database which is supplied in elements to handle the different functions involved in creating and running a program and producing a report. Pearl is more user-friendly and flexible than most other databases: the instructions are helpfully displayed at the bottom of the screen most of the time.

The number of discs required to carry the Pearl system depends, obviously enough, on the capacity of the discs. In the Apple version there are seven: Design Forms; Design Reports; Install Forms and Reports; Pearlup; Enter Data; Product Reports with File Maintenance; and Sort with Help.

Version 1.4 was supplied with extra sheets of documentation, apart from the manuals, which tell you to relax and let Pearl take over. The first step is to insert the Pearlup or Welcome disc into drive A, type in Welcome and indicate the type of computer being used. The system then takes you through a demonstration. If a Videx card is used with the Apple Ctrl-A and Ctrl-B clash with Pearl commands and have to be redefined before using the program.

Just like the other generators you start by designing a form, installing a form, and so on. Only three of the seven discs are needed to run a program: Enter Data, Print Reports and Sort. The Paint the Screen technique makes Personal Pearl one of the easiest of all the programs to use.

Features had been added to the system even since the manual has been produced: the ability to print reports up to 250 columns; provision for page pause to allow printing on to cut sheets; and a wild-card selection to let you have selected values when running a report. A free-memory check and a batch-install mode makes changes in forms easier when many of them are invovled.

Personal Pearl does not produce a separate stand-alone program like The Last One or Codewriter. It is availalbe under CP/M-80, CP/M-86 and MS-DOS and so can be used on most micros on the market today. Personal Pearl is supplied by Pearl Software, 15 Glenair Road, Parkstone, Poole, Dorset; telephone (0202) 737206.

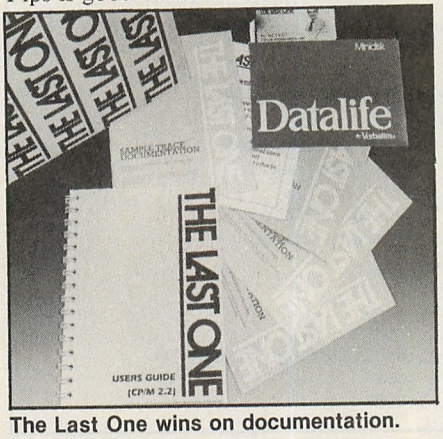
Like The Last One, Pips is British made and at £125 it is currently the cheapest program generator on the market. Pips is available for the Apple II only, and is supplied on a single 5.25in. disc.

Pips only provides a 40-column display, but can print reports up to 255 columns. It starts with basic questions to determine what is needed from the program, such as which drive is being used for the program through to how many lines per page are required in the report.

After checking that the answers are correct, the next step is to lay out the screen for information. Next, decide how many fields you are going to have, how many printouts you need and the names for the printouts. If you need results columns from the calculating figures they can be indicated at this point. The conditions for each field must also be defined — whether they are dependent on the date, another field, input from the keyboard or are always applicable. A summary page can be added to reports, which are numbered with special headings and a date.

Once these questions have been answered, you are asked to insert a disc into the drive which will be used to store the generated program. After pressing any key and waiting a few minutes, the program is saved on the disc in the drive. It was easy to follow the instructions, and creating is a simple matter of answering the questions.

The Pips manual is only 20 pages, and most of it is taken up with examples of a phone list and a stock-control program. For a budget-priced program generator Pips is good value. It comes from Micro-Technic Computer Systems, CSI House, Corporation Road, Middlesborough, Cleveland; telephone (0642) 221501.



The Last One wins on documentation.

Instead of producing a stand-alone program Techwriter creates a skeleton, leaving you to put meat on the bones. Techwriter is intended for the user who has some knowledge of Basic and wants a tool to take the boring and tedious parts out of programming, like all those input and output routines which really have no part in your creativity.

When Techwriter is loaded, you are asked for the program name. The next question asks for all the variables and arrays needed, and is followed by a request for commands in plain, ordinary English which will be used to call up your subroutines.

There is provision for up to 100 arrays, variables and commands so you can define whole families of commands to analyse all aspects of even the most complex problem. For each of these variables and arrays, Techwriter writes the code enabling the user to check the value or alter it. With arrays, whole columns or rows of a matrix can be individually zeroed.

Each command has a section of 1,000 lines reserved for the corresponding code, and writes this code when the command is used. The commands and arrays are summarised in the form of a listing like a program menu and can be called up by typing in Help.

Once Techwriter has written the bare bones of the program, you add the subroutines for all the commands and variables. The routines can be written in directly or produced separately and Execed into the skeleton.

Techwriter is now available for the Apple II, Apple III and the Commodore 8000 series. Techwriter plus the user demo costs £125; a version for the Apple which includes Easitran, a utility which lets you transfer data from an Applesoft Basic program directly into VisiCalc, costs £185. It is supplied by Dynatech Microsoftware Ltd.



Personal Pearl acts as a database but does not produce stand-alone programs.



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Pots, pits and portables

Dominic Powlesland explains how a Sharp PC-1500 is helping to streamline classification of archaeological data.

EXCAVATION OF A SITE is unrepeatable. Unlike other scientists, the archaeologist cannot repeat an "experiment" — the excavation of a site. Every site is different and is itself destroyed by the excavation.

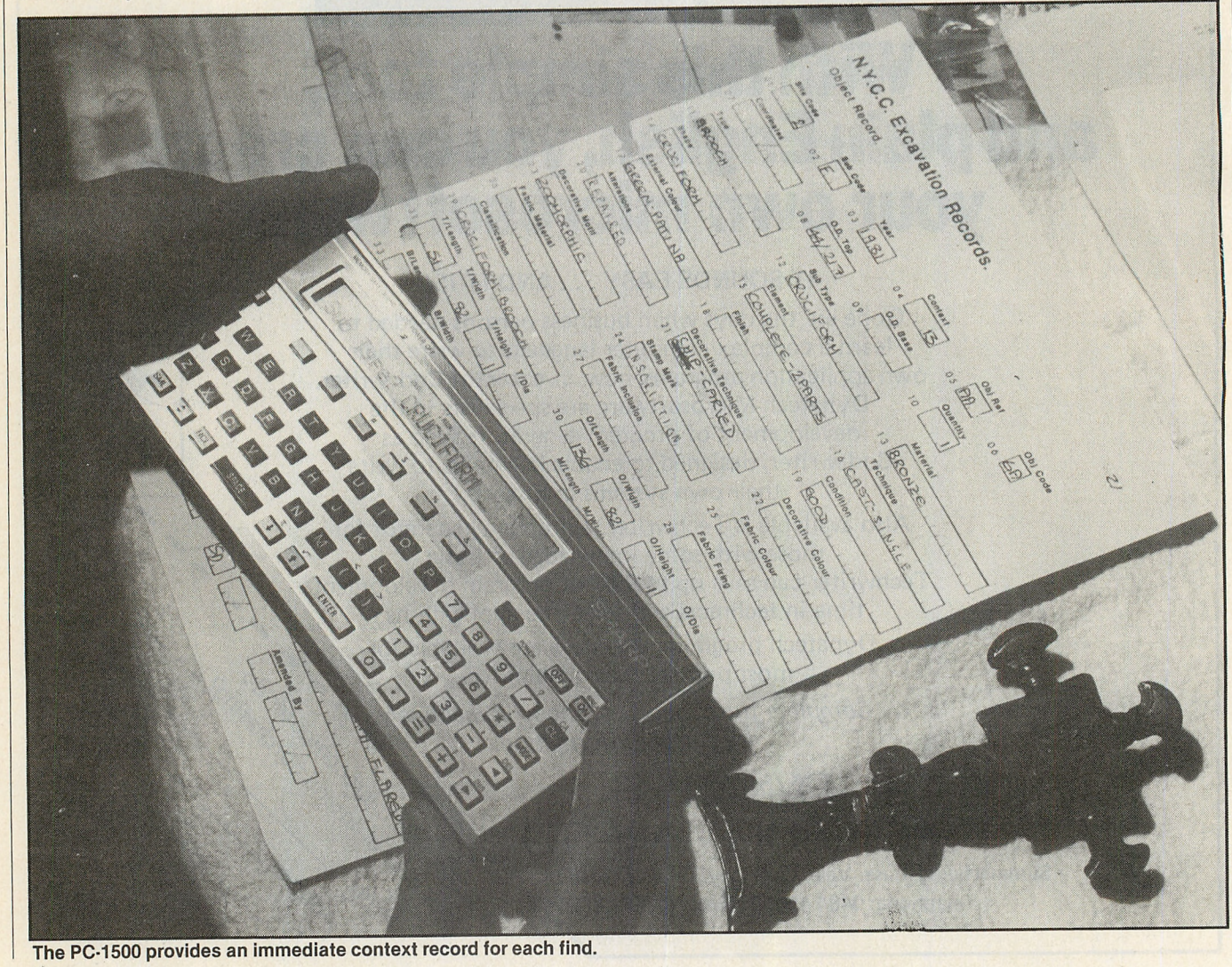
It is the excavator's responsibility to record as accurately as possible all the evidence encountered during the dig. It should then be possible to reconstruct the site from the evidence gathered. The recorded data forms an archive which represents the foundations of any reconstruction of past activities, climates and ecologies of the site. Now that cheap micros are available, archaeological fieldworkers have started to computerise their records.

At the turn of the century the total record of a whole site may have been carefully contained by the back of an old envelope. Modern excavation records more often revolve around a series of standardised forms, which may be compatible with computer use. The data produced by any site can be broken down into a number of categories. At the simplest level they are finds, drawings, photographs and written descriptions.

For the last five years I have been concerned with the excavation of a 10 acre site in Eastern Yorkshire. The Heslerton Parish Project is concerned with the reconstruction of the evolution of the landscape of the region. The first phase of rescue excavation is now completed, and work is in progress preparing for publication the vast store of data produced.

The history of the site spans over 7,000 years. It has been the setting for a number of settlements and cemeteries, and for early agriculture and industry. The quantity of data being produced was so great that the only efficient way of dealing with it would be through the use of a computer. An offer of mainframe facilties on an ICL 2900 confirmed the change three years ago.

Rather than attempt to prepare our own software for the entry of the site data we decided to use the package called MDE, developed by the County Council. A new



The PC-1500 provides an immediate context record for each find.

Dominic Powlesland is director of the Heslerton Parish Project for research into the evolution of the Yorkshire landscape.

recording system was designed to be directly compatible with the data-collection package, and a remote terminal was provided near the site. The system has now been in operation for over a year.

Like all systems, there was one very weak link in the chain which reduced the overall efficiency and, potentially, the quality of the record. All data had to be entered twice — once on to paper on-site and then keyed into the mainframe off-site. A smaller excavation running on a long-term basis could have used same-day entry by the same people, but this would have been difficult to operate at Heslerton. The soil conditions and the availability of volunteers dictated that the excavation should be run on a very large scale for the summer only, and data was produced too fast to operate this sort of system. But by using portable micros double entry can be reduced to a minimum, and the data archive can now be created at a pace that is synchronised with the excavation itself.

When I first heard about the Husky I thought "Wouldn't it be wonderful if . . ." but there was no way we could afford such an expensive machine. At the other end of the portable spectrum are desk-top models which, while happy in a dry, clean, electrified office are not suitable for an archaeological site. Much though I would like an Osborne, the machine would not take kindly to being dragged around in the dirt and the rain.

Attempting to bridge the gap between the hand-held and the desk-top portables, machines such as the Epson HX-20 and the Newbrain are unattractive on account of size and weight and their openness to the elements. An approach to Epson for the loan of a machine was politely refused. On

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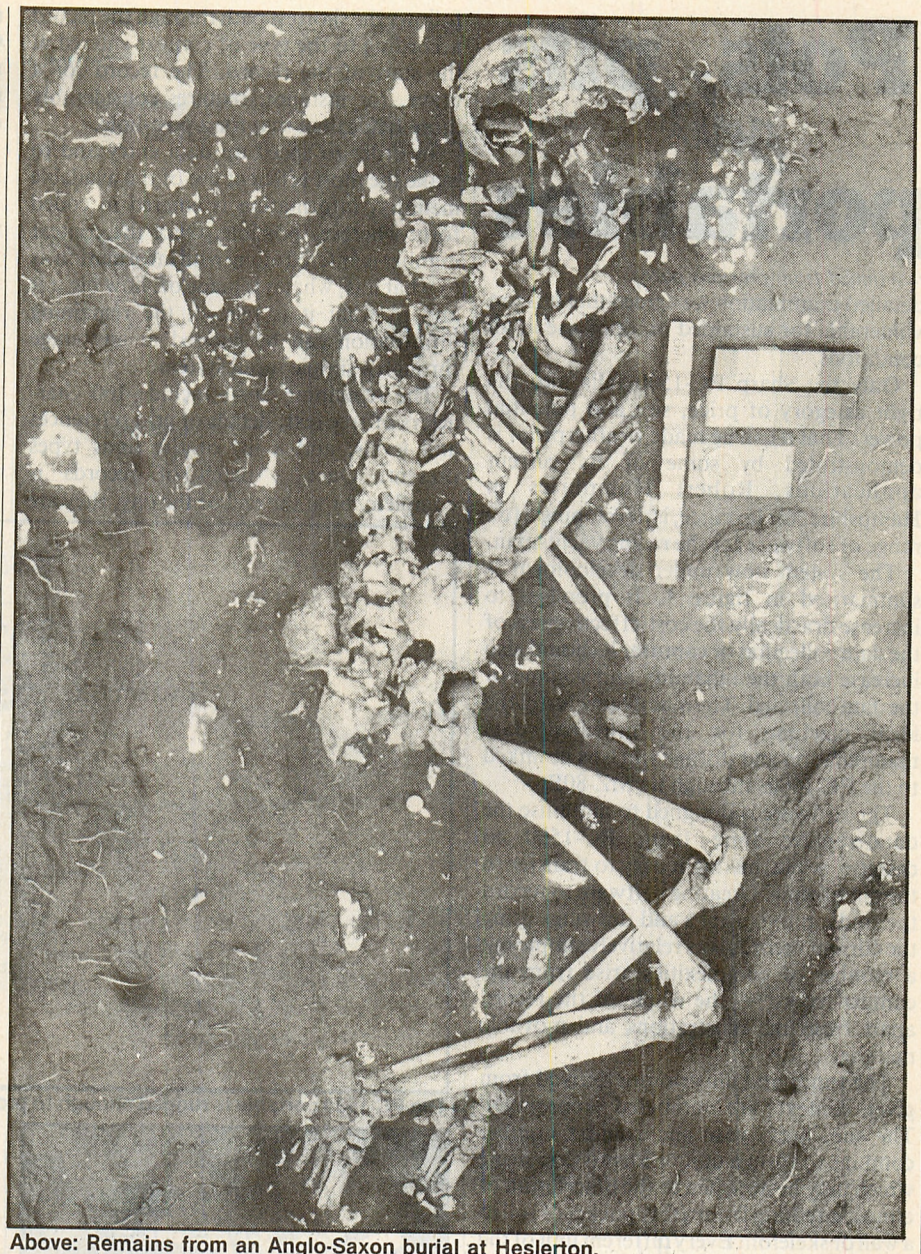
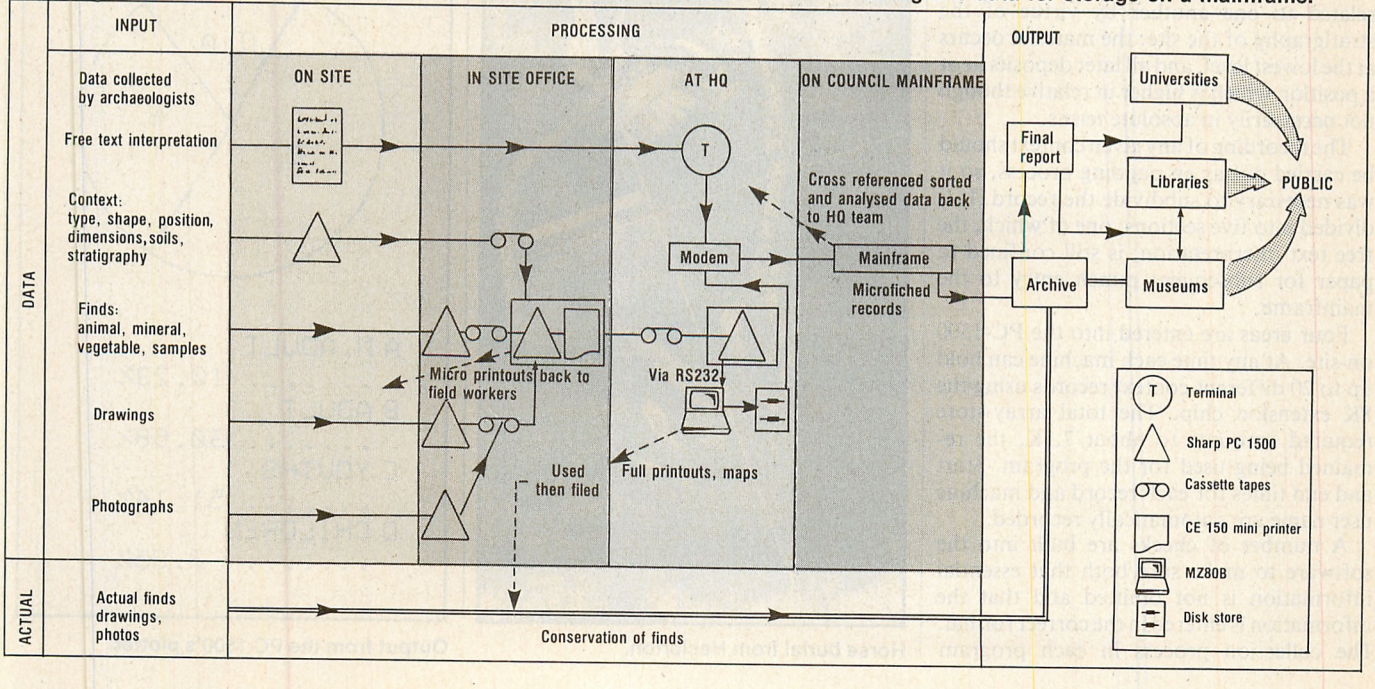


Above: Remains from an Anglo-Saxon burial at Heslerton.
Below: The eventual scheme for transferring site data for storage on a mainframe.



Pots, pits and portables

(continued from previous page)

detailed examination we agreed that it is too vulnerable for sustained outdoor use in all conditions.

Only the Sharp PC-1500 falls into the right category of price, size and potential power. That it can be made weatherproof is demonstrated by some of its current applications. Robert Humphries in Hampshire, for instance, is developing a full range of software for the racing yachtsman.

The system now under development is summarised in figure 1. It promises to increase drastically the cost-effectiveness of the data collection or capture. It should also increase both the reliability and volume of the data collected. The mainframe is still the ideal machine for the principal data manipulation and storage and is to be linked to the PC-1500s through an MZ-80B.

The software is designed to minimise the data-transfer time from PC-1500 to cassette, while making it easy to transfer to the mainframe. Creating software to record the finds, photographs and drawings using the current records was relatively simple but a number of complexities arise from the context record — the whole of the record apart from the illustrations and movable materials.

The funds and illustrations derived from given contexts are numbered accordingly. The site, area, year and context number combine to form a unique identifying string which may be attached to the description of almost anything from a tiny pocket of soil to a wall or skeleton. Every different unit of the site has its own number. All contexts are related to one another by virtue of the stratigraphy of the site: the material occurs at the lowest level, and all later deposits lie at a position which is higher in relative though not necessarily in absolute terms.

The recording of any given context should be carried out as an ongoing process, so it was necessary to subdivide the record. It is divided into five sections, one of which, the free text interpretation, is still confined to paper for subsequent punch entry to the mainframe.

Four areas are entered into the PC-1500 on-site. At any time each machine can hold up to 20 different context records using the 8K extension chip. The total array-store required amounts to about 7.5K, the remained being used for the program. Start and end times for each record and machine user name are automatically recorded.

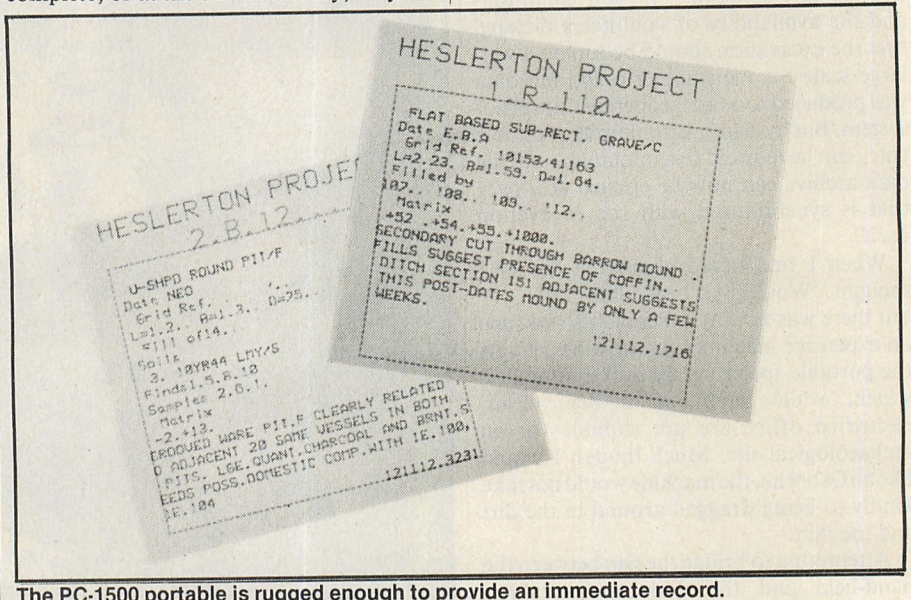
A number of checks are built into the software to make sure both that essential information is not omitted and that the information is entered in the correct format. The collection process in each program follows the shortest path through the record according to the type of context entered at the start of the record. The record for a grave, for instance, requires considerably more fields than that for a post-hole.

In order to speed up data entry and to make the most efficient use of the available memory, information is entered in coded form wherever possible. Once the context number is entered along with information as to what it is, what it is made of, how big it is and to what it is related, the remaining information can be entered at any stage through a simple recall system.

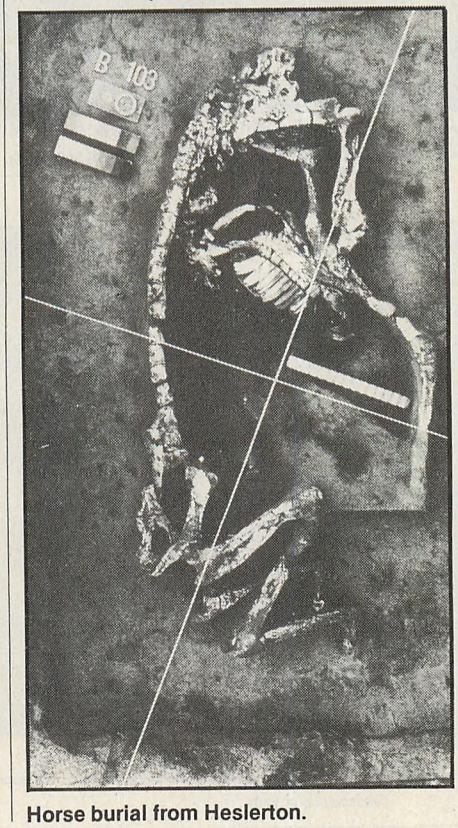
The remaining areas include 160 characters of free text, details of grid references and levels, and a list of the finds types present. Once a batch of records is complete, or at the end of the day, they are dumped on to cassette in about five minutes. Companion print programs allow a miniaturised printout to be produced a few minutes later for return to the site and the data collector for checking and filing.

The system is not yet complete and it is likely to take up to 18 months before it can be fully proven. A micro-mainframe link is to be established. All tapes derived on-site will be dumped overnight into the MZ-80B and then on to the mainframe.

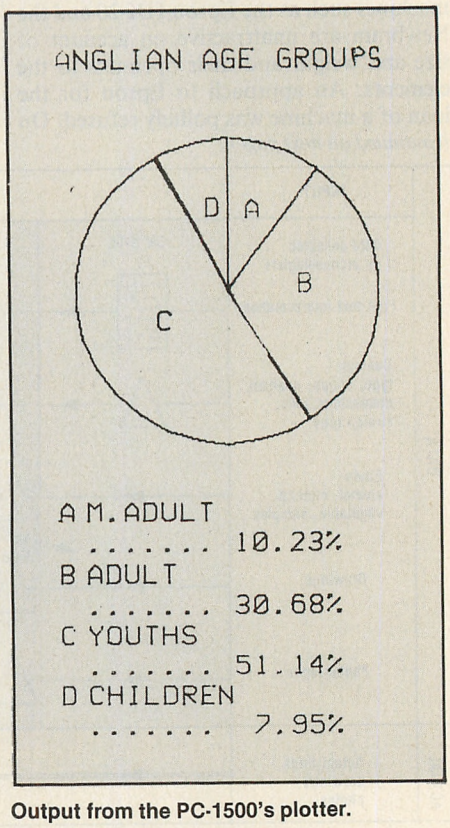
Back-up copies of the record will be retained on floppy disc and then accessed by a suite of checking programs that isolate completed and incomplete records according to area and supervisor. Decoded printout will be produced for return to the site file next morning, accompanied by basic plots of feature types and finds.



The PC-1500 portable is rugged enough to provide an immediate record.



Horse burial from Heslerton.



Output from the PC-1500's plotter.

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Runs on its own power for over 50 hours and can be easily recharged overnight or whilst in use – with the ability to retain information in memory even when switched off.

