Personal Computer World

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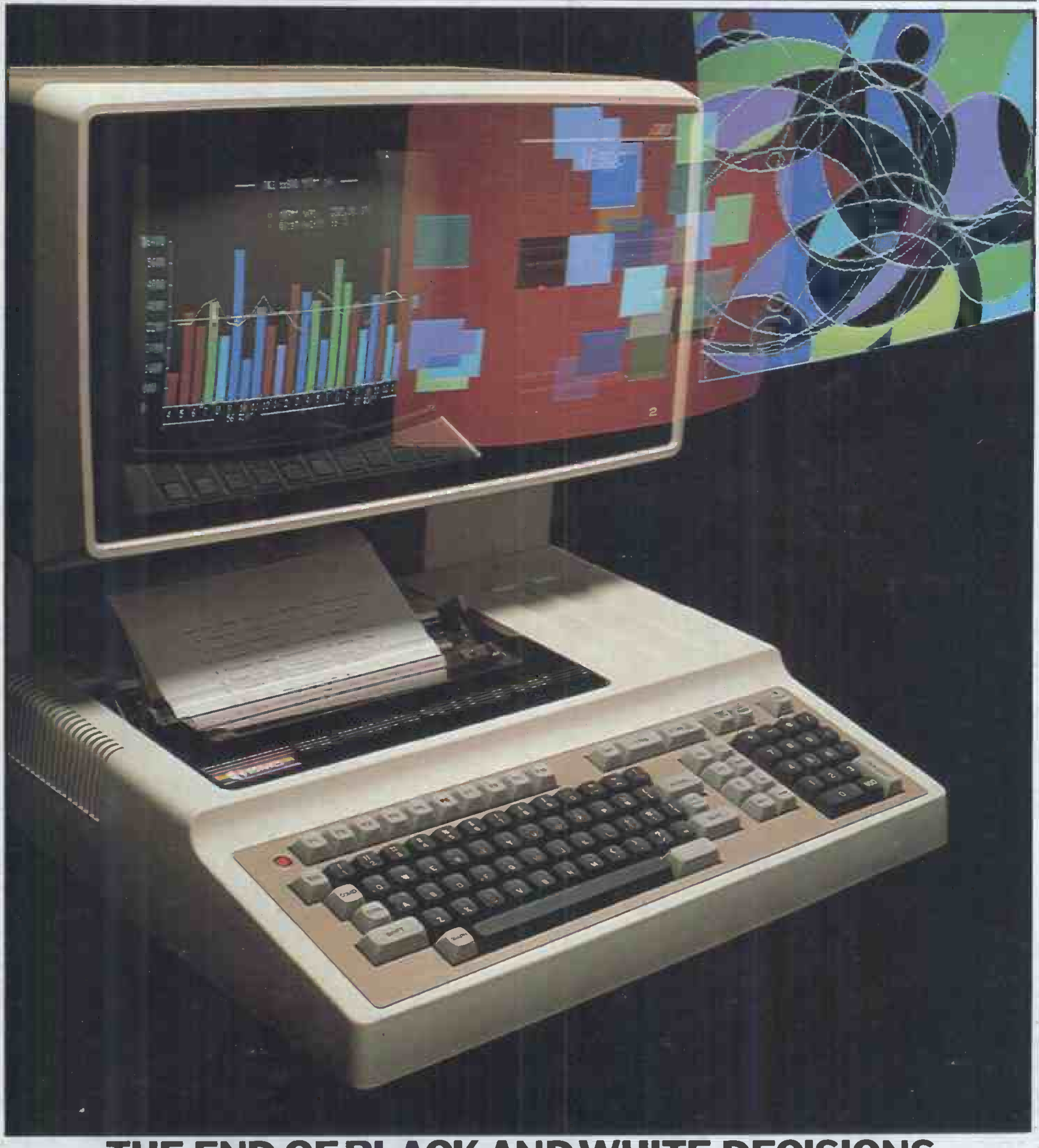
October 1981 75p

PUT YOUR ZX81 IN CONTROL

BRITAIN'S LARGEST SELLING MICRO MAGAZINE



THE END OF BLACK AND WHITE DECISIONS

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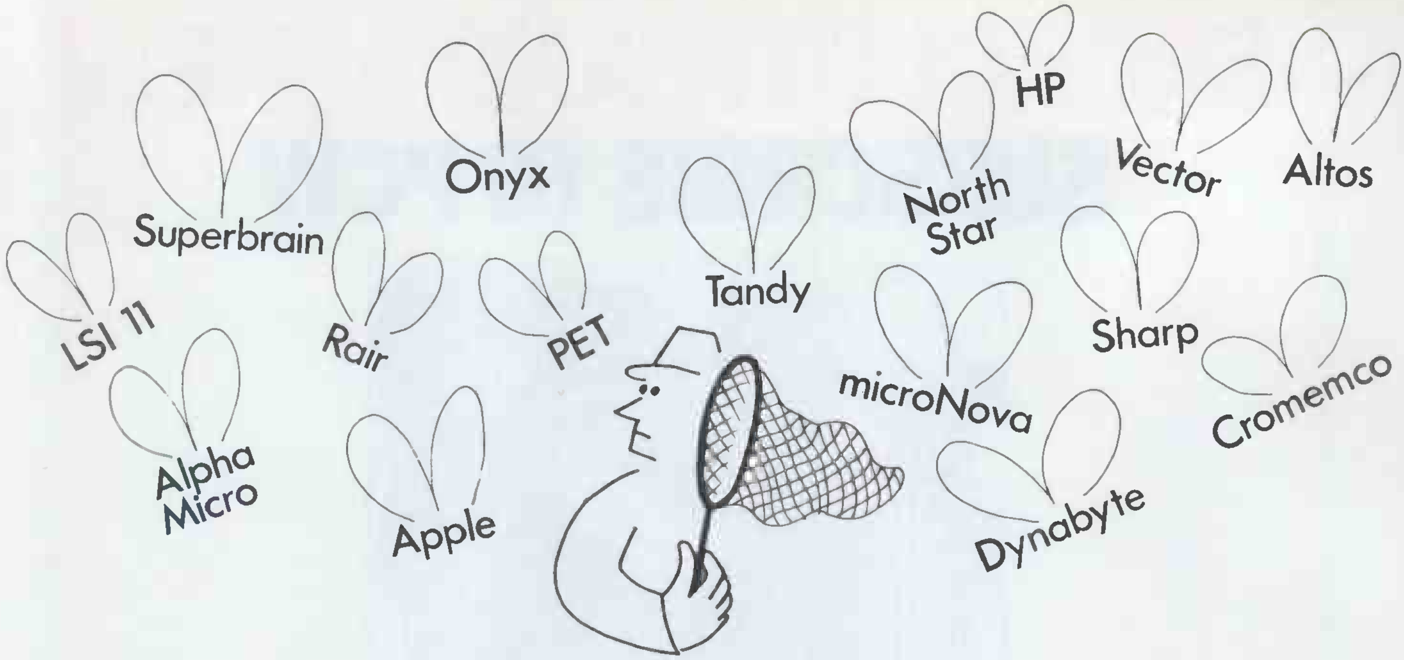

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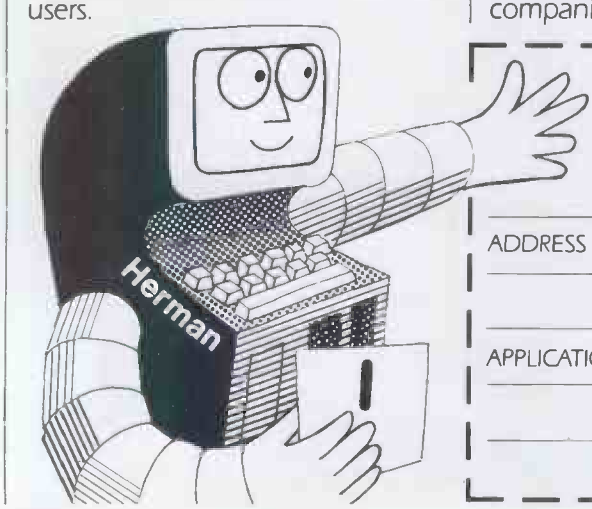

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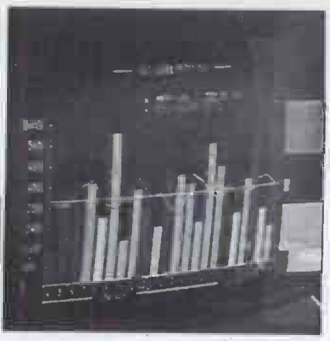
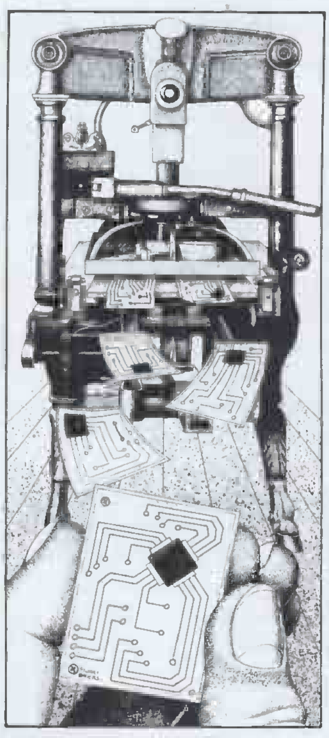


Photography by Chris Stevens

Volume 4 No 10 October 1981



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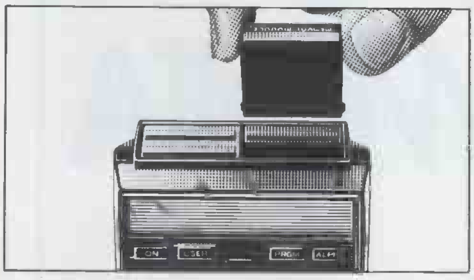
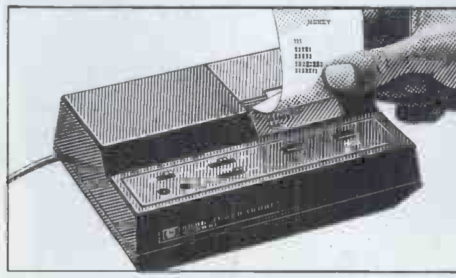
ABC

Two ways to make your system grow...

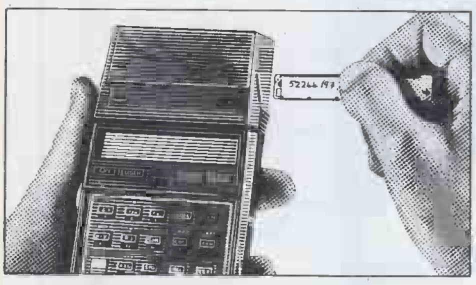


Snap-in more memory. *A single module will double the memory available. A quad module adds no fewer than 256 registers at once. Suddenly you've over 1800 lines of memory at your command.*

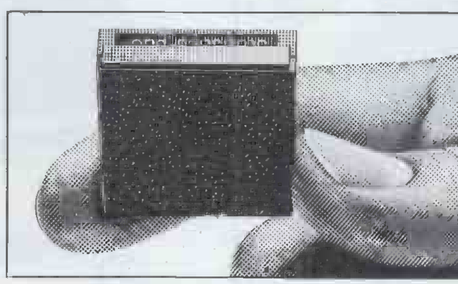


Plug-in a printer. *The HP-41C printer handles upper and lower case, in alpha, numeric and graph-plotting modes. Use it for final hard copy, or to follow program execution.*

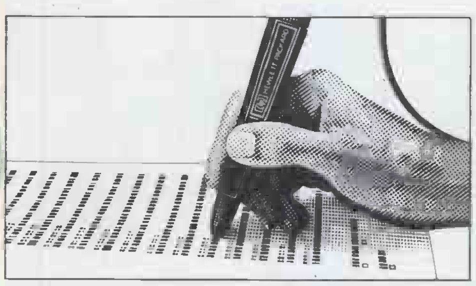
Four ways to program your HP-41C...



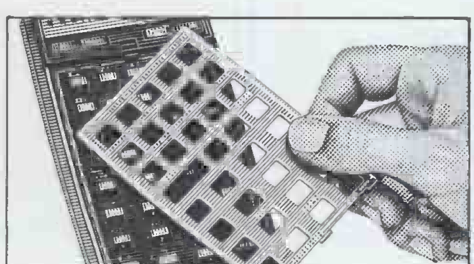
Card reader. *This reads pre-programmed magnetic cards. It can also record and read your own programs and data.*



Application modules. *These are plug-in modules each containing a whole range of ready-made programs on your chosen subject.*



Bar code reader. *A quick and easy way of loading any one of the software packages. The wand simply 'lifts' the coded program straight off the page of your HP-41C solution books.*



Keyboard customising. *Develop your own programs and enter them through the keyboard. You can assign any function or program to any key and mark them on your own customising overlay.*

Thousands of easy ways to solve problems.

Think of a problem! As an HP-41C owner you won't have far to look for the solution – or long to wait before it's locked in your system's memory. Any of HP's hundreds of pre-programmed solutions can be easily entered in any of the four ways we illustrate above. You'll certainly want to devise your own solutions, too. The guidance manual in your basic pack tells you how. If you develop an original one you could submit it to the HP-41C Users' Library. It already contains thousands of tested programs which 10,000 users world-wide are happy for you to share.

Quality from HP – the big computer manufacturer.

The HP-41C is made from the chip upwards by Hewlett-Packard, a world leader in computers. And you can tell! By the detail like the permanent inlaid key notations, tough ABS case, and gold-plated port contacts. By the elegant simplicity designed into the HP-41C's operating style. By the sort of software support only a computer giant would be capable of. By the utter reliability that is the HP hallmark throughout the world of computers.

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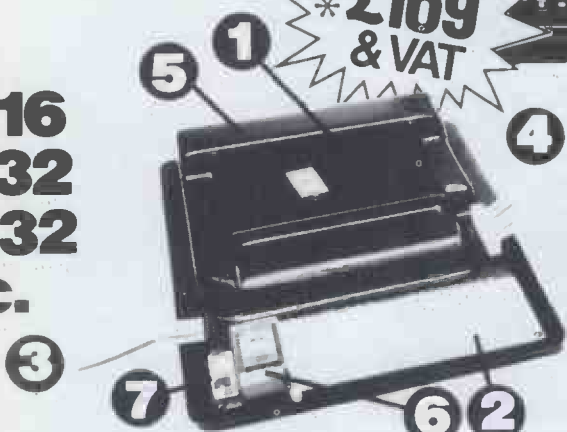
DEVELOPMENT

EPROM-PROGRAMMER
ROMULATOR

SOFTY 2



2716
2732
2532
etc.

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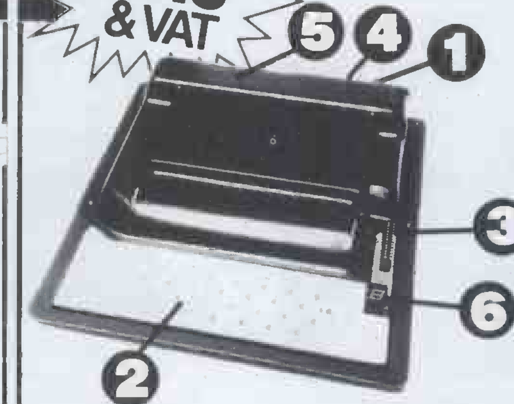
TEACHING

Z80-ASSEMBLER
MICRO-CONTROLLER

MENTA



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3. 24 bits of I/O can control external machinery, indicators etc.
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5. BEEPER gives entry and error feedback.
6. LED gives prompt and page number.

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MENTA is from the same stable as the SOFTY development systems.

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Silentype Manual	1.00	–	1.00
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Serial Interface Female	235.26	35.29	270.55
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GP I/O Interface	294.82	44.22	339.04
B.C.D. Interface	294.82	44.22	339.04
Centronics Interface	175.70	26.36	202.06
HP-IB Cable ½M	41.51	6.23	47.74
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HP-IB Cable 2M	44.48	6.67	51.15
HP-IB Cable 4M	50.41	7.56	57.97
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Personality Module	439.50	65.93	505.43
O'Head Transp. Kit	58.06	8.71	66.77
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100 Sheets Metric	4.21	.63	4.84
50 Sheets Blank EF	1.81	.27	2.08
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4 Colour Pen PAC	3.82	.57	4.39
5 Red Pens	3.82	.57	4.39
5 Blue Pens	3.82	.57	4.39
5 Green Pens	3.82	.57	4.39
5 Black Pens	3.82	.57	4.39
100 Transp. Films	12.97	1.95	14.92
Tansp. Solvent	2.35	.35	2.70
Transp. Pens BRBG	5.00	.75	5.75
Transp. Pens BOBV	5.00	.75	5.75
Transp. Pens BRBG Wide	5.00	.75	5.75
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● Printer HP 82905A	597.00	89.55	686.55
Printer HP 2631B	2314.70	347.21	2661.91
Printer Stand	169.94	25.49	195.43
Paper Rack	31.06	4.66	35.72
Sound Cover	61.53	9.23	70.76
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Printer Ribbon (Pack of 3)	36.92	5.54	42.46
Tape Cartridge (Pack of 5)	55.67	8.35	64.02
Thermal Paper Blue (Box 2)	18.06	2.71	20.77
Thermal Paper Black (Box 6)	54.17	8.13	62.30
Cartridge Manual Holder	6.02	.90	6.92
HP 83/85 Carrying Case	72.23	10.83	83.06
3 Ring System Binder	6.02	.90	6.92
Dust Cover	9.03	1.35	10.38
Owners Manual HP 83/85	15.05	–	15.05
Pocket Guide	3.01	–	3.01
Mass Storage ROM Manual	6.02	–	6.02
Plotter Printer ROM Manual	6.02	–	6.02
I/O ROM Manual	18.05	–	18.05
Matrix ROM Manual	6.02	–	6.02
Assembler ROM Manual	12.04	–	12.04
Flexible Disk Operating Manual	6.02	–	6.02
HP-IB Manual	6.02	–	6.02
Serial Installation Manual	6.02	–	6.02
GP-I/O Manual	6.02	–	6.02
BCD Manual	6.02	–	6.02
Centronics Manual	6.02	–	6.02
Standard PAC	56.58	8.49	65.07
Basic Training	56.58	8.49	65.07
General Statistics	56.58	8.49	65.07
Finance	56.58	8.49	65.07
Maths	56.58	8.49	65.07
Circuit Analysis	56.58	8.49	65.07
Games	56.58	8.49	65.07
Linear Programming	56.58	8.49	65.07
Text Editing	56.58	8.49	65.07
Wave Form Analysis	56.58	8.49	65.07
Basic Stat and Data	56.58	8.49	65.07
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Graphics Presentation	119.12	17.87	136.99
Visicalc Plus	119.12	17.87	136.99
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Single Master 5¼" (270K)	893.40	134.01	1027.41
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Dual Add on 8" (2400K)	3387.03	508.05	3895.08
Single Master 8" (1200K)	2924.14	438.62	3362.76
Single Add on 8" (1200K)	2308.84	346.33	2655.17
Flexible Disk 5¼" (Pack 10)	43.30	6.50	49.80
Flexible Disk 8" (Pack 10)	61.53	9.23	70.76
Graphics Tablet	1201.30	180.20	1381.50

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● PC1211 Computer	80.00	12.00	92.00
CE121 Cassette Interface	11.00	1.65	12.65
CE122 Printer Interface	60.00	9.00	69.00
CSR 700 Paper Rolls (40)	5.00	.75	5.75
EA 800R Ink Ribbons	1.80	.27	2.07
● MZ80K Computer 20K	395.00	59.25	454.25
● MZ80K Computer 48K	410.00	61.50	471.50
MZ80 I/O Expansion Interface	96.00	14.40	110.40
MZ80 F.D. Dual Disks	560.00	84.00	644.00
MZ80 F I/O Disk Interface	52.00	7.80	59.80
MZ80 FMD Master Disk and Manual	20.00	3.00	23.00
MZ80 F15 Disk Cable	8.00	1.20	9.20
MZ80 FOS Extra Disk Cable	7.00	1.05	8.05
MZ80 P3 Dot Matrix Printer	365.00	54.75	419.75
MZ80 T20C Machine Language	18.00	2.70	20.70
MZ80 TU Assembler	36.00	5.40	41.40
● MZ80 T40E Pascal	40.00	6.00	46.00
MZ80 I/O-1 Universal Interface Card	40.00	6.00	46.00
● MZ80B Computer 64K	1020.00	153.00	1173.00
MZ80 FI Disk Interface	94.00	14.10	108.10
MZ80 MDB Master Disk and Manual	30.00	4.50	34.50
MZ80 BJC Disk Cable Jointer	15.00	2.25	17.25
MZ80 EU Expansion Interface	47.00	7.05	54.05
MZ80 P5 Dot Matrix Printer	387.00	58.05	445.05
MZ80 GMK Graphics Option	112.00	16.80	128.80
MZ80 I/O-2 Universal Interface Card	40.00	6.00	46.00
MZ80 T10C K→ B Converter	7.00	1.05	8.05
PC 3201 Computer 64K	1300.00	195.00	1495.00
CE 320C 80 x 25 Monitor	220.00	33.00	253.00
CE 332P Dot Matrix Printer	390.00	58.50	448.50
CE 331M Dual Disks	585.00	87.75	672.75
CE 341M Disk Interface	110.00	16.50	126.50
● Total System	2605.00	390.75	2995.75
CE 350L Extra Disk Cable	30.00	4.50	34.50
CE 330G Direct Generator	105.00	15.75	120.75
CE 332A Extra 48K RAM	130.00	19.50	149.50
CE 340R RS232 Interface	130.00	19.50	149.00
CE 340G GP I/O Card	130.00	19.50	149.50
CE 350R Printer Ribbon	8.00	1.20	9.20