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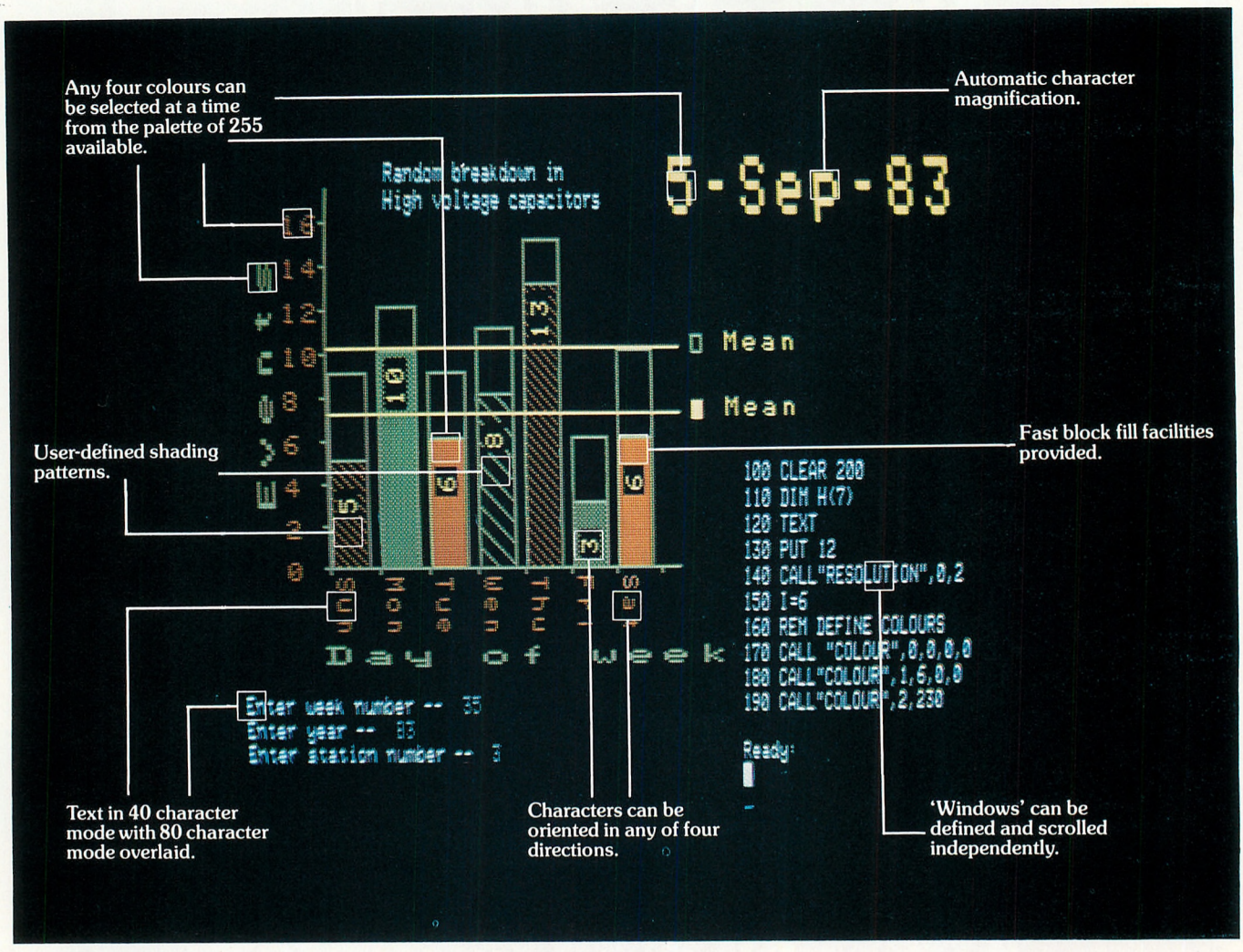

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● **Circle No. 181**

Spearman's test for correlation

Counting greenfly one by one is not an ideal way to establish how infested your rose bush is. Owen Bishop suggests an alternative method.

MR RAMBLER has a rose garden. Every year he finds that some or all of his rose bushes are attacked by greenfly. Later in the year Mr Rambler notices that some of the bushes produce a poor showing of blooms, while others are as fine as he would ever desire. He might avoid the problem by spraying the bushes to kill the greenfly, but Mr Rambler is not one to accept blindly the claims of insecticide manufacturers. Sprays are expensive and the time required for spraying could be spent more pleasantly dozing in a deck-chair.

So Mr Rambler decides to do a simple test. He knows all his bushes by name, and on a certain day in early summer he sets out to measure how much each bush is attacked by greenfly.

He cannot count how many greenfly there are on each bush but he does know which is the most heavily infested, which is next most heavily infested, and so on. So he rates the bushes on a scale from 0 to 8. The value 0 on his scale does not necessarily mean the bush has no greenfly, it simply labels the bush with the least infestation.

Later in the season Mr Rambler rates the bushes according to how well he thinks they have bloomed. He could have constructed a ratio scale by counting the number of blooms produced on each bush. But there is more to rose growing than mere numbers. His rating, on a scale from 0 to 10, takes into account such features as size, sweetness of perfume, and numerous other features too subtle to be amenable to quantitative evaluation. His results are shown in table 1.

Firecracker had the least infestation and bloomed the best, while Dearest was the most infested and the second worst in blooming. In general, there seems to be fair amount of agreement between the two sets of rankings, yet they are not identical. Can Mr Rambler say that they are correlated? If so, he must certainly fetch out his spray gun next year. If not, he can happily sleep the summer away knowing that spraying is a waste of time and money, for his roses at least.

What is needed is some way of measuring the amount of agreement between the two sets of ranks, x and y. The difference between each pair of ranks is given in the column headed d, where d stands for deviation. The sum of all the ds is necessarily zero, since positive deviations are cancelled out by negative ones, so adding up all the ds will not give a measure of total deviation.

Table 1.

	Greenfly rating	Bloom rating	Greenfly rank (x)	Bloom rank (y)	d	d^2
Allgold	4	5	4	5	−1	1
Ballet	3	4	3	4	−1	1
Casino	6	10	6	8	−2	4
Dearest	8	9	8	7	1	1
Elegance	5	3	5	3	2	4
Firecracker	0	1	1	1	0	0
Garvey	7	7	7	6	1	1
Highlight	1	2	2	2	0	0

Instead you square the ds as in the last column of the table, then add them. The total of the squared ds is Σd^2, which is 12 in this example. Obviously, the more rose bushes the more ds there are to add and the greater the total can be. To take into account the number of bushes you calculate Spearman's coefficient of rank correlation:

$$r_s = 1 - (6\Sigma d^2 \div (N(N^2 - 1)))$$
$$= 1 - ((6 \times 12) \div (8 \times 63))$$
$$= 0.857$$

The value of r_s always lies between +1 and −1. It is −1 when the rankings are in exactly the opposite order. The value obtained in this example is relatively high, showing a certain amount of correlation. The important question is whether it is high enough to be significant.

The most obvious way to test its significance is to write down all the possible ways in which the ranks can be paired. If you arrange the bushes in order according to their greenfly ranks, their bloom ranks fall into the order:

1, 2, 4, 5, 3, 8, 6, 7

You can now write down all possible orders of eight ranks and calculate r_s for each. It begins with:

1, 2, 3, 4, 5, 6, 7, 8 $r_s = 0$
1, 2, 3, 4, 5, 6, 8, 7 $r_s = 0.9762$
1, 2, 3, 4, 5, 7, 6, 8 $r_s = 0.9762$
1, 2, 3, 4, 5, 7, 8, 6 $r_s = 0.9286$

finishing with:

8, 7, 6, 5, 4, 3, 2, 1 $r_s = -1$

A micro can easily perform this operation, but will take rather a long time to do so, for there are 8-factorial orders in which the eight ranks can be arranged. The value of 8! is 40,320, and with only one extra rose bush the number of possible rankings leaps to 362,880. Nevertheless, if time is no object you can find out how many of the orders have an r_s which is equal to or greater than the 1 for Mr Rambler's roses.

If there are very few orders with scores equal to or greater than Mr Rambler's, it is unlikely that his order arose by pure chance. His rankings for greenfly and blooms are almost certainly correlated. If, on the other hand, there are hundreds or even thousands of rankings which give r_s equal to or greater than 0.857, he can argue that his figures fail to demonstrate correlation. The fact that some roses are blooming better than others has no clear connection with greenfly.

There is always the possibility that the two sets of ranks will be very much alike, even when no real effect is caused by greenfly. Such apparent correlations might arise by chance, though not often. You can work out how often they can occur by counting up how many of the possible arrays have scores equal to or greater than that of Mr Rambler.

If you write out all 40,320 combinations you might find that 336 of them have r_s equal to or greater than 0.857. The chance of getting such a pairing at random is therefore 336 in 40,320, or 1 in 120. The roses show this rather unlikely pairing of ranks, so Mr Rambler has to believe one of two alternatives:

(continued on next page)

Spearman's test for correlation

(continued from previous page)

- He has obtained one of the odd 1-in-120 rankings by chance; greenfly do not harm the blooms.
- The rankings indicate correlation; greenfly do harm the blooms.

If he believes the first alternative there is only one chance in 120 that he is right; he must, reluctantly, pick the second.

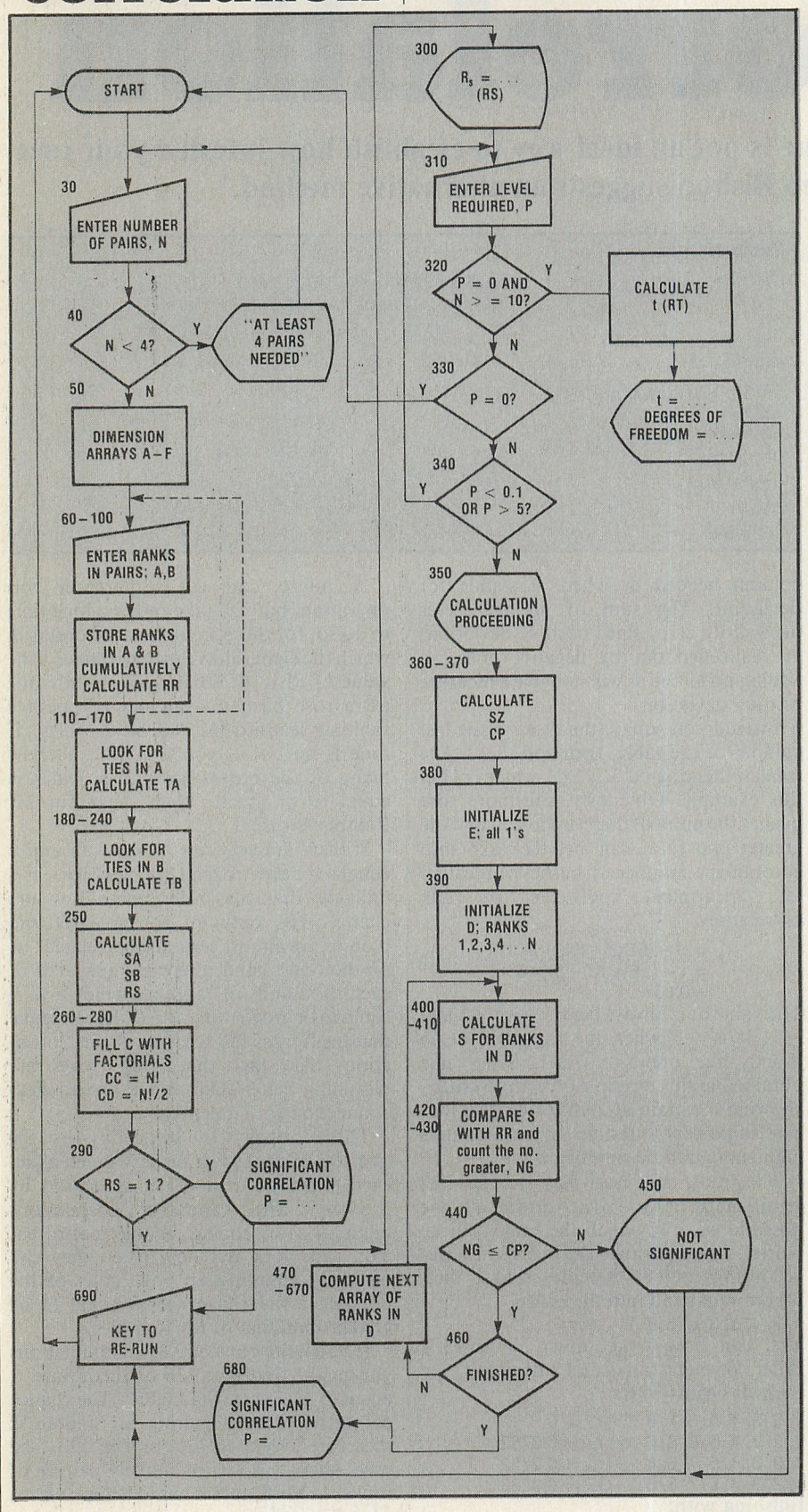


Figure 1. Flowchart of systematic ranking.

Once you have calculated r_s as a measure of the agreement between two sets of ranks, you need to know how frequently such a score turns up in all possible pairs of rankings. Fortunately it is not necessary to write out all 40,320 sets and calculate r_s for each. There are probability tables which tell us, for example, that for a sample of eight only one set in 100 has r_s greater than or equal to 0.833; in that case you can say that there is a correlation, with a chance of one or less in 100 of being wrong.

The published tables usually quote critical values for various values of N and for two significance levels, $p = 0.05$ — or one in 20 — and $p = 0.01$ — or one in 100. They allow you to assess the significance of a correlation at one of the following three ranges:

- Not significant — less than one in 20, could easily be a random effect.
- One-in-20 to one-in-100 significance.
- Better than one-in-100, as in the example of the roses.

If you want to know the exact probability level, there is nothing for it but to write out all the rankings and begin counting, which is where the computer might help.

The correlation test program performs the calculation of r_s for paired ranks. The only complication is that it allows for tied ranks: Mr Rambler might have ranked some of his bushes as equally infested or equal in their blooming, and such bushes would share the average of the ranks they

Listing 1. Systematic ranking program.

```
10 DEFDBLC,E:DEFINTA,B,D,F,I-L:I=1
20 CLS:PRINTTAB(14)"SPEARMAN RANK CO
RELATION TEST":PRINT
30 PRINT:INPUT"HOW MANY PAIRS OF RAN
KS";N
40 IF N<4PRINT:PRINT"THIS TEST REQUI
RES AT LEAST 4 PAIRS.":GOTO 30
50 DIMA(N),B(N),C(N-1),D(N),E(N-1),F
(N)
60 PRINT:PRINT"ENTER RANKS IN PAIRS,
SEPARATED BY A COMMA."
70 FORJ=1TON
80 PRINT:PRINT"PAIR NO.";J:INPUTA(J)
,B(J)
90 RR=RR+(A(J)-B(J))[2
100 NEXT
110 FORJ=1TON
120 T=0
130 FORK=JTON
140 IFA(K)=A(J)THENT=T+1
150 NEXTK
160 TA=TA+(T[3-T)/12
170 NEXTJ
180 FORJ=1TON
190 T=0
200 FORK=JTON
210 IFB(K)=B(J)THENT=T+1
220 NEXTK
230 TB=TB+(T[3-T)/12
240 NEXTJ
250 SA=(N[3-N)/12-TA:SB=(N[3-N)/12-T
B:RS=(SA+SB-RR)/2/(SA*SB)[.5
260 C(N-1)=1
270 FORJ=N-2TO1STEP-1:C(J)=C(J+1)*(N
-J):NEXT
280 CC=C(1)*N:CD=CC/2
290 IFRS).999999 THENPRINT:PRINT"THE
 CORRELATION IS SIGNIFICANT, WITH";I
NT(1000*(100/CC+.0005))/1000;"% PROB
ABILITY.":GOTO 69
300 PRINT:PRINT"THE CORRELATION COEF
FICIENT IS ";RS;".":PRINT:PRINT"WHAT
LEVEL OF PROBABILITY (%) IS REQUIRED
 FOR SIGNIFICANCE?     ENTER A NUMBE
R BETWEEN 0.1 AND 5.":PRINT
310 INPUT"LEVEL";P
320 IFP=0ANDN)=10THENRT=RS*((N-2)/(1
-RS[2))[.5:PRINT:PRINT"SIGNIFICANCE
MAY BE TESTED BY THE T-TABLE, WITHT=
";RT;",":PRINT"AND ";N-2;" DEGREES O
```

would otherwise have. Tying of ranks affects the value of r_s slightly, which is compensated for by calculting TA and TB for the two sets of ranks. If T values are tied you calculate $(T^3 - T)/12$ and sum theseerms for every set of ties to obtain TA and TB. In line 250 r_s is calculated by a formula which takes TA and TB into account. If there are no ties this equation gives exactly the same result as the simpler equation for r_s.

At line 290 the program makes a special exception if $r_s = 1$, which occurs when both sets of ranks are identical. Correlation is significant with a probability of only 1 in factorial N of error — variable CC. The expression

IF RS>.999999

is used instead of If RS = 1 because line 290 may return a value minutely less than 1 owing to approximation in the square-root routine.

At this point the user is given a choice:

- Look up the level of significance of r_s using published tables to allow the conventional three-way interpretation.
- Ask the computer to calculate the level exactly. The user enters a minimum level, so that the routine can be halted when it is clear that the correlation is less significant than the stipulated minimum.

The first alternative is simple and quick, though it does mean turning to a set of tables, and provides no means for the computer to analyse the data and take appropriate action automatically. A look-up table could be included, but would represent a considerable amount of work for the programmer and is copyright.

If there are 10 or more items in the sample — N = >10 — the correlation may be assessed another way. The distribution approximates to that of Student's *t*, which is calculated in line 320. It can then be looked up in the *t*-table, which has several probability levels, allowing you to assess significance more precisely. To reach line 320, simply enter zero in response to the Level prompt — line 310.

The remainder of the program computes all possible orderings of N ranks, from 1, 2, 3, . . . ,N onward. It is an exceedingly slow procedure, but eventually does give the exact answer. When N is 4, 5 or 6 the result comes in a matter of minutes, but as N increases the run time extends to hours and even to days.

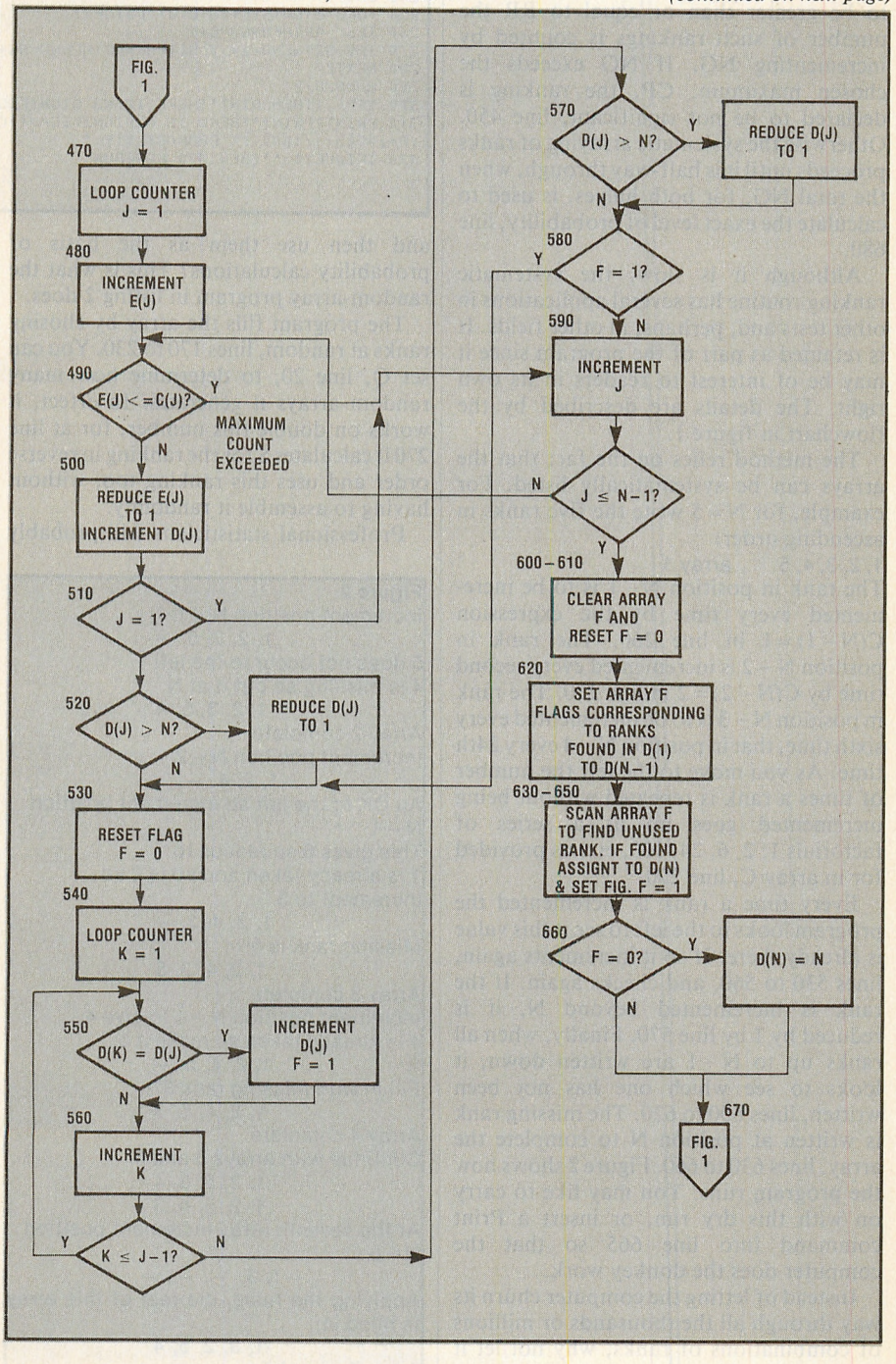
The number of computations required increases in proportion to factorial N so any increase in the speed of each computation will save a lot of time over all. Using a variable I instead of the frequently-occurring 1 makes an appreciable difference.

It is unnecessary to calculate r_s each time, since N is constant throughout. Instead you can calculate and compare the sums of squares of deviations, RR for the original data, line 90, and S for the current rank array, lines 400 to 410. The distribution of values of r_s is symmetrical. For example, for a ranking with r_s 0.9 near the beginning of the list there is a

(continued on next page)

```
F FREEDOM.":GOTO 690
330 IFP=0RUN
340 IFP(.1ORP)5PRINT:GOTO 310
350 PRINT:PRINT"CALCULATION OF PROBA
BILITY LEVEL IS PROCEEDING."
360 SZ=(N[3-N)/6
370 CP=INT(CC*P/100)
380 FORJ=ITON-I:E(J)=1:NEXT
390 FORJ=ITON:D(J)=J:NEXT
400 S=0
410 FORJ=ITON:S=S+(J-D(J))[2:NEXT
420 IFS(=RRTHENNG=NG+I
430 IFS)SZTHENS=2*SZ-S:IFS(=RRTHENNG
=NG+1
440 IFNG(=CPTHEN 460
450 PRINT:PRINT"THE SIGNIFICANCE OF
THE CORRELATION IS LESS THAN";P;"%":
GOTO 690
460 CD=CD+1:IFCD=CCTHEN 680
470 FORJ=ITON-I
480 E(J)=E(J)+I
490 IFE(J)(=C(J)THEN 590
500 E(J)=I:D(J)=D(J)+I:IFJ=IANDD(I))
NTHEN 680
510 IFJ=ITHEN 590
520 IFD(J))NTHEND(J)=D(J)-N
530 F=0
540 FORK=ITOJ-I
550 IFD(K)=D(J)THEND(J)=D(J)+I:F=I
560 NEXT
570 IFD(J))NTHEND(J)=D(J)-N
580 IFF=ITHEN 530
590 NEXT
600 FORJ=ITON-I:F(J)=0:NEXT
610 F=0
620 FORJ=ITON-I:F(D(J))=I:NEXT
630 FORK=ITON-I
640 IFF(K)=0THEND(N)=K:F=I
650 NEXT
660 IFF=0THEND(N)=N
670 GOTO 400
680 PRINT:PRINT"THE CORRELATION IS S
IGNIFICANT, WITH";INT(1000*(NG/CC*10
0+.005))/1000;"% PROBABILITY."
690 IFINKEY$=""THEN 690 ELSERUN
```

The Tandy printer prints [for the up-arrow character ↑ in lines 90, 160, 230, 250 three times), 320 (twice) and 410.



Listing 1. Systematic ranking program.

Spearman's test for correlation

(continued from previous page)

corresponding ranking in reverse order, with $r_s - 0.9$ near the end of the list. The program works only half-way through the list. The variable, CD, established in line 280, stops the computation at line 460.

Line 360 calculates SZ, the value of the sum-of-squares that makes $r_s = 0$, and at line 430 this is used to find the value of S for the reverse ranking, which is then compared with RR. Every time S is found to be greater than or equal to RR the number of such rankings is counted by incrementing NG. If NG exceeds the chosen maximum, CP, the ranking is declared to be not significant, line 450. Otherwise the systematic arraying of ranks proceeds until it is half-way through, when the total NG, for both halves, is used to calculate the exact level of probability, line 680.

Although it is slow, the systematic ranking routine has several applications in other tests and, perhaps, in other fields. It is retained as part of the program since it may be of interest to readers in its own right. The details are described by the flowchart in figure 1.

The method relies on the fact that the arrays can be systematically listed. For example, for N = 5 write the five ranks in ascending order:

1, 2, 3, 4, 5 array 1

The rank in position N – 1 is to be incremented every time by the expression C(N – 1) = 1 in line 260. The rank in position N – 2 is incremented every second time by C(N – 2) = 2 in line 270. The rank in position N – 3 is to be incremented every sixth time, that in position N – 4 every 24th time. As you move to the left the number of times a rank is repeated without being incremented goes up as a series of factorials 1, 2, 6, 24, 120, etc. as provided for in array C, line 270.

Every time a rank is incremented the program looks to the left to see if this value is already there. If so it increments again, lines 530 to 560, and checks again. If the rank is incremented beyond N, it is reduced by 1 by line 570. Finally, when all ranks up to N – 1 are written down, it looks to see which one has not been written, lines 600 to 620. The missing rank is written at position N to complete the array, lines 630 to 660. Figure 2 shows how the program runs. You may like to carry on with this dry run, or insert a Print command into line 665 so that the computer does the donkey work.

Instead of letting the computer churn its way through all the thousands or millions of combinations of ranks, why not let it generate a fair sample of combinations, and then use them as the basis of probability calculations? This is what the random-array program in listing 2 does.

Listing 2. Random-array program.

```
10 DEFINTA-N,Q,S-Z:I=1
20 Q=200
30 CLS:PRINTTAB(14)"SPEARMAN RANK CORRELATION TEST":PRINT
40 PRINT:INPUT"HOW MANY PAIRS OF RANKS";N
50 IF N<4PRINT:PRINT"THIS TEST REQUIRES AT LEAST 4 PAIRS.":GOTO 40
60 DIMA(N):DIMB(N):DIMD(N)
70 PRINT:PRINT"ENTER RANKS IN PAIRS, SEPARATED BY A COMMA."
80 FORJ=1TON
90 PRINT:PRINT"PAIR NO.";J:INPUTA(J),B(J)
100 RR=RR+(A(J)-B(J))↑2
110 NEXT
120 RS=1-6*RR/(N↑3-N)
130 PRINT:PRINT"THE CORRELATION COEFFICIENT IS ";RS;".":PRINT:PRINT"CALCULATION
OF PROBABILITY LEVEL IS PROCEEDING."
140 SZ=(N↑3-N)/6
150 FORZ=ITOQ
160 PRINTZ;
170 FORK=ITON
180 D(K)=RND(N)
190 IFK=ITHEN 230
200 FORL=ITOK-I
210 IFD(L)=D(K)THEN 180
220 NEXTL
230 NEXTK
240 S=0
250 FORJ=ITON:S=S+(J-D(J))↑2:NEXT
260 IFS<=RRTHENNG=NG+I
270 IFS>SZTHENS=2*SZ-S:IFS<=RRTHENNG=NG+1
280 NEXTZ
290 P=NG/Q/2
300 IFP>.1THENPRINT"THERE IS NO SIGNIFICANT CORRELATION":GOTO 320
310 PRINT:PRINT"THERE IS A SIGNIFICANT CORRELATION, WITH PROBABILITY ";INT(1000*
(P+.0005))/1000;"% PROBABILITY."
320 IFINKEY$=""THEN 320 ELSERUN
```

Figure 2.

Increment position N – 1:
1, 2, 3, 5, –
5 does not occur to the left
4 is missing so put it at N:
1, 2, 3, 5, 4
Array 2 complete
Increment position N – 2:
1, 2, 4, –, –
All OK to the left so increment position N – 1
This gives 6 so reduce to 1
1 is already taken and so is 2 so increment to 3:
1, 2, 4, 3, –
Missing rank is 5:
1, 2, 4, 3, 5
Array 3 complete
Increment position N – 1 to give 4
4 is already taken so make it 5:
1, 2, 4, 5, –
Fill in with missing rank 3:
1, 2, 4, 5, 3
Array 4 complete
Continue with arrays 5 and 6:
1, 2, 5, 3, 4
1, 2, 5, 4, 3
At the seventh array increment position N – 3:
1, 3, –, –, –
Applying the rules, the rest of this array is filled in;
1, 3, 2, 5, 4
Array 7 complete

The program fills the array by chosing ranks at random, lines 170 to 230. You can set Q, line 20, to determine how many random arrays it generates. In effect, it works on double this number, for at line 270 it calculates S for the ranking in reverse order and uses this ranking too, without having to assemble it randomly.

Professional statisticians will probably be aghast at the idea of adding an element of randomness to the business of estimating probability, but this method is presented as a practical solution to a practical problem. The program runs much faster than the conventional program and provides an exact estimate of probability. How precise it is depends on the value set for Q. The greater you make Q, the more precise the answer will be, but the longer you will take to reach it.

The random-array program eliminates the astronomical increases in run time associated with factorials. The program takes longer to assemble each array as N increases but this does not increase to the extent that factorial numbers increase. For example, when N is 5, it takes an average of 0.9 seconds to generate and evaluate each array. When N is 20 it takes 12 seconds, which is only 13 times longer. A factorially based computation would take 2×10^{16} times longer.

A weakness of the procedure is found when r_s is close to 1, when it is unlikely to generate many arrays with r_s equal to or greater than your large r_s, even if Q is large. A few too many arrays with large r_s arising by chance, or a few too few, will upset the probability estimate disproportionately.

For $r_s = 1$ you can add line 290 of the conventional program to this program. There is little point in adding the tie-resolving calculations. Ties cause small effects below the level of resolution of this method. For r_s close to 1 — say, greater than 0.95 — you might arrange for the program to increase Q. An alternative is to run the program a few times and average the results. For most data, which will have r_s between 0.3 and 0.8, this effect is of no consequence.

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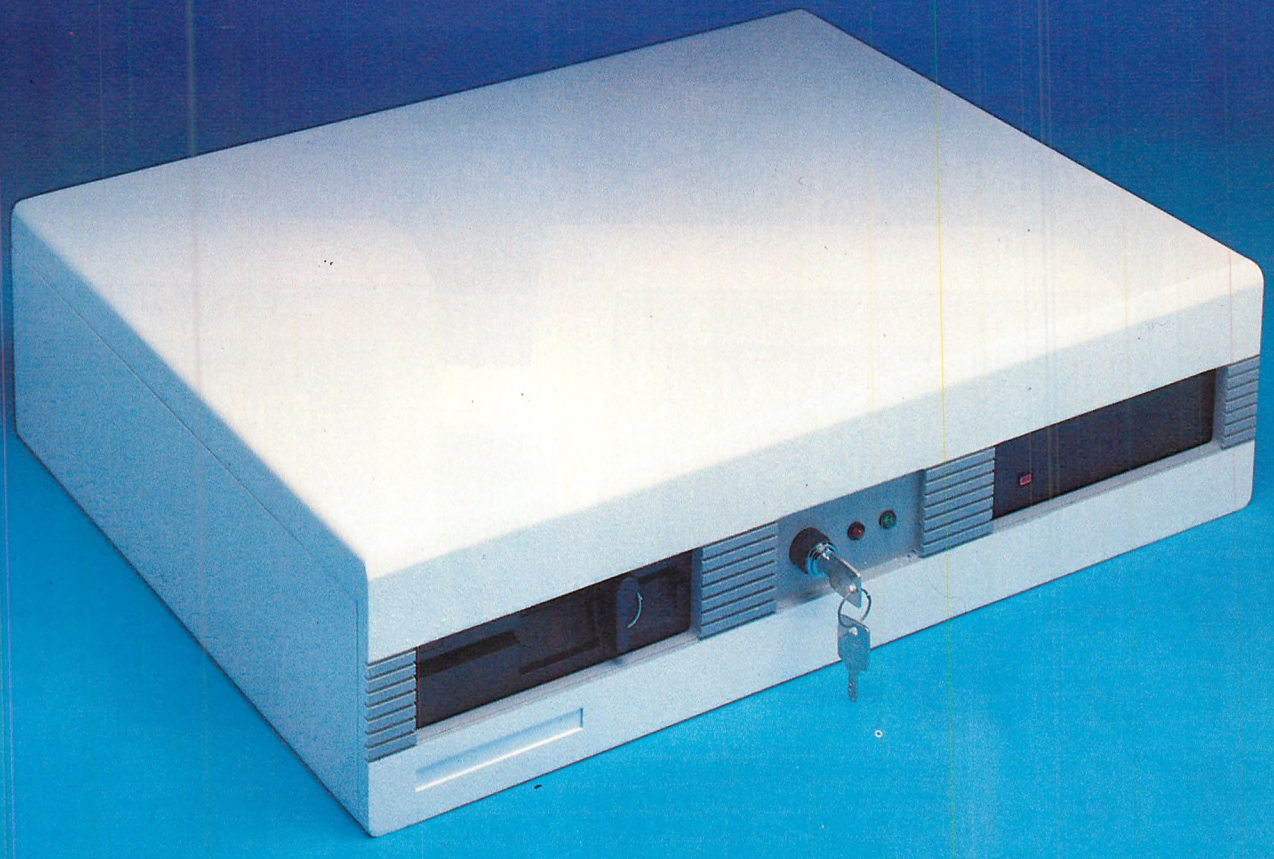

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Processor: 16-Bit 8086, cycle time 215 Nano Seconds. **Architecture:** DMA Bus based, true 16-Bit. **Speed:** DMA @ 6MB/sec; Disc transfer @ 3MB/sec. **Memory (RAM):** 128KB standard, expandable to 640KB. **Screen:** High resolution green; anti-glare optical filter. Colourgraphics optional extra. **Discs:** Two 8" DS/DD giving 2.36 MB usable. IBM compatible. **Interfaces:** 2 RS 232 communications interfaces. Plus: Centronic printer interface. **Operating Systems:** MS-DOS CP/M-86. 8-bit software emulator. **Languages for 16-bit:** Basic, Cobol, Pascal, Fortran, PL/1, BCPL compilers and interpreters available. **Customising:** with logo, namestyle and house colours, can be arranged. **"So simple to operate" – and don't forget, the S16-bit Mega Micro is built to military standards with laboratory-level quality control for complete dependability.**

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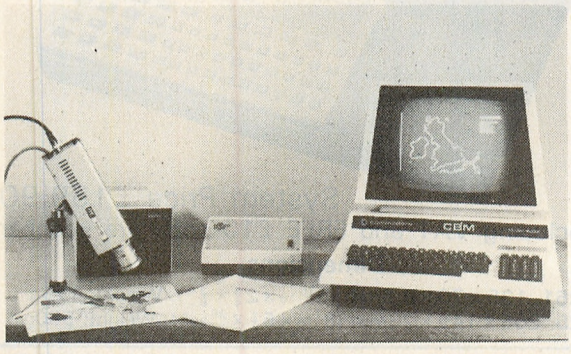

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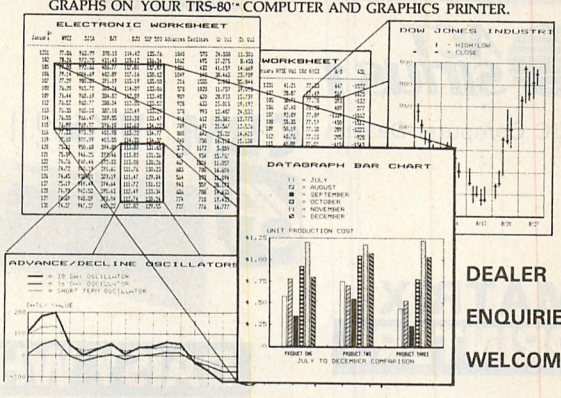

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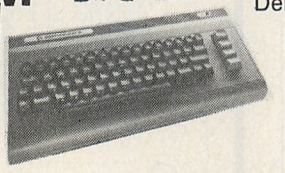

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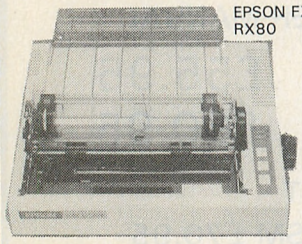

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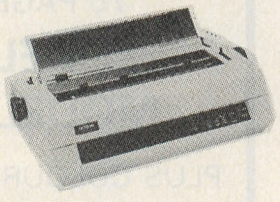

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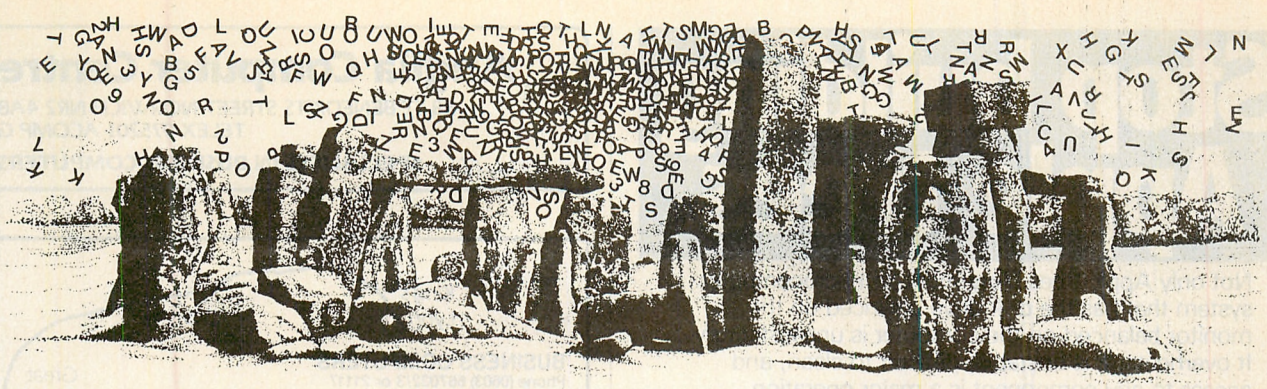

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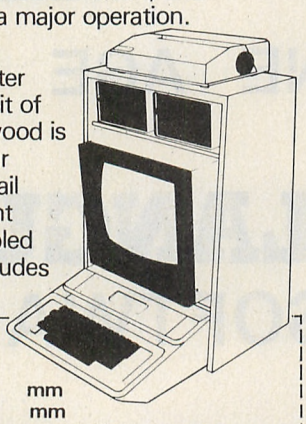

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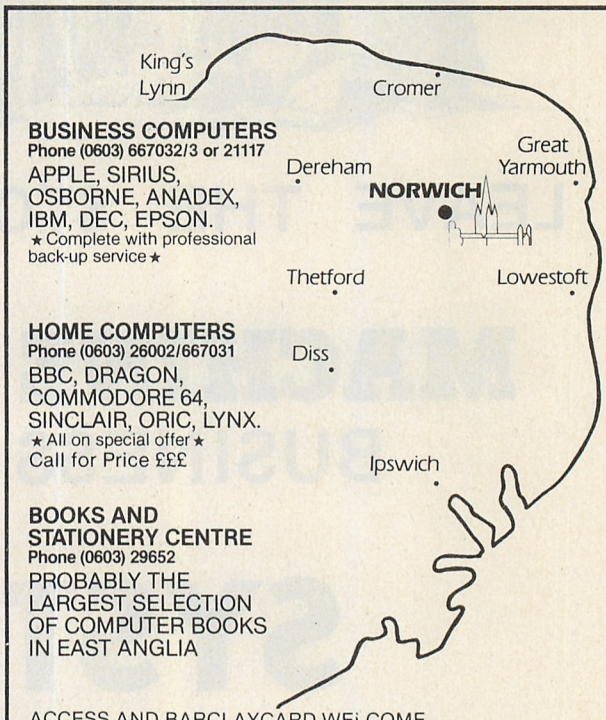

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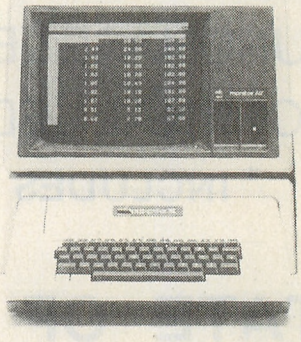

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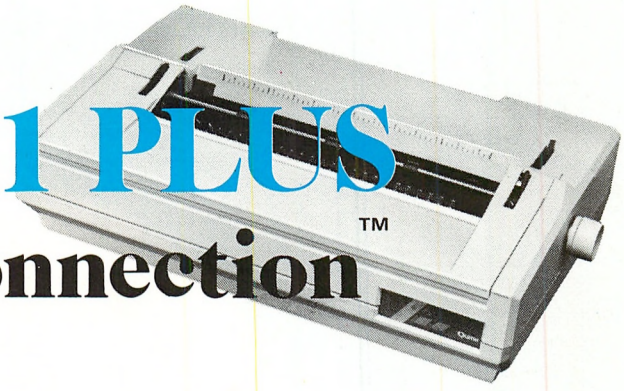



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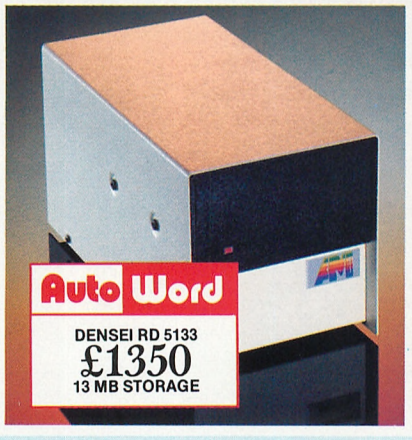

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Open File

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.

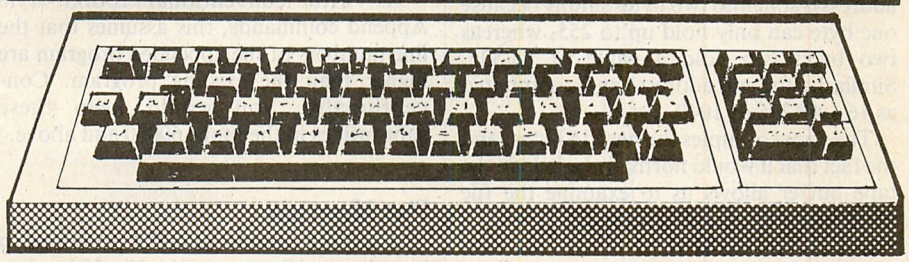
Commodore Corner: Making use of program headers; Pet Nasties, a conversion from the Vic — introduced by Mike Todd **165**

Apple Pie: Maths pack for O-levels; Play the organ; Graphics-handling routines; Hambly's maze game — introduced by John Harris **173**

Tandy Forum: Astro-Dodge game; Drawing circles and spirals; Graphics reflections — introduced by John Wellsman **180**

Sinclair Line-up: Solar system plotter on a Spectrum; How to keep the ZX-81 screen free of rubbish; Entering Spectrum machine code; A bigger screen for the Spectrum **184**

End of File: Superbrain Invaders; User-defined Forth graphics and Othello on Jupiter Ace **187**



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.

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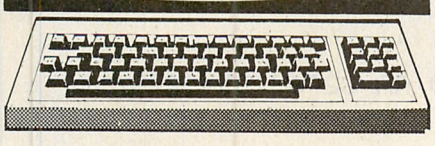
COMMODORE CORNER

by Mike Todd



Use your headers

A PROGRAM saved on tape is essentially a file of data which, when read back by the operating system, is put back to the same locations that it came from. To do this, the

(continued on next page)

location		contents		Headers. Figure 1.
hex	dec	hex	dec	
$027A	634	$01	01	Identify "program" file
$027B	635	$01	01	low byte of START address
$027C	636	$04	04	high byte of START address ($0401 = 1025)
$027D	637	$10	16	low byte of END address
$027E	638	$04	04	high byte of END address ($0410 = 1040)
$027F	639	$4E	78	"N" - 1st character of filename
$0280	640	$41	65	"A" - 2nd character of filename
$0281	641	$4D	77	"M" - 3rd character of filename
$0282	642	$45	69	"E" - 4th character of filename
$0283	643	$20	32	space
$0284	644	$20	32	space
$0285	645	$20	32	space
$0286	646	$20	32	space
$0287	647	$20	32	space
$0288	648	$20	32	space
$0289	649	$20	32	space
$028A	650	$20	32	space
$028B	651	$20	32	space
$028C	652	$20	32	space
$028D	653	$20	32	space
$028E	654	$20	32	space

(continued from previous page)

operating system must know where to put the data.

The relevant information is held in a special "header" which precedes the data. It contains the start and end addresses, the name of the file and an identification marker to distinguish between data and program files. With an understanding of the structure of these headers it is possible to modify the addresses so that data may be loaded into an address different from those specified in the header.

As well as providing details of the header structure, Mr Hart of Leicester Polytechnic has provided an example of how this knowledge can be used. It is a simple method of appending a program from tape or to the end of the program currently in memory.

Figure 1 shows the header from a very short program. It would normally be loaded into the tape buffer starting at address 634, $027A in hex. In this example, the first byte is the identification byte, 01 for a program, and the next two bytes are the starting address which in this case is 1 + 4*256. The address is split into two bytes simply because one byte can only hold up to 255, whereas two bytes can hold a value of 65,535. Similarly, the end address can be computed as 16 + 4*256 or 1040.

The name occupies the next 16 bytes, and the fact that it would normally be held in the tape buffer allows us to examine the file name using the simple program:

```
FOR I = 0 TO 15: PRINT
CHR$ (PEEK(639 + J));: NEXT I
```

If you just want to read a header from tape without doing anything with it, Open 1 will do it. It reads the first header on tape into the buffer irrespective of its type. It is then possible to identify the header type, start and end addresses and file name.

Headers. Command list.

```
get program header into buffer  OPEN1,1,0,"FILENAME"
E = new LOAD start address      E=PEEK(42) +256*PEEK(43) -2
N = new LOAD end address        N=PEEK(637)+256*PEEK(638)+E-1025
Set new start address in header POKE635,E AND 255:POKE636,E/256
Set new end address in header   POKE637,N AND 255:POKE638,N/256
Tell BASIC of new end address   POKE42,PEEK(637):POKE43,PEEK(638)
Do the LOAD in BASIC 4          SYS 62456: SYS 46262
Do the LOAD in BASIC 2          SYS 62393: SYS 50242
```

Armed with this information, you can now append a program on tape. The list of commands shown will do just that; they are listed in a form for typing in Direct mode. Two sets of Sys commands are given, one for Basic 2 and the other for Basic 4.

The first Sys does the actual loading and the second links the two programs together. Whether or not the pointers are set up within a program, the Sys commands must be executed in Direct mode and not from within a program.

As with conventional toolkit-style Append commands, this assumes that the line numbers of the appended program are higher than the existing program. Conventionally, you would keep these subroutines in the range 60000 and above.

Pet Nasties

It is quite common for Pet programs to be converted for use on the Vic-20 but it is unusual to see a Vic program converted for the Pet. K Ward of Nottingham has done just that with his game based on the Blue Meanies demonstration game provided with the Vic. It will run on any 40-column Pet, although old-ROM Basic 1 Pets will need to have the Poke 158,0 in lines 20, 420, 940 and 950 changed to Poke 525,0.

In the game you have six laser guns, three on each side of your space station, and the Nasties move downwards between them. You have to stop them reaching the asterisks at the bottom of the space station. If a Nasty hits your station it destroys itself and a piece of the space station. If you destroy one with a laser gun you gain 10 points, but each time you fire the laser you lose 50 units of energy.

Damaged sections of the station can be repaired by moving the robot parked at the left of the station, but the robot cannot move if a hole is below it. To repair a section the robot must be standing in the section. A repair uses 100 units of energy. Refuelling ships descend at intervals, each delivering 500 units of energy. If you hit one you lose 80 points. Lasers and robot will not function if you have no energy, but the Nasties continue their attack.

After 200 points have been scored, the game progresses to a second skill level, and to a third after 600 points. At 1,000 points, the Nasties give up and retreat. Sound effects are provided for those who have a loudspeaker connected to the CB port.