Sharp Cassette Software

	NETT	V.A.T.	TOTAL
Towering Inferno	5.85	.88	6.73
Block Kuzushai	5.85	.88	6.73
Head-On	5.85	.88	6.73
Asteroids	5.85	.88	6.73
Escape from Colditz	8.45	1.27	9.72

ATARI

	NETT	V.A.T.	TOTAL
400 16K Computer	300.00	45.00	345.00
800 16K Computer	560.87	84.13	645.00
410 Tape Recorder	43.48	6.52	50.00
810 Disk Drive	300.00	45.00	345.00
822 Thermal Printer	230.43	34.57	265.00
825 80 Column Printer	478.26	71.74	550.00
850 RS232 Interface	117.39	17.61	135.00
16K RAM Upgrade	56.52	8.48	65.00
Light Pen	39.13	5.87	45.00
Pair Paddles	10.43	1.57	12.00
Pair Joysticks	10.43	1.57	12.00
I/O Cable	8.26	1.24	9.50
Printer Cable	24.78	3.72	28.50
Interface Cable	20.43	3.07	23.50
RS 232 Cable	20.43	3.07	23.50
Monitor Cable	20.43	3.07	23.50
Thermal Paper	3.48	.52	4.00
Master Disk	13.91	2.09	16.00
5 Blank Disks	13.91	2.09	16.00
Word Processor	73.91	11.09	85.00

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Inv. Prog. 1	10.39	1.56	11.95
Conversational French	28.26	4.24	32.50
Conversational German	28.26	4.24	32.50
Conversational Spanish	28.26	4.24	32.50
Conversational Italian	28.26	4.24	32.50
Music Composer ROM	28.26	4.24	32.50
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Calc/Tor	14.74	2.21	16.95
Graphit	10.39	1.56	11.95
Statistics	10.39	1.56	11.95
Eng. Czar	7.78	1.17	8.95
Hangman	7.78	1.17	8.95
Kingdom	7.78	1.17	8.95
States and Capitals	7.78	1.17	8.95
States Europe	7.78	1.17	8.95
Scram	11.26	1.69	12.95
Telelink ROM	13.00	1.95	14.95
Asteroids ROM	26.04	3.91	29.95
Bask/Ball ROM	21.30	3.20	24.50
Blackjack	7.78	1.17	8.95
Chess ROM	21.30	3.20	24.50
Miss. Comd ROM	26.04	3.91	29.95
Space Inv. ROM	21.30	3.20	24.50
Space Inv.	11.26	1.69	12.95
Star Raiders ROM	26.04	3.91	29.95
Super Breakout ROM	21.30	3.20	24.50
Assembler Editor ROM	30.00	4.50	34.50
Pilot ROM	43.04	6.46	49.50
Microsoft Basic	43.04	6.46	49.50
Technical Notes	14.74	–	14.74
Operating System Lists	9.52	–	9.52
DOS Lists	2.61	–	2.61
DOS 2 Manual	6.04	–	6.04

VIDEO GENIE

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Video Genie Computer	279.00	41.85	320.85
EG3013 Expander	185.00	27.75	212.75
EG3013 Expander + RS232	215.00	32.25	247.25
32K Memory Board S100	105.00	15.75	120.75
Single Disk Drive	215.00	32.25	247.25
Dual Disk Drive (40 Track)	410.00	61.50	471.50
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4 Drive Cable	32.00	4.80	36.80
Printer Cable	17.00	2.55	19.55
Parallel Interface EG3016	33.00	4.95	37.95
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Lower Case Kit	33.00	4.95	37.95
Fitting Above	5.00	.75	5.75
Keyboard Update Kit	3.00	.45	3.45
RS232 Interface	52.00	7.80	59.80

Cassette Sofware for Video Genie

	NETT	V.A.T.	TOTAL
Space Invaders	13.00	1.95	14.95
Asteroids	8.75	1.31	10.06
Golden Baton	8.75	1.31	10.06
Zost in Space	8.75	1.31	10.06
Space Eye	8.75	1.31	10.06

PRINTERS

Epson

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MX80 T Newtype 2	415.00	62.26	477.25
MX80 FT/1	399.00	59.85	485.85
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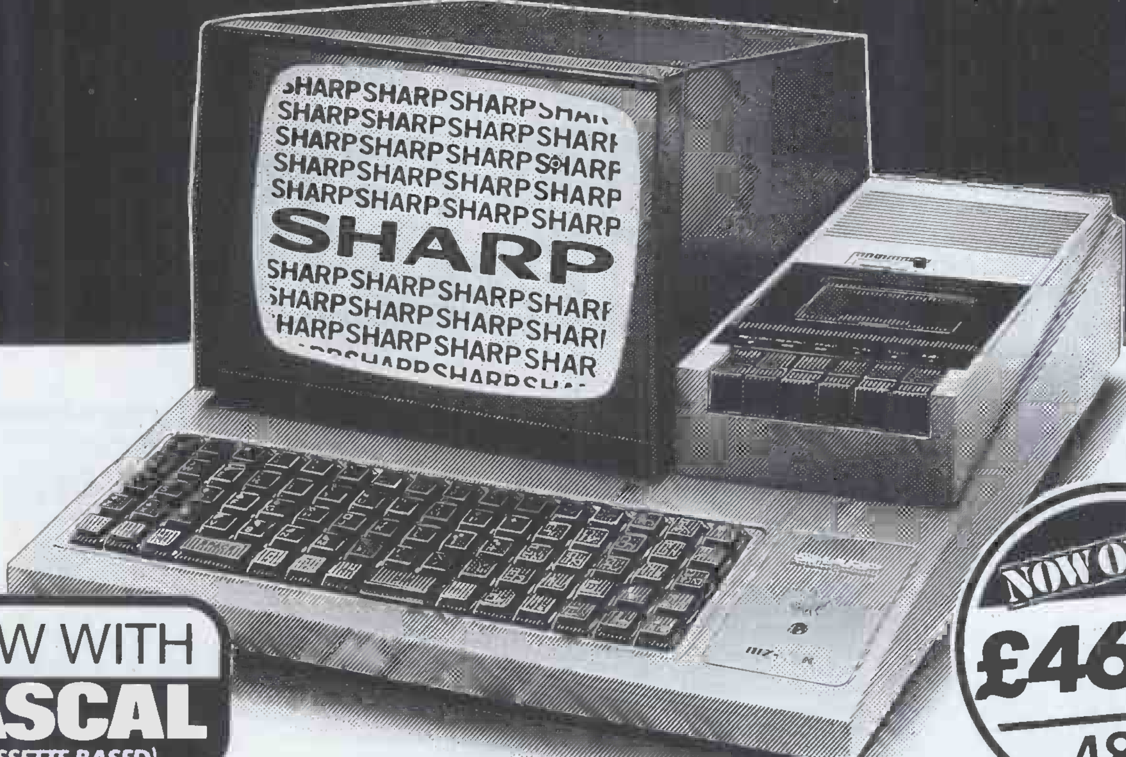

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Tomorrows World Ltd
Dublin 2, Tel: 0001 776861

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Computer Corner
Shrewsbury, Tel: 0743 59788
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Aberdeen, Tel: 0224 630526
Business and Electronics M/Cs
Edinburgh, Tel: 031-226 5454
Micro Centre
Edinburgh, Tel: 031-556 7354
Microforth
Dunfermline, Tel: 0383 34954
Moray Instruments Ltd
Elgin, Tel: 0343 3747
Pointer Business Equipt Ltd
Glasgow, Tel: 041-332 3621
Tyseal Computers Ltd
Aberdeen, Tel: 0224 573111
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Norsett Office Supplies Ltd
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SOUTH HUMBERSIDE
Silicon Chip Centre
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Cannock, Tel: 0543 75555
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C. J. R. Microtek Co. Ltd
Ipswich, Tel: 0473 50152
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Huddersfield, Tel: 0484 20774
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Sheffield, Tel: 0742 755005
Ram Computer Services Ltd
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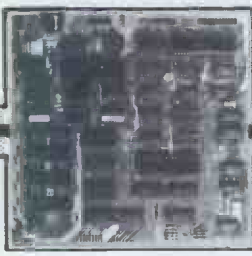
MicroValue

New British Microsystem. Gemini MultiBoard

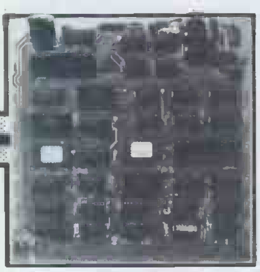


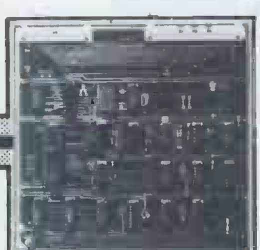
● Eight boards available NOW ● 8" x 8" board modules ● Z80A CPU board ● Z80A Video board ● 64K RAM ● Built and tested

Developed by one of the most experienced micro board design teams in the UK, Gemini MultiBoard* is the ultimate modular board system. Unlike most systems of its kind, virtually nothing is made redundant when you expand it. And for those who want expansion this can be immediate, for we are launching eight boards simultaneously. No other system has offered so much so soon.

All MultiBoard modules are Nasbus† and Gemini 80-BUS* compatible and can be used in a wide spectrum of application, e.g. educational, personal, business, system development and process/production control.

MultiBoard modules are built and tested to the highest standards. And offer enormous computing power and potential at astonishingly low cost.





MultiBoard Modules available now

Z80A CPU

Processor: Z80A CPU at 4MHz. Optional wait-states. Reset jump to any 4K boundary.

Parallel I/O: 8 bit ASCII keyboard socket. Uncommitted Z80A PIO giving two 8 bit bi-directional ports with handshake.

Serial I/O: 8250 UART with programmable baud rates and software selectable between RS232 or 1200 baud CUTS cassette interfaces.

Memory: 4 'Bytewyde' sockets to accept EPROM/ROM/RAM. Memory switched in/out of memory map under software control.

Software: Comprehensive monitor. Optional 12K Microsoft BASIC (ROM). Standard configuration PROM provides decodes for 4 x 2732 (4K x 8) EPROMs.

The CPU Board is fully buffered to the Gemini 80-BUS standard.

INTELLIGENT VIDEO

- Z80A microprocessor controlled.
- 80 x 25 display controlled by 6845 CRTC chip.
- Adjustable dot clock for alternative screen formats.
- Character set: 128 in EPROM + 128 in RAM which can be defined as the video inverse of the main set or as block graphics with 160 x 75 resolution.
- I/O port communication with host computer.
- Light pen socket.
- 8-bit input port allowing several video boards (each with its own keyboard) to be connected to a single CPU board.

FLOPPY DISK CONTROLLER

- Controls: Pertec FD250 5.25in 48 TPI, Micropolis 1015 5.25in 96 TPI, Pertec FD650 8in.
- Controls up to 4 drives of same type.
- Single/double density software selectable.
- Single or double sided.
- Western Digital FD1797 controller.
- Up to 8 drives (2 boards) can be used in the same system.

64K RAM

- Runs at 4MHz with no wait-states.
- 4 banks of 16K dynamic RAM, each bank locatable on any 4K address boundary.
- Page Mode supplied as standard allowing up to 4 memory boards to be addressed.
- All the memory can be used by switching out on-board CPU memory, e.g. in disk environment.

EPROM/ROM BOARD

- Accepts up to 40K of firmware.
- 4 banks of 4 sockets.
- Banks can be mixed between 2708 or 2716.
- 24-pin ROM socket.
- Wait-state generator.
- Supports Page Mode scheme.

EPROM PROGRAMMER

- Programs multi-rail 2708 or single rail 2716.
- Connects to PIO on CPU board.
- Software provided on tape.

3A PSU

- Supplies 4/5 boards.
- LED on each output.
- +5V at 3A; +12 at 1A; −5V at 1A; −12V at 80mA.

KEYBOARD

● Full alpha-numeric ● 59-keys ASCII encoded ● Exclusively designed for Gemini ● Auto repeat ● Cursor control keys

MULTIBOARD PRICES (excl VAT)

(All built and tested except where marked)

CPU (G811)	£125.00
Video (G812)	£140.00
64K RAM (G802)	£140.00
FDC (G809)	£140.00
EPROM/ROM (G803)	£ 70.00
EPROM PROG. (G808) Kit	£ 29.50
3A PSU (G807)	£ 40.00
Keyboard (G613)	£ 57.50

FLOPPY DISK UNIT

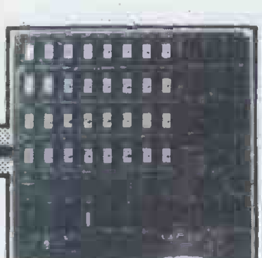
Gemini unit suitable for MultiBoard. Holds one or two 5¼in double sided, double density Pertec drives. Intergral power supply. Price £375 plus VAT for one drive, £575 plus VAT for two drives. CP/M2.2 and documentation £90 plus VAT.

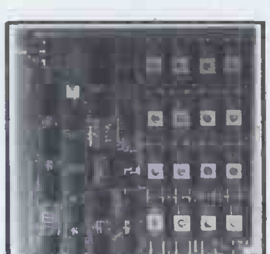
KENILWORTH CASE for MultiBoard	£49.50 + VAT
5-Card Support Kit	£19.50 + VAT
VERO Frame (also suitable for Nascom)	£32.50 + VAT
PSU Enclosure Kit	£24.50 + VAT

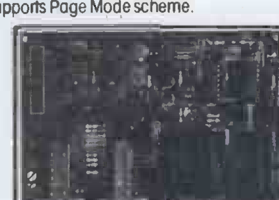
KEYBOARD enclosures available soon.

MultiBoard Modules are available from the MicroValue dealers listed on facing page.

*Trademarks of Gemini Microcomputers Limited
†Trademarks of Nascom Microcomputers Division of Lucas Logic
††Trademarks of Digital Research Inc.







MicroValue

COMPATIBLE

Nasbus products from your MicroValue Dealers

GEMINI G805 FLOPPY DISK SYSTEM FOR NASCOM-1 & 2

It's here at last. A floppy disk system and CP/M

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

Single drive system .... **£450 + VAT**
Double drive system .... **£640 + VAT**
Additional FD250 drives .... **£205 + VAT**

D-DOS SYSTEM. The disk unit is also available without CP/M to enable existing Nas-Sys software to be used. Simple read, write routines are supplied in EPROM. The unit plugs straight into the Nascom PIO. Single drive system **£395 + VAT**

DCS-DOS A greatly enhanced version of D-DOS, running under Nas-Sys. Gives named files in BASIC, ZEAP, NAS-PEN and machine code programs .... **£50 + VAT**

DISKPEN

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

NASCOM COMPUTERS

NASCOM-2 Microcomputer Kit
£225 + VAT
NASCOM-1 Microcomputer Kit
£125 + VAT
Built and tested **£140 + VAT**

16K RAM KIT .... £100 + VAT
3A PSU KIT .... £32.50 + VAT

KENILWORTH CASE FOR NASCOM-2

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

Kenilworth case .... **£49.50 + VAT**
2-card support kit .... **£7.50 + VAT**
5-card support kit .... **£19.50 + VAT**

CASSETTE ENHANCING UNIT

The Castle Interface is a built and tested add-on unit which lifts the Nascom-2 into the class of the fully professional computer. It mutes spurious output from cassette recorder switching, adds motor control facilities, automatically switches output between cassette and printer, simplifies 2400 baud cassette operating and provides true RS232 handshake.
Castle Interface Unit .... **£17.50 + VAT**

A NASCOM-2 BASED SYSTEM FOR LESS THAN £1500 + VAT

The proven Nascom-2 microcomputer can now be bought as a complete system from under £1500 + VAT. For this price you get the Nascom-2 kit, 16K RAM board kit, Kenilworth case with 2 card frame, Centronics 737 printer—10 inch monitor, and the Gemini Dual Drive Floppy Disk System. The CPU and RAM boards are also available built – the additional cost is available on application.

A-D CONVERTER

For really interesting and useful interactions with the 'outside world' the Milham analogue to digital converter is a must. This 8-bit converter is multiplexed between four channels – all software selectable. Sampling rate is 4KHz. Sensitivity is adjustable. Typical applications include temperature measurement, voice analysis, joystick tracking and voltage measurement. It is supplied built and tested with extensive software and easy connection to the Nascom PIO.
Milham A-D Converter
(built and tested) .... **£49.50 + VAT**

PROGRAMMER'S AID

For Nascom ROM BASIC running under Nas-Sys. Supplied in 2 x 2708 EPROMs. Features include: auto line numbering; intelligent renumbering; program appending; line deletion; hexadecimal conversion; recompression of reserved words; auto repeat; and printer handshake routines. When ordering please state whether this is to used with Nas-Sys 1 or 3. **Price £28 + VAT.**

GEMINI 'SUPERMUM'

12 x 8 piggy-back board for Nascom-1 offering five-slot motherboard, quality 5A power supply and reliable buffering with reset jump facility. **Kit Price £85 + VAT.**

CENTRONICS 737 MICRO PRINTER

A high performance, low price, dot-matrix printer that runs at 80cps (proportional) and 50cps (monospaced). This new printer gives text processing quality print. And can print subscripts and superscripts. It has 3-way paper handling and parallel interface as standard. Serial interface is optional. **Price £375 + VAT.** Fanfold paper (2000 sheets) **£18 + VAT.**

BITS & PC's PCG

5 x 4 board which plugs straight into Nascom-2. Operates on cell structure of 128 dots, producing 64 different cells. Once defined, each cell may be placed anywhere, any number of times on screen simultaneously. Max screen capacity: 768 cells. Dot resolution: 384 x 256 98304. Many other features including intermixing of alpha-numeric characters and pixels. **Price (kit) £60 + VAT.**

PORT PROBE

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

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

HEX & CONTROL KEYPADS

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

BASIC PROGRAMMER'S AID

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

'SCREENPLUS'

Screenplus enables a programmer to blank or display in reverse video, selected words, letters or areas of the screen under program control. Suitable for use with either Nascom 1 or 2. 'Screenplus' (built and tested) .... **£40.00 + VAT.**

DUAL MONITOR BOARD

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

YOUR LOCAL MICROVALUE DEALER

All the products on these two pages are available while stocks last from the MicroValue dealers listed below.
(Mail order enquiries should telephone for delivery dates and post and packing costs.) Access and Barclaycard welcome.

BITS & PC'S
4 Westgate, Wetherby, W. Yorks.
Tel: (0937) 63774.

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

ELECTROVALUE LTD.
680 Burnage Lane, Burnage, Manchester M19 1NA.
Tel: (061) 432 4945.
28 St Judes, Englefield Green, Egham, Surrey TW20 0HB.
Tel: (0784) 33603. Tlx: 264475.

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

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

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

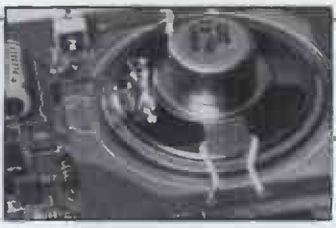
THE AM SPEECH BOARD

Make your inputs and many of your outputs audible as well as visible. Hearing the question and answer will speed up your acceptance and enhance your usage. With words as well as display the use of any computer system is greatly expanded.

The initial ROM set will be expanded and future ROMs will add to your direct library. Your own expansion using the fragmented sections of the words provided to create new words will be as complex as you wish.

The speech is generated by a National Digitalker chip together with two 64 K ROMs. The first ROM set gives you a vocabulary of 256 words and sub-sounds.

The on-board power amplifier and 2½" speaker will give you immediate speech from your software instructions. The Instructions are simple and



demand no extensive re-write or patching, in fact, speech is as easy as display.

A socket is provided to allow external use of a tape recorder or for the use of external speakers.

The product is supplied in a custom built case which incorporates the speech board, interface board and its own power supply. A plug to the mains and a simple connection to your computer and you can start discussion.

£120 + £2.99 p&p + Vat
(Nascom + Apple Boards only
£85 + £2.99 p&P + VAT

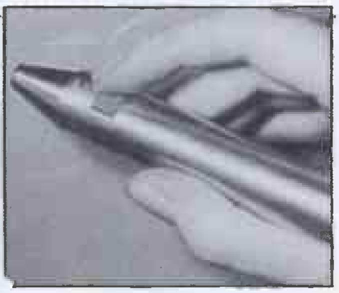
& AM LIGHT PEN

At last a true light pen in the UK at a low cost! Its interactive flexibility and simplicity of use allows even the totally untrained user to liase with the computer.

The uses are as varied as the applications however some of the more obvious areas could be: answer selection, editing, menu selection, identification of block or specific areas, movement of displayed data blocks and X Y plotting. The ramification of uses in these areas alone are tremendous.

All applications depend on software and the light pen is supplied with straight forward operational software which is easily interfaced into your own programs.

The pen uses a high speed photo diode which works directly with the normally illuminated pixcels. The outputs it provides are debounced microswitch and



gated strobe. The pen's speed is typically 500nS.

The pen itself is professionally presented in anodised aluminium and is supplied with an interface board for your computer and a power supply, both of which are housed in our custom designed case.

£80.00 + £2.99 p&P + VAT
Arfon Microelectronics Ltd.,
Cibyn Industrial Estate,
Caernarfon, Gwynedd, Wales
— Telephone: (0286) 5005. —
Reg. No 1553140

Both products are boxed with their own power supply.

So far compatable with Pet, Apple, Tandy, Video Genie, Nascom, UK 101, Gemini & RS232*

* these are trade names

AM AM AM

to: Arfon Microelectronics Ltd., Cibyn Industrial Estate, Caernarfon, Gwynedd, Wales — Telephone: (0286) 5005. —
Please send me the following:
☐ AM Light Pen & Interface – £95.44 (inc p&P + VAT)
☐ AM Speech Board Nas & Apple – £101.19 (inc p&P + VAT)
☐ AM Speech Board Interface £141.44 (inc p&p + VAT)
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INNOVATIVE

TRS-80 SOFTWARE

FROM THE PROFESSIONALS

LDOS

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

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

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

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

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

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

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

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

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

LDOS ....£85.00 plus VAT and £1.50 P&P.

TRS-80 & VIDEO GENIE SOFTWARE CATALOGUE £1.00 [refundable] plus 50p postage.

MOLIMERX LTD.

A. J. HARDING (MOLIMERX)

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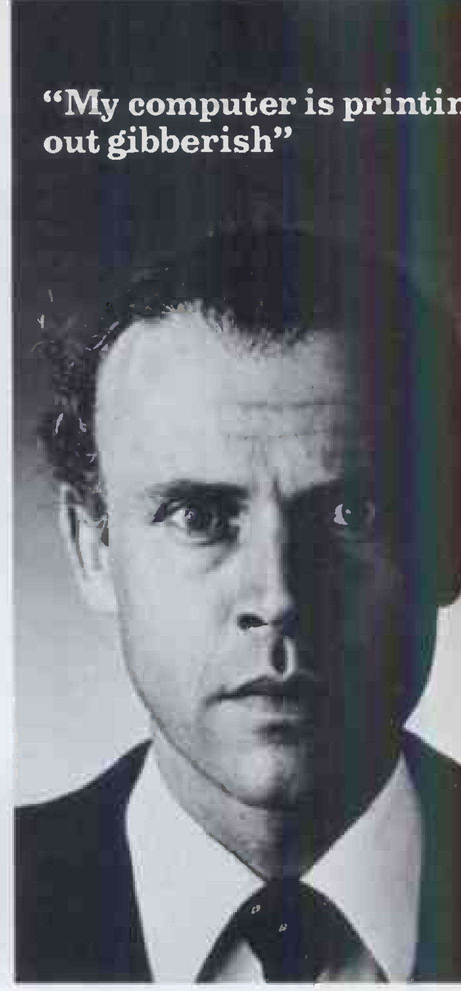

At Micro-C, we test all software. If it isn't easy to understand or fr from errors, we won't stock it.

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At Currys' Micro-C, before we talk about hardware or software, we'll talk about your business, or practice.

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Again, it'll handle book-keeping, word processing, and incomplete records.

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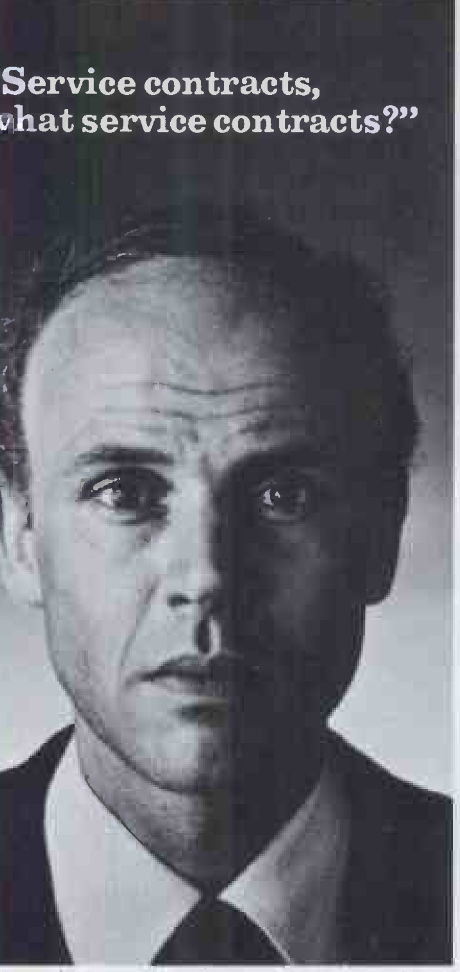

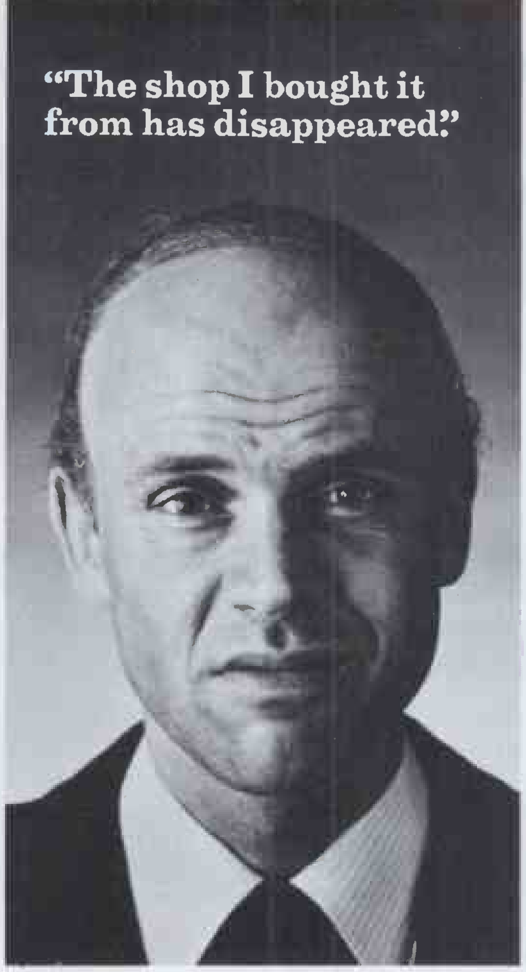

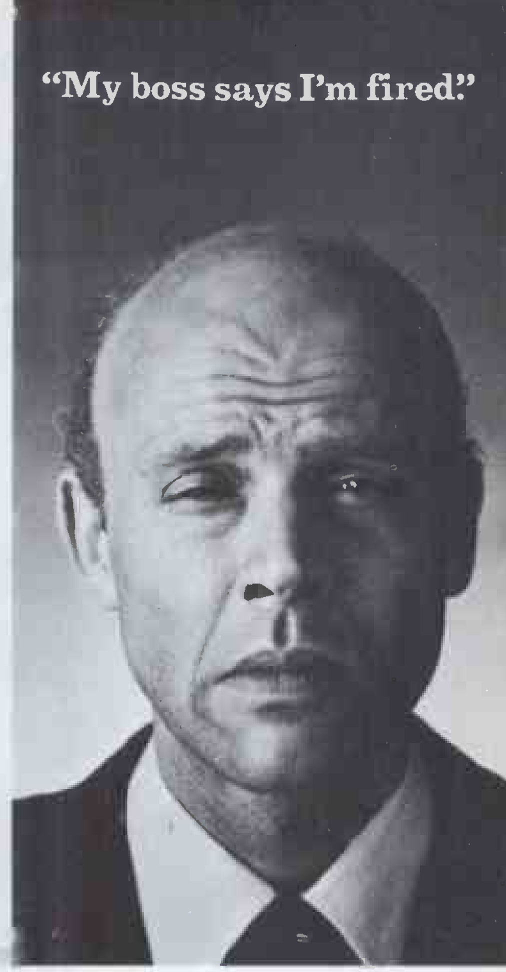

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Video Genie...

Are you a home enthusiast taking your first tentative steps into the enthralling world of micro-computers? If so, the Video Genie is the ideal complete system for you!

It's a real micro-computer, not a pocket one, yet it only needs connecting to a domestic T.V. set to produce superb results.

The Genie is compatible with the popular TRS 80 16K level 2, the best selling computer of all time. As well as its lower price, the Genie offers an in built cassette deck, 16K RAM, 12K ROM with BASIC interpreter, full size keyboard and a stylish carrying case. So it is not only excellent value for money, but an ideal "First computer" on which to learn programming.

There are literally 1000's of pre-recorded programs available, including educational, leisure and small-business applications, and simple BASIC language means you can write your own programs with ease.

Extended BASIC.

The Microsoft extended BASIC has many powerful features, including double precision variables, scientific functions, formatted printing, extended editing sub-commands, automatic line numbering, multiple dimensional arrays, complete string manipulation, direct access to graphics and machine language sub-routines.

Memory.

The Genie EG 3003 model has 16K of internal RAM expandable externally to 48K using the special Expansion unit. 12K of ROM contains the Microsoft BASIC.

Cassette.

Two cassette interfaces are provided for both the internal and an external cassette unit.

CPU.

The machine uses the industry Standard Z80 micro-processor.

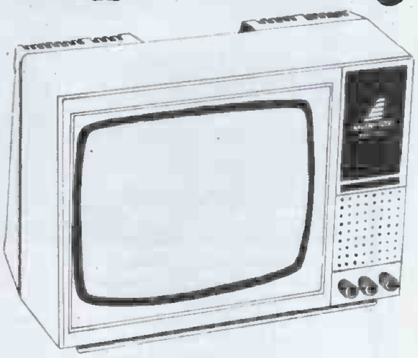
Display.

64 or 32 characters × 16 lines are available on the full display.

LOWE electronics

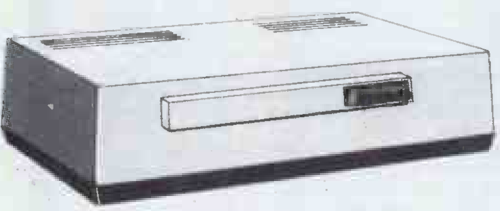
one giant step for micro-computer systems

12" Monitor.



The additional purchase of the EG 100 Monitor offers 3 distinct advantages

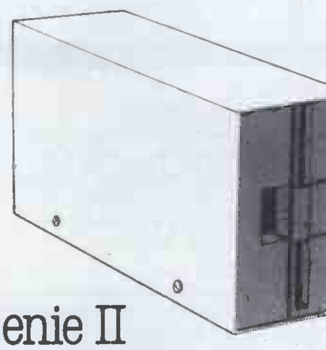
- It gives a considerably better quality display.
- It does not interfere with domestic T.V. viewing.
- It comes in an attractive matching style.



Expander.

The expansion box unleashes the full possibilities of the Genie. It contains a selection of interfaces, allowing the connection of up to 48K RAM, 4 disk drives, printers and S100 cards.

Disk Drive.



As well as the obvious advantage of mass-storage, the addition of the disk system to the Genie means much faster access to other languages and full random access file handling. Up to 4 drives can be used on a system.

. . . and introducing Genie II

. . one giant leap for micro, business systems!

New and exclusive! The Genie II is a breakthrough for small business computers. Harnessing all the advantages of the Genie, including low price, Genie II adapts perfectly to commercial functions with the following features.

- Numeric keyboard
- Four usable, definable function keys.
- Extension to BASIC
- Basic business commands
- Fully expandable for same peripherals.

For full details and demonstrations of the Video Genie system or Genie II contact your local dealer, or write directly to the sole importers at the address below.

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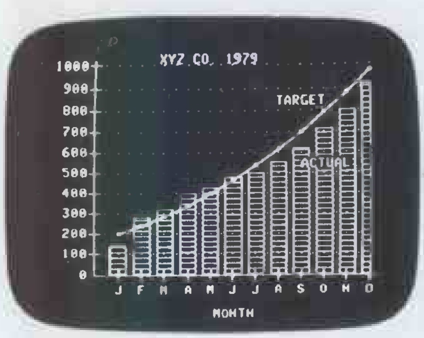

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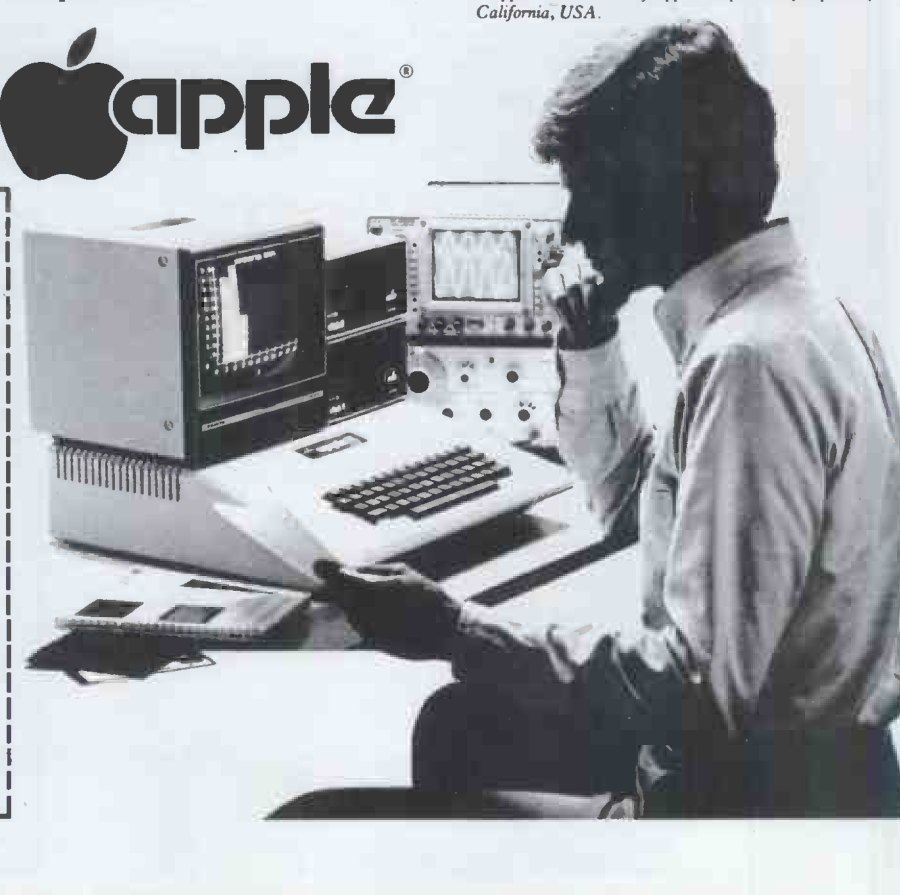

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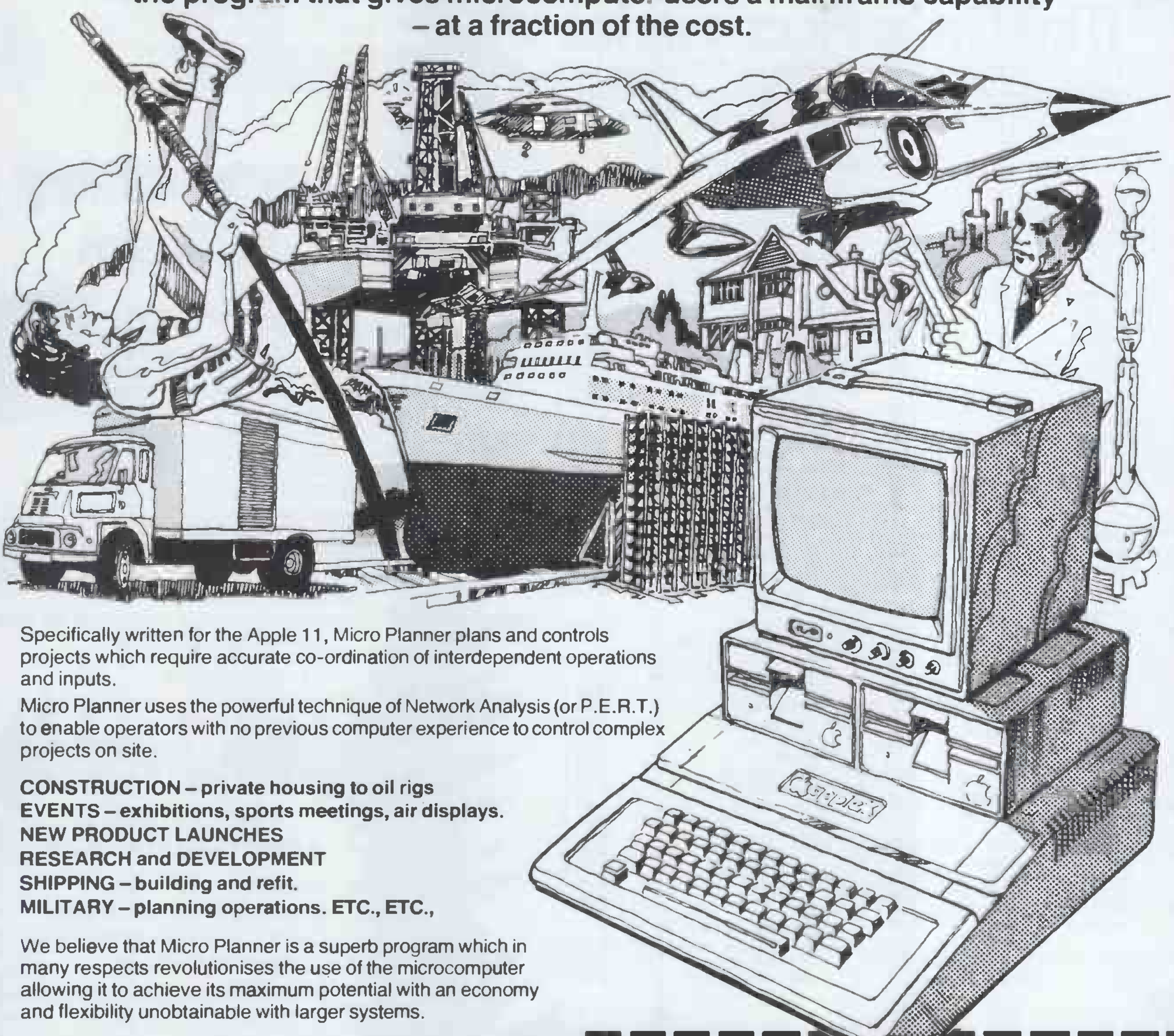

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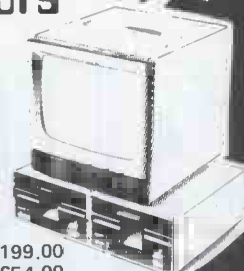

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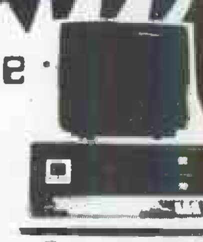

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SPECIFICATIONS

Picture Tube	310KMB31
Phosphor	P31
Video Input Signal	
Polarity	Negative sync.
Level	1.0Vp-p
Impedance	75Ω
Active Display Area	235(W) x 185(H) m
Scanning Frequency	
Horizontal	15.75 kHz (63.5 μs)
Vertical	60 Hz (16.67 ms)
Active Video Period	
Horizontal	54.5 μs max.
Vertical	15.57 ms max.
Video Band Width	More than 18 MHz (–3 dB)
Display Characters	80 characters with 25 lines
Operating Ambient Temperature	0~+40°C
Power Supply	230V AC ±10%
Power Consumption	26W
Dimensions	310(W) x 286(H) x 308(D) mm
Weight (Net)	7kg

NOTE: The above specifications are subject to change without notice for further improvement.