Pet Nasties.

```
10 REM VI=SOUND EN=ENERGY SC=SCORE V=SKILL LEVEL
20 POKE158,0:PRINT"■":FORA=0TO39:POKE32768+A,160:NEXT
30 VI=59464:POKEVI+3,16:POKEVI+2,51:POKEVI,20:POKEVI+2,15
40 POKEVI,236:POKEVI+2,15:POKEVI,100:FORA=39TO0STEP-1:POKE33648+A,160
50 NEXT:POKEVI+3,0:Z=10
60 PRINT"■                                                    "
70 PRINT"■                  NASTIES                  "
80 PRINT"■                                           "
90 PRINT"■          FROM OUTER SPACE                 ":V=25
100 PRINT"■                                          "
110 D$="■                                                    "
120 :
130 EN=1000:PRINT:PRINT:SC=0
140 PRINT:PRINT:PRINT" DO YOU WANT INSTRUCTIONS ('Y''N')  "
150 GETC$:IFC$=""THEN150
160 IFC$="Y"THENGOSUB1140
170 PRINT"■":VI=59464:POKEVI+3,16:M=33411:U=32:C=160:AA=32768:BB=32787
180 FORI=0TO2:POKEAA+I,C:POKEBB+I,C
190 NEXT:POKEVI+2,15:POKEVI,200:
200 AA=AA+40:BB=BB+40:IFBB=33467ORAA=33448THEN220
210 GOTO180
220 PRINT"■                                              "
230 PRINT"■                        "
240 PRINT"■           ***          "
250 PRINT"■                                                  ";
```

(continued on page 168)

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(continued from page 166)

```
260 PRINT"■"TAB(18)"■■■
```



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● Circle No. 198

(continued from page 168)

```
880 FORI=50TO250STEP20:POKEVI,I:NEXT:POKEVI+2,51:POKEVI+3,0
890 POKEE,32:POKEE-40,32:POKEE-1,32:POKEE-41,32:POKEE+40,32:POKEE+1,32
900 POKEE+41,32:POKEE+39,32:POKEE-39,32
910 IFSC=200THENV=50:GOTO940
920 IFSC=600THENV=100:GOTO950
925 IFSC>1000THEN1390
930 GOTO980
940 POKE158,0:PRINT"■■■■■■■■■■■■WE'RE GONNA BE NASTIER NOW ":GOTO970
950 POKE158,0:PRINT"■■■■■■■■■■■■THAT DOES IT YOU HAVE NO CHANCE NOW"
960 PRINT"■■■■■■WE'RE GONNA BE REAL NASTY "
970 FORI=1TO4000:NEXT:GOTO170
980 RETURN
990 IFE=HTHENG=0:GOSUB840:GOTO680
1000 B=0:GOSUB840:GOTO680
1010 IFE=HTHENG=0:GOSUB840:GOTO830
1020 B=0:GOSUB840:GOTO830
1030 PRINT D$SPC(40)M$;:GOSUB1040:GOTO270
1040 PRINTD$SPC(248)"■          "
1050 PRINTD$SPC(240)"■ENERGY="EN"■ ";:RETURN
1060 POKEA,35:POKEA+1,70:POKEA-1,70:POKEA+41,77:POKEA+39,78:POKEA+40,93
1070 POKEA-41,77:POKEA-40,93:POKEA-39,78:GOTO1100
1080 POKEH,35:POKEH+1,70:POKEH-1,70:POKEH+41,77:POKEH+39,78:POKEH+40,93
1090 POKEH-41,77:POKEH-40,93:POKEH-39,78:GOTO1100
1100 PRINT"■■■■■■■■■■■■■■■■   OVERRUN    ":POKEVI+3,16:POKEVI+2,85:FORI=1TO10
1110 POKEVI,185
1120 FORZ=190TO250:POKEVI,Z:NEXT
1130 NEXT:POKEVI+3,0:FORI=1TO200:NEXT:RUN
1140 PRINT"■■■■■■■■■■■■YOU ARE BEING ATTACKED BY A "
1150 PRINT"■■■■HORDE OF NASTIES THEY MUST BE HELD "
1160 PRINT"■■■■BACK AT ALL COSTS THEY MUST NOT        OVERRUN YOUR STATION."
1170 PRINT:PRINT"IF THEY GET TO ■■■■■ YOU HAVE HAD IT"
1180 PRINT:PRINT"YOU CAN SHOOT THEM WITH YOUR LASER "
1190 PRINT"THE FOLLOWING BUTTONS FIRE THE LASERS":PRINT
1200 PRINT"■'C'TOP LEFT. 'X'MID LEFT 'Z'LOW LEFT":PRINT
1210 PRINT"■'B'TOP RIGHT.'N'MID RIGHT.'M'LOW RIGHT":PRINT
1220 PRINT"■ DO NOT SHOOT'+'IT IS YOUR FUEL BEING    DELIVERED":PRINT
1230 PRINT"■■■■■■■■■■■■■■■■
```



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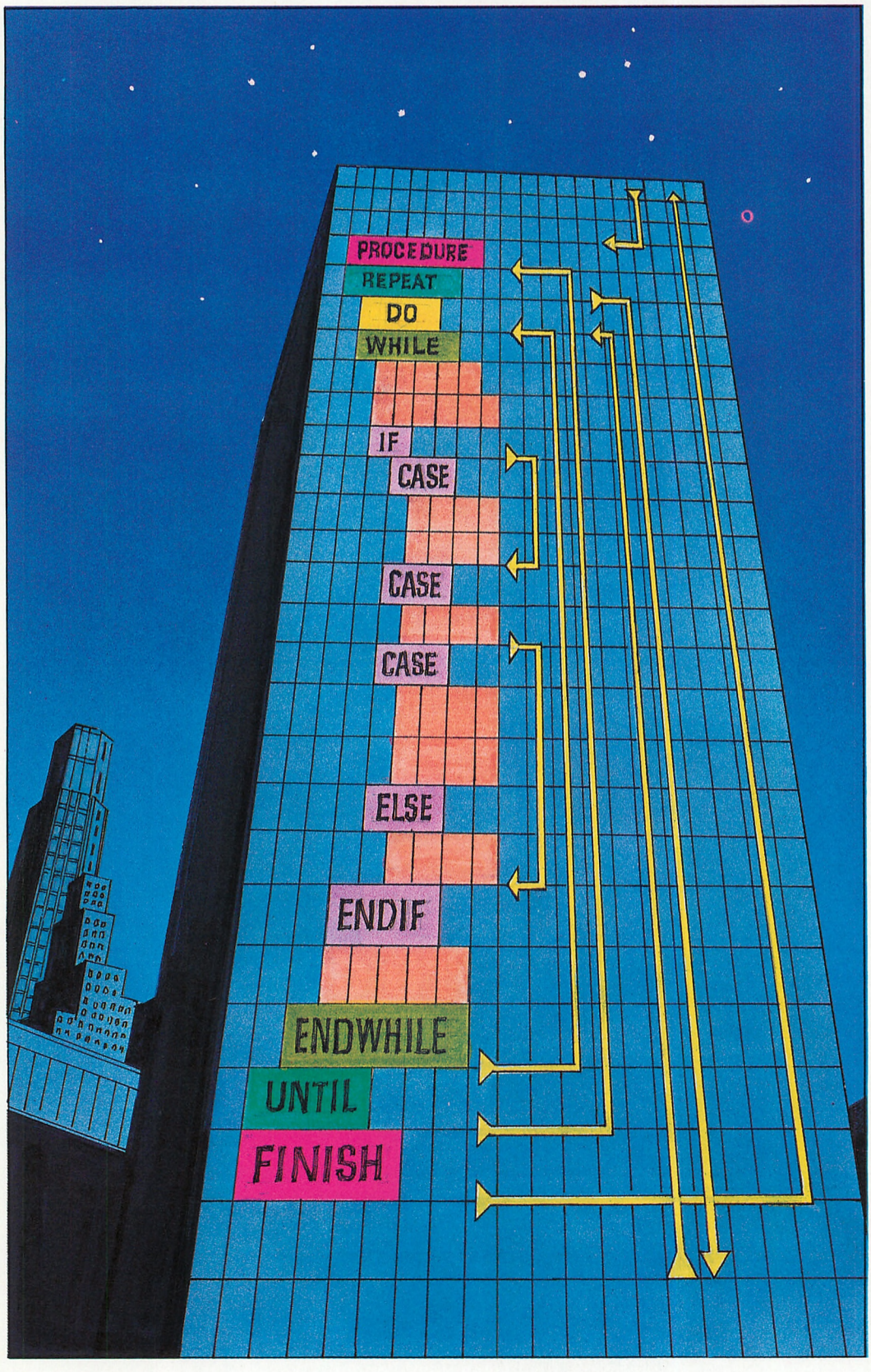

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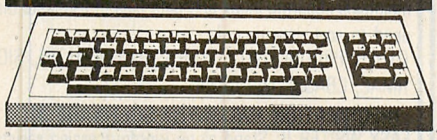
APPLE PIE

by John Harris



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Maths pack

A PROGRAM designed to help a student doing an O-level course in mathematics has been submitted by Peter Dadswell of Ranmoor, Sheffield. Built-in equations permit evaluation of square roots, squares, areas of circles, triangles and trapezia, and the derivation of straight-line equations from intercepts on a graph.

The program is one of the few I have seen which concentrates on providing user-friendly responses rather than cramming the screen with as much data as possible. It would be possible to extend the range of functions within the framework provided if the existing set is found to be excessively limited.

Organ

Kes Smith, head of computing at St Felix School in Southwold, has developed a program to allow the Apple keyboard to be used as a two-manual organ. It employs an assembler routine written by Michael Findlay of Belfast and originally printed in this column in May 1982.

A range of two-and-a-half octaves is defined with an overlap of two notes. The bass notes run along the Z to / bottom line with their sharp/flat semitones on the A to ; second line. The tenor notes are on the two upper lines: naturals on Q to P and the "black" keys on 1 to →.

The frequencies to which the keys are tuned are those suggested by Mr Findlay in his original note generator. There is a significant clock-rate difference between individual Apples and those capable of telling an off note from an accurate one should tune the data in lines 70 and 80.

The program generates notes of variable frequency taken from Dim NA, which is subscripted by the Asc value of the character code of the key depressed less 43. It gives a value of 1 for the active character on the keyboard with the lowest ASCII collating sequence, the comma, and 47 for that with the highest, Z. The duration of the note is fixed in line 40.

The main weakness of the program lies in that fixed duration. It would give much more flexible results if the note duration were tied to the duration of the key depression. That, of course, would only be possible by avoiding the use of Get to test for the key depression, using instead a Peek to some abtruse location or other, and replacing the hard-loop assembler routine with another which returned to the keyboard scan.

The whole scan-generate function —

(continued on page 175)

Maths pack.

```
 10  HOME : GR
 20  COLOR= 9
 30  VLIN 3,12 AT 1: VLIN 3,12 AT
     7
 40  VLIN 3,6 AT 4: HLIN 1,7 AT 3
 50  COLOR= 11
 60  VLIN 3,12 AT 9: VLIN 3,12 AT
     15
 70  HLIN 9,15 AT 3: HLIN 9,15 AT
     7
 80  COLOR= 6
 90  VLIN 3,12 AT 20: HLIN 17,23 AT
     3
100  COLOR= 1
110  VLIN 3,12 AT 30: VLIN 3,12 AT
     25
120  HLIN 25,30 AT 7
130  COLOR= 14
140  VLIN 3,7 AT 32: VLIN 7,12 AT
     39
150  HLIN 32,39 AT 3: HLIN 32,39 AT
     7
160  HLIN 32,39 AT 12
170  PLOT 39,4: PLOT 32,11
180  PLOT 32,11
190  COLOR= 8
200  VLIN 15,22 AT 6: VLIN 19,22 AT
     9
210  HLIN 6,9 AT 19
220  HLIN 6,9 AT 22
230  COLOR= 15
240  PLOT 12,19: PLOT 13,20
250  PLOT 14,21: PLOT 15,20
260  PLOT 16,19
270  PLOT 13,22: PLOT 16,19: PLOT
     12,23
280  PLOT 12,23
290  COLOR= 12
300  VLIN 25,34 AT 1: VLIN 25,28 AT
     3: HLIN 1,3 AT 25: HLIN 1,3 AT
     28: PLOT 3,31
350  VLIN 25,34 AT 5: VLIN 26,27 AT
     6: VLIN 32,33 AT 6
380  VLIN 27,32 AT 7: VLIN 25,34 AT
     9
400  VLIN 25,34 AT 12: HLIN 9,12 AT
     25: HLIN 9,12 AT 29
430  VLIN 25,34 AT 14: VLIN 26,27
      AT 15: VLIN 32,33 AT 15
470  VLIN 27,32 AT 16: VLIN 25,29
      AT 18: VLIN 29,34 AT 21
500  HLIN 18,21 AT 34: HLIN 18,21
      AT 29: HLIN 18,21 AT 25: PLOT
     21,26: PLOT 18,33
540  VLIN 25,34 AT 23: VLIN 25,34
      AT 27: VLIN 31,34 AT 25
570  HLIN 23,27 AT 34: VLIN 25,34
      AT 29: HLIN 29,31 AT 25: HLIN
     29,31 AT 34: HLIN 29,30 AT 2
     9
620  VLIN 25,34 AT 33: HLIN 33,35
      AT 34: VLIN 25,34 AT 37: HLIN
     37,38 AT 34: PLOT 39,31
670  INPUT "PRESS 'M' AND 'RETURN
     ' TO CONTINUE...";X$
680  IF X$ = "M" THEN  GOTO 700
690  IF X$ <  > "M" THEN  GOTO 10

700  TEXT
710  HOME
720  PRINT "YOU HAVE A CHOICE OF.
     ...."
730  PRINT "1.SQUARE ROOT"
740  PRINT "2.SQUARE"
750  PRINT "3.AREA OF A CIRCLE"
760  PRINT "4.AREA OF A TRIANGLE"

770  PRINT "5.AREA OF A TRAPEZIUM
     "
780  PRINT "6.THE EQUATION OF A L
     INE ON A GRAPH"
790  INPUT "WHICH NUMBER DO YOU W
     ANT?";P$
800  IF P$ = "1" THEN  GOTO 860
810  IF P$ = "2" THEN  GOTO 900
820  IF P$ = "3" THEN  GOTO 930
830  IF P$ = "5" THEN  GOTO 1060
840  IF P$ = "6" THEN  GOTO 1020
850  IF P$ = "4" THEN  GOTO 960
860  INPUT "WHAT NUMBER DO YOU WA
     NT?";A
870  HOME
880  PRINT "SQUARE ROOT OF ";A"
      =" SQR (A)
890  GOTO 1110
900  INPUT "WHAT NUMBER DO YOU WA
     NT?";B
910  HOME : PRINT "THE NUMBER ";B
     " ,SQUARED    ="B * B
920  GOTO 1110
930  INPUT "WHAT IS THE RADIUS OF
      THE CIRCLE?";C
940  HOME : PRINT "THE AREA OF TH
     E CIRCLE,WITH A RADIUS OF ";
     C"     ="C * C * (22 / 7)
950  GOTO 1110
960  INPUT "WHAT IS THE BASE LENG
     TH?";D
970  INPUT "WHAT IS THE HEIGHT ?"
     ;E
980  HOME
990  PRINT "AREA OF TRIANGLE,WITH
      BASE ";D
1000  PRINT "AND WITH HEIGHT ";E"
      ="(D * E) / 2
1010  GOTO 1110
1020  INPUT "WHERE DOES IT PASS T
     HROUGH THE Y-AXIS?";K
1030  INPUT "WHAT IS IT'S GRADIEN
     T?";J
1040  HOME : PRINT "EQUATION OF L
     INE=    Y=";J"X+";K
1050  GOTO 1110
1060  INPUT "WHAT IS THE LENGTH O
     F THE FIRST PARALLEL SIDE?";
     W
1070  INPUT "WHAT IS THE LENGTH O
     F THE SECOND PARALLEL SIDE?"
     ;V
1080  INPUT "HOW FAR ARE THE PARA
     LLEL SIDES APART?";Q
1090  HOME : PRINT "THE AREA OF A
      TRAPEZIUM WITH TWO PARALLEL
      SIDES MEASURING ";W" AND ";
     V" WHICH ARE ";Q" APART   ="
     ((W + V) * Q) / 2
1100  GOTO 1110
1110  PRINT "DO YOU WANT ANOTHER
     GO?(Y/N)";: GET Z$
1120  PRINT
1130  IF Z$ = "Y" THEN  GOTO 710
1140  IF Z$ = "N" THEN  GOTO 1150

1150  HOME : PRINT "THANKS FOR US
     ING ME!": GOTO 1160
1160  GR : COLOR= 7
1170  VLIN 1,39 AT 1: VLIN 1,19 AT
     12: HLIN 1,12 AT 39: HLIN 1,
     12 AT 1
1210  VLIN 21,39 AT 12: HLIN 1,12
      AT 21: HLIN 1,12 AT 19: VLIN
     7,39 AT 20
1250  PLOT 14,1: PLOT 15,2: PLOT
     16,3: PLOT 17,4: PLOT 18,5: PLOT
     19,6
1310  PLOT 21,6: PLOT 22,5: PLOT
     23,4
1340  PLOT 24,3: PLOT 25,2: PLOT
     26,1
1370  VLIN 1,39 AT 28
1380  HLIN 28,37 AT 1
1390  HLIN 28,37 AT 39
1400  HLIN 28,35 AT 20
1410  COLOR= 4
1420  VLIN 1,34 AT 39
1430  COLOR= 2
1440  PLOT 39,37
1450  END
```

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LEVEL II COBOL: Mainframe-level compiler. Extends standard COBOL for interactive screen handling, line sequential file handling, and run time specification of external file names and program names. Permits an integrated heirarchy of programs to be loaded and run under the control of a single resident COBOL program.

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dBASE II: Highly regarded programmable data base management package. Write menu driven application packages to suit your individual needs. From the simplicity of a mailing list to the complexity of a complete accounting system. Comprehensive file, screen and report handling facilities. Interfaces with other language files.

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PERFECT WRITER: Word processing program with dual display windows and automatic saver facilities. Combines with PERFECT SPELLER for a high performance team.

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CONCURRENT CP/M: Lets you run as many as four different programs simultaneously on your IBM PC. At a keystroke you can bring any one of the programs to the screen while others continue to run.

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INFORMATION UNLIMITED SOFTWARE INC

EASY WRITER II: Stand alone wordprocessing results at P.C. price. Indents, paragraphs, underlines and boldface. Simultaneous printing and editing capability and page orientation. Compatible with other IUS software mentioned.

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PRO PASCAL: True object code pascal compiler. Separate compilation facility allows large programs to be subdivided into manageable segments. Includes link-editor, run-time library, library management utility and cross reference generator.

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As well as the software listed here, we stock a wide range of CP/M CPM-86 and MS-DOS compatible software. All software can be supplied on formats suitable for all the popular disk-based microcomputers. Please telephone or write (Freepost no stamp required) for full details of our competitive prices.

● Circle No. 201

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essentially the program itself less initialisation — would thereby become a time-dependent assembler routine where all clock pulses would need accounting for. While such things can be coded, they always seem terribly show-offish when they work and beyond redemption when they do not.

Plotting

Handling the high-resolution pages can be a headache for programmers with no experience of the techniques involved, and reading listings to discover the how and why often presents the problem of sorting the wheat from the chaff. Adrian Savage of Eccleshall in Lancashire has submitted a program which is all wheat and consequently provides a useful introduction to the subject.

For all its brevity the listing allows the user to draw pictures of any complexity. A Save and Reload option is built in to allow further work on the picture or to permit other programs to access the results. The instruction set may appear limited to those with experience of complex graphics packages, yet the program is complete and lends itself to enhancement if Fill or Arc commands are desired.

I have never before commented on a contributor's age, but find the fact that Mr Savage is only nine years old remarkable enough to mention. I recognise that nine year olds write programs, but the style of this contribution raises the feat beyond the ordinary.

Hambly's maze

A game program from Michael Hambly of County Mayo takes the form of a maze. It allows two playing options: to see only part of the maze and attempt to escape within a fixed number of moves, or to see all the maze and rescue as many as possible of the maidens trapped therein.

In the latter case the mobility and intelligence of the monster may be nobbled by selecting an easier level of play. At its fastest and brightest it is rather like stalling on a level-crossing with an express heaving into view.

Organ — Basic listing.

```
7  REM  + SETTING UP +
10 D$ =  CHR$ (4)
20  PRINT D$;"BLOAD TUNE,A$02E2"
30 F = 736
40  POKE 737,64
50 T = 738
60  DIM NA(47)
70  DATA 128,0,114,103,54,135,121
    ,108,0,92,82,0,68,60,48,108,
    0,0,0,0,0,255,175,205
80  DATA 216,103,0,185,164,64,0,1
    35,121,145,152,57,52,128,96,
    242,88,72,195,114,228,76,255

90  FOR N = 1 TO 47: READ DN:NA(N
    ) = DN: NEXT N
97  REM  + KEYBOARD LOOP +
100  GET C$: PRINT :KB =  ASC (C$
    )
110  IF KB = 3 THEN  STOP
120  IF KB < 43 OR KB > 90 THEN 1
    00
130 NV = KB - 43
140 P = NA(NV): IF P < 48 THEN 10
    0
150  POKE F,P: CALL T: GOTO 100
```

Organ — assembler routine.

```
02E2-   AD 30 C0    LDA   $C030
02E5-   88          DEY
02E6-   D0 05       BNE   $02ED
02E8-   CE E1 02    DEC   $02E1
02EB-   F0 09       BEQ   $02F6
02ED-   CA          DEX
02EE-   D0 F5       BNE   $02E5
02F0-   AE E0 02    LDX   $02E0
02F3-   4C E2 02    JMP   $02E2
02F6-   60          RTS
02F7-   00          BRK
```

Plotting.

```
10  REM ********************
20  REM *                  *
30  REM *     HGR PLOT     *
40  REM *                  *
50  REM * BY ADRIAN SAVAGE *
60  REM *                  *
70  REM ********************
80  REM       MAIN PROGRAM
90  REM
100  HGR
110  HCOLOR= 7
120  HOME : VTAB 24: PRINT "COMMA
    ND (0 FOR OPTIONS) ";: INPUT
    "";C0$
130  IF C0$ = "0" THEN  GOSUB 290

140  IF C0$ = "@" THEN  INPUT "CO
    ORDINATE X,Y ";X,Y: HPLOT X,
    Y: GOTO 120
150  IF C0$ <  > "L" THEN 190
160  IF C0$ = "L" THEN  INPUT "FR
    OM X,Y ";X,Y: INPUT "TO   X,
    Y ";X1,Y1
170  HPLOT X,Y TO X1,Y1
180  GOTO 120
190  IF C0$ = "C" THEN  HGR : GOTO
    120
200  IF C0$ = "E" THEN  POKE  - 1
    6303,0: END
210  IF  LEFT$ (C0$,1) <  > "P" THEN
    260
220  IF  MID$ (C0$,1,1) = "P" AND
     MID$ (C0$,2,2) <  > " " THEN
     PRINT  CHR$ (4);"PR£"; RIGHT$
    (C0$,1)
230 P = 1: PRINT  CHR$ (17): REM
     CONTROL-Q
240  PRINT  CHR$ (4);"PR£0"
250  GOTO 120
260  IF C0$ = "HC" THEN  INPUT "C
    OLOR (1-7) ";C0: HCOLOR= C0:
    C0 = 0: GOTO 120
270  IF C0$ = "SA" THEN  INPUT "F
    ILENAME ?";F0$: PRINT  CHR$
    (4);"BSAVE ";F0$;",A8192,L81
    92": GOTO 120
280  IF C0$ = "LO" THEN  INPUT "F
    ILENAME ?";FM$: PRINT  CHR$
    (4);"BLOAD ";FM$: GOTO 120
290  POKE  - 16303,0
300  HOME : PRINT " P           PL
    OT ANY POINT"
310  PRINT " L           DRAW LINE
    "
320  PRINT " C           CLEAR SCR
    EEN TO BLACK"
330  PRINT " P*          DUMP PICT
    URE ON PRINTER"
340  PRINT " HC          CHANGE CO
    LOUR"
350  PRINT " SA          SAVE PICT
    URE ON DISC"
360  PRINT " LO          LOAD PICT
    URE FROM DISC"
370  PRINT " E           END PROGR
    AM"
380  VTAB 23: PRINT "*=SLOT NUMBE
    R"
390  PRINT "PRESS ANY KEY TO CONT
    INUE.............";: GET ZZ
    $: POKE  - 16304,0: GOTO 120
```

Hambly's maze.

```
10 :
20  REM   COPYRIGHT (C) MICHAEL H
    AMBLY
30 :
100  GOTO 10000
200  POKE 6,NO(NB): POKE 7,BE(NB)
    : CALL 768: RETURN
300  FOR I = 1 TO ST(NB)
310  FOR J = NO(NB) TO 0 STEP  -
    BE(NB): POKE 6,J: POKE 7,2: CALL
    768: NEXT
320  FOR K = 0 TO NO(NB) STEP BE(
    NB): POKE 6,K: POKE 7,2: CALL
    768: NEXT
330  NEXT : RETURN
497 :
498  REM   ***** PLOTTING PIECE O
    F MAZE *****
500 DT = 10000
510  HGR2
520 R =  INT (P / L): REM     ***
    * ROW THAT P IS IN ****
530  FOR I =  - ROWS TO ROWS
540  FOR J =  - COLUMNS TO COLUMN
    S
550 M = P + I * L + J:TST = R + I

560  IF M < 0 OR M > H THEN M = P

570  IF  INT (M / L) <  > TST THEN
    M = P
580  DRAW CELL(M) + 1 AT  FN X(M)
    , FN Y(M)
590  NEXT J,I
600  GOSUB 650
610  GOTO 510
620 :
630  REM  ***** GETTING MOVE FROM
     KEYBOARD *****
640 :
650  HCOLOR= 3: DRAW 12 AT  FN X(
    P), FN Y(P):NB = 1: GOSUB 20
    0
660 K =  PEEK ( - 16384):MC = MC +
    1: IF K < 128 AND MC < DT THEN
    660
670  POKE  - 16368,0
680  IF K < 128 THEN  RETURN : REM
     ** MOVE MONSTER **
690  IF K = 201 THEN A = 3: GOTO
    740
700  IF K = 202 THEN A = 2: GOTO
    740
710  IF K = 203 THEN A = 0: GOTO
    740

720  IF K = 205 THEN A = 1: GOTO
    740
730  GOTO 660
740  IF TURNS <  = 0 THEN  GOSUB
    30000: REM  *** NO MORE TIME
     ***
750 T1 =  ABS (TURNS - 25): IF T1
     < 4 AND T2 = 0 THEN T2 = 1:
     GOSUB 13000
760  IF CELL(P) / W(A) =  INT (CE
    LL(P) / W(A)) THEN TURNS = T
    URNS - 5: PRINT "": GOTO 650
```

(continued on next page)