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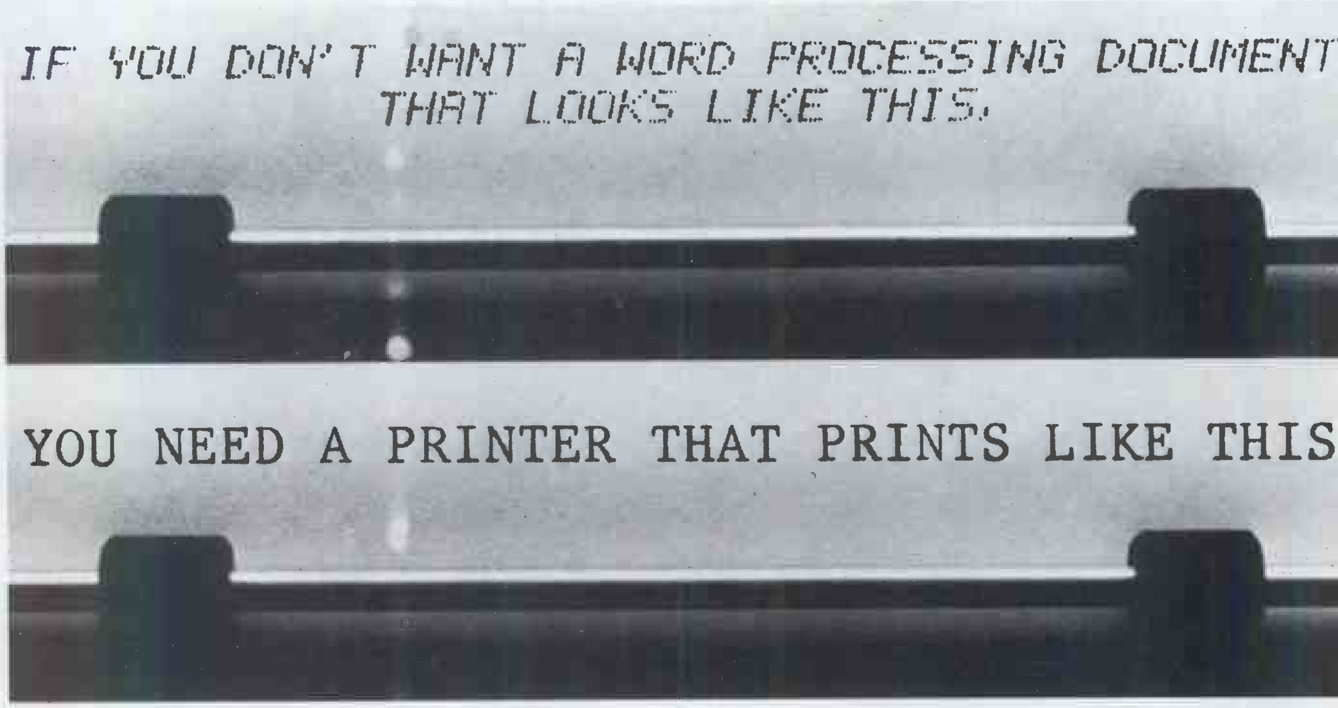

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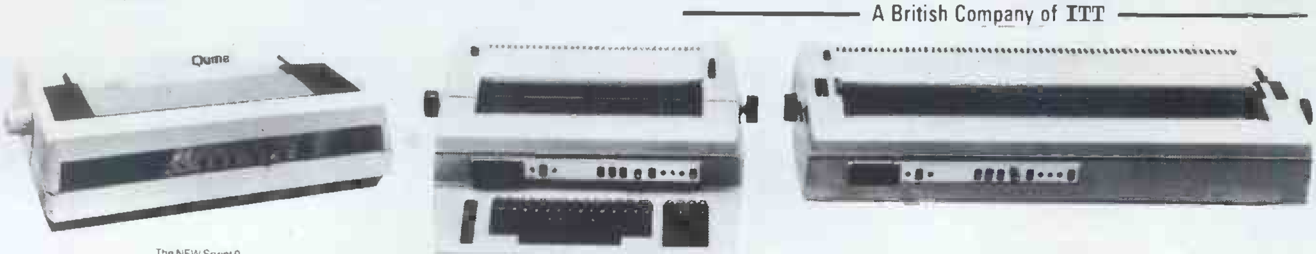

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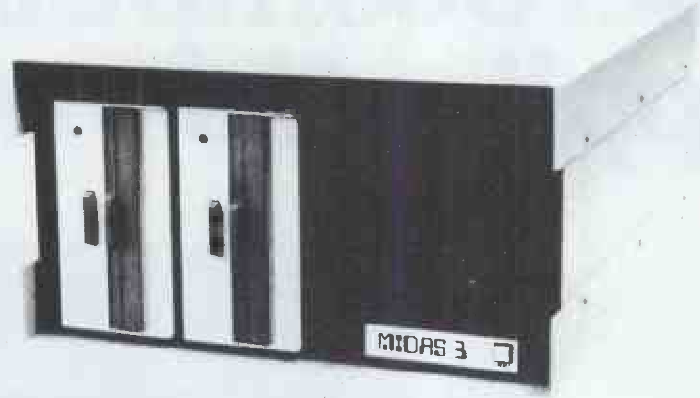

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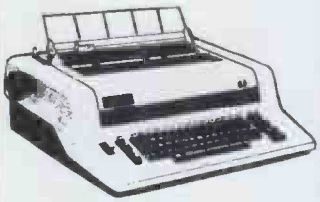

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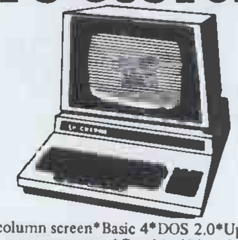

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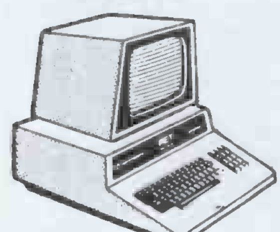

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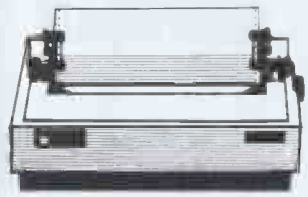

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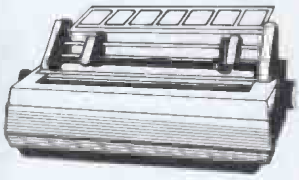

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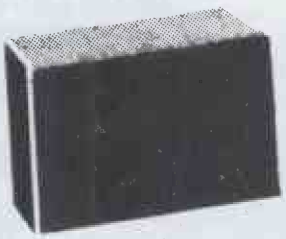

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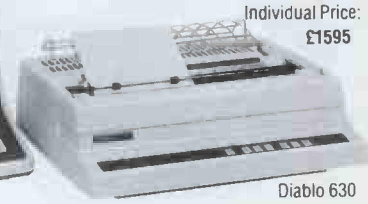

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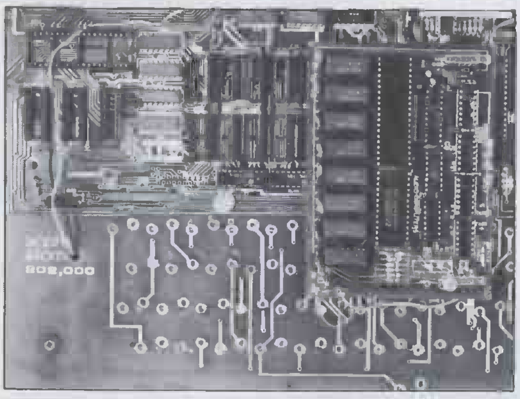
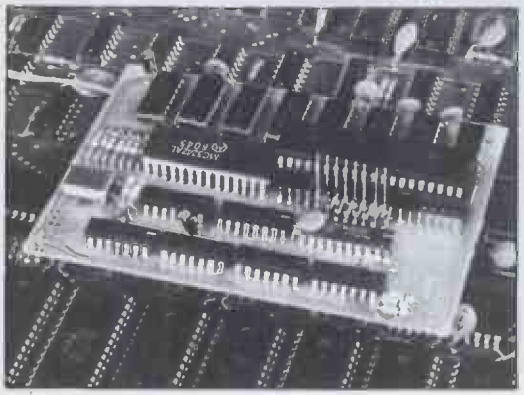


(and other 6502/680X Motorola users)

BEFORE YOU BUY ANY STATIC RAM EXPANSION

CONSIDER THE FACTS



Besides the price, which is nearly half that of the equivalent product equipped with static Ram, DRC modules offer the following important advantages over other Ram expansions:

1) **SAVING ON EXPANSION PORT**: since most microcomputers have only one, the expansion port is precious. The DRC module is microprocessor attached and therefore saves you the port for other uses.

2) **EASY ASSEMBLY AND INSTALLATION**: you obviously need to know a little about basic electronics to install the DRC module, but you should have no difficulty with the instructions provided. The most powerful 64K requires you only to recognize the MPU chip (6502 or 6802), remove it, insert it into the reserved socket on the module and plug the module into the now empty MPU socket on the computer board, with no wires to connect.

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4) **PRICE**:

6502	Kit	Ready built
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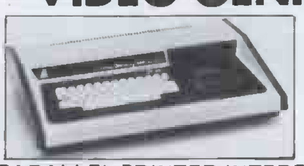

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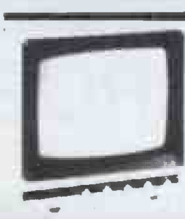

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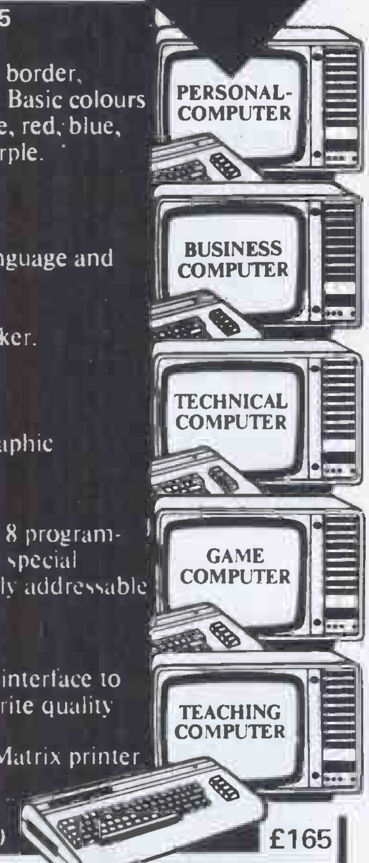

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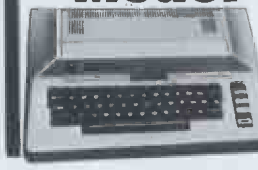

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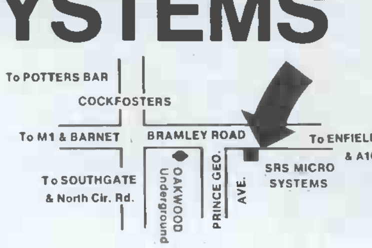

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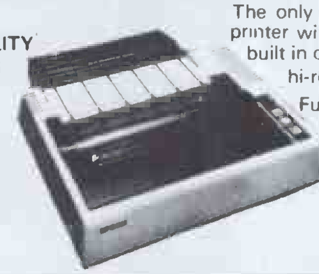

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Guy Kewney, editor of Datalink, *brings his latest compilation of news, gossip, rumours and hard micro-facts.*

At last - The Last One

The Last One — the program which writes programs — was given its first British showing at a crowded press conference last month. And by the time you read this (or at least fairly soon afterwards), it should be on sale and available on half a dozen machines.

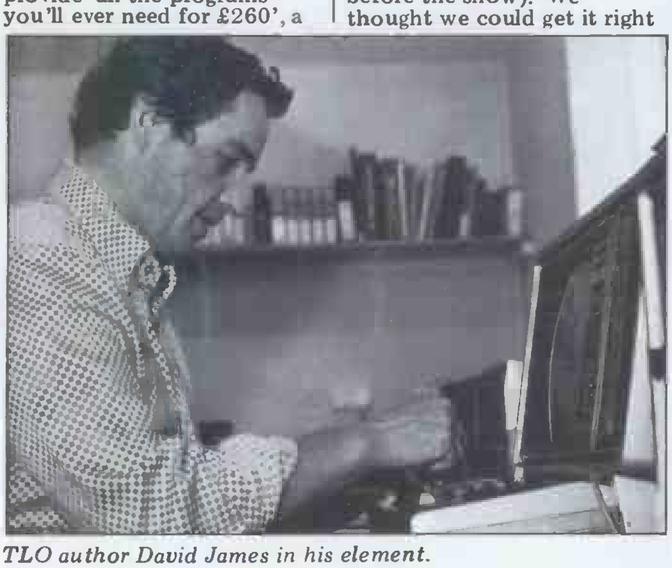
Since The Last One was featured exclusively in February's *PCW*, two things have happened: DJ 'AI' Systems, the company set up to develop and market TLO, has launched a reputed $1 million advertising campaign and hired a team of ace programmers to develop marketable versions of TLO for various micros; and the computing world has split into two camps: those who've been to see TLO and realised its potential, even if the development versions have been rather ragged at the edges, and those who've said — in print, sometimes — that it wasn't anything special/couldn't be done/didn't exist/was a con.

The attitude of the latter group was considerably strengthened by TLO adverts, which claimed it would provide 'all the programs you'll ever need for £260', a claim considered wildly optimistic by TLO critics. And those who thought it was a con were beside themselves when the end of July — the promised delivery date — rolled round and copies of TLO still weren't leaving the DJ 'AI' offices in Ilminster, Somerset.

Now it's by no means unusual in the microworld for a product to miss its launch date — in fact, it seems almost mandatory. But when you've made yourself as public as DJ 'AI' has, and when you've aroused considerable controversy in the process, it's scarcely surprising that missing your release date should provoke deafening cries of 'I told you so' from your critics.

So what's the situation with TLO? Will it write all the programs you'll ever need? Is it really different from other micro packages that write programs? And when will it be on sale?

To answer the last one first, DJ 'AI' managing director Michael Falter was hoping that TLO would be on sale at the *PCW* show (this was written three weeks before the show). 'We thought we could get it right and ready by the end of July but, because we're such perfectionists, we're not prepared to let it go while there's still something not quite right with it,' he said. 'It's to everybody's benefit in the long run.'



TLO author David James in his element.

What this means is that work on tidying up TLO and preparing versions to run on various machines has taken longer than anticipated. To understand how this situation has arisen, it's necessary to look at the background to our story in February's issue (which itself explains the background to how TLO came into existence).

When we received our first phone call from TLO author David James last November, The Last One didn't even have a name. It was an interesting development project which had 'spun off' from David's work on artificial intelligence and David had, in fact, become quite bored with it. In fact, the way he felt then, *PCW* could have published the program's listing and that would have been the end of it. David had spent so long immersed in the program that he couldn't see any end to it; Scotty Bambury, his backer, could see a light at the end of the tunnel, though.

Scotty had had some considerable trouble with the minicomputer system which he'd installed in his tyre company. He wanted a way of enabling himself, an ordinary businessman with no previous computing experience, to get the system to do what he wanted it to do without the time, expense and hassle involved in getting a software house to write special packages. If computers were so damned clever, he reasoned, why shouldn't they write their own programs after being told the requirements in plain, non-technical English? And, if his computer could be made to do this, why shouldn't other businessmen be able to obtain the same service?

David's program-writing routines seemed to be just what Scotty needed and he thus backed David's development work, which involved a lot of tidying up to make the system user-friendly, and the production of versions to run on different machines.

At this point, Scotty then had several options. He could have sold the program listing to *PCW* — but this wouldn't nearly have compensated for the considerable time and money invested by him and David.

He could have set up a time-sharing bureau, allowing access to the program-writing routines for those willing to pay. This, though, would tend to restrict access to DP people and wouldn't — in Scotty's view — liberate users from the DP industry's 'tyranny'.

The third option would have been to sell it at a high price to those who could afford it, but this would similarly prevent end users from benefiting.

Thus, Scotty chose a fourth course of action, to his mind the only one possible, and decided to make the routines available as widely as possible at a reasonable price.

By the time the *PCW* article was written (mid-December last year), Scotty had christened the product 'The Last One' and at this time we realised that Scotty's ideas on marketing tactics were far, far removed from traditional computer industry techniques. He has, in fact, adopted the sort of 'cavalier' attitude towards selling TLO that he has used successfully for years in selling tyres.

The first the outside world heard of The Last One was in our February article, which came out in mid-January. We sent copies to a number of papers and magazines — both computer trade press and more general publications — as we figured that any follow-up stories would mention *PCW* (one trade rag did, in a storm of childish abuse, as they clearly didn't believe in TLO).

Reactions to TLO varied from 'I want one' to 'Nonsense'; the story spread around the world and we had a few hectic weeks handling a deluge of phone calls. Before Scotty & Co made their final decision to market TLO as a commercial product, David James and David Tebbutt had promised to present a paper on TLO at a conference session at the West Coast Faire in San Francisco.

Part of the TLO development team.

made, things really started to hot up. Machines were borrowed, someone was appointed to prepare the documentation and a software house was contacted to help in 'tidying up' TLO and preparing versions for other machines. Now at this point we start to dip our toes into hot water, for it appears that there was some disagreement between DJ 'AI' Systems and the software house; as this disagreement may, by the time you read this, be subject to legal proceedings, we can't elaborate. All we *can* say is that, as a result, DJ 'AI' had to hire a team of programmers to carry on with the conversion work and this appears to have been the cause of TLO missing its launch date.

On a visit to Ilminster towards the end of July, we were able to see a 'pre-production' version of TLO in action. Yes, it works. Yes, it had been considerably tidied up since we had first seen it and yes, it'll probably be a reasonable product when it appears — watch this space!

by David Tebbutt and Peter Rodwell

'81 bug-sorting

Users of the Sinclair ZX81 must be a very uncomplaining bunch. Uncle Clive has cheerfully admitted that there is a bug in the new ROM of the ZX81, the chip that gives the machine a lot more power than the ZX80.

The bug comes in the form, he says, of a dud memory bit. 'Four or five people have been in touch about it,' he added, blandly. The way to tell if your own ZX81 has the bug in is to ask it to PRINT SQR(1/2) and see if the answer makes sense. He also admitted to a problem with the add-on memory box, which, he says, he has cured. The problem, says Sinclair, was caused by dirt on the copper contacts between computer and memory and has been cured by putting a special lubricant on the memory socket at the factory.

Now the strange thing about these two faults is that everybody I've met who has a Sinclair machine with the new ROM has the arithmetic bug, and everybody who has the add-on memory says you have to be careful using it. And the 'dud bit' problem has impressed Sinclair as serious enough to develop an add-on fix circuit, which he will add to any faulty machine sent in. That isn't the sort of thing I'd do for only five complaints, but then I'm not as meticulous as Uncle Clive.

The problem with the memory expansion isn't quite as easily cured as the Sinclair Lubrication Service seems to think. It is true that before the cure, a ZX81 (or ZX80) with this add-on box used to just go mad for no apparent reason and start moving text up and down the screen, flickety-flicker; now, it doesn't.

But that doesn't mean you can pick up the machine and move it around. The memory block hangs onto the printed circuit board itself and flaps about. This occasionally causes the signal lines to flicker and introduces untraceable errors.

Now it is one of the great strengths of the Sinclair design that it is impossible to enter a faulty instruction, because the Basic won't accept it. However, on older designs, where fault checking only occurs when you type RUN, you do at least pick up faults that have crept in later. On the Sinclair, you're stuck with them and occasionally, you can't pick them up.

On the Sinclair, they are assumed to have been purged before digestion. Just occasionally, they completely poison the machine.

So far, I've received rather fewer complaints about the ZX machines than I expected given human frailty and the very large number made and sold in a very short time.

Most complaints involve late delivery, where I can sympathise with the frustration. But I do find it a bit hard to understand why only four or five people have bothered to complain about a software bug.

IBM micro launched

IBM has deeply infuriated me by launching a cheap micro earlier than I expected and by producing an impressive design which should last for many years.

The key to the new micro is the processor chip, ostensibly an ordinary 8-bit processor (if a fast one) like the chips that power the Petappletandy machines, but one which can be turned into a much more flexible one without changing any of the software written for it.

The system itself, however, is obviously not intending to sweep the world in the first month. At a price of $3000 for a system with one disk and only 16 kbytes of user memory, the IBM Personal Computer undercuts none of the top-sellers. And with one standard program (Visicalc) it is obviously very useful, but without CP/M or any language but Basic (yet) it seems that IBM is going to get into the water carefully, no splashing until they know how deep it is.

Once the depth is plumbed, however, the machine looks to have amazing scope. The Intel 8088 processor will run the same machine code instructions, direct from memory to processor, as the bigger Intel 8086. More to the point, perhaps, it will run the more advanced, but similarly compatible versions of the 16-bit 8086 that Intel is planning over the next few years.

As things stand, in the micro world it isn't possible to close down one program (say a word processor) and start up another (say a stock control program) with any guarantee of being able to restart the first where you left off.

A proper multi-tasking system on a cheap micro, if it is intended to allow two users to run two programs on the same processor, is silly. However, its value in allowing one user to run two programs, switching from one to the other, could be enormous.

Enthusiasts who complain that there already is a multi-tasking operating system (MP/M) are assured that it isn't up to the job. That's no criticism of Digital Research, who wrote it: the normal 8-bit 8080 family micro just isn't able to run a safe operating system. Normally, multi-tasking executives run in sections of memory that users can't get at and use machine instructions that users can't use. On today's primitive micros, even the Intel 8088 and 8086, there are no such privileged instructions or areas of memory. But on the future descendents of the 8086, there will be.

At that stage, IBM will suddenly find itself in a very strong position. At the moment, there is almost no software for its machine beyond what it has prepared for the launch — but in four years' time, it will have a 16-bit micro with a mass of software, and a workable multi-task executive.

Minimakers in microwar

Apparently a 'horse before the cart computer' is one where the manuals were produced first, then the software written, and then the hardware was developed.

The machine in question is an American micro which British minicomputer builder CTL hopes will let it catch up with its home rival, Digico. Digico recently produced a rather nice little micro of its own design, and its Prince (as the company called it in Wedding Year) is building up a dealer list. When it is widely available, it should sell well, since the price is nice for what you get. And it must have made near neighbours CTL in Hemel Hempstead a bit jealous.

The CTL machine is in a very different league. It is a powerful machine, using a 16-bit processor, and you have to be fairly wealthy to buy one because the smallest model in the series costs £10,000.

By 1983, CTL hopes to be selling at least 100 of these machines a year — two per week — estimating the market for 'desk-top minis' at £100 million annually now and wanting a tenth of this.

IF ANY OF THE FOLLOWING WORDS GIVE YOU A BUZZ . . . ANALYSIS STATISTICS DESIGN PLOTTING GRAPHICS REPORT WRITING SPECIFICATIONS SCHEDULES COSTING PLANT MAINTENANCE PRODUCTION CONTROL SIMULATIONS IEEE INTERFACING INSTRUMENT CONTROL MONITORING TERMINAL COMMUNICATIONS PAPERTAPE READING PUNCHING & EDITING SELF PROGRAMMING BASIC ASSEMBLER LANGUAGE MACHINECODE . . . GIVE US A BUZZ (OR SEND BACK THE COUPON)

The micro comes of age. The PET has come a long way since micros were regarded as toys. It's designed and built for demanding work and this shows in the 32K memory and 80 column screen as well as in its impressive disk capacity. When it comes to languages, you'll find the PET fluent in BASIC, PASCAL, FORTH, COMAL, LISP, PILOT and ASSEMBLER.