(continued from previous page)

```
770 P = P + M(A):MC = 0
780  IF P = EXIT THEN  GOTO 20000
     : REM   *** GOT THROUGH MAZE
      ***
790 TURNS = TURNS - 1: IF TURNS <
     = 0 THEN  GOTO 30000: REM
        *** RUN OUT OF TIME ***

800  RETURN
970 :
980  REM  ***** DRAWING COMPLETE
     MAZE *****
990 :
1000 Y1 = 10
1010  FOR I = 0 TO W - 1
1020 X1 = 10
1030  FOR J = 0 TO L - 1
1040  DRAW CELL(I * L + J) + 1 AT
     X1,Y1
1050 X1 = X1 + 16
1060  NEXT J
1070 Y1 = Y1 + 16
1080  NEXT I
1090 :
1100  REM  **** A FEW MAIDENS ***
     *
1110 :
1120  FOR I = 1 TO 10 + 2 * D
1130 MA =  INT ( RND (1) * H):CEL
     L(MA) = CELL(MA) * 11
1140  IF CELL(MA) / 121 =  INT (C
     ELL(MA) / 121) THEN CELL(MA)
      =  INT (CELL(MA) / 11)
1150  IF MA = EXIT THEN 1130
1160  DRAW 24 AT  FN X(MA), FN Y(
     MA):NB = 2: GOSUB 200
1170  NEXT
1180 OM =  INT ( RND (1) * H): REM
      ** MONSTER **
1190  DRAW 23 AT  FN X(OM), FN Y(
     OM)
1200 MA = 0
1210 :
1220  REM  **** MOVE OUT MAN ****

1230 :
1240 OP = P
1250 DT = (D - 1) * TURNS: GOSUB
     650
1260  IF K < 128 THEN 1310
1270  HCOLOR= 0: DRAW 12 AT  FN X
     (OP), FN Y(OP)
1280  IF CELL(P) / 11 =  INT (CEL
     L(P) / 11) THEN CELL(P) = CE
     LL(P) / 11:MA = MA + 1: DRAW
     24 AT  FN X(P), FN Y(P):NB =
     5: GOSUB 200: REM       ** CH
     ECK FOR MAIDEN **
1290  IF P = NM THEN NB = 6: GOSUB
     300: GOTO 30000: REM     ***
     EATEN ***
1300 OP = P
1310  IF  ABS (P - OM) < 3 AND MC
      < TURNS THEN NM = OM + 2 *
     ( INT ( RND (1) * 2)) - 1: GOTO
     1360
1320  IF P - OM > L THEN NM = OM +
     L: GOTO 1360
1330  IF P - OM <  - L THEN NM =
     OM - L: GOTO 1360
1340  IF P - OM > 0 THEN NM = OM +
     1: GOTO 1360
1350 NM = OM - 1
1360  IF NM < 0 OR NM > H THEN NM
     = OM
1370  HCOLOR= 0: DRAW 23 AT  FN X
     (OM), FN Y(OM)
1380  IF CELL(NM) / 11 =  INT (CE
     LL(NM) / 11) THEN CELL(NM) =
     CELL(NM) / 11: DRAW 24 AT  FN
     X(NM), FN Y(NM):NB = 4: GOSUB
     300: REM   ** MAIDEN EATEN *
     *
1390  HCOLOR= 3: DRAW 23 AT  FN X
     (NM), FN Y(NM):NB = 3: GOSUB
     200: REM  ** MONSTER MOVE **

1400  IF NM = P THEN NB = 6: GOSUB
     300: GOTO 30000: REM      ***
       EATEN ***
1410 OM = NM
1420  GOTO 1250
4960 :
4970  REM  ***** CALCULATE MAZE *
     ****
4990 :
5000 P = P + 1: IF P > H THEN P =
     0
5010 A =  INT ( RND (1) * 4):DC =
     0
5020 A = A + 1:DC = DC + 1: IF DC
      > 3 THEN 5000
5030  IF A > 3 THEN A = 0
5040 M = P + M(A): IF M < 0 OR M >
     H THEN 5020
5050  IF C > 0 AND CELL(P) = 210 THEN
     P = M: GOTO 5010
5060  IF (CELL(P) = CELL(M) OR CE
     LL(M) < 210) AND C > 0 THEN
     5020
5070 MSIDE = M - L *  INT (M / L)



     : IF (MSIDE = 0 AND M(A) = 1
     ) OR (MSIDE = G AND M(A) =  -
     1) THEN 5020
5080 OD =  INT (15 / W(A)):CELL(P
     ) = CELL(P) / W(A):CELL(M) =
     CELL(M) / OD
5090 P = M:C = C + 1: PRINT "*";
5100  IF C = 40 OR C = 80 THEN  RETURN


5110  IF C < H THEN 5010
5120  RETURN
9960 :
9970  REM  ***** INITIALISATION A
     ND INSTRUCTIONS *****
9980 :
10000 D$ =  CHR$ (4): TEXT : HOME

10010  FOR I = 768 TO 786
10020  READ X: POKE I,X
10030  NEXT
10040  DATA     173,48,192,136,20
     8,4,198,7,240,8,202,208,246,
     166,6,76,0,3,96
10050  PRINT D$;"BLOAD MAZE SHAPE
     S"
10060 ST = 37000
10070  HIMEM: ST - 1: REM   PROTE
     CT TABLE
10080  POKE 232,ST - 256 *  INT (
     ST / 256): POKE 233, INT (ST
     / 256)
10090 NO(1) = 116:BE(1) = 25: REM
                ** MAN MOVE **
10100 NO(2) = 28:BE(2) = 50: REM
                ** MAIDEN PLOTTED
     **
10110 NO(3) = 255:BE(3) = 25: REM
                ** MONSTER MOVE
     **
10120 NO(4) = 80:BE(4) = 7:ST(4) =
     3: REM    ** MAIDEN EATEN **

10130 NO(5) = 58:BE(5) = 150: REM
                ** MAIDEN RESCUED
     **
10140 NO(6) = 150:BE(6) = 12:ST(6
     ) = 5: REM ** MAN EATEN **
10150  DEF  FN X(X) = 10 + (X -  INT
     (X / L) * L) * 16: DEF  FN Y
     (Y) = 10 +  INT (Y / L) * 16

10160  DIM CELL(190)
10170 W(0) = 5:W(1) = 7:W(2) = 3:
     W(3) = 2:L =  INT ( RND (1) *
     10 + 8)
10180 M(0) = 1:M(1) = L:M(2) =  -
     1:M(3) =  - L
10190 W =  INT ( RND (1) * 6 + 6)
     :H = L * W - 1:G = L - 1:C =
     0:DC = 0:T = 0:RM = 0:CM = 0
10200  FOR I = 0 TO H
10210 CELL(I) = 210
10220  NEXT
10230 :
10240  REM   **** INSTRUCTIONS FO
     R MAZE *****
10250 :
10260  TEXT : HOME
10270  PRINT "YOU ARE ABOUT TO BE
      THROWN INTO A MAZE"
10280  PRINT "AND YOU HAVE 2 CHOI
     CES :-": PRINT
10290  PRINT "1£  YOU ARE ONLY AL
     LOWED TO SEE A SMALL PART OF
      THE MAZE AROUND YOU AND YOU
      HAVETO FIND THE EXIT": PRINT

10300  GOSUB 5000: PRINT
10310  PRINT "2£ YOU CAN SEE ALL
     THE MAZE BUT YOU HAVETO RESC
     UE AS MANY MAIDENS AS POSSIB
     LE ` BEFORE BEING CAUGHT BY
     THE MONSTER (WHO CAN MOVE TH
     ROUGH WALLS)!!!"
10320  PRINT : IF C < H THEN  GOSUB
     5000
10330  PRINT
10340  PRINT "THIS IS HOW YOU MOV
     E THROUGH THE MAZE"
10350  PRINT "              I   - U
     P"
10360  PRINT "   LEFT - J   K - R
     IGHT"
10370  PRINT "              M   - D
     OWN"
10380  PRINT : IF C < H THEN  GOSUB
     5000
10390 :
10400  REM    **** FIND EXIT CELL
      AT MAZE EDGE ****
10410 :
10420 A =  INT ( RND (1) * 2):A =
      INT ( RND (1) * 2)
10430  IF A = 1 THEN 10470
10440 LE =  INT ( RND (1) * L)
10450  IF B = 0 THEN EXIT = LE: GOTO
     10500
10460 EXIT = LE + (W - 1) * L: GOTO
     10500
10470 WIDTH =  INT ( RND (1) * W)

10480  IF B = 0 THEN EXIT = WIDTH
      * L: GOTO 10500
10490 EXIT = WIDTH * L + L - 1: GOTO
     10500
10500 CELL(EXIT) = 19
10510 D(1) = 3:D(2) = 1
10520  PRINT : PRINT "THE MAZE HA
     S "H + 1" CELLS": PRINT
10530  INPUT "YOUR CHOICE PLEASE,
      1 OR 2 ..? ";CHOICE$
10540 CHOICE =  VAL (CHOICE$)
10550  IF CHOICE < 1 OR CHOICE >
     2 THEN 10530
10560  PRINT "WHAT LEVEL OF DIFFI
     CULTY  ("D(CHOICE)"-5)"
10570  INPUT D
10580 D =  INT (6 - D)
10590  IF D < 1 OR D > 6 - D(CHOI
     CE) THEN  PRINT "INPUT AGAIN
      PLEASE": GOTO 10560
10600 ROWS = D - 1:COLUMNS = D -
     1
10610 P =  INT ( RND (1) * H): REM
      *** MAN ***
10620  IF CHOICE = 1 THEN R1 = 1 +
      INT (P / L):C1 = 1 + P - (R
     1 - 1) * L: PRINT "STARTING.
     . ROW "R1" COLUMN "C1: INPUT
     "PRESS RETURN TO CONTINUE ";
     R$
10630  HGR2 : HCOLOR= 3: ROT= 0:
     SCALE=  1:X = 10:Y = 10
10640 T2 = 0:TURNS = H + 1:CT = T
     URNS
10650  ON CHOICE GOTO 500,1000
12950 :
12970  REM  ***** WARNING FOR 25
     MOVES LEFT *****
12990 :
13000  GOSUB 63000: TEXT
13010  HOME : VTAB 10: HTAB 10
13030  PRINT "ONLY "TURNS" MOVES
     LEFT"
13040  GOSUB 63000
13050  POKE  - 16304,0: POKE  - 1
     6302,0: POKE  - 16299,0: REM
      ** RETURN TO GRAPHICS WITHO
     UT CLEARING **
13060  POKE  - 16368,0
13070  RETURN
19960 :
19970  REM  ***** WIN ROUTINE ***
     **
19980 :
20000  FOR J = 1 TO 3
20002  FOR I = 1 TO 25: POKE 7,2:
      POKE 6,I: CALL 768: NEXT I,
     J
20010  POKE  - 16368,0: TEXT : HOME

20020  PRINT " WELL YOU MADE IT "

20030  PRINT : PRINT
```

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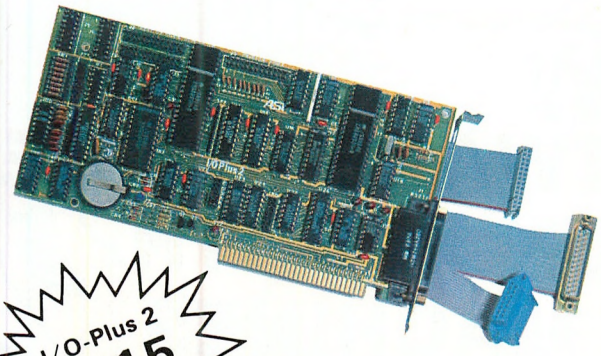
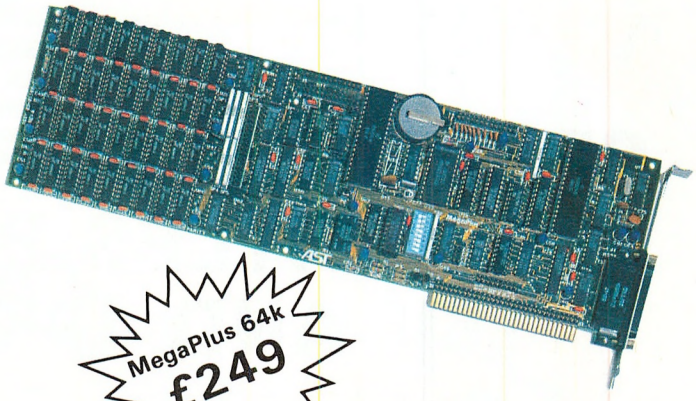


I/O-Plus 2 £115



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(continued from page 176)

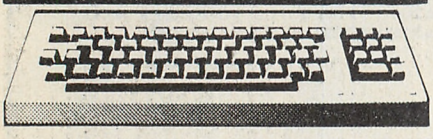
```
20040  PRINT "      CELLS IN MAZE
       = "H + 1
20060  PRINT "      TURNS LEFT
       = "TURNS
20070  IF CHOICE = 1 THEN 20130
20080  PRINT "      MAIDENS RESCUE
     D   = "MA
20130  PRINT : PRINT
20140  PRINT "YOUR SCORE WAS   " INT
     (TURNS * H / D + 1000 * MA)
20150  GOSUB 63000: PRINT
20170  GOTO 35000
20210  HOME : VTAB 10: HTAB 10: PRINT
     "THANKYOU & GOODBYE"
20250  HIMEM: 38400
20260  END
29950 :
29970  REM  ***** LOSE ROUTINE **
       ***
29990 :
30000  POKE  - 16368,0: TEXT : TEXT

30030  IF TURNS <  = 0 THEN  PRINT
     "YOU HAVE USED UP ALL OF YOU
     R TURNS": GOSUB 63000: GOTO
     35000
30040  PRINT " NOT FAST ENOUGH, T
     RY HARDER"
34970 :
34980  REM  *** NEW GAME OR OLD ?
       ***
34990 :
35000  PRINT : INPUT " WOULD YOU
     LIKE ANOTHER GO?";ANS$
35010  IF  LEFT$ (ANS$,1) = "N" THEN
     35070
35030  FOR I = 0 TO H
35040  IF CELL(I) / 11 =  INT (CE
     LL(I) / 11) THEN CELL(I) = C
     ELL(I) / 11: GOTO 35040
35050  NEXT
35060  GOTO 10520
35070  GOSUB 63000
35090  INPUT " WOULD YOU LIKE TO
     TRY AGAIN WITH A     DIFFERE
     NT MAZE ?";ANS$
35100  IF  LEFT$ (ANS$,1) = "Y" THEN
     10170
35110  GOTO 20210
62960 :
62970  REM  ***** DELAY ROUTINE *
       ****
62990 :
63000  FOR I = 1 TO PAUSE: NEXT
63100 PAUSE = 3000: RETURN
```

Hambly's maze — shape table.

```
9088- 6D 00 D4 00 DC 00 DE 00
9090- EF 00 FE 00 00 01 0F 01
9098- 27 01 37 01 39 01 3B 01
90A0- 52 01 9D 01 9F 01 A1 01
90A8- C2 01 E0 01 E2 01 33 02

90B0- 35 02 57 02 59 02 70 02
90B8- C0 02 E3 02 E5 02 E7 02
90C0- E9 02 EB 02 ED 02 EF 02
90C8- 0E 03 10 03 12 03 14 03
90D0- 16 03 2D 03 2F 03 31 03

90D8- 33 03 35 03 37 03 39 03
90E0- 58 03 5A 03 5C 03 5E 03
90E8- 60 03 62 03 64 03 66 03
90F0- 68 03 6A 03 6C 03 6E 03
90F8- 70 03 72 03 74 03 76 03

9100- 78 03 7A 03 7C 03 7E 03
9108- 80 03 82 03 84 03 86 03
9110- 88 03 8A 03 8C 03 8E 03
9118- AD 03 AF 03 B1 03 B3 03
9120- B5 03 B7 03 B9 03 BB 03

9128- BD 03 BF 03 C1 03 C3 03
9130- C5 03 C7 03 C9 03 CB 03
9138- CD 03 CF 03 D1 03 D3 03
9140- D5 03 D7 03 D9 03 DB 03
9148- DD 03 DF 03 E1 03 E3 03

9150- E5 03 E7 03 E9 03 EB 03
9158- ED 03 EF 03 F1 03 12 04
9160- 14 04 16 04 01 00 41 08
9168- 08 08 08 08 08 38 3F 3F
9170- 3F 3F 3F 3F 3F 3F 00 92

9178- 92 D2 DB DB 23 24 24 24
9180- 24 24 24 24 24 00 15 00
9188- 92 92 52 49 49 21 24 24
9190- 24 24 24 24 24 24 00 92
9198- 92 D2 DB DB 23 24 24 24

91A0- 24 24 24 24 2C 2D 2D 2D
91A8- 2D 2D 2D 2D 2D 1D 00 92
91B0- 92 92 49 49 09 38 3F 3F
91B8- 3F 3F 3F 3F 3F 3F 00 15
91C0- 00 15 00 92 92 52 49 49

91C8- 21 24 24 24 24 24 24 24
91D0- 3C 3F 3F 3F 3F 3F 3F 3F
91D8- 3F 00 2D 2D 2D 3E 3F 3F
91E0- 3F 3F 3F 77 09 2D 2D 2D

91E8- 0D 35 CD 3B 1F 3F 3F 3F
91F0- 2E 2D 2D 6D F5 1B 3F 3F
91F8- 3F 9F 2D 6D 50 29 2D 35
9200- 06 38 3F FF 1B 3F 3F 24
9208- 08 C0 20 2D 2D 2D 2C 3F

9210- DF 3B 2C 4D 2D 2D FC 1B
9218- DF 67 49 2B 2D 2D 25 FF
9220- 1F 67 2D 2D 00 15 00 15
9228- 00 49 49 89 92 92 3A 3F
9230- 3F 3F 3F 3F 3F 3F 3F 08

9238- 40 C0 40 C0 40 40 18 18
9240- 28 2D 2D 2D 2D 2D 2D 2D
9248- 2D 00 51 8A 51 8A 51 22
9250- 24 24 24 24 24 24 24 24
9258- DF DB DB DB DB 33 14 36

9260- 36 36 36 36 36 36 36 00
9268- 15 00 2D 2D 2D 24 37 35
9270- 3E 37 2E 2E 3F 2D 3D 3C
9278- 34 3E 37 2E 3E 27 24 3F
9280- 3F 36 3E 27 25 3C 3F 2F

9288- 2C 2C 24 3F 24 35 2E 2D
9290- 25 2D 27 0D 24 2C 3F 3F
9298- 37 0F 36 0D 3C 2D 35 16
92A0- 2E 36 3F 3F 3F 2F 24 2D
92A8- 2D 35 3F 3F 24 04 20 24

92B0- 3C 2C 2D 2D 35 3F 3F 3F
92B8- 0F 0E 00 15 00 0A 2D 2D
92C0- DE 36 FE DB 3F 67 25 27
92C8- 25 3D 3F 04 28 2D 4D 4D
92D0- E1 1F 0C 05 28 F8 13 07

92D8- F8 3B 3F 36 26 2D 00 15
92E0- 00 51 8A 51 49 92 3A 3F
92E8- 3F 3F 3F 3F 3F 3F 27 24
92F0- 24 24 24 24 24 24 24 00
92F8- 49 49 24 24 24 3F 3F 3F

9300- 3F 3F 3F 36 36 36 36 2E
9308- 2D 2D 2D 2D 2D ED 24 36
9310- 3F 24 36 3F 24 36 3F 24
9318- 36 3F 24 36 3F 24 36 36
9320- 3E 2D 0D 2D 27 24 2D 2D

9328- 36 2E 3F 25 24 2D 24 24
9330- 24 3F 36 24 3F 36 24 3F
9338- 36 24 3F 36 24 3F 36 24
9340- 2F 2D 2C 2C 2E 3D 3C 00

9348- 2C 3C 37 35 2E 2D 25 34
9350- 3E 3F 2E 2E 2E 3F 36 3D
9358- 7C 3C 3F 37 3E 25 3C 2F
9360- 2C 24 3F 24 36 2D 35 2E
9368- 25 27 00 15 00 15 00 15

9370- 00 15 00 15 00 15 00 92
9378- 92 52 49 49 21 24 24 24
9380- 24 24 24 24 3C 3F 3F 3F
9388- 3F 3F 3F 3F 37 36 36 36
9390- 36 36 36 36 36 00 15 00

9398- 15 00 15 00 15 00 DB DB
93A0- 9B 92 92 2A 2D 2D 2D 2D
93A8- 2D 2D 2D 25 24 24 24 24
93B0- 24 24 24 24 00 15 00 15
93B8- 00 15 00 15 00 15 00 15

93C0- 00 49 49 89 92 92 3A 3F
93C8- 3F 3F 3F 3F 3F 3F 27 24
93D0- 24 24 24 24 24 24 2C 2D
93D8- 2D 2D 2D 2D 2D 2D 2D 00
93E0- 15 00 15 00 15 00 15 00

93E8- 15 00 15 00 15 00 15 00
93F0- 15 00 15 00 15 00 15 00
93F8- 15 00 15 00 15 00 15 00
9400- 15 00 15 00 15 00 15 00
9408- 15 00 15 00 15 00 15 00

9410- 15 00 15 00 15 00 DB DB
9418- 9B 92 92 2A 2D 2D 2D 2D
9420- 2D 2D 2D 25 24 24 24 24
9428- 24 24 24 3C 3F 3F 3F 3F
9430- 3F 3F 3F 3F 00 15 00 15

9438- 00 15 00 15 00 15 00 15
9440- 00 15 00 15 00 15 00 15
9448- 00 15 00 15 00 15 00 15
9450- 00 15 00 15 00 15 00 15
9458- 00 15 00 15 00 15 00 15

9460- 00 15 00 15 00 15 00 15
9468- 00 15 00 15 00 15 00 15
9470- 00 15 00 15 00 15 00 15
9478- 00 41 08 08 08 08 08 08
9480- 30 36 36 36 36 36 36 36

9488- 3E 3F 3F 3F 3F 3F 3F 3F
9490- 27 24 24 24 24 24 24 24
9498- 24 00 01 00 05 00 01 00
94A0- 00
```

TANDY FORUM

by John Wellsman



Astro-Dodge

A WELL-DESIGNED game has been sent to me by A M Cummings of Stockport, Cheshire. He calls it Astro-Dodge, and while it lacks the addictive qualities of Space Invaders it is, nevertheless, a well-designed game where the player has to dodge a continuous shower of asteroids.

Co-ordination of eye and finger is tested to the limit and the only small criticism that I have to make is that the game, though intended to be a test of skill, is unduly influenced by luck which can sometimes distort the scoring.

Remember that this is a Level II program, and as it stands it cannot be played with Disk Basic, though I can see no reason why it could not be adapted.

Tandy Newsletter

IT IS GOOD to see that Tandy has resumed publishing the *Newsletter*. Edition 5 has appeared eight months after Edition 4. When the *Newsletter* first came out we were told that it was to be a monthly, so let's hope we do not have to wait quite so long for Edition 6.

The latest number contains some very useful tips, notes and patches for all the Tandy computers, including the Pocket and Color models.

In the last two editions there has been a discussion about random files which could help to clear up many mysteries for beginners. There have also been some really deep ideas and suggestions about VisiCalc,

(continued on page 182)

Astro-Dodge.

```
10 REM    ***     ASTRO-DODGE     ***
20 REM    ***    LEVEL II ONLY    ***
30 REM    *** A.M.CUMMINGS 1983 ***
40 CLS:CLEAR2000:RANDOM:DEFINTA-E,G-Z:DEFSTRF:PRINT@340,CHR$(23);"
ASTRO-DODGE";STRING$(8,13);" COPYRIGHT";CHR$(26);"A.M.CUMMINGS";CH
R$(26);"1983.";:GOSUB140
50 SC!=0:CLS:PRINT@27,"ASTRO-DODGE":FORN=1TO32:PRINTF1;:NEXT:F=CHR
$(34):PRINT@200,"";USING" THE HIGHEST SCORE SO FAR IS -=>>> **£,££
££";HS!
60 PRINT@320,"THE OBJECT OF THE GAME IS TO GUIDE THE SMALL ";F;"SH
IP";F;" ON THE LEFT OF THE SCREEN THROUGH THE ASTEROID BELT."
70 PRINT@512,"TO DO THIS YOU USE THE UP AND DOWN ARROWS TO MOVE TH
E SHIP.":PRINT@640,"YOUR SCORE IS INCREASED EACH TIME THE ASTEROID
S ADVANCE."
80 PRINT@768,"THE GAME ENDS IF YOU HIT AN ASTEROID OR THE EDGES OF
 ";F;"SPACE.";F
90 PRINT@965,"*** PRESS <CLEAR> TO START OR <BREAK> TO EXIT. ***";
100 F=INKEY$:IFF=CHR$(31)THENCLS:GOTO230:ELSEIFF=CHR$(2)THEN120ELS
E100
110 GOTO100:REM TRAP / RETURN
120 CLEAR50:CLS:POKE16396,25:END
130 END:REM SIDE SCROLL AND VIDEO "INVERT" M/L ROUTINE SET UP
140 FS="":FQ="":FORN=1TO16:FS=FS+CHR$(33):FORB=1TO5:READA:FS=FS+CH
R$(A):NEXTB:FS=FS+CHR$(1)+CHR$(63)+CHR$(0)+CHR$(237)+CHR$(176):NEX
T:FORN=1TO25:READA:FS=FS+CHR$(A):NEXT
150 F1=CHR$(166)+CHR$(153):POKE16396,23:FORN=1TO46:READA:FQ=FQ+CHR
$(A):NEXT:RETURN
160 DATA1,60,17,0,60,65,60,17,64,60,129,60,17,128,60,193,60,17,192
,60,1,61,17,0,61,65,61,17,64,61,129,61,17,128,61,193,61,17,192,61,
1,62,17,0,62,65,62,17,64,62
170 DATA129,62,17,128,62,193,62,17,192,62,1,63,17,0,63,65,63,17,64
,63,129,63,17,128,63,193,63,17,192,63,33,0,0,58,64,56,254,8,32,5,3
3,1,0,24,7,254,16,32,3,33,2,0,195,154,10
180 DATA33,64,60,126,254,32,32,4,54,191,24,31,254,128,40,248,254,1
66,32,4,54,153,24,19,254,153,32,4,54,166,24,11,254,191,32,4,54,32,
24,3,254,131,200,35,24,213
190 END:REM SIDE SCROLL EXECUTE
200 POKE16526,PEEK(VARPTR(FS)+1):POKE16527,PEEK(VARPTR(FS)+2):XX=U
SR(0):RETURN
210 END:REM VIDEO "INVERT" EXECUTE
220 POKE16526,PEEK(VARPTR(FQ)+1):POKE16527,PEEK(VARPTR(FQ)+2):X=US
R(0):RETURN
230 CLS:POKE15423,191:PRINT@0,"***$$$*** ASTRO-DODGE *** HIGH SCOR
E =";HS!;:X=0:FORY!=20TO4STEP-.5:SET(X,Y!):SET(X,47-Y!):X=X+1:NEXT
:FORX=33TO125:SET(X,4):SET(X,43):NEXT:SET(125,3):SET(125,44)
240 T=RND(50):FORN=1TOT:PRINT@RND(30)+20+RND(14)*64,F1;:NEXT:PRINT
@960,"***$$$*** PRESS <ENTER> TO START GAME ***$$$***";:POKE16383,
191:YC=23:XC=1:SET(XC,YC)
250 IFINKEY$<>CHR$(13)THEN250ELSEPOKE16405,0
260 GOSUB200:SET(XC,YC):SC!=SC!+1:PRINT@61+RND(14)*64,F1;:IFPOINT(
XC+1,YC)THEN290ELSEONXXGOTO270,280:GOTO260
270 IFPOINT(XC,YC-1)THEN290ELSEYC=YC-1:GOTO260
280 IFPOINT(XC,YC+1)THEN290ELSEYC=YC+1:GOTO260
```

(listing continued on page 182)

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● **Circle No. 204**

(listing continued from page 180)

```
290 RESET(XC,YC):PRINT@0,STRING$(63,176);:PRINT@960,STRING$(63,131
);:FORN=0TO50:GOSUB220:FORR=1TO15:NEXT:GOSUB220:FORR=1TO15:NEXTR,N
300 FORN=1TO64:PRINT@960,CHR$(131);:GOSUB220:GOSUB200:NEXT:PRINT@9
60,STRING$(3,191);:PRINT@262,CHR$(23);F1;" *** ASTRO-DODGE *** ";F
1;STRING$(4,13);TAB(7)"YOUR SCORE =";SC!;STRING$(2,13);
310 IFSC!>HS!THENHS!=SC!:PRINTTAB(5)"* A NEW HIGH SCORE *";
320 FORN=1TO1500:NEXT:PRINT@904,"PRESS <SHIFT> TO CONT.";:POKE1640
5,1
330 IFPEEK(14464)<>1THEN330ELSEPRINT@896,CHR$(30);
340 POKE16383,32:POKE15423,32:FORN=1TO64:GOSUB200:NEXT:FORN=1TO500
:NEXT:GOTO50
```

Round in circles.

```
10 CLS:DEFINT P,R-T,W-Y' **..SPIRAL BY
KEITH BLOUNT 14/03/83
20 X%=62 : Y%=24    ' X AND Y ARE THE
CENTRE CO-ORDINATES
30 R%=23            ' R = RADIUS
40 S%=1             ' S= ANGLE TO START
THE CIRCLE
50 T%=.0001         ' T= RATE OF
TWIST OF SPIRAL
60 P%=200
70 W%=2.5           ' W=THE WIDTH OF THE
SPIRAL
80 SET(X,Y)
90 FOR R%= R% TO 1 STEP -1
100 FOR A%=S% TO S% + 360 STEP
INT(360/P%)
110 SET (X%- (W% * R% * (COS (A% *
.01745))), Y% - (R% * (SIN (A% *
.01745))))
120 NEXT A%
130 S% = S% + T% : NEXT R%
140 GOTO 140
```

(continued from page 180)

revealing the quite remarkable depths of this utiltity. How you get on the mailing list I am not sure but I suggest that you write to Tandy Ltd, PO Box 58, Walsall, West Midlands.