It can be used as a complete system in itself, or can be linked to other PETs or a mainframe.

Who needs PET? And why? The list above speaks for itself, but that's only part of the story as the PET now has over 600 applications. It's good news for any engineer who's tried to get even a modest budget approved – the PET is very acceptable to the most sceptical of money people.

It's an attractive proposition, too, to DP professionals who need their fingers on the pulse and are fed up with waiting for their turn on the company computer.

In fact, it's the nearest thing to the all-purpose computer for everyone. An extravagent claim? A demonstration can prove it to be true.

The PET has track record. We've been involved with electronics for over 20 years and there are now over 40,000 PET installations in the UK.

We manufacture our own microchip which is happily accepted and used by makers of other well-known microcomputers.

You get nationwide dealer back-up with Commodore.

What's more, many of our dealers have specific expertise – which means they can advise on anything from business systems to specialist technical applications. So, if your particular problem is of a highly specialised nature, it may be best to contact our Information Department direct. They will then recommend the dealers who understand – and who speak your kind of language.

What does all this cost? Not a lot. In fact, our computers start at £200 and go through to £3,000 – and that will buy you a complete system.

Which is just one more reason why any professional worth his salt would be interested in a microcomputer that's made its name in the business world . . . but is far more than just an efficient business brain.

Send to: Commodore Information Services, P.O. Box 109, Baker Street, High Wycombe.
Tel: Slough 79292.
I'd like to know how a Commodore PET could give me a buzz.

Name ....

Company ....

Address ....

Tel: .... 39 PCI

COMMODORE PET
Quite simply, Britain's biggest selling microcomputer

NEWSPRINT

Sources in America say that the machine sells well under the name of Convergent Technologies there, but even with a free method of linking up to 16 machines plus communications software to let them talk to conventional mainframes, it's hard to see what it does for UK users that a Digital Equipment mini with proper user partitioning can't do. The price and the network alone aren't enough. What would make it really attractive would be a single-user, screen plus-floppies-only version for £1500 or so, to get a few trial machines in and get users hooked. But that would look like the wrong sort of market to CTL and Convergent. Details on (0442) 3272.

Red faces at BMA

Much to the embarrassment of the British Medical Association, two weeks after publishing a stern call for improvements to 'data protection for personal medical information,' it was caught with its files open; an insurance company was found to be accessing names and addresses from the BMA computers.

The BMA described this as an administrative mix-up. I suppose you could say it proves the Association's point: 'The BMA is concerned that proposals for standardisation of names and addresses and other information to facilities transfer between Government computers may seriously compromise the principle that information gathered from a person for one purpose should not be used out of context or for any other purpose without consent.'

Micro makers v government

British micro maker Transam is lobbying hard to erase the Government decision which says that Civil Servants can buy Apples made in America, but not Tuscans made in Britain. Its agitation has finally provided an unofficial explanation of how the strange situation arose, and the scent of a promise that it will be changed in less than a year's time.

Behind Transam are several other British micro builders, in the shape of the new British Micro Manufacturers' Group (BMMG).

The explanation does concede the point that the decision was deliberate. I spoke to the senior Civil Servant whose name was given and pointed out that the Central Computer Agency had run two very small ads, which merely asked for tenders for 'a contract' and pointed out that this would lead to follow-up orders.

First, I said, did he realise that some manufacturers hadn't noticed the ad? And second, did he not think it was daft to leave out the rather important corollary of the contract — that if you didn't get this one, nobody in Government departments would be *allowed* to buy your machine?

No to mince words, he admitted that the choice of tactics was deliberate. The logic was simple: some people had machines just off the drawing board, not yet in production, or in short supply. If a grand announcement were made saying 'This Is The Great Race For Government Approval' then all these paper machines would have been tendered.

And he made the point that every machine on the approved list has to be supported by trained engineers. Yes, in the event it appeared that the ruling was unfair to Transam, but did I not realise (he asked me) that the list was only in force for a year, and did I realise what it would cost to set up support for every possible UK built machine? 'Our job is to protect the users inside the Civil Service,' he ended, not to support British Industry — we aren't the Department of Industry.'

He's right, of course, but I wish the Americans took the same approach to UK hardware as he does to American.

Anyway, the group of British manufacturers (which does include some that are approved) has decided to step up its campaign by including those insignificant people such as Acorn and Sinclair, who make the odd machine but charge less than £2000 for them.

Details from Julie Hamilton, BMMG, PO Box 2, St Neots, Huntingdon, Cambs.

The evaluators

The almost impossible task of finding a useful piece of cheap software has been tackled head on by a new team, set up inside the micro distributor Digitus to evaluate software. This is no leg-pull; it is an attempt to set up standards by which software can be judged, and to publish a catalogue showing how various packages measure up.

In charge of the project is Peter Wolfdenden. (He's the guy with the glasses in the pic, sitting down.) His Software Products Group will select cheap software packages (some of which will not be cheap, of course, by

The Digitus team — see 'The evaluators'.

our micro standards) and test them on the following points: whether they use plain English commands; whether the product is of real practical use; whether the documentation is clear; whether it is easy to use; and whether it can be crashed — that is, if pressing the wrong button at the wrong moment can destroy all the hard work of the previous half hour.

If a product comes through this checkout okay, then give it a trial at some genuine user's office. And if they stand up to this, says Digitus, they go into the approved list, providing the supplier helps properly with any problems.

It sounds great to me, or I wouldn't have given it so much space, but I have to admit that I can see a further step that is needed in this exercise. Once the list is available, it will be of great help to a lot of people but it can hardly be exhaustive. For a start, the first two machines to be listed are Apple and those running under CP/M — which makes it so much waste paper for PET, Tandy, Acorn (etc, etc) machines.

Second, and more important, the list will effectively be a catalogue of Digitus software. Unless a miracle occurs, there will be other software suppliers, some producing their own stuff, some importing or distributing overseas stuff, and some produced on a publishing basis by people such as AJ Harding (Molimerx) or The Software House, or SBD. It's a fair bet that not everybody will have all programs at their command, and someone without Wordstar will speak well about Easywriter without necessarily proving that Easywriter is 'better'.

And if Digitus writes its own PERT package and says it is the best, nobody will know whether that is unbiased pride or partial praise.

We will have to wait until somebody with enough money and sense comes forward to offer a suitable independent expert a platform from which to launch a Catalogue of Catalogues, to work with all the software wholesalers and publishers and to compile a compendium.

BBC micro builders named

The BBC has selected the builders of its micro. At least, the designers have selected them.

The machine is to star as the workbench of a series of programs on How To Microcompute early next year and the Acorn design has been attacked most powerfully as 'unbuildable in the time' — on the fairly solid grounds that Acorn doesn't have a big enough factory.

Now it has selected two mass-producers of electronics: audio company Cleartone and computer assembler ICL (yes, *that* ICL, International Computers Limited) who thus get into micros on the navvy level. Surprise. Cleartone starts first, hoping to get 1000 machines built in September. By November, ICL Logiclayer hopes to have built a further 2000 machines. Good luck to you all; I'm certainly not going to make any rash guesses or predictions on how it'll go, except for the certain fact that luck will be needed.

Not to worry: the BBC is showing it three times a week (each episode, that is) but is carefully arranging times when as few people as possible are looking. This way, they hope to keep demand for the machines in reasonable limits the first time round, and hopefully this way they'll find out what is wrong with the hardware and software in the hands of relatively few people. Then they can repeat it in more populous slots a few months later.

By then, maybe, I'll have got the answer to a simple question: if I record a BBC TV program about micros on my common-or-garden home video, will I record the Ceefax lines that contain the software and pick them up later on playback?

And will my BBC computer not interfere with the video machine the way my Acorn and Sinclair machines do?

Watch these spaces for answers.

New micro from HP

Hewlett-Packard has asked the world for an astonishing £4400 for its latest microsystem, including processor, two small disks, the CP/M operating system, and a thermal printer.

At the time of writing, I've still not sat down in front of the HP-125, but to be worth this price it must be truly phenomenally easy to use. And users must be very sophisticated to appreciate the need for ease of use and probably won't realise how much they need it, so I'm lost by the logic.

On the face of it, you get a wonderful system for the money. Always, Hewlett-Packard computers prove to be much nicer and easier to use than any others, and I see no reason to doubt this one's strong points.

For instance, control of the system is by special keys, which print their own labels on the screen. These 'prompt and guide the operator', says HP, and on all the other HP machines I've seen, they certainly do. But that's controlled by software.

The screen displays the contents of not just one but five pages of memory, and you can look up or down into pages that have gone long past or pages you scrolled off the bottom of the screen. It's absolutely great for testing out a program, or looking through text. But apart from the little memory, which is cheap, the feature is provided purely in software.

The list of things provided by software (some running on an extra Z80 micro which works with the main Z80) is delightful, including Visicalc at an extra £118. But software is a once-and-for-all cost.

In other words, once you have your software done, no matter how good or how bad it is, and no matter how much or how little you spend it, that is the end of the software cost.

So if you sell twice as many machines, then you can charge half the price for the software. And the machine itself just can't cost that much to build; yes, it's a nice screen and a nice keyboard, but *that* nice? So why charge the earth? To persuade the few that it is wonderful? Or to give some Japanese competitor a blueprint from which to work? Details on 0734 61022.

Where are the Silver Apples?

Details of ITT's new microsystem not having been received by press time, you will have to wait until next month to read about the replacement for the Silver Apple. The question of 'what happened to the Silver Apple' is even harder to answer.

Originally, ITT very kindly condescended to help little Apple launch its little machine into Europe by taking on a distributorship. Plainly, it wouldn't sell as it stood, so ITT generously made one or two improvements — slowed the system clock a bit, adjusted the power supply, and put an extra bit of memory in to give proper British colour, among other things.

A year or two later, it became clear that the ITT version was the minority one and that one or two Apples had been sold, here and in America, to people who had thoughtlessly written software which didn't run properly on the ITT 2020. Exactly how many Silver Apples are lying around still is a tricky question to answer since ITT is loath to talk about them. Understandably, it feels that if it admits that it

Hewlett-Packard's new HP125.

SURVIVAL KIT

If you service or maintain a range of computer peripherals OASIS 820 is the cost-effective and logical solution to your control and exercising problems.

OASIS 820 uses firmware application Peripheral ALgorithm Modules (PALMs) to configure the keyboard to control various computer peripherals. To test a printer, plug in a printer PALM — for a floppy disc drive, a floppy disc drive PALM. The same principle applies to terminals, accessories such as front feeds, hard discs, cartridge tape drives, etc. As and when different new peripherals have to be supported more PALMs can be added to the library.

OASIS TECHNOLOGY LIMITED 820

the revolutionary multiperipheral exerciser in a briefcase -tests virtually any computer peripheral

Each PALM comes with a set of instructions so that various drive routines within the PALM can be selected from the "soft" keys on the keyboard. The operator is prompted through the tests by a display panel so that progression through each test can be constantly monitored.

OASIS 820 is not only low-cost in its basic form, but is also flexible and expandable. Each briefcase will hold several PALMs and interface cables so that an engineer can carry, in one hand, all of the peripheral driving equipment which he needs. Because OASIS 820 replaces any number of test boxes, the cost per function is minimal so that a Service Engineering Department can plan ultimately to have one briefcase for each engineer. *In the field of peripheral testing this gives OASIS 820 the lowest cost per function in the industry.*

For more information on this revolutionary new product contact us at the address below.

OASIS 820 is designed and built completely In Britain and patents are applied for.

HAL Computers Limited
57 Woodham Lane New Haw
Weybridge Surrey KT15 3ND
Telephone: Weybridge 48346/7

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WINCHESTERS?

I've got just what you're looking for....

Our new Micro Winchester gives you from 5 to 20 M.bytes of hard disc storage from as little as £1425.00 for a complete ready-to-go, plug-in system with software.

Floppies and larger more expensive hard discs are no match for our new drives which pack enough data to run serious business or technical applications software into a mini-floppy size 5¼" unit. Your data is protected in the sealed enclosure making diskette handling problems a thing of the past. The disc is fast — 40 times faster transfer rate than a mini-floppy — yet fits into the same space and so can be used as a replacement or an enhancement.

Controllerbility

Our controller comes with a range of adaptors to plug on to most popular micros and there are more adaptors on the way. It supports two discs with ease and while others are struggling with less stable analog data separators and speed-eating error correction circuits, we use a high performance digital design which literally locks into the data stream and stays there. Incidentally we also sell digital data separator cards to OEMs. Real time and multi-tasking applications benefit from the controller's interrupt capability and macro level command structure and the OEM version features a simple software interface and CP/M 2.2 BIOS with extensive development aids. The software comes on either 5¼" or 8" diskettes together with Boot PROMs.

Service and Support

If you are impressed with the specifications so far, there is more to come. Our packaged sub-systems are assembled in-house and they carry a full one year parts and labour warranty. Our controllers are built completely from TTL logic — there are no fancy chips — so we can fix them if they ever break down. Dozens of floppy disc drives go through our workshops every month and we are well known within the industry both for our training courses and our heavy investment in computer based disc test equipment. If your Winchester ever stops working you can depend on us to fix it.

For: SUPERBRAIN, S-100, APPLE II, HEATH H89, TRS-80.

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DEALER ENQUIRIES INVITED


HAL COMPUTERS LTD
STROBE MODEL 100 GRAPHICS PLOTTER
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MODEL 100 · DIGITAL GRAPHICS PLOTTER
VECTOR PLOTTING, MICRO PRICE
The new Strobe Model 100 drum-type plotter gives you real vector plotting, interfacing to your computer hardware and system software, from only £690*
* High resolution — 0.1mm at 7.6cm/sec. * A4 paper capacity. * Will plot in most colours, uses off-the-shelf felt tip pens. * Precise operator control. * Interactive input of coordinates.
The Strobe Model 100 can be interfaced to any computer through two parallel 8-bit output ports and one 8-bit input port. Optional interfaces for TRS-80*, Apple II*, PET*, and S-100 bus computers are currently available.
Driver Routines
Source listings of the assembly language motor drivers and vector plot routines for use on 8080, Z80, and 6502 microprocessors are supplied with Model 100. Flow charts of these routines simplify modifications of drivers for custom machine level software.
* Unit price for plotter ex-delivery and ex-VAT
* TRS-80, APPLE II, and PET are trademarks of Tandy Corp., Apple Computer Co., and Commodore Business Machines Inc., respectively.
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DEALER ENQUIRIES INVITED

got fired by Apple as a distributor, people won't want the Silver Apples and, also understandably, feels that if people know that nobody wants the things, then even more people won't want the things.

I would have thought that the announcement that ITT had a thousand or so in storage would be a good idea. At half price, they could suddenly become very attractive, and could all shift in a month. Instead, I think we will see interesting deals. Templeman Software's integrated stock control and reordering system may be one of these. For less than £4000 plus VAT (ie over £4000), you get a processor (Silver Apple) plus display and disks and printer — and Templeman Software's software. My guess is that the markup on the software is higher than you think, even with a reasonable printer. But nonetheless, it's probably a good deal providing you don't think you've bought an Apple. Details on (0789) 66237.

New characters

There are a whole new set of characters which any PET user can display by buying the Avon Computer Rentals Alpha Pluscharacter generator. This, Avon Rentals assures me 'is not a hoax. This is a plain straightforward fact with no catches.'

The fact may have no catches, but I'm afraid you'll have to get their little leaflet to be sure about the plain and straightforward part. For around £70, you get (I think) four character sets in addition to the normal letters and numbers and shapes displayed on a PET screen. And now, in addition, the device can now be programmed to make all four sets of characters appear on the screen at the same instant, line-by-line.

You can even play snakes and ladders race cars, it says, but for the life of me, I can't see how you can do both together, *line by line* (see photo below)?

Details on (0454) 415460.

Not so EEEsy

It should not be mistakenly assumed that, because the Apple II now has its own (optional) IEEE bus connection and because the IEEE bus is most used to connect computers to instruments, that this makes it easy to connect the Apple to instruments.

The point about the IEEE 488 standard is not that it is easy but that it is standard. This means that if an instrument already has the interface, you know exactly what is coming down it. On this basis many a Commodore PET has been sold to laboratory technicians, since the PET had the interface (with a slight omission) from early on. However the IEEE 488 bus is horribly complex and many people involved in connecting the PET to other electronics have chosen to use the ordinary user port instead of the IEEE interface. It is simpler to add just one device that way.

The new product (the interface) comes at £276 including VAT from any of Microsense's 400-odd Apple dealers. Details on 0442 40574.

Future phone fun?

To me, the most important thing about the computer-controlled telephone exchange recently installed in Woodbridge, Suffolk, is the fact that it can handle computer communications without turning them into squeaks and sqwarks first. . . but there is another angle.

The big thing about computers is that they use software. And software must be testable. So it's a pretty good bet that somebody clever could, if they were irresponsible enough, try to find a way of phoning up the exchange and testing the software. . . and maybe changing it?

Sharp notes

Music lovers can draw some comfort from the information that if the Commodore VIC's notes are out of tune, it is not the fault of mathematics. Despite my claim that an octave was not an exact doubling of frequency, the truth will out: it is. According to John Aldred, a computer musician of some, er, note, I may be confusing a natural scale with an even-tempered one.

	Interval between successive notes (Natural scale)	Interval above C: Natural	Equal tempered	MZ-80K	MZ-80K frequency (Hz)
C		1.000	1.000	1.000	261.64
	9/8 = 1.125				
D		1.125	1.122	1.122	293.60
	10/9 = 1.111				
E		1.250	1.260	1.260	329.60
	16/15 = 1.067				
F		1.333	1.335	1.334	349.16
	9/9 = 1.125				
G		1.500	1.498	1.498	391.85
	10/9 = 1.111				
A		1.667	1.682	1.681	439.75
	9/8 = 1.125				
B		1.875	1.888	1.886	493.58
	16/15 = 1.067				
C		2.000	2.000	2.000	523.28

All the fiddly bits around this naked screen are designed to see if a finger is touching the glass. The idea is that a computer can detect where on the screen someone is pointing and then check what it has displayed at that spot.

All the programmer has to do is display something like 'Touch this square to hear the National Anthem' and then wait for the finger to be detected before playing the Muppets theme, through the system speaker. To use it, you need the kit as provided for the Lear Siegler ADM 32 intermediate terminal.

The kit is available through the maker, Interaction System Systems Inc of 24 Munroe St Newtonville, Mass 02160 (tel 617 964 5300) or through Lear Siegler agents.

To help composers use a Sharp MZ-80K to write music, Aldred has submitted the following table of numbers which show how to make it play in tune. It shows differences between the two scales, plus details of the MZ-80K tuning as used by Aldred in his MZ-80K program announced two issues ago.

'Contained in the monitor of the MZ-80K,' Aldred adds, 'is a table of pitch values which are directly related to the reciprocal of the frequency of the note produced. As the information in the monitor is copyright I can't give it in the table, but it can be found on page 8 of the Newbear monitor listing.'

So now you know.

Control your washing machine

Using computers for calculating, game playing or business data manipulation, observes a British electronics company, 'doesn't require any knowledge of how a computer monitors and controls other outside equipment. But now, the new generation of technologists is required to understand and use microcomputers to control all kinds of things.'

So the firm has started out with a washing machine. The firm, Feedback Instruments, showed several of its tutorial devices at the PET Show ealier in the year. It provides several 'projects' including control of a stepping motor, of a temperature monitoring system, of a traffic light, of binary input and output, and something called a Project Board — plus a washing machine.

The projects use one of several machines. If a plug is the interface between the CEGB and an electric motor, then Feedback has plugs for PET, Apple, Aim 65, ABC80 and planned plugs for Tandy TRS-80, Research Machines RML 380Z and even the

Sinclair ZX81 'soon'.

The interfaces cost between £45 (Aim) and £107 (ABC80). The board that pretends to be a washing machine costs £74, a nice average from the 'project board' at £45 to the temperature control system at £132, and the plugs and boards are all used at the Nottingdale Technology Centre. That is the centre for training young humans in electronics, the one that so impressed the Prime Minister that she ordered a whole set of them for the rest of the country. Details on (08926) 3322.

NewBrain revived

Britain's own portable (hand-held) computer is not going to die after all, as was feared when Newbury Laboratories abandoned its NewBrain micro. Instead it is to be rescued by the man who gave it birth, Bob Smith of Grundy.

Actually, the NewBrain can't be described quite so simply. It was originally designed (in outline at least) by Clive Sinclair before he split away from the National Enterprise Board and Sinclair Radionics. Then it was adopted by NEB company Newbury, where Smith was managing director, and developed over a year or more, to last summer, when it was announced. It was then selected as the BBC microcomputer, and when Smith left Newbury for Grundy, looked set for success. Nobody who knows will say what actually happened to delay and eventually cancel production plans at Newbury, but delay and then cancellation is what happened. Eventually Newbury looked around for someone to rid them of this turbulent micro and Smith, now doing exciting things with Grundy, got together with the NEB and NRDC. Both these Government bodies sponsor new ideas in British industry, and they were merged by the Government itself just in time to put some money behind the NewBrain and a new Grundy subsidiary, Grundy Business Systems. Smith is very pleased with the deal, because he hopes to supply Newbrains between £200 and £300 this year, and has all the people from Newbury who worked on the project originally. Details on 01-977 1171 (*Dealers only*, for a while, I would suggest)'

Boost for Prestel

A device, originally designed to give owners of cheap TV sets access to Prestel, has now been improved to turn most computers into Prestel receivers, which could be good news for you and for British Telecom.