Round in circles

Drawing circles is one of the difficult problems in Tandy graphics. There was even a competition a few years ago to devise the best program for drawing a circle. Keith Blount of Lings, Northampton has sent a little routine which can draw not only circles, but spirals as well. By modifying the variables as indicated in the remarks against lines 20 to 70 almost any variety of circles, arcs and spirals can be drawn.

We are printing Mr Blount's program exactly as he sent it in, and I hope he will not mind me pointing out a little mistake. He makes a Defint statement in line 1, but then adds integral identifiers to all his variables. The Defint statement makes this unnecessary; it is only when you want to use one of your defined variables as another type, say as a string or single-precision variable, that it is necessary to use an identifier.

Graphics reflections

To continue with graphics, here is a little routine from S J Combes of Bishop's Stortford, Hertfordshire. It produces a graphics character joined to its reflection, horizontally and vertically.

To understand the program you should understand how the computer interprets grahics codes: the character itself is composed of six elements or pixels which are either on or off. They are switched on or off according to the status of bits 5 to 0. The pixels are numbered across and down, so the top two pixels are 0 and 1, the middle two 2 and 3 and the bottom two, 4 and 5. Two to the power of the pixel number plus 128 is the CHR$ number of the graphic.

The program operates as follows:

Lines 20 and 40 — input CHR$ character code.

Lines 50 to 90 — obtain reversals and print them.

Lines 9000 onwards — convert number to bits and store in A(C); 1 if bit set, 0 if bit not set.

Lines 8000 to 8020 — reverse of above; result in Z.

Lines 1000 to 1020 — adjust A(C) to reverse character; input character in A, output character in Z.

Lines 2000 and 2010 — as 1000 but inverts character vertically.

Graphics reflections.

```
1 DEFINTA-Z
10 CLS:DIM C(5)
20 INPUT"ASCII CHARACTER
CODE";AA:A=AA:CLS
40 IF A(128 OR A)191 THEN 20
50 GOSUB 1000:E=Z
60 GOSUB 2000:F=Z
70 A=F:GOSUB 1000:G=Z:A=AA
80 PRINT@460,"ORIGINAL GRAPHIC
CHARACTER WAS       ";CHR$(AA):
81 PRINT@588,"ORIGINAL PLUS REVERSE
          "CHR$(A);CHR$(E)
85 PRINT:
90 PRINT@716,"ORIGINAL PLUS REVERSE
INVERTED      ";CHR$(F);CHR$(G)
100 PRINT:PRINT:GOTO 20
999 REM ** DUPLICATE HORIZONTALLY **
1000 GOSUB
9000:Z=0:P=A(0):Q=A(2):R=A(4)
1010 A(0)=A(1):A(1) = P : A(2)=
A(3):A(3)=Q:A(4)= A(5)
1020 A(5)=R:GOSUB 8000:RETURN
1099 REM ** DUPLICATE VERTICALLY **
2000 GOSUB
9000:Z=0:P=A(0):Q=A(1):A(0)=A(4):A(4)=P
2010 A(1)=A(5):A(5)=Q:GOSUB
8000:RETURN
7999  REM ** CONVERTS BITS BACK TO
CODE **
8000 FOR C=5 TO 0 STEP -1
8010 Z=Z+A(C)*2[C
8020 NEXT C:Z=Z+128:RETURN
8999 REM ** BREAK DOWN CODE INTO BITS
**
9000 B=A-128:FOR C=5 TO 0 STEP -1
9010 D=2[C: IF D(= B THEN B=B-D:A(C)=1
ELSE A(C)=0
9020 NEXT C: RETURN
```

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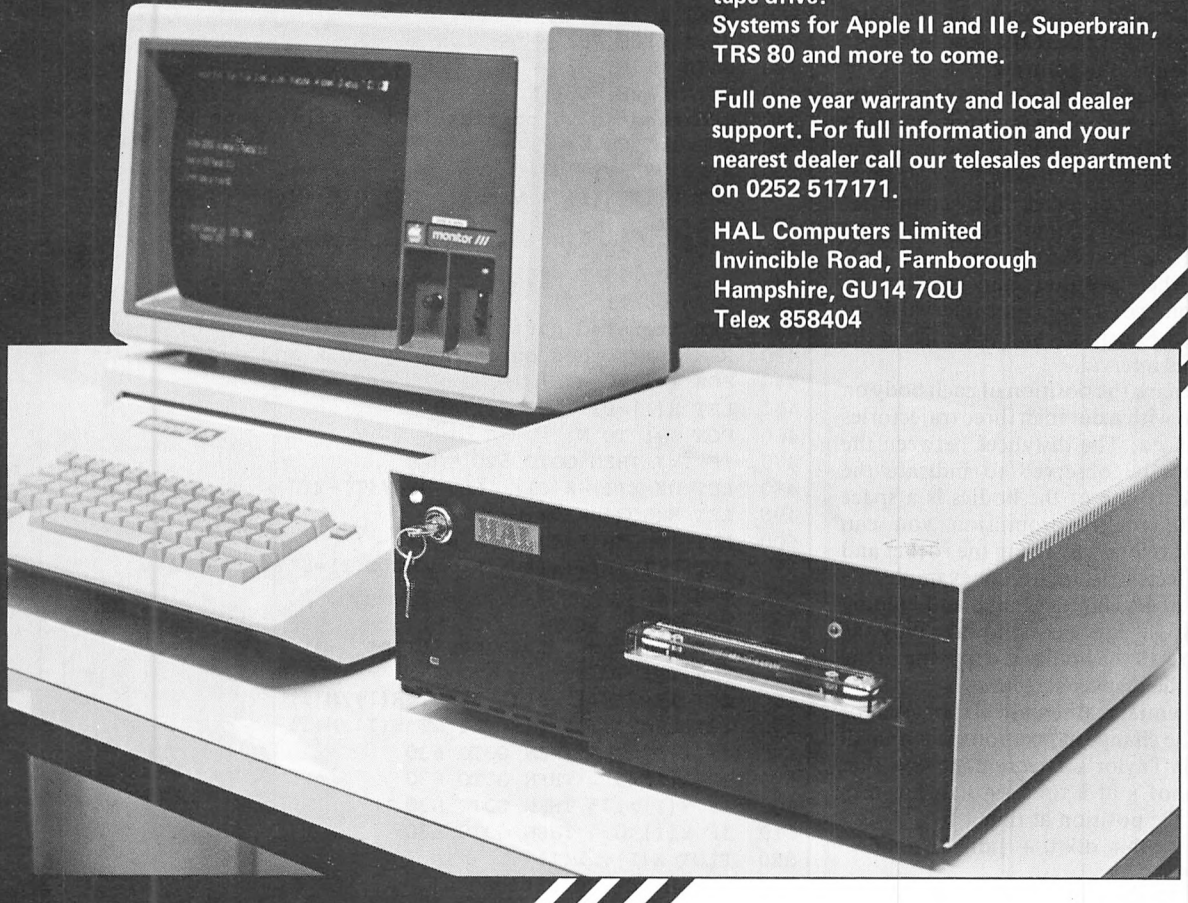

SO MUCH SPACE, WE'RE OUT OF THIS WORLD

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• Circle No. 205



Solar system

WITH A SMALL computer-graphics system like the Sinclair Spectrum or a pen plotter you can solve problems in celestial mechanics which taxed the best minds of the 18th and 19th centuries.

The problem of the description of the motion of three bodies acting on each other through gravitational forces is one which cannot be solved exactly by algebra, but it can be modelled easily by computer. The method used is simply to calculate the forces of the bodies on each other and, knowing their positions and velocities at the beginning of a small time interval dt, to calculate the positions and velocities at the end of this interval.

If you mark the position of each body on the screen with a dot then three trajectories are produced. The distances between the points can be observed to indicate the velocities. If one of the bodies is a space craft with rocket propulsion you can change its velocity by firing the rocket and see the effects to simulate, for example, the problem of leaving the Earth and landing on the Moon. It is easiest to take only the case where all the bodies are moving in the plane of the display screen.

The essential mathematical tool used for finding the change in position after a small interval is Taylor's Theorem. It says that the value of x at a time $t+dt$ is given in terms of the position at time t by:

$x(t+dt) = x(t) + dt\dot{x}(t) + \frac{1}{2}(dt)^2(t) + 1/6 (dt)^3 \dddot{x}(t) + ...$

where $\dot{x}(t)$ is the velocity at the time t, $\ddot{x}(t)$ is the acceleration at time t, $\dddot{x}(t)$ is the rate of change of acceleration, and so on.

If you write down the same expression for the previous time interval $(t-dt)$ and add it to the previous expression, then a number of terms cancel out giving:

$x(t+dt) = 2\,x(t) - x(t-dt) + (dt)^2\,\ddot{x}(t)$

Thus the new position $x(t+dt)$ equals the old position $x(t)$ plus the change which took place in the previous interval $(x(t)-x(t-dt))$ plus the acceleration time $(dt)^2$.

Since the acceleration of a body equals the force on it divided by its mass, knowing the forces gives you the motion. The x and y co-ordinates of each body change independently, since the axes are at right angles. It is necessary to calculate the components of the forces in the corresponding directions so that the forces between particles must be resolved into components parallel to x and y.

The force of gravitational attraction between two particles is

$$F = G M_1 M_2 / (r^2)$$

where G is the gravitational constant, M_1 and M_2 are the masses, and r is the distance between them. The components along the x-axis due to each body must be added to give the total force in this direction, and similarly for y.

For a stable, circular orbit of a small mass 1 about a large mass 2, the centrifugal force equals the gravitational attraction so that

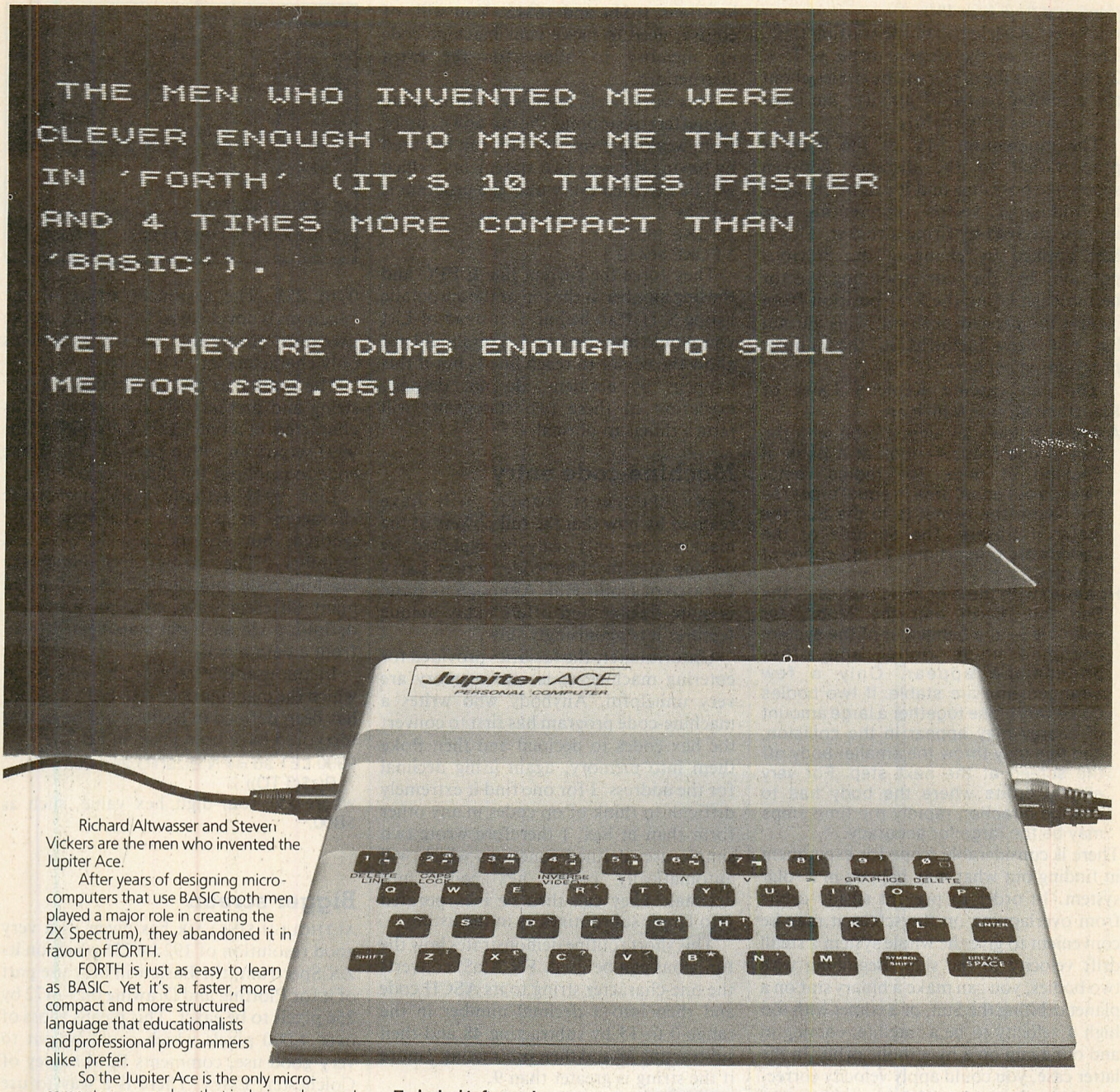
$$M_1V^2/r = G M_1M_2/(r^2)$$

This formula gives the velocity necessary to start the system for such an orbit. The velocity is brought into the calculation most simply by stating where the body was

(continued on page 186)

Solar system.

```
100  REM program LAPLACE for Sinclair Spectrum
110  REM traces satellite orbits under mutual gravitational forces
120  REM number of bodies = N
130  LET N=3
140  REM set gravitational constant G
150  LET G=1
160  REM set time interval for plotting positions
170  LET DT=0.20
180  DIM X(5):  DIM Y(5):  REM positions x,y
190  DIM P(5):  DIM Q(5):  REM previous positions x,y
200  DIM R(5):  DIM S(5):  REM forces in x,y directions
210  DIM M(5):  REM masses
220  REM read in masses of each body
230  FOR I=1 TO N
240  READ M(I)
250  NEXT I
260  DATA 10000, 100, 100
270  REM read in initial x,y positions of each body
280  FOR I=1 TO N
290  READ X(I), Y(I)
300  NEXT I
310  DATA  128, 83
320  DATA  178, 83
330  DATA  188, 83
340  REM read in velocities in x,y directions
350  FOR I=1 TO N
360  READ VX, VY
370  LET P(I)=X(I) - VX*DT:  LET Q(I)=Y(I) - VY*DT
380  NEXT I
390  DATA 0, -0.267
400  DATA 0, 15.7
410  DATA 0, 11
420  REM iterated part of program begins
430  REM sum forces on each body in x and y directions
440  FOR I=1 TO N
450  LET R(I)=0:  LET S(I)=0
460  FOR J=1 TO N
470  IF I=J THEN GOTO 520
480  LET DX=X(I)-X(J):  LET DY=Y(I)-Y(J)
490  LET R=SQR(DX*DX+DY*DY)
500  LET T=-G*M(I)*M(J)/R/R
510  LET R(I)=R(I)+T*DX/R:  LET S(I)=S(I)+T*DY/R
520  NEXT J
530  NEXT I
540  REM compute future positions
550  FOR I=1 TO N
560  LET XF=2*X(I)-P(I)+DT*DT*R(I)/M(I)
570  LET YF=2*Y(I)-Q(I)+DT*DT*S(I)/M(I)
580  IF X(I)>255 THEN GOTO 630
590  IF X(I)<0   THEN GOTO 630
600  IF Y(I)>175 THEN GOTO 630
610  IF Y(I)<0   THEN GOTO 630
620  PLOT X(I), Y(I)
630  REM update positions
640  LET P(I)=X(I):  LET Q(I)=Y(I)
650  LET X(I)=XF:    LET Y(I)=YF
660  NEXT I
670  GOTO 420
```



Richard Altwasser and Steven Vickers are the men who invented the Jupiter Ace.

After years of designing micro-computers that use BASIC (both men played a major role in creating the ZX Spectrum), they abandoned it in favour of FORTH.

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The Jupiter Ace manual is a complete introduction to personal computing and a simple-to-follow course in FORTH, from first principles to confident programming.

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It'll take you no time at all to realise how clever Richard and Steven were to design the Jupiter Ace around FORTH. And even less time to realise what a silly price £89.95 is to charge for it.

Technical Information

Hardware
Z80A; 8K ROM; 3K RAM.

Keyboard
40 moving keys; auto repeat; Caps Lock.

Screen
Memory mapped 32 col x 24 line flicker-free display upper and lower case ascii characters.

Graphics
High resolution 256 x 192 pixel user defined characters.

Sound
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(continued from page 184)

one interval earlier than the starting time. The period of the circular orbit is T = 2r/V. In fact the orbits will be circles about the common centre of gravity, the large mass moving only slightly.

The momentum MV of the body is proportional to the distance between successive positions and it can be changed by adding a vector representing the impulse derived by firing a rocket. This is best applied by changing the previous position by the corresponding vector before calculating the next position from it, and the present position. This variant has not been included in the simpler programs given here.

You can explore Kepler's Laws of Planetary Motion which are:

A planet follows an elliptic orbit with the Sun at one focus — look at a Bank of England £1 note. The radius vector sweeps out equal area in equal times, so the nearer the planet is to the Sun the faster it travels. The squares of the periods are proportional to the cubes of the radii.

However, with three or more bodies — the Sun, the Earth and the Moon, for example — the behaviour of the system becomes much richer and other phenomena appear. Only a few arrangements are stable: if two bodies come very close together a large amount of energy may appear in the collision, and this may throw the smaller body off the screen at the next step. For very elliptic orbits where the body has to change direction rapidly the time steps may be too large for accuracy.

There is considerable scope for experiment in finding out what may happen in a solar system. In order to prevent steady orbits from overlapping on the screen it may be convenient to give the whole system a small drift velocity to the side. Beginning with two bodies, you can make a binary star on a planet orbiting the Sun, or a comet with too high a velocity to be a satellite, coming in and out again on a hyperbolic orbit. In the latter case, you could apply velocity corrections by rocket and see if that puts it into circular orbit, like the spacecraft circling the Moon.

With three bodies, unexpected things begin to happen. Try making a Moon, Earth and Sun system. You can find out whether three suns circling their common centre of gravity are stable, and can ask what happens if you change the inverse-square of attraction to some other power.

Clean screen

A REM STATEMENT at the beginning of your ZX-81 program with machine code in it can produce a very messy screen, write David Threlfall and John Hodgson of Bristol. In extreme cases it can cause Sinclair's automatic listing system to loop endlessly.

A simple cure is to Poke the two locations after the token representing Rem with the number 118. If this statement is the first in your program these are locations 16514 and 16515. You will, of course, need to move your machine code up memory to allow for the extra instructions.

This works well, but has an unfortunate side-effect of stopping the up/down cursor from working properly. This can be cured by having the next two statements, which will be executed every time the program is run, as

2 POKE 165394,3
3 POKE 16419,3

They force the current line E PPC and the line number at the top of the automatic listing S TOP to be line 3. Instead of List you should now use List 4. You should not allow the cursor to reach line 1, but if this happens by accident, do not despair: execution of these two statements will return things to normal.

Machine-code entry

MANY SPECTRUM OWNERS will have realised by now that the full powers of the machine can only truly be exploited by delving into machine code, writes Larry Carasco of Dollis Hill. Although its Basic is quite flexible and offers many unique features it is agonisingly slow.

Unfortunately the facilities provided for entering machine code into memory are very unhelpful. Anybody who writes a machine-code program has first to convert the hex codes to decimal and then Poke them into memory, again using decimal for the address. I for one find it extremely difficult to think of op codes in any other form than in hex. I therefore wrote two simple user-defined functions which will automatically covert hex codes into decimal. They can then be incorporated into larger subroutines as in the listing.

This short routine demonstrates how the functions can be used. FN A(a$) converts the one-character string to its ASCII code and then into a decimal number in the range 0 to 15 by subtracting 48 and then subtracting 48 and then subtracting 7 more if the string is greater than 9.

FN B(a$) simply takes a two-character string and uses FN A to convert each character to decimal, multiplying the first number — the value of the first character of a$ — by 16 and adding to the second number. This leaves a result in the range of 0 to 255. The argument string of the functions is not checked for validity, so the user must ensure that the string contains only characters 0 to 9 or A to F.

Bigger screen.

```
 900 REM  x holds x coordinate,
          0-255.
 910 REM  y holds y coordinate,
          0-191.
 920
1000 LET y=191-y
1010 LET a=16384+INT (y/64)*2048
1020 LET a=a+256*(y-8*INT (y/8))
1030 LET a=a+32*INT ((y-64*INT (
y/64))/8)
1040 LET a=a+INT (x/8)
1050 LET bit=7-x+8*INT (x/8)
1060 LET y=191-y
1065
1070 REM  a holds address to be
          poked.
1080 REM  bit is the bit to be
          set.
1085
1090 REM  POKE a,2↑bit+PEEK a
          will plot x,y on the
          enlarged screen.
1100 REM  Points can only be
          plotted if the point
          is not set already
1110 REM  POKE a,PEEK a-2↑bit
          will unplot x,y on
          the enlarged screen
          if that point has
          been set.
```

Machine-code entry.

```
9990 LET ad=23296
9991 DEF FN A(a$)=CODE a$-48-7*(
a$>"9")
9992 DEF FN B(a$)=FN A(a$(1))*16
+FN A(a$(2))
9993 LET a$="3E 20 06 85 F5 D7 F
1 3C 10 FA C9"
9994 FOR x=1 TO LEN a$ STEP 3
9995 POKE ad,FN B(a$(x TO x+1))
9996 LET ad=ad+1: NEXT x
9997 PRINT AT 0,0;: RANDOMIZE US
R 23296
```

ad is start address

a $ is machine code in hex

The routine as presented takes a larger string and presents FN B with two of its characters at a time, lines 9994,9995. Line 9993 sets a$ up with a portion of machine code to print out the character set.

Line 9994 actually skips over three characters at a time. The spaces are ignored, but are included here to aid legibility. The string containing the machine code could actually be defined in many different ways, either by a straight definition via an Input statement or read from a data block.

In the example routine the address at which the machine code is to be Poked, ad, has been defined in decimal although that too could have been given in hex by:

9990 LET ad = FN B(z$(TO 2))* 256 + FN B(z$(3 TO))

where z$ = four-digit hex value, such as 5B00.

Bigger screen

ALTHOUGH SINCLAIR has given us a very good resolution of 192 by 256 pixels on its ZX Spectrum, the Basic will only use part of it for Plotting and Drawing on — 172 by 256 pixels to be eaxct. This means a loss of over 4,000 pixels which could be put to very good use, comments Bill Longley of Colchester, Essex. There is a way to use them, however, with this routine and a little Peeking and Poking.

Before using the routine, set up the values of X, the X co-ordinate betwee 0 and 255, and of Y, the y co-ordinate between 0 and 192. The routine will give you the address A which must be Poked and Bit, which is the bit to be set. So

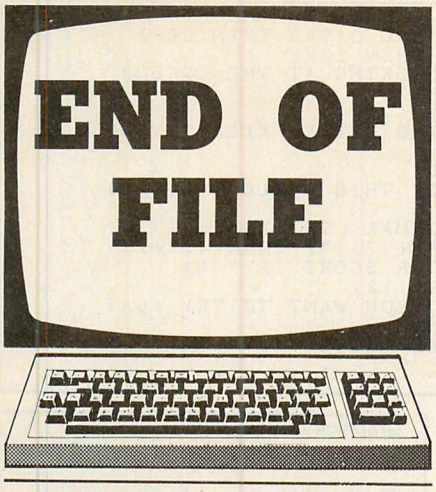
POKE A,2↑BIT + PEEK A

will set the point X,Y on the large screen, which is equivalent to the point X – 16,Y on the normal screen.

The Peek A is needed to avoid erasing the other seven pixels in the byte. To erase the pixel, use

POKE A,PEEK A – 2↑BIT

Setting pixels that are already set, or erasing non-existent pixels will give unusual displays, but will not affect the rest of the program. A little care is needed, but it is worth it to get at the spare 4,000 pixels. Who said that Poking the Spectrum's screen was impossible?



SUPERBRAIN

Invaders

SPACE INVADER programs may be 10-a-penny, but this one by Professor R V Thompson of the University of Newcastle upon Tyne runs on an unmodified Superbrain. It uses cursor-control codes to place invaders on the screen; no special graphics board is required.

JUPITER ACE

User-defined graphics

THE ACE MANUAL gives a method of defining graphics characters, observes William Kirby of Tarporley, Cheshire. It also explains that the character RAM cannot be read from without the data being corrupted since the data is logically Ored with the ASCII code. Character definitions cannot therefore be directly stored on tape. It is necessary to duplicate the eight bytes needed for each character in another area of memory.