There's a bonus for users of machines like PET, Tandy and Microtan machines, because this product, the Tangerine Tantel Prestel Adaptor, produces Prestel standard colour output.

That means that for the Tantel cost of £170 + VAT (around £195) you get colour graphics as well as Prestel.

This may be the sneakiest move yet in a race, that still hasn't yet started, to become the UK's dominant micro supplier. Tangerine has been a long underated range of micros, with a very loyal following but without the glamour and big headlines that Sinclair and Acorn have generated.

The Tantel, it should be remembered, also attaches your computer (or TV) to the phone lines. As of today, it can only talk directly to Prestel, but the chip that controls the phone line is quite capable of doing more than that; with a little alteration to the supporting software and addition of some special circuitry.

At the same time as the Tantel offer, Tangerine has put together a rather more detailed-output graphics card for users of its own range of systems. This provides 256 by 256 pixels, using 8 kbytes of memory (included on the board) and allowing mixed text and graphics.

Cost around £92 including postage and VAT; full details on 0353 3633.

Fast words

It is possible to send six pages of text from London to Boston in two minutes, for four pence. The trick, according to Rostronics, who has done it, is to use Prestel.

The product which, Rostronics says, makes it all possible is one it picked up through former director John Barton, who is marketing several products abandoned by Cherry Leisure when its old viewdata subsidiary, Sparrow, went under earlier this year.

The device isn't actually designed to send messages to Boston, but to give ordinary people the power to edit Prestel pages. Working with the Government's own Prestel service, Rostronics launched a device which could disguise itself as the Government editing terminal. Built into it is the Laser editing code and software which will take a page, and input a new version according to changes which the user enters at the keyboard.

The obvious application is Barton's Hotel Information Services notion of putting a whole series of hotel chain bookings on the system. Booking agencies will use this special viewdata terminal to check for vacant rooms around the country, and when they find a suitable one, will instruct local software to book it. The editor will find the appropriate Prestel page, will delete the vacancy shown, and then transmit the new version to replace the old.

However, there is the new Mailbox facility on Prestel pages, where users with proper terminals can enter a letter and have it sent to all Prestel computers around the country.

Rostronics has packaged most of this into a £400 board that fits on most Z80-based processors, including the S100 machine, the Z-Plus, which the company imports from America. Details on 01-874 1171

Nascom link-up

A new chain of micro retailers has been formed by the six individual shops which claim to have kept one of Britain's earliest micro-computers (the Nascom) alive while the manufacturer went bust.

The six dealers are already known in the trade for their joint advertising campaign, aimed at users of the Nascom machines and offering various add-ons and replacement boards.

Now they have banded together a bit more formally, which explains the name MicroValue Group. It isn't a new company: it is a group containing Bits and PCs of Wetherby, Electrovalue of Manchester, Business and Leisure of Kenilworth, Henry's Radio of London, Target Electronics of Bristol, and of course, the Nascom originator himself, John Marshall's company Interface Components in Amersham. Details from Brian Wingfield at Wetherby 0937 63774.

New Editor

Peter Rodwell has been appointed Editor of *PCW* to replace David Tebbutt, who has left to get his hands dirty again in the computer business, running a newly established software publishing house. Peter has been Deputy Editor for the last 18 months and before joining *PCW* worked for more years than he cares to remember in journalism and public relations before getting into micros six years ago. Joining Peter will be calculator expert and computer freak Dick Pountain, who becomes Managing Editor.

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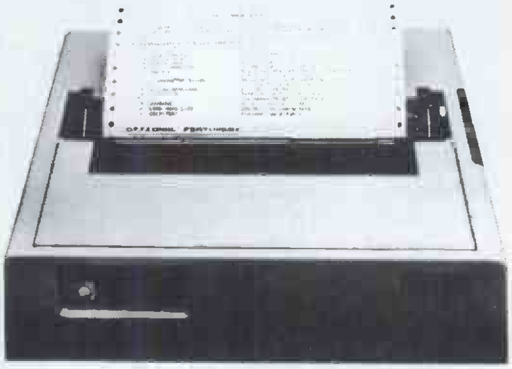

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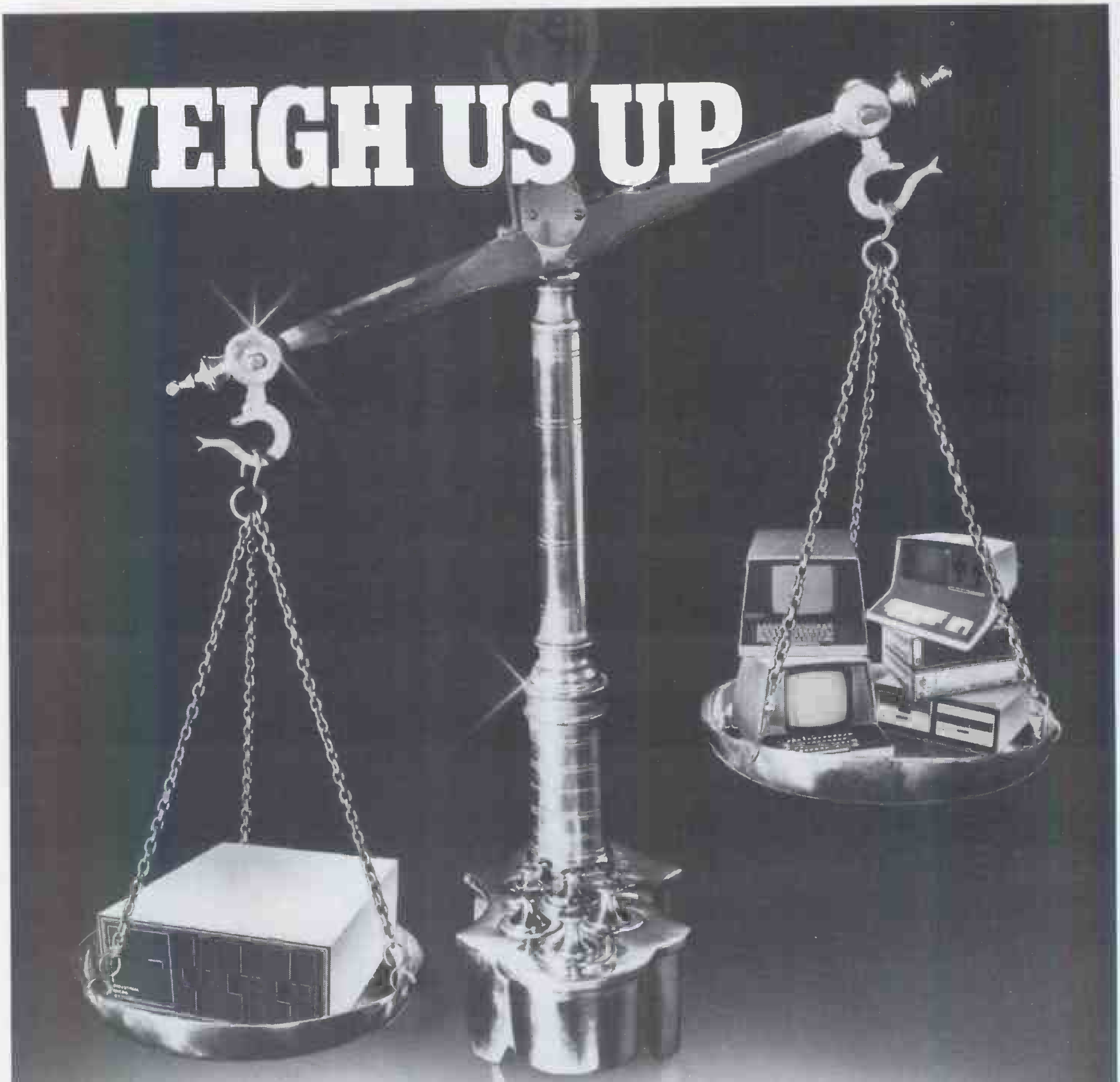
WEIGH US UP

YANKEE DOODLES

Tom Williams reports on the American side of the microscene

APPLE III ON ITS WAY

There seems to be a few rumblings from Apple Land, which are possibly more upsetting to folks in Europe who are being kept in official darkness than to Americans who still see a very strong company here. The two sources of unease are worries over the status of the Apple III and over some of Apple's tactics in marketing, particularly in regard to Microsense, the British distributor.

The 'official word' is that an agreement for purchase has indeed been signed with Microsense and that the deal is going ahead, but on a low key. The (again official) reason is that Apple wants to avoid drastic changes that might affect the goodwill that Microsense has established. Knowing nothing about Microsense's goodwill, I leave judgement of that remark up to my British readers. At any rate, the go-slow policy is also tied up with problems surrounding the Apple III.

Shortly after the Apple III was introduced over a year ago, there were

"Software sells hardware"

delays in the projected availability here in the US which were supposedly due to design flaws. One source even claimed that the Apple III's DMA simply didn't work. I cornered some of Apple's technical people at a reception at last May's National Computer Conference in Chicago and asked about that. They told me that there had indeed been problems, but that they were not fundamental design flaws, rather minor electrical and mechanical mistakes and problems that compromised the overall operation of the system — things like flaky connectors and IC sockets. They (once again officially) assured me that the problems had been identified and had now been solved. And it is true that you can now go into a store here in the US and buy an Apple III and complaints about reliability have largely ceased.

The reason that people in Europe have not been able to get their hands on an Apple III or heard much about it is that Apple has been trying to isolate the problems to the US with the intention of reintroducing, or 'repositioning' the machine before making a big push in Europe. One of the big problems with Apple III was that there was little if any software to run on the machine other than that which would also run on Apple II. Why buy a $4000 computer when you can get one for around $2000 that will run the same programs? Apparently this elementary subtraction equation sunk in with the marketing people and they have been keeping a low profile on Apple III while frantically pushing a hardware and software program that will be able to sell it

Steve Jobs of Apple: "We're going to bury you"

effectively.

In the meantime, Apple has gotten into agreements with Seagate Technology to supply 5¼in Winchester drives and has been pursuing a vigorous software effort. Software soon to be available will come from sources external to Apple as well as from within the company. When all this is ready and orchestrated there will presumably be a great convocation of the heavenly host and the new image will be announced with silver trumpet fanfares in Europe and America. There is, however, no truth in the rumour that every Apple executive has had branded on his backside the motto: 'Software sells hardware'.

Apple has managed to get into another lawsuit with one of its dealers, charging it with unfair trade practices. Computer Words, Inc has accused Apple of encouraging its dealers to pursue the educational market and then circumventing the dealers by selling to schools through a consortium run by the state of North Carolina. The dealer's claim that the burden of service and support placed on them by their contracts with Apple makes it impossible for them to compete with the kind of volume and pricing possible with direct sales from Apple.

The big boys are coming

As competition in the personal computer world, look for IBM (that's not really news any more) and DEC. DEC's entry may well be the result of a grudge. The minicomputer pioneer is rumoured to be working on a personal computer code-named the Falcon. The project is said to have originated from a remark by Steve Jobs of Apple, who, while sitting in the office of DEC's president, in blue jeans with his feet on the table, reportedly said, 'We're going to bury you.' This so incensed the president, Mr Ohlson, that he called in his engineers and ordered them on pain of joblessness to develop an answer to that piece of Californian impudence. Time will tell.

Another big-name entrant into the personal computer arena that has announced a product is Hewlett-Packard. HP recently introduced a Z80, CP/M-based desktop computer called the HP-125. The computer is — with the exception of the disk drives — contained in one of those pedestal-type terminal cabinets so characteristic of HP, and has a detached keyboard. The terminal portion, which is controlled by another Z80, supports dot resolution graphics, communications and remote terminal functions, and user-programmable softkeys.

The machine has an optional thermal printer that is contained in the top of the terminal housing. Hewlett-Packard supports the CP/M operating system as well as Visicalc, Microsoft Basic, and an intelligent terminal communication program that allows it to access databases on HP-3000 computers.

The interesting thing about the introduction of the HP-125 is the price — $7460 for the computer with 5¼ in dual disk drive and thermal printer. Compare this with the Osborne 0-1 at $1750 which is also a 64k, Z80, CP/M computer with 5¼in drives and extensive software. The intriguing question is how will two fairly similar

Compare the HP-125 at $7460 with the Osbourne 0-1 at $1750

computers with such divergent prices fare on the open market? Admittedly, the 0-1 doesn't have the office styling, the softkeys, the printer and the graphics of the HP-125, but is that really covered by the $5710 difference in price? Once again, time will tell.

On another quick note, the San Francisco area is experiencing a blossoming of Conference Trees. These miniature teleconferences can now take place on an Apple which has an auto-answer modem and the Communitree software. Dialing in can get you into running conferences on all sorts of futuristic topics from space, alternative communities and political/privacy issues to magic and Tarot readings. I've been particularly intrigued by a conference in which the users leave messages with voice comments on publishers.

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NEWS

David Tebbutt brings you the latest update.

FIRST NIGHT FUN!

ComputerTown UK! is an ever-growing network of computer literacy centres, where members of the public are given free access to microcomputers, courtesy of those willing to volunteer their time and equipment. ComputerTowns might be found anywhere: in a church hall, a library or maybe in a school after hours. The emphasis is on making computing enjoyable and non-threatening and, because Computer Town is entirely non-commercial, overt axe-grinding of any sort is banned. Guidelines are available for those interested in setting up their own 'Towns: Write to CTUK!, 7 Collins Drive, Eastcote, Middlesex HA4 9EL and remember to enclose a large SAE (A4 would be fine) for your reply. Please don't try to telephone *PCW* for information because this project is entirely a spare-time activity.

This month's big news is that ComputerTown Worcester is up and running and, wow, what a start — over 300 kids turned up! 'They were like lemmings!' said Tony Cartmell, the man who started it all. Tony was aided and abetted by among others, the local Tandy store and the Worcester Computer Club. Tony didn't say where the event was held but he's now been offered a room by the local library and there's even a strong chance of a machine being donated to the project. We'll tell you all about that when it happens. The local 'freebie' paper picked up the story, spent over three hours interviewing the organisers and then splashed the story across the front page. Incidentally, it should be mentioned that the reporter did an excellent job — not always the case as you may know. It looks as if special meetings are going to be organised for local teachers since they are very enthusiastic about the scheme and, presumably, don't want to be left behind by their pupils! What an excellent start. Well done all of you.

Lyn Antill tells us that she's been running an occasional ComputerTown for residents in the Barbican. If you're a resident and you're interested in helping/joining then contact Lyn at 1 Defoe House or ring 01-638 3225.

Let's have a look now at a 'Town that's on the verge of starting in Dorchester. Chris Donaldson and Derek Moody are the men behind this one. They're trying to attract attention by putting leaflets in copies of *PCW* at their local newsagents. The leaflets have the CTUK logo on them and (neatly) ask for computers, programs and help. If anyone else is thinking of taking the same approach, all we ask is that you do things tidily (Letraset, typing or professional artwork, please) and obtain the newsagent's permission before doing it. We'd also appreciate your dropping us a line at *PCW* to say what you're planning to do. To contact ComputerTown, Dorchester write to Derek Moody at 2 Victoria Terrace, Dorchester, Dorset DT1 1LS.

Incidentally, we must thank Henry Budgett of *Computing Today*. Henry kindly gave permission to Dorchester to slip their leaflets into his own esteemed periodical and, what's more, he also gave ComputerTown a mention in his magazine. Thanks a lot, Henry, you'll be pleased to hear that we're getting enquiries as a result.

Every month we receive a substantial document from ComputerTown Enfield full of interesting information about its own project. The gem I'm selecting from it this month is the idea of 'twinning' with ComputerTowns in America. What a neat idea. Next time I write to CTUSA! I'll ask to be sent regular lists of active 'Towns over there. When, and if, they arrive I'll let you know.

Quite a few people wrote this month to express a very keen desire to start their own ComputerTowns. I think the best thing to do is to list their names and addresses and leave you to make contact. Here they are: J V Flynn, 30 Hermitage Way, Kenilworth, Warks CV8 2DW; John Kilburn, 6 Milford Gardens, Appleton Park, Warrington, Cheshire; Trevor Jordan, Eardley House, 84 Market Street, Ashby de la Zouch, Leics; Len Wood of 41 Goddington Road, Bourne End, Bucks SL8 5TU is interested in getting something going in the Great Marlow area. I hope we hear from you all again soon.

Malcolm Part wrote again from Witham in Essex. He'd tried once already to get a ComputerTown going but without too many people coming forward to help out. He'd like to try again, so here's his address once more: 35 Town End Field, Witham, Essex, CM8 1EU.

Bob Brittain wrote from Twickenham to say that he'd like to run some 'fun evenings' at all Saint's Hall in Twickenham. Anyone willing to take along their machines and demonstrate their programs would be most welcome. Write to Bob at All Saints Hall, Cambbell Road, Twickenham, Middlesex or, better still, ring him on 01-979 4970. Good luck, Bob.

Visitors to Acton ComputerTown may be astonished to find it gone. The fact is that Mike Baker has moved it to Southall. He'd love some help there, so if you're interested give him a ring on 01-840 0030. Incidentally, Mike very kindly took the lion's share of the work involved in organising the ComputerTown stand at the show. Thanks a lot Mike.

If anyone has been having trouble contacting Kevin Stock of Coventry and Belfast, it's because he goofed with one address and we goofed with a postcode. Coventry-based people should write to him at the Department of Computer Science, University of Warwick, Coventry, CV4 7AL. The Belfast address should have read 44 Park Avenue, Belfast, BT4 1JJ. Let's hope we got it right this time.

The Beeb has written to us twice in the last month — once for a set of guidelines and again to see if ComputerTowns would be good places to refer viewers interested in computing. We'll be meeting the people concerned very soon and will let you know the outcome as soon as possible.

Other enquiries received this month came from: London NW2 and SE12, Ilford, Birmingham, Portsmouth, Glasgow, Peterborough, Swindon and Hemel Hempstead.

Finally, thank you all once again for your news and your excellent support for ComputerTown. Keep up the good work — we've now got 23 'Towns running, and more starting up all the time. Mind you, we've no cause to be complacent — when you consider the number of communities in Britain, we've got a fair way to go before the country is covered. Still, keep those letters rolling in with your news and, if you're seriously considering having a go yourself, ask for a set of guidelines. We look forward to hearing from you.

Finally, Here's a complete list of ComputerTowns up and running. If you want to contact one in your area, drop us a line (with an SAE, please) and we'll put you in touch: Southall, Jesmond, Romford, Street, Colchester, Worcester, Leeds, Enfield, Croydon, Caversham Park Village, Wokingham, New Addington, Gateshead, Retford, Horsham, Sutton in Ashfield, Newcastle upon Tyne, South Shields, Eastcote, Renold Ltd, Gloucester, Norbury, Barbican.

BANKS' STATEMENT

THE GATES ARE WIDE OPEN

Martin Banks examines an upcoming generation of chips which promise to change hardware design concepts radically.

'Once upon a time,' Daddy said, as he tucked Junior gently into bed, 'there were a lot of big companies that made a great deal of money making very, very clever things called integrated circuits.

'These were used by other companies that made a great deal of money putting them together into little boxes. Now these did clever things as well and were called microcomputers. The people who worked for these companies were all extremely clever and were able to do things that ordinary people, like you and me, just couldn't do for love nor money.

'Then, there were the people and companies who were just as clever, but in a different way. They were able to sit down and work out all the detailed instructions that were needed to make those microcomputers do what other people wanted them to. It was all terribly involved, and there weren't many people who could do it well. In fact, there weren't that many who could do it at all.'

'Oh, Daddy,' said Junior turning over and closing his eyes, 'I don't believe your boring rotten old story. No-one ever did it like that. Look, I can build a system easy, and I'm only six It's not quite as boring as Lego.'

How far into the future this particular fairy story has to be set is hard to tell. Probably it will never actually occur in the words as set down. There is a good chance, however, that the idea — that the way in which the semiconductor companies produce chips that others engineer into systems that others provide complex programs for will drift off into antiquity — is quite valid.

What's more, the trends and developments in the design and manufacture of integrated circuits that will cause that drift are starting now.

The first, and possibly most important, is gate array design. The second is the development of firmware modules, which will have a more long-term impact.

The idea of gate array design in integrated circuits has been around for some time. Patents were taken out by Texas Instruments in the early seventies. That company's initial work had been aimed at a technique it called discretionary wiring, where each silicon wafer would hold a variety of different circuit types rather than the normal practice of a large number of circuits that were all the same. The Texas idea was that, instead of breaking up the wafer into individual circuits, it would be used intact and that a system function would be produced by wiring together the needed individual circuits. Because of yield problems (where one defective circuit could mean the complete wafer was useless) the technique never caught on. The idea, however, stuck.

It was translated to the individual chips instead of wafer, and instead of attempting individual circuits the idea became that of putting a range of logic functions onto a single chip.

One of the first companies to pioneer this approach was Ferranti with its Uncommitted Logic Array. By 1974 it was producing devices with about 100 uncommitted gates on each and started to corner what was then a very small market.

That market is now set to take off, for the idea of the gate array device is now taking off, and for some very sound reasons.

Gordon Moore, one of the three founders of Intel, is also famous among the semiconductor fraternity as a 'law' maker. One of his laws states, in essence, that as device complexity increases, the number and diversity of potential functions that can be incorporated into a circuit also increases. Extrapolate this and a point is reached at which the users of the circuits can legitimately expect to see devices that contain exactly the functions they alone require. But from the industry's point of view there can be nothing worse, for it means that it becomes impossible to manufacture the devices the market wants at any thing like the volume required to make them economically. QED, increasing complexity and high volume manufacture are mutually incompatible.

The game array neatly sidesteps this problem. By using it, the semiconductor companies can maintain volume manufacture of the basic uncommitted arrays and even gain the inherent advantages of better product yield. The final product will also be able to meet the majority of applications and functional requirements of the majority of users.

This is how it is done. The gate array chip consists of a circuit that is partially manufactured. Each chip contains an array of logic gates and other circuit functions found in every device ever made. They are, however, unconnected. It is therefore possible for a circuit designer to carry out the specific task of matching the logic functions to a user's requirements with relative ease. With the design complete, the final masks which define the pattern of interconnections are produced and the circuit completed.

The major disadvantage of this approach is that only the majority of applications can be tackled. It should be noted, however, that with the general increase in circuit complexity, that majority is getting ever bigger.

The advantages are that customer specific circuits can be produced quickly, easily and cheaply. It also means that the semiconductor industry can maximise production and process skills and make the best use of the complexity available to it (and the users).

When Gordon Moore first put forward his law, he noted that many of the large systems houses (especially large computer companies) had internal semiconductor fabrication operations making the devices they specifically required. He suggested that the trend would continue.

With the gate array it certainly will and the ability for small systems companies to follow the trend will have some interesting results. Ferranti, for example, states that for many applications the design work is simple enough for the user to do — no more semiconductor 'black art'. This ability of small systems companies to design the circuits they require for the systems products they plan — rather than 'make do' with the devices the semiconductor companies care to manufacture — opens up a whole new growth arena in microcomputer capability.

Specific products advantages (more power, more flexibility, greater communication capability, lower cost and easier manufacture) can now be engineered into new systems as and when required. Just look at what Uncle Clive has achieved with the Sinclair ZX81, which uses a Ferranti gate array, compared to the ZX80. A better computer is also cheaper.

A natural extrapolation of the small microcomputer manufacturer being able to make use of gate array circuits to economically produce exactly what is required is that the user (or more specifically the local distributor/dealer/systems house) will also be able to do it. Why shouldn't such people, who in theory at least know what their

GOTO page 165

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The Microline 82A prints bidirectionally at 120 characters per second and includes a short line seeking logic that can increase throughput by 80% over equivalent unidirectional printers. A dense 9 x 9 dot pattern is used to produce crisp, clean copies, first copy to last.

In addition to normal upper and lower case, ten character per inch printing, the 82A prints both double width and condensed characters at six or eight lines per inch. Font selection, character pitch and line spacing are all standard and program-controlled.

Graphics

Microline users can generate charts, graphs and illustrations and explain them with captions of double width characters. The Microline 82A prints 64 block shapes in addition to the full character ASCII set.

Three Printers in One

Microline 82A users do not have to purchase different models for different forms. The standard platen accommodates friction and pin feed forms and optional tractors snap in place and adjust to suit form width. The Microline 82A provides versatile forms controls including vertical tab, top of form and a vertical format unit that provides switch and program selection for up to ten form lengths.

Interfaces

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IEEE 488 parallel and current loop interfaces are also available.

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CONTROL YOUR OWN SUBSTATION!

Well, maybe not quite a substation, but a new add-on for the Sinclair ZX80 and '81 will let you connect up to the outside world, as D E Graham describes.

Early adverts for the Sinclair XZ80 promised that the machine could do 'anything from playing chess to running a power station'. This, of course, was wildly optimistic; chess on the basic ZX80 then available would have been laughable and as to controlling a power station — well, apart from anything else, for a computer to control anything in the outside world, it has to be connected up by one or more *ports*, or interfaces, which allow signals to be passed between the computer and the device under control. The '80 and '81 both came with just one port, the cassette port, which is patently unsuitable for control purposes.

This article describes the use of a two-way data port on the ZX80 and 81; and, while not allowing complete control over all power station functions, it does offer a wide range of applications from push button data input, proximity detectors and joysticks, to light sensors, seven-segment displays, relay operation and sound output.

The 80/81 port to be described here comes in two versions — one for the ZX80 and one for the 81. Each plugs into the rear of the machine — see photograph — and runs from the computer's internal power supply. Unfortunately, it isn't possible to plug in both the RAM expansion pack and the port board at the same time, which means that unless your machine has extra internal memory, you'll be rather limited in what you can do. Don't despair, though; firstly, you can still do quite a few interesting things even with 1k of RAM; and secondly, when the printer becomes available, there will presumably be an adaptor to allow its use with the RAM pack in place — and this should also allow the board to be used with the memory extension. The 80/81 port is available in kit form from Technomatic Ltd, tel 01-452 1500, at £11.50p excluding VAT & PP.

In the first of two articles, we will cover how the port is used and what it can do, and will look at some simple applications. Next month will treat more complex applications — including sound output.

What's a port?

A port is simply a channel or series of channels through which information can pass either to or from a computer. On the 80/81 port to be described here, there is one *input port* for data to be received (or *read*) by the ZX80 or 81, from the outside world, and one *output port* for data to be sent (or written) to the outside world. Both

The port plugs neatly into the rear of the '80/81.

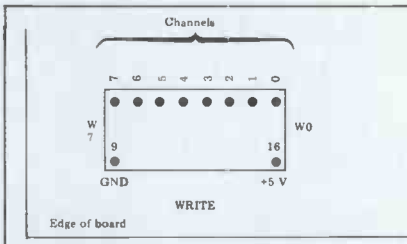

Fig 1 Connections to output socket

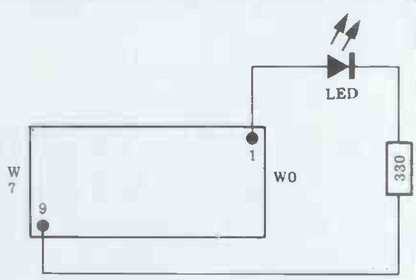

Fig 2 Output port with LED on channel zero

ports have a total of eight channels (as is usual in 8-bit computers). This means that there are eight separate lines whose signal levels the ZX80/81 can test or read in, and eight other lines whose voltage level the ZX80/81 can individually control.

Each of the input lines could be connected to a different device. Line zero could be wired to a light sensor, line one to a push button, lines two and three to a joystick, and so on, and the computer could be programmed to respond differently to each different combination of input data.

Each of the output lines could be connected to a different device. Line zero could cause a lamp to flash, line one could activate a loudspeaker to give sound output of varying tones, line two could cause a relay contact to close, which may in turn be used to switch on pretty well any imaginable device. As may be seen, such an input/output facility offers a very wide range of data collecting and control capabilities.

Output port

The output port is accessed through the 16-pin socket labelled WRITE. Its connections are given in Figure 1. Pins 1 to 8 carry the eight channels, pin 9 the earth and pin 16 the 5-volt supply. The voltage on each channel can be set by the computer at one of two levels — so-called *logic low* (about 0.1 volts) or *logic high* (about 4.5 volts). Software control of the port is extremely simple and requires no setting up procedures. The port may be accessed either in machine code or in Basic, but for most applications we shall be using the latter.

To control the output levels of the port, the command POKE 25000,X is used for the ZX80 and POKE 11000,X for the ZX81. X is any integer between 0 and 255. With X=0 all outputs are set to logic low, while 255 sets them all high. To set any one channel to high output, while leaving the remainder low, the following values should be used:

Poke	Channel activated
1	0
2	1
4	2
8	3
16	4
32	5
64	6
128	7

Thus the command POKE 25000,8 (or POKE 11000,8 on the ZX81) will set channel 3 high, leaving all other channels low. Setting a high output on a number of channels simultaneously is achieved by using the sum of the individual data. Thus the command POKE 25000,7 (11000 for the 81) will make channels 0,1 and 2 high and the rest low (since 7=1+2+4). All channel outputs remain in the condition set until another POKE command is encountered. In most of the program listings which follow, I shall use the command POKE P,X. When you type in the programs, type 25000 instead of P if you have a ZX80, or 11000 instead of P if you have an '81.

LED indicator

The light emitting diode (or LED) is a low power (and low cost) indicator lamp that may be driven directly from any channel of the output port, using only a single series resistor. Figure 2 shows the connections for a single LED lamp on channel zero. Note that LEDs are polarised and will only give off light when placed the correct way around — but that placing them the wrong way will not harm either them or the port. To light the LED in channel zero, execute POKE P,1. POKEing the value zero will extinguish it. The programs below will cause the LED to flash on and off indefinitely.

```
10 REM ZX80 FLASHER
20 POKE 25000,1
30 FOR A=1 TO 100
40 NEXT A
50 POKE 25000,0
60 FOR A=1 TO 100
70 NEXT A
80 GO TO 20
```

```
10 REM ZX81 FLASHER
20 POKE 11000,1
30 FOR A=1 TO 10
40 NEXT A
50 POKE 11000,0
60 FOR A=1 TO 10
70 NEXT A
80 GO TO 20
```

The ZX81 program assumes the slow mode. In the fast mode, a longer waiting loop at lines 30 and 60 could be used to slow the speed of the flashes. Either program could be used as part of a subroutine of a larger program but some means of escaping from it at the required point would have to be incorporated — eg, by counting the number of flashes.

It is possible to connect up to eight LED indicators to the output port (see Figure 3 for wiring). Each one may be turned on and off separately and a number of effects may be produced with very simple software. For example, the program below ripples through the outputs from zero to 255, and then repeats:

```
10 REM RIPPLE COUNTER
20 FOR A=0 TO 255
30 POKE P,A
40 NEXT A
50 GOTO 20
```

This causes each lamp to flash at a different rate. That on channel zero flashes most rapidly, channel one follows at half the rate, and so on up to channel seven. A waiting loop could be inserted between lines 30 and 40 to slow things up if desired.

It is also easy to produce a light chaser effect in which a lighted LED appears to run repeatedly across the eight lamps. The following program produces this effect. When used with the ZX81, the fast mode must be used in order to achieve any useful speed.

```
10 REM LIGHT CHASER
20 FOR F=0 TO 7
30 POKE P,2**F
40 NEXT F
50 GOTO 20
```

The program works by taking powers of two and POKEing them to the port (since the values that set each of the individual channels are the sequence of powers of two — ie, 2^0 (=1) sets channel zero, 2^1 (=0) sets channel one, 2^2 (=4) sets channel two, and so on). In the first cycle of the FOR loop, F=O so that 2 to the power zero is sent to the port, illuminating channel zero. The second cycle sends 2 to the power one, and so on up to 2 to the power seven, (=128) which lights channel seven. The sequence then repeats by returning to line 20.

Alternatively, random combinations may be displayed on the eight lamps, using the RND function. Note that on the ZX80 the three letters must be typed in full since there is no key for RND.

```
10 REM RANDOM DISPLAY - ZX80
20 LET X=RND(255)
30 POKE 25000,X
40 FOR A=1 TO 100
50 NEXT A
60 GO TO 20
```

```
10 REM RANDOM DISPLAY ZX81
20 POKE 11000,255*RND
30 GO TO 20
```

The relative shortness of the XZ81 program arises because, in the slow mode, no delay loop is required since the natural calculating speed is really very slow.

One or more LEDs may also be used as readout indicators — for indicating useful scores, program position, etc. This is particularly useful on the ZX80, where the screen blanks during computation. A single LED could be made to flash to indicate that a certain point in the program had been reached. This is easily achieved with a modification of the software already given. Alternatively all eight LEDs could be used for data output to give a score, or other result. One way to achieve this would simply be to POKE the data (assuming that it is an integer between 0 and 255) directly to the port. This will produce a combination of ons and offs which uniquely represents any one of the 256 possible integers from 0 to 255. In fact the readout produced is the *binary* representation of the number POKEd to the port, with a one being represented by a lighted LED, and a zero by an extinguished one. For example, the binary representation of the number 131 is 10000011; and if you POKE the value 131 to the output port, you should see its binary representation on the LEDs — provided you have W0 on the right hand side. One could even use this to write a games program that output a random number on the LEDs and required the correct decimal equivalent to be entered through the keyboard by the players.

If the eight lamps are being used for readout purposes, and you do not automatically think in binary, you may prefer a simpler method of readout. The following is much easier to read, but allows only nine possible levels of output. It produces a line of lights whose length is the number to be output. Zero is thus represented by all lamps off, the number 8 by all lamps illuminated, and so on. The following routine achieves this effect where X is the value to be displayed and is assigned to any integer value from 0 to 8 before entering the routine.

```
300 REM ROW OF LEDS READOUT
310 LET B=0
320 FOR A=0 TO X-1
330 LET B=B+2**A
340 NEXT A
350 IF X<2 THEN LET B=X
360 POKE P,B
```

Relay output

Each one of the eight output channels may be used to activate a relay. The relay may in turn be used to switch on and off almost any device imaginable. A set of eight relays, for example, could be used with the light chaser program, or the random display program to reproduce the effect on a much large scale. Relays cannot generally be connected directly to the output port in the way that LEDs can and a so-called buffer or driver amplifier will be needed in each channel used for relay driving. Also, very few relays will operate satisfactorily from supplies as low as 5 volts. A single uncommitted buffer amplifier has been included on the 80/81 port board for such purposes as relay driving; and Figure 4 shows it connected up to drive an Omron type LZNZ 03 6-volt relay from channel zero. In this case the relay is powered by the ZX 9/10 volt DC supply taken to pin 11 of the WRITE socket and this should satisfactorily drive two or three such relays. If more are to be used, then a separate 9-volt supply should be used. Note the use of the diode across the relay coil. This is necessary to protect the buffer from voltage spikes caused by the relay. Note also that if it is intended to use the relay contacts to drive mains voltages, extreme care should be taken

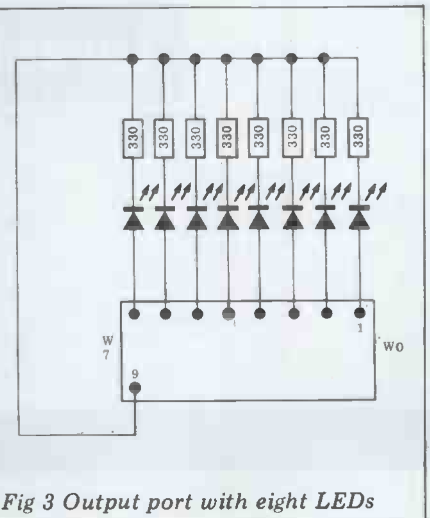

Fig 3 Output port with eight LEDs

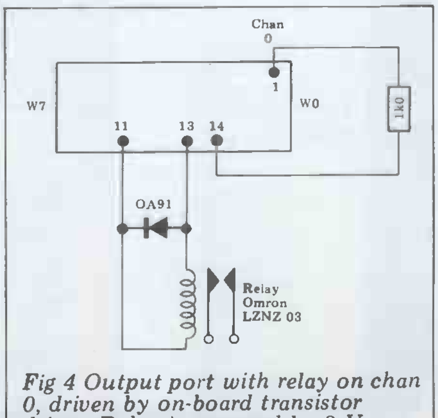

Fig 4 Output port with relay on chan 0, driven by on-board transistor driver. Relay is powered by 9 V supply at pin 11. The resistor connects chan 0 to the transistor's base; the transistor's collector is connected to the relay.

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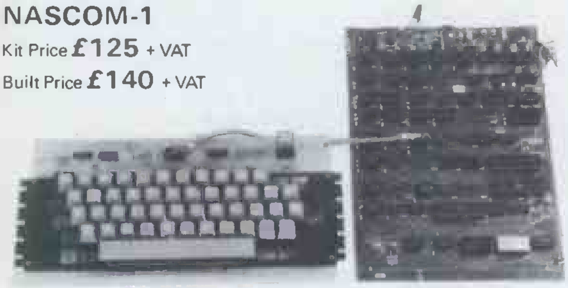

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to isolate all live leads, and to ensure that the current and voltage ratings of the relay contacts are not exceeded. It may also be necessary to prevent pick up from the relay contacts by screening, etc.

If more than one relay is to be used with the 80/81 Port, a convenient way to buffer each channel is to use a hex (ie, six-channel) driver integrated circuit. Figure 5 gives a circuit showing the use of the 7416 integrated circuit to drive relays on channels 0 and 1. With this configuration, POKEing 0 to the port will turn off both relays, 1 will turn on the first, 2 the second, and 3 will activate them both.

Sound output

Sound output will be dealt with in some detail next month, but for now there are two simple ways to produce noises at the output port. The first is, rather obviously, to use a relay to switch on a device such as an electric bell or buzzer. The second utilises a so-called solid state buzzer. These devices work at low voltages — typically 6 volts — and very low currents — perhaps 10 or 20 milliamps, and can produce a good deal of noise. It is possible to wire one of these directly to a channel of the output port as in Figure 6, which shows it connected to channel zero. To make it buzz, POKE zero to the port and to stop it, POKE 1. The inversion effect (ie, 0 TURNS it on not off) arises because the buzzer is taken to the positive supply rather than to earth as were the LEDs.

The programs above for the single flashing LED may be used with the buzzer without modification and will cause it to bleep on and off. The buzzer obviously has quite a range of uses on the 80/81 port, from telling you that the ZX thinks that your egg is cooked, to sending morse code from letters entered via the keyboard.

Seven-segment displays

The 80/81 Port will support one or more seven-segment displays. These are illuminated readouts capable of displaying the digits zero to nine. Such a display has many uses, allowing data to be read out while keeping the screen clear for other purposes, for example. And with the ZX80 (and ZX81 in the fast mode) it offers the possibility of reading out data without stopping (or slowing) the program.

The easiest way to run such a display is to use a so-called decoder-driver integrated circuit such as the 7447. What this does is to arrange for the correct segments of the display to be lit for any given number from 0 to 9 sent to the IC. It also contains a set of buffer amplifiers to enable the display to be lit to full brightness. Figure 7 shows the circuit for driving an FND 507 single-digit display from the 80/81 port. Note that a separate supply has been used to drive the display so as not to put too much strain on the ZX internal power supply. The external supply may be a 5 volt regulated power supply but, failing this, a single 4½ volt torch battery (Ever Ready type 1289) will work perfectly adequately.

To display any number from 0 to 9, simply POKE that number to the output port. Thus POKE P,6 will display a 6, and so on. The displayed digit will remain until another value is POKEd to the port. The program below may be used to test the display:

```
10 REM SEVEN SEG DISPLAY TEST
20 INPUT A
30 POKE P,A
40 GO TO 20
```

Using this you will see that values of A between 10 and 16 are also uniquely represented on the display by a set of symbols — and these can obviously be used to extend the range of the display to 16.

Two-digit readout

Since this display uses only four of the eight channels available at the 80/81 output port, a second may be added by duplicating the circuitry of the first, on channels 4 to 7. This will give a representational capability of 0-99 decimal, or 0-255 if the symbolic representation of 10-16 is made use of.

If the double display is being used for a decimal representation of the numbers 0-99, it is necessary to filter out the unwanted symbols using software. The following program uses such a routine in order to achieve a repeating count from 0-99.

```
10 REM 0-99 COUNTER
20 FOR C=O TO 99
30 LET N=C
40 GO SUB 200
50 POKE P,N
60 NEXT C
70 GO TO 20
200 REM CONVERSION ROUTINE
210 LET A= N/10
(for ZX82 this must be changed to:
LET A= INT (N/10).)
220 LET B=N-A*10
230 LET N=16*A+B
240 RETURN
```

Waiting loops may be added in each case to vary the count rate. The subroutine at 200 may be used in other similar applications. It takes a variable N equal to any integer from 0 to 99, and

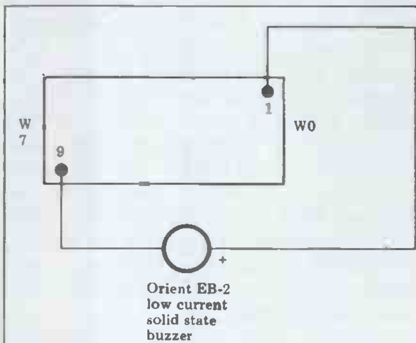

Fig 6 Output port driving solid state buzzer on chan 0.