The Forth words defined in listing 1 simplify editing the definitions of any of the 128 characters, and allow redefined characters to be saved on cassette files.

CArray creates an array of n*8 bytes, where n is the number of characters for which you wish to store data. A word defined by CArray, given the element number on the stack, returns the address of the required element.

Element 0 holds the size of the array in bytes; it is used by Inchars, which expects an address on the stack. Inchars fetches the size of the array and allows data to be input from the keyboard in hexadecimal, until the array is full, listing the data on the screen. CMove copies n bytes, starting at address a1 to n addresses starting at a2.

It is a good idea to Save these three words for future use before going any further. The example in listing 2 defines the characters for a game.

You can now see the characters by entering 1 Emit, 2 Emit, etc. or by using Graphics mode. In Graphics mode the A key gives ASCII code 1, the B key ASCII code 2 and so on. If you have made a mistake entering the data it can be corrected by changing individual elements of Chars. For example, to set byte 3 of character code 5 to A0 hex you must change element (5 – 1)*8 + 3 = 27 of Chars, with

160 27 CHARS C! (enter)

You will not see the effect until you copy the data across again with CMove.

When you have set up the data correctly, it can be stored on tape with

1 CHARS 120 BSAVE PIECES (enter)

Using BLoad, the data can be read back from tape into any memory location. To retrieve a file of graphics characters, load them straight into the character RAM with

11272 0 BLOAD filename (enter)

(continued on next page)

Invaders.

```
100 REM ****************************
110 REM *                          *
120 REM *        INVADERS          *
130 REM *                          *
140 REM ****************************
150 REM
160 REM +++ PRESS KEY A TO MOVE LEF
T:KEY D TO RIGHT:S TO SHOOT+++
170 PRINT CHR$(12)
180 PRINT CHR$(27);"Y";CHR$(32+10);
CHR$(32+38);"*** INVADERS ***"
190 FOR I=1 TO 1000:NEXT I
200 PRINT CHR$(12)
210 J=5:M=142:A$=STRING$(J,M)
220 B$="    XXX"
230 C$="              "
235 F$="  !! POW !!  "
236 Z=0
240 S$="^":O$="  "
250 X=38:GOSUB 720
260 X1=38:S=0
280 REM *** GENERATE INVADERS ***
290 FOR I=1 TO 1000
300 REM
310 REM ***GENERATE POSITION OF INV
ADERS ***
320 REM
330 Y2=INT(RND*15)+1:X2=INT(RND*70)
+2
334 X5=X2
335 S=S-1
336 X6=X
340 GOSUB 580
345 IF X5)(X6+2) AND X5((X6+8) THEN
 940
350 I$=INPUT$(1)
360 IF I$="A" THEN 390
370 IF I$="D" THEN 450
380 IF I$="S" THEN 510
390 S=S-1:X1=X1-1:X=X1: IF X(=1 THE
N 450
400 GOSUB 720
410 REM
420 REM  *** MOVE PLATFORM TO THE L
EFT ****
430 REM
440 GOTO 530
450 S=S-1:X1=X1+1:X=X1: IF X)=68 TH
EN 390
460 GOSUB 720
470 REM
480 REM  *** MOVE PLATFORM TO THE R
IGHT ***
490 REM
500 GOTO 530
510 S=S+3: GOSUB 780
511 D$=" *** "
515 PRINT CHR$(27);"Y";CHR$(32);CHR
$(32+60);D$;"SCORE ";S;D$
520 GOTO 350
530 NEXT I
540 GOTO 2200
550 REM
560 REM  *** INVADER ALLOCATION TO
CURSUR ROUTINE ***
570 REM
580 X=X2:Y=Y2
590 REM
600 REM  *** PRINT INVADER ON SCREE
N ***
610 REM
620 PRINT CHR$(27);"Y";CHR$(32+Y);C
HR$(32+X);CHR$(7);A$
630 GOSUB 860
640 REM
650 REM *** REALLOCATE VALUES OF Y
AND X ***
660 REM
670 Y=0:X=X1
680 RETURN
690 REM
700 REM  *** CLEAR SPACE FOR PLATFO
RMS NEXT MOVE ***
710 REM
720 PRINT CHR$(27);"Y";CHR$(32+22);
CHR$(32+X);C$
730 REM
740 REM   *** ENTER NEW POSITION OF
 PLATFORM ***
750 REM
760 PRINT CHR$(27);"Y";CHR$(32+22);
CHR$(32+X);B$
770 RETURN
780 FOR Y=21 TO 1 STEP -1
790 REM
800 REM *** PLATFORM FIRING ROUTINE
 ****
810 REM
820 PRINT CHR$(27);"Y";CHR$(32+Y);C
HR$(32+(X+4));S$
830 PRINT CHR$(27);"Y";CHR$(32+Y);C
HR$(32+(X+4));O$
840 NEXT Y
850 RETURN
860 FOR Y4=Y TO 22 :Y=Y4
870 REM
880 REM *** INVADER BOMBING ROUTINE
 ****
```

(listing continued on next page)

(listing continued from previous page)

```
890 REM
900 PRINT CHR$(27);"Y";CHR$(32+Y);C
HR$(32+X);S$
910 PRINT CHR$(27);"Y";CHR$(32+Y);C
HR$(32+X);O$
920 NEXT Y4
930 RETURN
940 PRINT CHR$(27);"Y";CHR$(32+22);
CHR$(32+X);F$
950 Z=Z+1:IF Z=>3 THEN 2000
960 PRINT CHR$(27);"Y";CHR$(32);CHR
$(32);"**NO OF HITS ";Z;"**"
970 GOTO 330
2000 FOR I=1 TO 1000:NEXT:PRINT CHR
$(12):Y=10:X=25
2040 IF S<100 THEN 2095
2050 IF S>100 AND S<200 THEN 2080
2060 IF S>200 AND S<500 THEN 2090
2070 IF S>500 THEN 2071
2071 L$="I'M LOOKING AT THE WORLDS
BIGGEST FIDDLER"
2075 GOTO 2100
2080 L$="GETTING BETTER KEEP TRYING
"
2085 GOTO 2100
2090 L$="OUT OF THIS WORLD":GOTO 21
00
2095 L$="SUBNORMAL  TRY AGAIN !!!!"
2100 PRINT CHR$(27);"Y";CHR$(32+Y);
CHR$(32+X);"YOUR SCORE IS ";L$
2150 PRINT CHR$(12)
2200 INPUT "DO YOU WANT TO TRY AGAI
N YES OR NO";M$
2300 IF M$="YES" GOTO 170
2400 END
```

(continued from previous page)

For this example, Filename would be replaced by Pieces. If you want to verify a tape file, this has to be done against the data in the array rather than the character RAM.

The remaining Forth words, shown in listing 3, enable the Ace to act as an Othello-type board game called Counters. They only just fit in the unexpanded Ace, so Forget anything in the dictionary before typing them in. The graphics characters used are shown in figure 1.

If you now type in HERE . and press Enter the result should be 16297. If not, you may well have missed something out. Before playing the game save the game words, just in case.

The rules of the game are as follows:

- The game is for two players. One plays with black counters, the other with white. Black always starts.
- To play, you place a counter on an empty square so as to capture at least one of your opponent's counters.
- To capture a counter, the counter you put down must complete a line of counters in any direction, with a counter of your colour at the far end, trapping at least one counter of the opposite colour in between. All counters so trapped are taken.
- If you canot make a valid move you must forfeit your move.
- To start the game, enter GO
- Enter your move with a letter A to H or a to h, followed by a number 1-8 and press Enter. On each move, the computer will check if the move is valid. If so, it will convert all the appropriate counters. If not valid, it will ignore the move and you can try again. To concede your turn in the event of there being no valid move, enter an x or X.
- The game ends either when the board is full, or when both players have conceded a turn. On this computer version, you must both concede even when the board is full to finish the game. The player with the most counters on the board at the end of the game is the winner.

Graphics — figure 1.

┌ Graphics C	└ Graphics I
┬ Graphics D	┴ Graphics J
┐ Graphics E	┘ Graphics K
├ Graphics F	│ Graphics N
┼ Graphics G	─ Graphics O
┤ Graphics H	

Graphics — listings 1.

```
DEFINER  CARRAY
  NUMBER  DROP  8  *  DUP
  C,  0
  DO
    0  C,
  LOOP
DOES>
  DUP  C@  ROT  SWAP  OVER
  <  OVER  0  <  OR
  IF
    ." SUBSCRIPT OUT OF RANGE
    CR  ABORT
  THEN
  +
;


: INCHARS
  ( Address - )
  INVIS  16  BASE  C!  22
  0  AT  DUP  C@  8
  /  1+  1
  DO
    CR  I  .  9  1
    DO
      BEGIN
        QUERY  NUMBER
      UNTIL
      DUP  .  SWAP  1+  DUP
      ROT  SWAP  C!
    LOOP
  LOOP
  DECIMAL  VIS
;


: CMOVE
  ( a1,a2,n )
  SWAP  3  PICK  -  ROT
  ROT  0
  DO
    OVER  OVER  DUP  C@  ROT
    ROT  +  C!  1+
  LOOP
  DROP  DROP
;
```

Listing 2.

```
 CARRAY  CHARS  15    (enter)

 0  CHARS  INCHARS    (enter)

3C  42  81  81  81  81  42  3C

3C  7E  FF  FF  FF  FF  7E  3C

 0   0   0  1F  10  10  10  10

 0   0   0  FF  10  10  10  10

 0   0   0  F0  10  10  10  10

10  10  10  1F  10  10  10  10

10  10  10  FF  10  10  10  10

10  10  10  F0  10  10  10  10

10  10  10  1F   0   0   0   0

10  10  10  FF   0   0   0   0

10  10  10  F0   0   0   0   0

 0   0   0   0   0   0   0   0

 0   0   0   0   0   0   0   0

10  10  10  10  10  10  10  10

 0   0   0  FF   0   0   0   0

1  CHARS  11272  120  CMOVE  (enter)
```

Listing 3.

```
: BOARD
  CLS  1 8  AT  ." ┌┬┬┬┬┬┬┬┐"
  9  1
  DO
    I  DUP  +  DUP  6
    AT  I  .  ." ├┼┼┼┼┼┼┼┤"
    1+  8  AT  ." └┴┴┴┴┴┴┴┘"
  LOOP
  17  8  AT  ." ▁▁▁▁▁▁▁▁"
  0  9  AT  ." A B C D E F G H"
  2  DUP  9487  C!  9553  C!
  1  DUP  9489  C!  9551  C!
  22  3  AT  ." to play"
;

0  VARIABLE  X
0  VARIABLE  Y
0  VARIABLE  DX
0  VARIABLE  DY
0  VARIABLE  COL


: PCE
  DUP  +  7  +  SWAP
  DUP  +  SWAP  AT  COL
  @  EMIT
;

: ?C
  DUP  +  SWAP  64  *
  +  9223  +  C@
;

: ENTER
  QUERY  32  WORD  1+  DUP
  C@  64  -  DUP  8
  >
  IF
    32  -
  THEN
  SWAP  1+  C@  48  -
  SWAP  OVER  OVER  Y  !
  X  !
;

: ?CH
  0  X  @  Y  @
  BEGIN
    DY  @  +  SWAP  DX
    @  +  SWAP  OVER  OVER
    ?C  3  COL  @  -
    =
  WHILE
    ROT  1+  ROT  ROT
  REPEAT
  OVER  OVER  ?C  COL  @
  =
  IF
    ROT  0
    DO
      DY  @  -  SWAP  DX
      @  -  SWAP  OVER  OVER
      PCE
    LOOP
    DROP  DROP  1
  ELSE
    DROP  DROP  DROP  0
  THEN
;

: TEST
  ?C  2-  0>  0  SWAP
  IF
    2  -1
    DO
      2  -1
      DO
        X  @  I  DUP  DX
        !  +  Y  @  J
        DUP  DY  !  +  ?C
        3  COL  @  -  =
        IF
          ?CH  +
        THEN
      LOOP
    LOOP
  THEN
;

: GO
  INVIS  BOARD  2  COL  !
  0
  BEGIN
    3  COL  @  -  DUP
    9921  C!  COL  !
    BEGIN
      ENTER  TEST  Y  @  24
      =  OR
    UNTIL
    Y  @  24  =
    IF
      1+
    ELSE
      DROP  0  X  @  Y
      @  PCE
    THEN
    DUP  1-  0>
  UNTIL
  22  1  AT  ." GAME OVER"
;
```



SIG/NET FOR A GROWING BUSINESS

At present, your business may only need a single workstation computer with floppy disc storage. But by next year you may require additional storage provided by hard disc. And then you may need more workstations so that several of your staff can use the computer at the same time to carry out different jobs.

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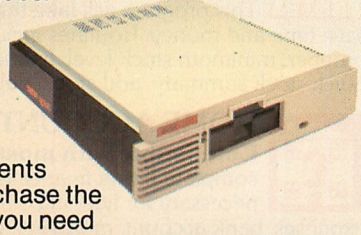

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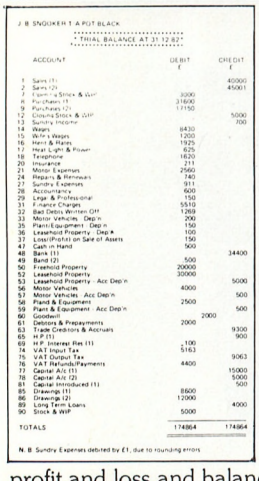
NEW.....£59.95


J B SNOOKER T/A POT BLACK
* TRIAL BALANCE AT 31.12.82*

ACCOUNT	DEBIT £	CREDIT £
1 Sales (1)		40000
2 Sales (2)		45001
7 Opening Stock & WIP	3000	
8 Purchases (1)	31600	
9 Purchases (2)	17150	
12 Closing Stock & WIP		5000
13 Sundry Income		700
14 Wages	8430	
15 Wife's Wages	1200	
16 Rent & Rates	1925	
17 Heat Light & Power	625	
18 Telephone	1620	
20 Insurance	211	
21 Motor Expenses	2560	
24 Repairs & Renewals	740	
27 Sundry Expenses	911	
28 Accountancy	600	
29 Legal & Professional	150	
31 Finance Charges	5510	
32 Bad Debts Written Off	1269	
33 Motor Vehicles Dep'n	200	
35 Plant+Equipment Dep'n	150	
36 Leasehold Property Dep'n	100	
37 Loss(Profit) on Sale of Assets	150	
47 Cash in Hand	500	
48 Bank (1)		34400
49 Bank (2)	500	
50 Freehold Property	20000	
52 Leasehold Property	30000	
53 Leasehold Property Acc Dep'n		5000
56 Motor Vehicles	4000	
57 Motor Vehicles Acc Dep'n		500
58 Plant & Equipment	2500	
59 Plant & Equipment Acc Dep'n		500
60 Goodwill	2000	
61 Debtors & Prepayments	2000	
63 Trade Creditors & Accruals		9300
65 H.P.(1)		900
69 H.P. Interest Res (1)	100	
74 VAT Input Tax	5163	
75 VAT Output Tax		9063
76 VAT Refunds/Payments	4400	
77 Capital A/c (1)		15000
78 Capital A/c (2)		5000
81 Capital Introduced (1)		500
85 Drawings (1)	8600	
86 Drawings (2)	12000	
89 Long Term Loans		4000
90 Stock & WIP	5000	
TOTALS	174864	174864

N.B. Sundry Expenses debited by £1, due to rounding errors

One of the most innovative business programs on the market. Replaces a manual cash book system, e.g. Simplex and 'All-in-One'. Written by practising Chartered Accountants, this practical program is simple to use and will replace your manual cash and bank records. By giving you access to vital management information as and when you want it, it will enable you to keep more positive financial control of your business.

The software is extremely well and lucidly documented, and Gemini provide a full technical back-up and product up-date policy. Take a look at the information this program will provide:-

* Summary of VAT information for VAT returns * Cumulative receipts and payments report analysed over the standard profit and loss and balance sheet headings * Option for departmental analysis of sales and purchases * Audit trail printout of all transactions. * Journal routine for entering transfers between accounts and year end adjustment for debtors, creditors etc. * Trial balance at any interval * Interfaces to 'Final Accounts' program to produce balance sheet and trading and profit/loss account etc. * Spectrum version may be used with Sinclair OR 80 column printer.

FINAL ACCOUNTS PROGRAM FOR BBC 32K, TORCH, SPECTRUM 48K.....£59.95

NEW

Requires Cash Book module. This program will take your cash book data to the logical conclusion of balance sheet, trading and profit/loss account and notes to the accounts i.e. fixed assets, land and buildings and capital accounts. Final accounts (BBC version) links to 'Beebplot' for graphic data presentation.

Format: Torch disk, BBC disk/cassette, Spectrum cassette.

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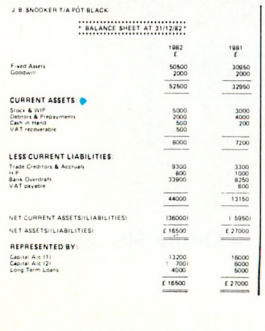
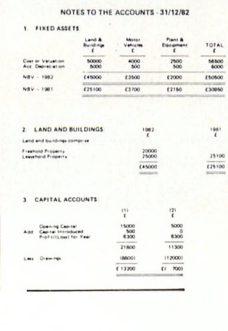

J B SNOOKER T/A POT BLACK
* BALANCE SHEET AT 31/12/82 *

	1982 £	1981 £
Fixed Assets	50500	30850
Goodwill	2000	2000
	52500	32950
CURRENT ASSETS		
Stock & WIP	5000	3000
Debtors & Prepayments	2000	4000
Cash in Hand	500	200
VAT recoverable	500	
	8000	7200
LESS CURRENT LIABILITIES		
Trade Creditors & Accruals	9300	3300
H.P.	800	1000
Bank Overdraft	33900	8250
VAT payable		600
	44000	13150
NET CURRENT ASSETS/(LIABILITIES)	(36000)	(5950)
NET ASSETS/(LIABILITIES)	£16500	£27000
REPRESENTED BY:		
Capital A/c (1)	13200	16000
Capital A/c (2)	(-700)	6000
Long Term Loans	4000	5000
	£16500	£27000


J B SNOOKER T/A POT BLACK
PERIOD 1 YEAR ENDED 31.12.82

	1982 £	1981 £
Sales (1)	40000	27001
Sales (2)	45001	32001
TOTAL SALES	85001	59002
Opening Stock & WIP	3000	2000
Purchases (1)	31600	21750
Purchases (2)	17150	11750
	51750	35501
Closing Stock & WIP	5000	3000
COST OF SALES	46750	29501
GROSS PROFIT (%)	38251 (45%)	29501 (50%)
Sundry Income	700	500
	38951	29501
LESS EXPENSES		
Wages	9630	7640
Wife's wages	1200	1200
Rent & Rates	1925	1925
Heat, Light & Power	625	588
Telephone	1620	1410
Insurance	211	211
Motor Expenses	2560	2100
Repairs & Renewals	740	610
Sundry Expenses	911	1000
Accountancy	600	500
Legal & Professional	150	250
Finance Charges	5510	3900
Bad Debts Written Off	1269	1000
TOTAL EXPENSES	25781	19961
DEPRECIATION		
Motor Vehicles	200	200
Plant+Equipment	150	150
Leasehold Property	100	100
Loss(Profit) on Sale of Assets	150	350
TOTAL DEPRECIATION	600	650
TOTAL OVERHEADS	26381	20611
NET PROFIT/(LOSS)	£12570	£ 8890


NOTES TO THE ACCOUNTS - 31/12/82

1. FIXED ASSETS

	Land & Buildings £	Motor Vehicles £	Plant & Equipment £	TOTAL £
Cost or Valuation	50000	4000	2500	56500
Acc. Depreciation	5000	500	500	6000
NBV - 1982	£45000	£3500	£2000	£50500
NBV - 1981	£25100	£3100	£2150	£30350

2. LAND AND BUILDINGS

	1982 £	1981 £
Land and buildings comprise		
Freehold Property	20000	
Leasehold Property	25000	25100
	£45000	£25100

3. CAPITAL ACCOUNTS

	(1) £	(2) £
Opening Capital	15000	5000
Add: Capital Introduced	500	0
Profit(Loss) for Year	6300	8300
	21800	13300
Less: Drawings	(8600)	(12000)
	£13200	£1 7000

"Gemini's range of software is in the vanguard of the releases for 'serious' micro users..."
(WHICH MICRO AND SOFTWARE REVIEW)

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Compatible with most micros. See table. Ideal for the small business. A complete suite of programs together with generated customer file for producing crisp and efficient business invoices and monthly statements on your line printer. All calculations include VAT automatically, and the program allows your own messages on the form produced. This program gives you superb presentation and saves time on one of the most tedious tasks in the office.

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Compatible with most micros. See table. A gem of a program, all for cassette, with the following features:- Daily Journal. Credit Sales. Cash Sales. Credit Purchases. Purchases – other. Sales Ledger. Purchase Ledger. Bank Account. Year to date summary. A fully interactive program suitable for all businesses. Files can be saved and loaded and totals from one file carried forward to another on cassette. Particularly useful from a cash flow point of view, with an immediate accessibility to totals for debtors and creditors. Bank totally supported with entries for cheque numbers, credits and, of course, running balance.

MAILING LIST...£19.95

Compatible with most micros. See table. A superb dedicated database to allow for manipulations of names and addresses and other data. Gemini's unique 'searchkey' system gives you a further ten 'user-defined parameters' to make your own selections. Features include the facility to find a name or detail when only part of the detail is known, it will print labels in a variety of user specified formats.

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Compatible with most micros. See table. The program that everyone needs, the most valuable and versatile in your collection. Facilities include sort search, list print if required. Can be used in place of any card index application; once purchased you can write your own dedicated database to suit your particular needs with a limitless number of entries on separate cassettes.

STOCK CONTROL...£19.95

Compatible with most micros. See table. Dedicated software with all that's necessary to keep control of stock. This program will take the tedium out of stock control and save time and money. Routines include stock set up, user reference number, minimum stock level, financial summary, line print records, quick stock summary, add stock, delete/change record and more.

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Compatible with most micros. See table. Runs a complete home finance package for you with every facility necessary for keeping a track of regular and other expenses, bank account, mortgage, H.P., etc. This program also allows you to plot graphically by Histograms your monthly outgoings.

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	POSITION A1 RC SPACE 5185 T			
	II A II B II C II			
1	–J.B. SNOOKER T/A POT–BLACK			
2	PROJECTED CASH FLOW		YEAR	ENDED
3				
4			Oct.	Nov.
5			£	£
6	INCOME			
7	Sales		11786	10944
8				
9				
10	REVENUE EXPENDITURE			
11	Purchases		500	500
12	Advertising		500	1000
13	Director's salary		1596	1596
14	Salaries		2216	2216
15	Rent			
16	Telephone			300
17	Insurance			200
18	Printing, stationary			400
19	Repairs & renewals			
20	Hire of equipment		60	60
	COMMAND BCDEFGPRSTW*?			

Without any programming knowledge at all, you may:-

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- Specify formulae relating any row or column to any other.
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Some typical applications:—

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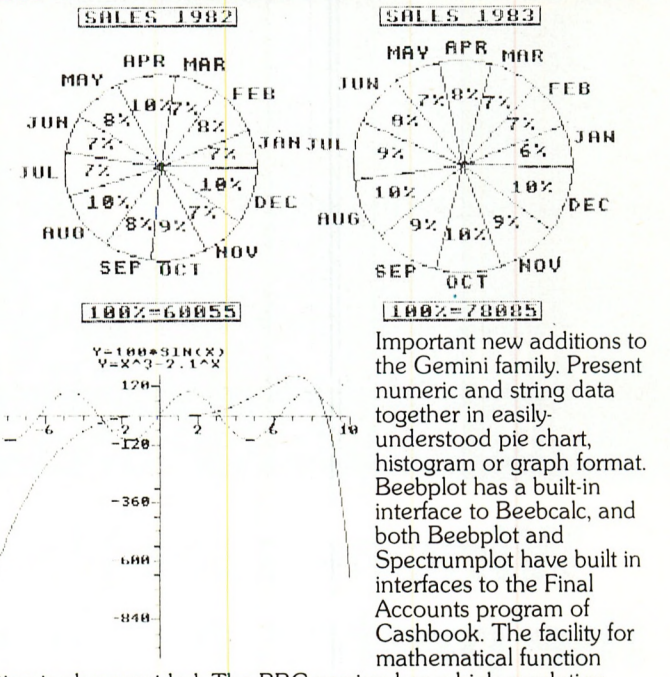
- Investment project appraisal— anything from double glazing to oil rigs!
- Comparing rent/lease/buy options.
- Processing the results of scientific experiments or field studies.
- Engineering calculation models.
- In fact, anything that involves repeated re-calculation of results presented in tabular or spreadsheet format.

Program Availability Chart:–

	Database	Stock Control	Mailist	Invoices & Statements	Spread sheet Analysis	Cashbook Accounting	Word processor	Home Accounts	Commercial Accounts	Plot	Final Accounts
Sinclair Spectrum 16k or 48k	●	●	●			●		●	●	●	●
Dragon 32k or 64k	●	●	●	●	●			●	●		
VIC 20 (16k +)	●	●	●	●				●	●		
Sinclair ZX81 (16k +)	●										
Grundy Newbrain	●										
Sharp MZ80A	●	●	●	●				●	●		
Sharp MZ80K	●	●	●	●				●	●		
Sharp MZ80B	●	●	●	●				●	●		
BBC Micro model A or B 32k	●	●	●	●	●	●	●	●	●	●	●
Atari 400/800	●										
Torch	●	●	●	●	●	●	●	●	●	●	●
Epson HX-20	●										
Commodore 64	●										

BEEBPLOT & SPECTRUMPLOT £19.95

NEW



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SUPERCALC	SORCIM's spread sheet and modelling system.
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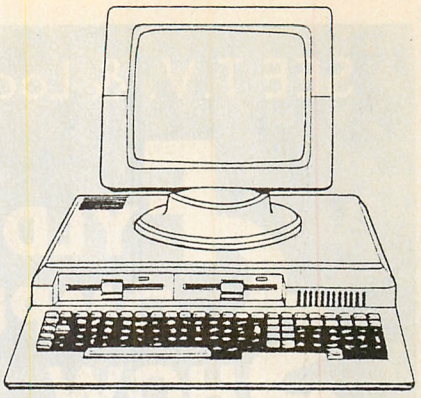

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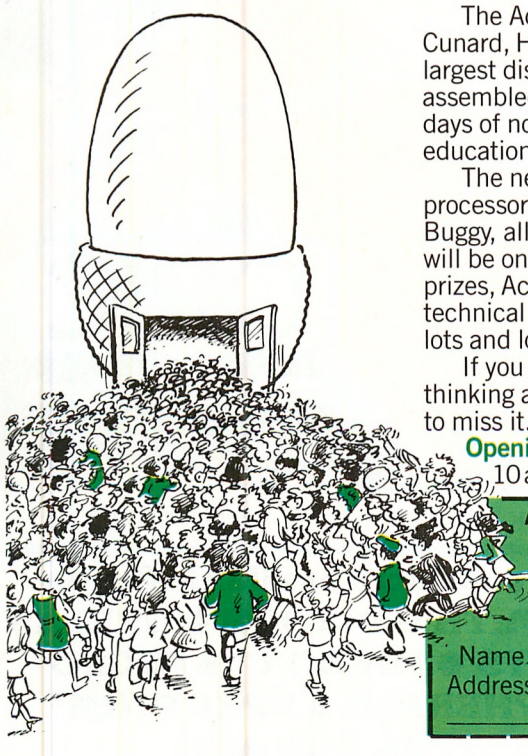

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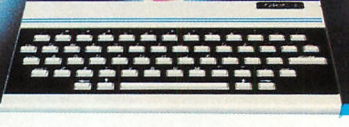

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"The sound commands on the Oric 1 are, for a computer of this price, very sophisticated. Three music channels, and one noise channel, mean that you can program some fairly complex sounds."

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YOUR COMPUTER

"The 16k Oric – fighting the 16k Spectrum – is £25 cheaper. It feels a good deal more 'professional' than the home-appeal Sinclair. Oric's sound is extremely versatile, and well up to the standard of the £300 or £400 BBC microcomputer made by Acorn."

WHICH MICRO?

"Oric was over twice as fast as the Spectrum. Surprisingly perhaps the Oric, which initially seemed only faster when performing the simplest of calculations, has come back to beat the Spectrum by a small amount. As the problems get more complex the Oric comes into its own. One final point – in entering the benchmark tests – the Oric was certainly the easiest to handle."

WHICH MICRO?

"This slope coupled with the design of the keys makes the Oric an easy machine to touch-type on. All keys have auto-repeat and there are four keys dedicated specifically to cursor control. It is certainly easier to type on than any of Sinclair's offerings."

YOUR COMPUTER

"Oric will soon be selling a Modem so that Prestel will become available. Owners will be able to accept telesoftware – programs loaded straight down the phone line – eventually electronic mail could come into the home by the same route, and with the addition of a tape recorder the Oric with its Modem could become a telephone answerer and message taker."

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"One good feature of the Oric is an on-screen reminder in the top right hand corner to show that you've engaged all-capitals mode. So much better than the BB's variety of lights in the corner of the keyboard. The Oric is sound, simple to get along with and offers great expansion potential."

WHICH MICRO?

"When compared to the stogginess of the Spectrum's keyboard this is certainly an improvement. I can't see any Orics failing through bad assembly. If only the £2400 IBM were so easy to use."

WHICH MICRO?

"Instead of the Spectrum's 28 look-up single-character error reports, the Oric has 18 self-explanatory messages. If you actually want to do computing, rather than just exploring the world of off-the-shelf games programme entertainment the Oric will be a better buy."

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On the Vic-20 bandwagon

Mike Todd sifts out a few Vic-20 books from the vast array currently available.

SINCE THE INTRODUCTION of the Vic-20 a wide variety of books has been produced offering everything from complete games to beginners' guides. In an attempt to fill the average Vic-20 owner's insatiable appetite for games most magazines provide at least the occassional games listing.

Jumping on this bandwagon, the first three books contain a range of games programs ready for typing. All three could usefully fill the gap while waiting for next month's magazine to arrive.

Many of the 24 programs in *Symphony for a Melancholy Computer* by Tim Hartnell are trivial — from simple guessing games to playing random music. But it does include versions of Othello and Checkers, as well as Breakout and a fruit machine program.

The programs are of not too high a quality, but the book does include some useful hints on writing and converting games for the Vic. There are limited notes on some of the programs and useful reference material in the appendices, including character-code tables, screen-planning charts and notes on producing sounds.

Zap! Pow! Boom! by Mark Ramshaw has 30 programs and a range of arcade-style programs, some of which are not too bad. There are versions of Space Invaders and Asteroids, as well as a simple version of the game that started the computer games craze — Star Trek. There is even a primitive Adventure game.

Neither book takes full advantage of the high-resolution capabilities of the Vic. Both take their listings straight off a Vic printer, making them at best difficult to read and in some cases downright impossible.

The third book *Vic Innovative Computing* by Clifford Ramshaw — any relation to Mark? — also contains 30 programs, but it is presented in a more helpful way. The graphics characters are printed in a special form, making them very easy to read. For those in any doubt there is a full list of symbols, which even tells you what keys to press to get a particular character. Even spaces are printed with little marks, which makes typing the program into the Vic a much easier task.



If you really do not want to type the programs in yourself there are three cassettes available, each containing seven programs from the book. But if you are going to buy a cassette of a program, why did you buy the book in the first place?

The programs are of a reasonably high standard and many have colour photos of the screen taken during the game. As well as the usual arcade games there are Snakes and Ladders, Blackjack, and even a Chess program.

A comment on page 137, "welcome to the wonderful world of Spectrum Chess", and the occasional use of Inkey, show that Mr Ramshaw is a Sinclair user. I suspect that many of the programs are converted from the Spectrum. But this does not detract from an attractively packaged book.

The games in all three books are a little on the slow side, having been written in Basic with no attempt to include any machine code. For beginners this is probably a sensible idea, but it does make some games rather tedious.

None of the books atempts to use the full capabilities of the high resolution on the Vic. *Innovative Computing* does have a simple high-resolution drawing program, the heart of which might usefully be incorporated into other programs. None states how much memory each program needs.

All appear to run on an unexpanded Vic and will also run with 3K expansion. If you have any more memory you could run into problems, as none of them allow for the repositioning of the screen in an expanded Vic.

If you are an absolute newcomer to computers, then *Learning to use the Vic-20* by Ron Geere could be of interest. It introduces the concept of a computer like the Vic-20 and explains, in slightly simpler terms than the Vic handbook, how to connect the Vic, Load and Save programs and write very simple programs.

You are taken through a simple course of plugging the Vic in, switching on and using the keyboard, and are then introduced to the concept of printing to the screen. From then on you have a simple guide to elementary programming concepts such as looping and decision making.

Manipulating strings and printing pictures on the screen are well described. By page 52 you have drawn a butterfly on the screen, and by page 59 you have made it flap its wings. But the book does not go any further than this and the concepts that are introduced often have poor and over-complicated examples. At least there are some useful self-test questions and a few simple example programs included.

Unfortunately its aims are rather confused, and as a result it is an uncomfortable mix of simple and advanced concepts. At the end of the book there is a section on how the Vic stores its programs. This is out of place in a book aimed at a beginner who has just learnt

(continued on next page)

(continued from previous page)
how to write a simple program and is looking for guidance on using some of the more sophisticated commands in his program.

At only £4.95 it is certainly cheap and well printed. My feeling is that unless you are really struggling to understand the first principles of the Vic it offers little more than Vic's own guide.

For more advanced programmers, there are two reference books available, *Vic Revealed* by Nick Hampshire and Commodore's own *Programmers Reference Guide*.

The *Programmers Reference Guide* starts by examining all aspects of Basic in some detail. It gives an in-depth tour of all the Basic commands and functions, the use of numbers and variables, how to edit programs and some simple Basic programming tips on how to get the most out of the limited space in the Vic.

The main features of the Vic are the sound generator and the ability to redefine the character set to use it as a means of producing high-resolution graphics. Both are described with several example programs, many of which could be used as the core for more advanced programs.

For those who want to venture into machine-code programming there is a substantial section starting from first principles. For the more advanced machine-code programmer there is an excellent summary of commands, lists of memory usage and details of the Vic's own ROM routines.

The book concludes with descriptions of all the major interfacing aspects of the Vic, details of the VIC chip itself, and other hardware-oriented matters. It includes a large fold-out circuit diagram for the complete Vic.

The book is of American origin, and does contain some errors. Many are not too serious and the book makes up for them with its coverage and presentation.

Not so the *Vic Revealed* I am afraid. It covers substantially less than the Commodore book, concentrating on the hardware and internal aspects of the Vic with example programs — some in Basic, some in machine code and some which do not work. It does at least cover the internal workings of Basic and the kernal ROMs in a little more detail. There is good coverage of the use of high-resolution graphics, with a couple of excellent example programs which will plot graphs, points, lines and circles.

The author also wrote a book some time ago called *Pet Revealed*, and has transferred some of the information directly from it without any concession to the often significant differences between the two machines. Much of the material is from the same source as that in the Commodore book, and is copied not only with most of the original intact but with many additional ones for good measure. They are compounded by the poor presentation and often confusing text.

There is now a second edition which boasts that it is "corrected and revised", but most of the errors remain. Like the first edition, it is not a book that I would buy out of choice.

If you were to ask me which books I would buy, I would take *Vic Innovative Computing* and the Commodore *Programmer's Reference Guide*, both of which would be extremely useful additions to the bookshelf.

Symphony for a Melancholy Computer by Tim Hartnell. Published by Interface, £6.95.

Zap! Pow! Boom! by Mark Ramshaw. Published by Interface, £7.95.

Vic Innovative Computing by Cliford Ramshaw. Published by Melbourne House.

Learning to use the Vic-20 computer by Ron Geere. Published by Gower Publishing, £4.95.

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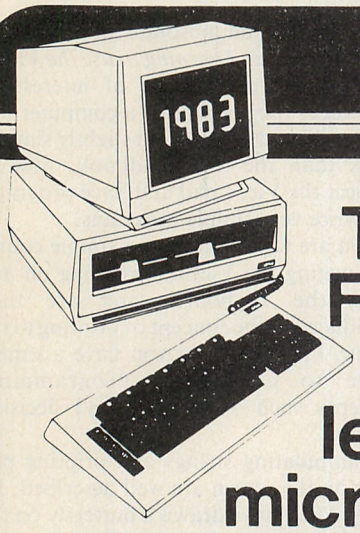

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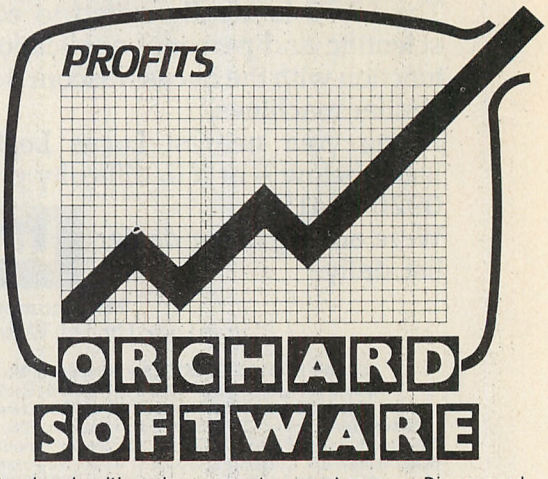

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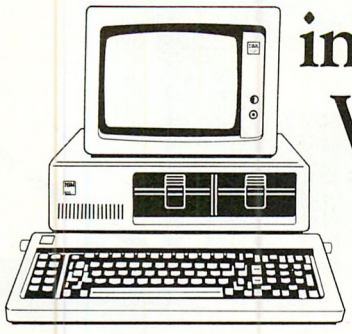

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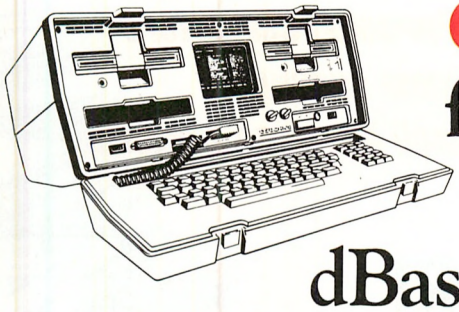

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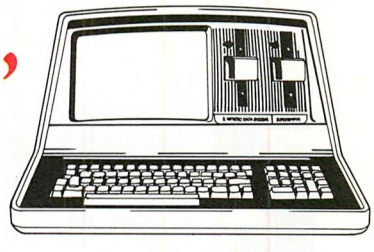



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>FINANCIAL PLANNING

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We also review a selection of "Calc-alikes" for the BBC Micro, and to show how spreadsheets can be written we present a listing which ZX-81 owners will be able to key straight in.

>REVIEWS

The Wang Personal Computer looks powerful and is designed to give its IBM and DEC rivals a run for their money. Chris Bidmead checks out this new 16-bitter. And our series on word processing with home micros continues with a look at the versatile and comprehensive Telewriter package for the low-priced Dragon 32.

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Other features in the July issue range from an in-depth guide to programming sprites on the Commodore 64, to how London's Capital Radio uses an Apple II in the day-to-day running of the station. Plus there will be the usual enjoyable fiction and columns, pages and pages of free software in Open File, new product news and your letters.

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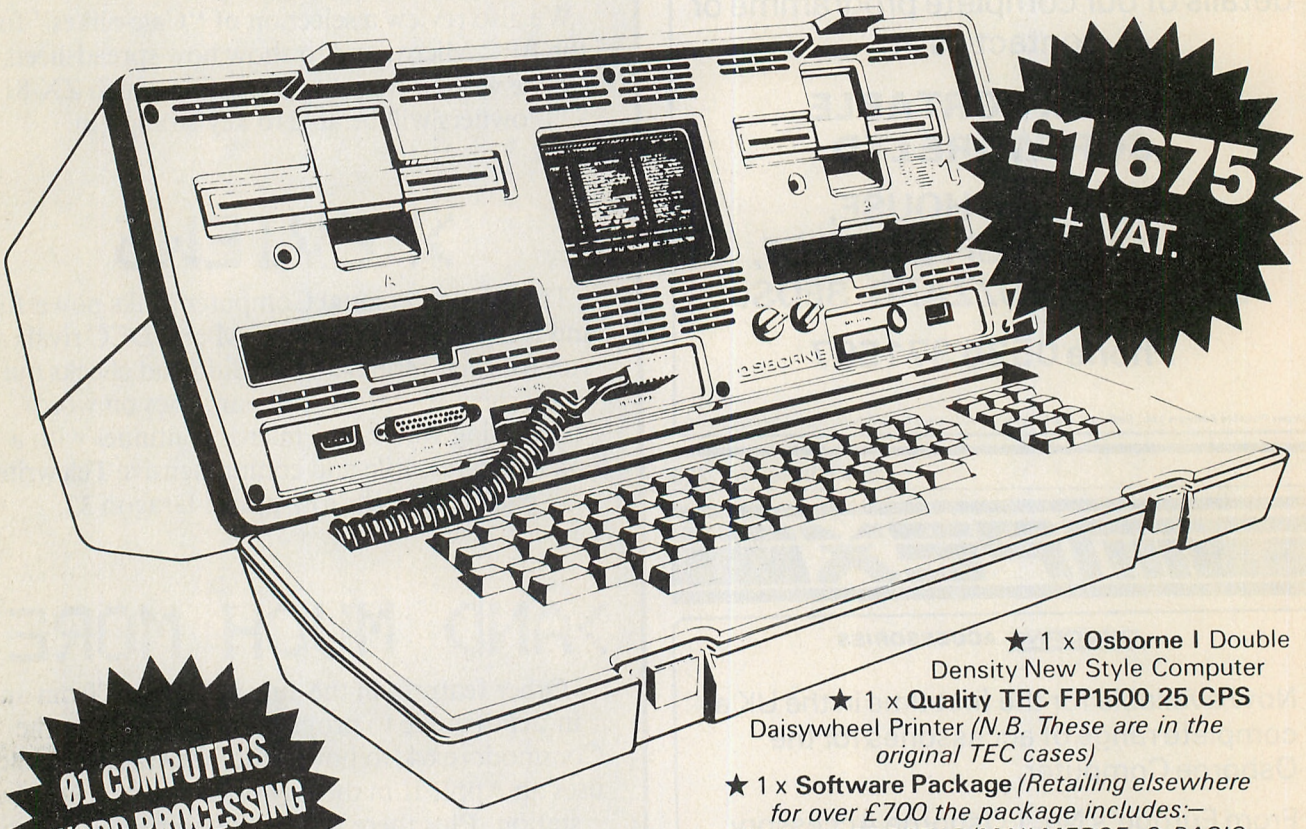

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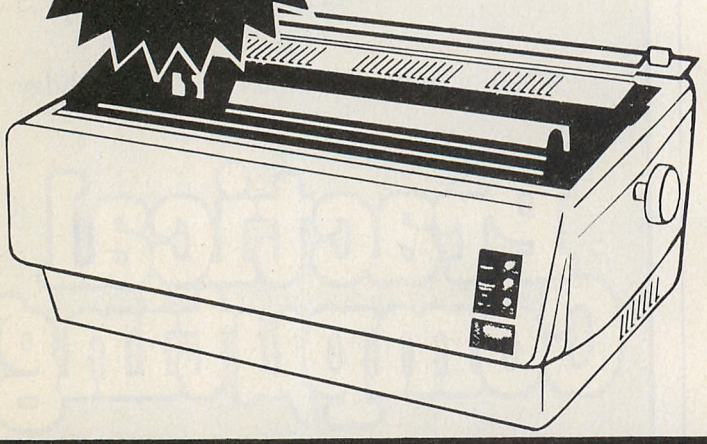

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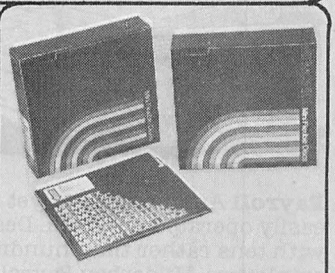

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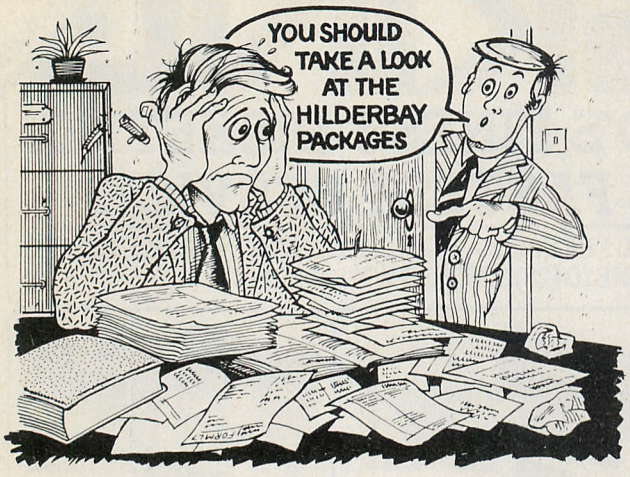

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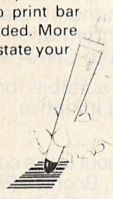

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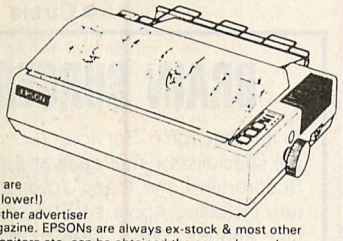

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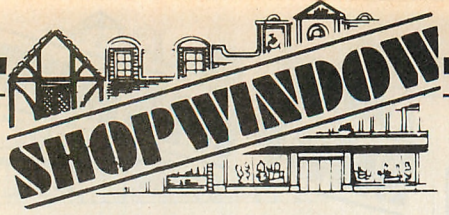

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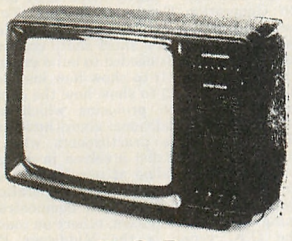

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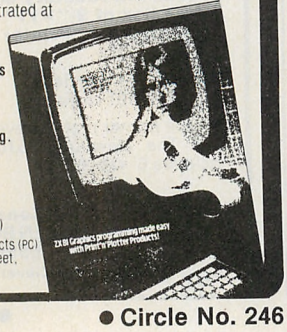

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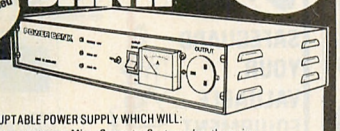

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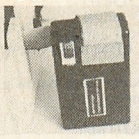

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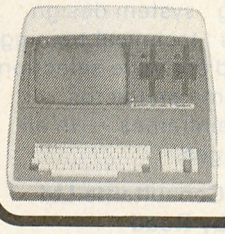

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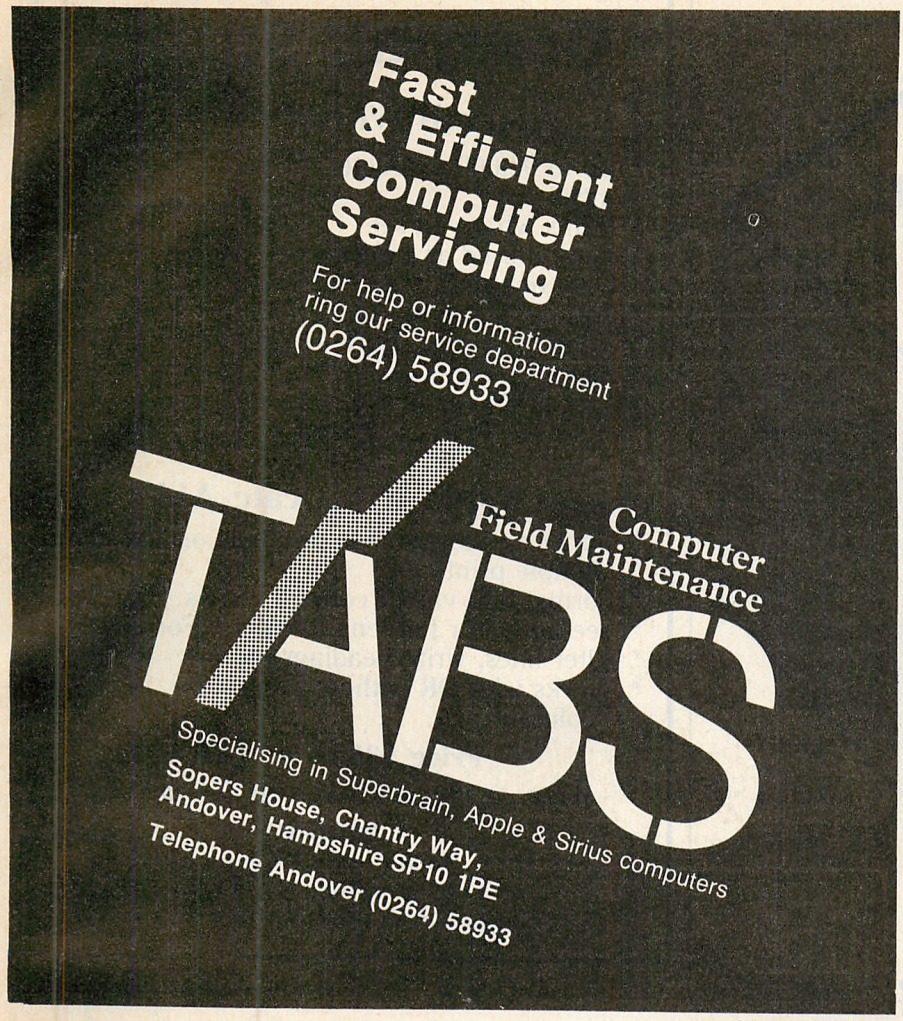

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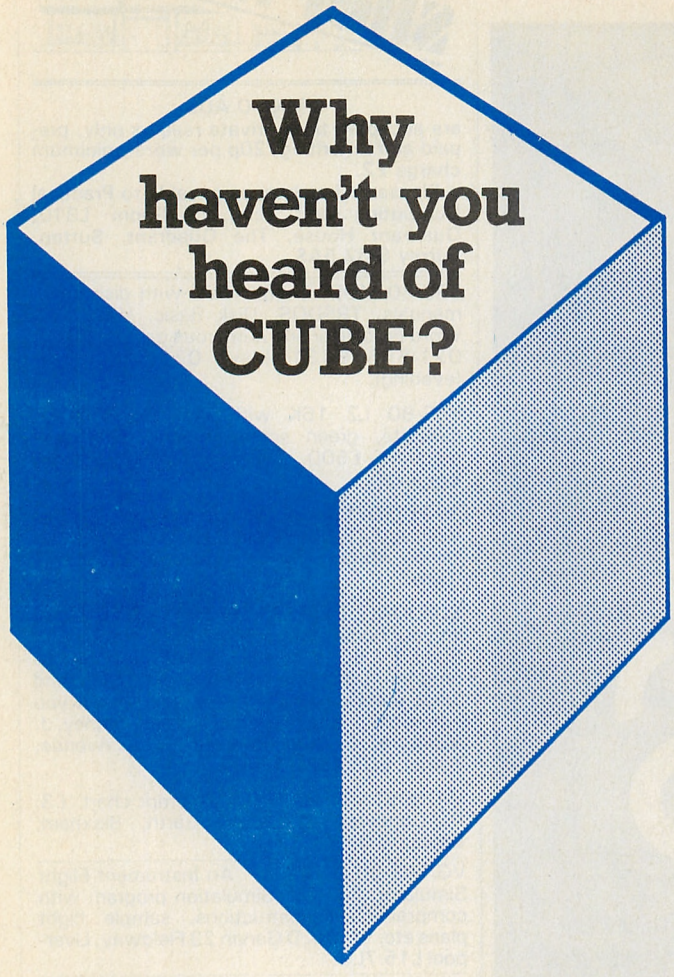

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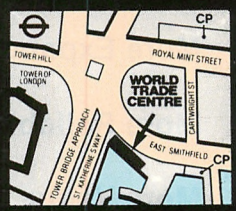

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