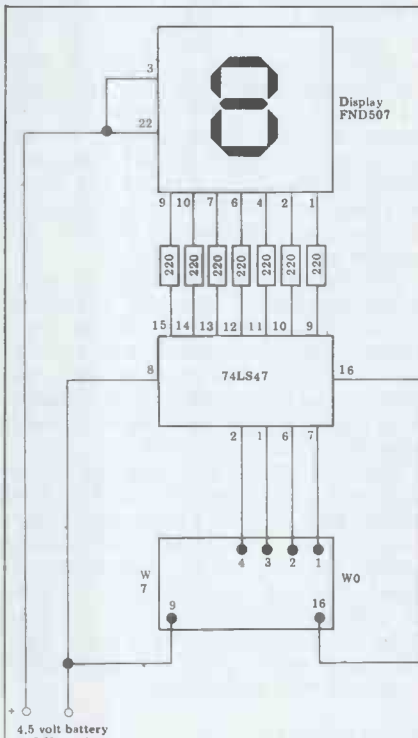

Fig 7 Output port driving single seven-segment display on channels 0-3

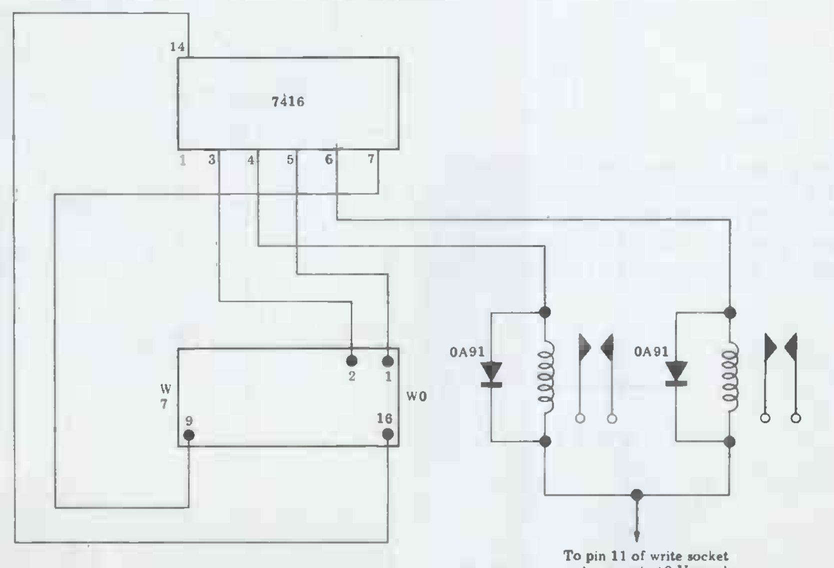

Fig 5 Output port driving two relays using 7416 inverting driver.

converts it to an integer which when POKEd to the port will produce a decimal display of the number required.

If it is required to output more data than the two digits allow — say, for example, to display the time in hours, minutes and seconds — then the data may be split up into pairs of digits, and these could be POKEd to the port sequentially. A blank (produced by POKEing 255) could indicate the start of the sequence and pairs of digits, representing hours, minutes and seconds, could be POKEd up at, say, one-second intervals.

Input port

The eight-channel input port on the 80/81 port board is accessed through the 16-pin socket labelled READ. Its connections are given in Figure 8. Pins 1 to 8 again carry the eight channels and pins 9 and 16 earth and 5-volt supply. Reading data present at the port is accomplished by the command PRINT PEEK. Note that on the ZX80 the command PEEK must be typed in full, and for this reason brackets are required around the address.

The above commands will print an integer between 0 and 255, representing the combined effect of the eight channels. If all channels are held at logic zero (or ground potential), the result will be a zero, while if all channels are at logic high (between about 3 and 5 volts), the result will be 255.

Figure 9 shows each channel of the input port connected to a push-button switch. The purpose of the 1k resistor in each channel is to hold the channel voltage at zero unless the switch is closed. Pressing any button will cause the voltage on that channel to be taken up to +5, so representing a logic high. The table below gives the data values associated with each channel.

Button pressed on channel no.	Result
0	1
1	2
2	4
3	8
4	16
5	32
6	64
7	128
none	0

These are the same as for the output port. Executing the command PRINT PEEK (P) — with the button on channel zero pressed will yield the result 1, channel 1 will cause 2 to be printed out, and so on up to the button on channel 7 which will yield the result 128. Combinations of the various buttons will give values found by adding the associated button values; again, in a similar manner to that for the output port. Thus PEEKing with the buttons pressed on channels 2 and 4 will give a result of 20 (=4+16) and so on. Pressing all buttons simultaneously will give the result 255; this being the numerical addition of the eight values in the table. Note that with nothing connected to any particular channel, it will be read in as a logic high. This may cause some confusion, and it is probably easiest to short to earth (either directly or via a 1k resistor) any channel not in use.

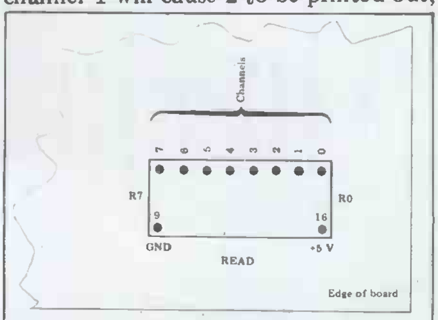

Fig 8 Connections to input socket

Data input

One or more push-buttons or switches, wired as in Figure 9, may be used to make decisions during the running of a program. For example, a switch could be placed in channel 8 of the input port (ie, on pin 8 of the READ socket) and a program could read the state of the switch from time to time in order to determine, say, the degree of difficulty of a game, or even which game or game variation was to be played next time around. A routine to effect this is given below:

```
100 REM CHAN 7 DECISION
110 IF PEEK (P)> 127 THEN GO
    TO 1000
120 REM FIRST COURSE OF ACTION
         :
999 END
1000 REM SECOND COURSE OF
     ACTION :
```

Note: brackets not required around the PEEK address on the ZX81.

Note that channel 7 has been used here so that by testing the PEEK value to see if it is greater than 127 we can determine whether the button has been pushed, *irrespective* of the states of the other channels. To accomplish this using any of the other channels requires more detailed software.

A similar basic polling technique could be used with one or more push-buttons to be activated at a given point during a program. The cue for this data input could be the flashing of a LED and in this way it is possible to input data during the running of a Basic program on the XZ80 without stopping the program with an INPUT statement. The routine below causes a LED (or buzzer) connected to channel zero of the output port (pin 1 of the WRITE socket) to flash/buzz on and off as a cue that data is required and the program will loop around until an input from the push button is received. If the button on channel 7 is pressed the program branches to line 200, while if any other button is pressed it branches to 300. It should be noted in this case that if the program is to work satisfactorily, all unused inputs must be taken to ground as described above.

```
10 REM FLASHING LED INPUT CUE
20 POKE P,1
```

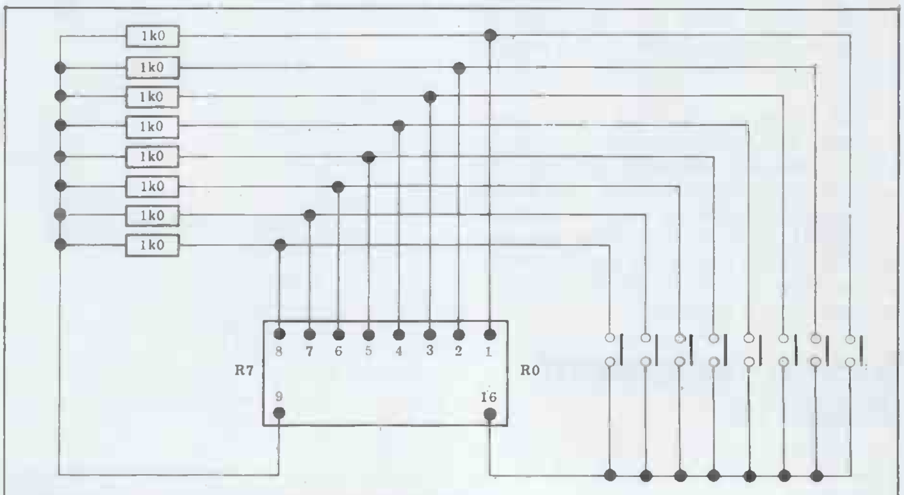

Fig 9 Input port with eight push buttons

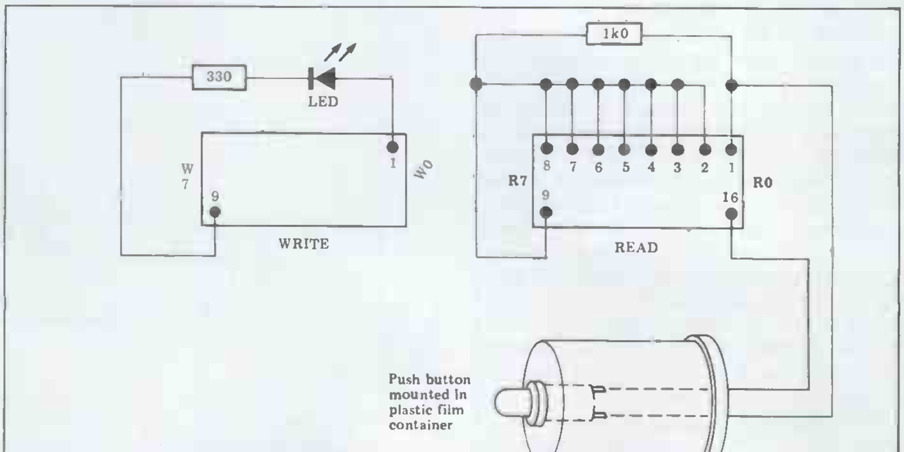

Fig 10 Connections for reaction speed tester

```
30 FOR A=1 TO 100
40 NEXT A
50 POKE P,O
60 FOR A=1 TO 100
70 NEXT A
80 LET X= PEEK (P)
90 IF X>127 THEN GO TO 200
100 IF X>0 THEN GO TO 300
110 GO TO 20
```

Reaction timer

Using a push-button on the input port in combination with a LED or buzzer on the output port allows the implementation of a reaction timer. The idea here is that the LED is lit after a random length of time; as soon as it comes on, the player must press the button and the ZX counts and prints out the time that elapsed between lamp and response. The circuit for the set up is given in Figure 10. For ease of use the push-button should be mounted on something solid. A good mounting may be made from a plastic 35 mm film container. The ZX80 and '81 differ a little in that with the '81 it is possible to switch over to the slow mode during the running of the program to display the result of each test.

The 81 program is written so that subsequent release of the button causes a second round of the game. This is not possible on the ZX80 and an INPUT statement is used to allow the result to be printed out. As the programs stand, both may be run until the screen has been filled but a routine could be added to average the results of the first ten attempts and to print this out as a game ending. The reaction times printed out are only relative and it is left to the reader to convert these, either by software or by brainpower to fractions of a second.

```
10 REM ZX80 REACTION TIMER
20 REM USES PUSH BUTTON ON
   ANY CHANNEL
30 REM AND LAMP ON CHANNEL
   ZERO
40 LET N=0
50 POKE 25000,0
60 LET A= RND(2000)+500
70 FOR S=1 TO A
80 NEXT S
90 POKE 25000,1
100 IF PEEK(25000)>0 THEN GO TO
    130
110 LET N=N+1
120 GO TO 100
140 PRINT N
150 PRINT "AGAIN — Y OR N"
160 INPUT Y$
170 IF Y$="Y" THEN GO TO 40
```

```
10 REM ZX81 REACTION TIMER
20 REM PUSH BUTTON ON ANY
   CHAN, LAMP ON CHAN O
30 FAST
40 LET N=0
50 POKE 11000,0
60 LET A=2000*RND+500
70 FOR S=1 TO A
80 NEXT S
90 POKE 11000,1
100 IF PEEK 11000>0 THEN GO TO
    130
110 LET N=N+1
120 GOTO 100
130 SLOW
140 PRINT N
150 PRINT "RELEASE BUTTON TO
    RESTART"
160 IF PEEK 11000=0 THEN GO TO
    30
170 GO TO 160
```

Combination lock

Another application of the 80/81 port using push-button data entry is an electronic combination lock. Up to eight buttons can be mounted remotely from the ZX close to the doorway concerned, with the ZX programmed to monitor their state and to respond in different ways to different codes input at the door. Some codes could automatically unlock the door using a relay to switch on a door release mechanism, while others could cause an alarm to be sounded, or to flash the owner's name on the screen, awaiting some response from the controller.

Figure 11 gives the circuit for such a system. It uses all eight channels for data input but channel 7 is used to indicate that the correct data has been set up on the other 7 buttons, so that all valid codes require button 7 to be pressed. The relay operating the door is connected to channel zero of the output port, and channel 1 operates a buzzer to indicate an invalid code. Below is a simple program for operating the system on the ZX81:

```
90 REM ZX81 COMBINATION LOCK
100 REM CODE DETECTING
    ROUTINE
110 POKE 11000,2
```

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RING-RING (Interface module)	£69.50

SOFTWARE

Microsoft MBASIC-80 Interpreter	£155/£18
Microsoft MBASIC-80 Compiler	£195/£18
Microsoft FORTRAN-80 Compiler	£205/£18
MMike's BaZic (Z80 North Star BASIC compatible)	£95/£25

MICROPRO SOFTWARE

WordStar – Word-processing Package	£205/£25
SpellStar – Dictionary Program for above	£125/£25
DataStar – Database Management System	£160/£25
SuperSort 1 – CP/M File Sort Utility	£110/£20
MailMerge – Mailing list for WordStar	£60/£15

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Televideo TVI–910 VDU	£460.00
Televideo TVI–920 VDU	£595.00
Televideo TVI–920 Customised for WordStar	£695.00
Televideo TVI–950 Detachable Keyboard, Many Features	£750.00
Epson MX80 Printer	£350.00
Anadex DP9500L Printer 150cps	£795.00
Anadex DP9500 Printer 150cps. Graphics	£895.00
TEC Starwriter Daisy Wheel Printer	£995.00
NEC Spinwriter RO Letter Quality Printer	£1695.00

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CP/M is a trademark of Digital Research Corp.

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CONTROL YOUR OWN SUBSTATION!

```
120 LET X=PEEK11000
130 IF X<128 THEN GO TO 120
140 IF X=143 OR X=152 THEN GO
    TO 600
150 IF X=131 THEN GO TO 500
160 GO SUB 700
170 GO TO 120
500 REM IDENTIFICATION ROUTINE
510 PRINT "SMITH IS AT THE
    DOOR"
520 PRINT "ADMIT – Y OR N"
530 INPUT S$
540 IF S$="Y" THEN GO TO 600
550 GO TO 120
600 REM OPEN THE DOOR
610 POKE 11000,3
620 PRINT X: "ADMITTED"
630 POKE 11000,2
640 GO TO 120
700 REM BUZZER
710 POKE 11000,0
720 RETURN
```

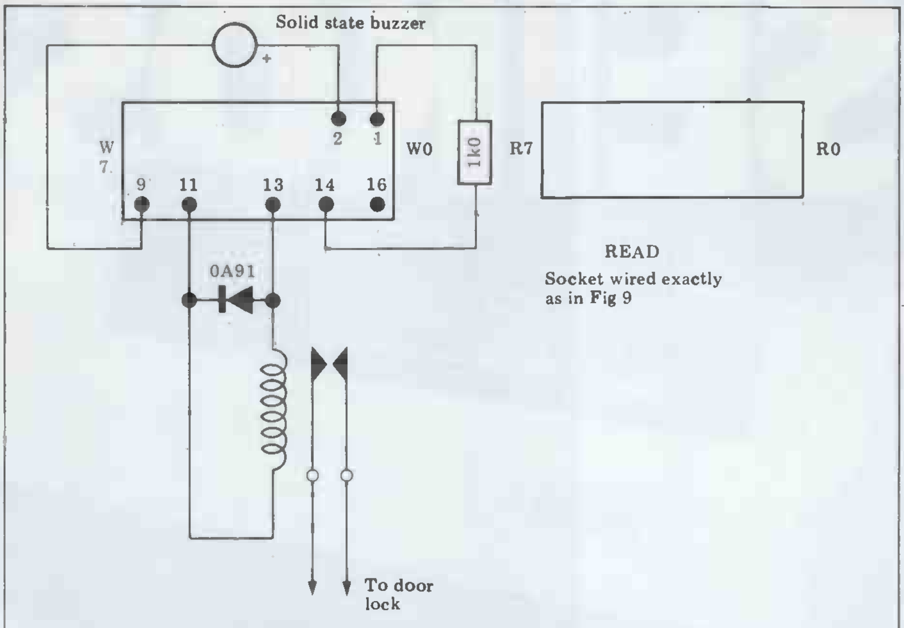

Fig 11 Connections for door combination lock

The program allows holders of the code 10011000 and code 10010001 direct entry, opening the lock and printing their code number (in decimal) to the screen, while with code 10000011 it prints the holder's name and at the same time waits for a response from the controller as to whether he should be admitted or not. All wrong codes that are keyed in with channel 7 pressed will cause the buzzer to sound (by sending a *low* to channel 1) until a correct code is entered. I leave it to you to add subtleties like shutting down for a few seconds after more than one incorrect entry, etc. To run the program on the ZX80, the PEEK and POKE commands should be readdressed to 25000, the PEEK addresses bracketed and an INPUT statement should be inserted after line 620 if an immediate readout is required of the codes of those admitted.

The basic circuit of Figure 9 using a 1k resistor on any channel will operate with any form of switch to allow data input through the port. Ordinary switches, micro-switches, magnetic reed switches and relay contacts will all perform in the same way.

Using a very similar circuit it is possible to connect a light sensor to one or more of the input channels. The so-called light dependent resistor, or LDR, is particularly well suited for use with the port, and with the circuit of Figure 12, an ORP12 LDR will give a reading which changes from high to low as the light level decreases. That is to say, executing the command PRINT PEEK (P) will yield a zero in dark conditions and 128 when illuminated. With such a simple set up it is, of course, only possible to detect whether the light level is above or below a given arbitrary value. To be able to *measure* that level using the computer requires a device called an analogue-to-digital converter — but this is beyond the scope of this article. There is, however, much that can be done with the simple two-state (ie, light or dark) detection facility. For example, the LDR allows the detection of moving objects, using a light beam which is interrupted by the object to be detected. Suppose, for example, that the ZX was being used to control a conveyor belt and was required to stop the belt when a certain article arrived at a given point. The set up shown in Figure 13 achieves this when used with the program below.

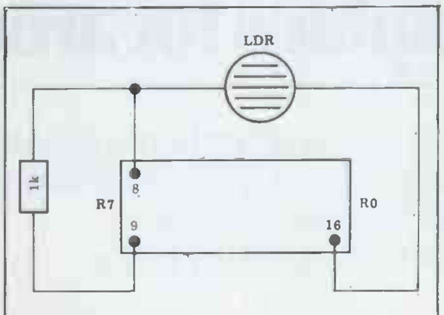

Fig 12 Input port with light dependent resistor on channel zero

```
10 REM CONVEYOR BELT
20 POKE P,1
30 LET X=PEEK(P)
40 IF X<128 THEN GO TO 30
50 POKE P,0
60 REM REST OF PROG TO DEAL
   WITH
70 REM ITEM ON THE BELT
```

The program first turns on the belt (via a relay in channel 0 of the output port) and then monitors the input port (channel 7) until it detects that the cell is in the dark. It then stops the belt and routines from line 60 onwards can be used for dealing with the article detected — eg, testing its size with more light beams, drilling a hole in it, spraying it with paint, or whatever.

Sometimes pairs of photocells are used in timing and speed determining operations. Here the LDRs would be arranged some distance apart, so that the object to be measured passes first one beam and then the next; the computer is programmed to calculate the time between crossings. Of course, since the photocell is sensitive to any light source, best results will be obtained in situations of low background illumination; in brighter environments it will be necessary to place the photocell at the end of a long darkened tube.

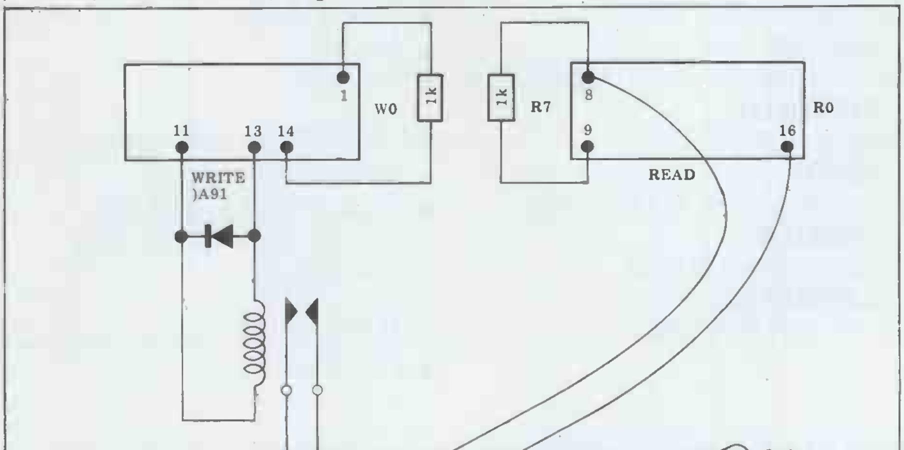

Fig 13 Conveyor belt control circuit

COMMUNICATIONS

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

The BBC micro

There were some rather cool references in August's 'Newsprint' to the forthcoming BBC micro: both Guy Kewney's own doubts about Acorn's ability to produce enough of the machines by January 1982 and the Amateur Computer Club's objection to the machine's use of the 6502 CPU.

There was further critical comment from Derrick Daines in 'Young Computer World', complaining of the BBC loosing its moral authority in promoting a *de facto* standard Basic by choosing a particular manufacturer, Acorn, to produce its microcomputer. I admit there was a certain redressing of the balance in Adrian Stokes' enthusiasm for the 'telesoftware' add-on which will provide the BBC machine with the ability to down-load software directly from the air. However, the general critical tone of the August issue has prompted me to write to you.

I have no connection with Acorn at all, save, I must admit, being the owner of an Atom, with which I am well pleased. I am, however, responsible for co-ordinating microcomputer development in the Management Services Division of a major public authority in the West Midlands. We have a great deal of experience with both the hardware and software aspects of microcomputers and it is our view that the whole BBC computer literacy project, including the BBC microcomputer and BBC Basic, are, by far, the most significant and exciting developments on the UK microcomputing scene to date.

Just consider what the computer literacy project involves besides the computer itself: there will be a series of ten TV programmes, large amounts of ready-written educational and consumer-type software, books, and a '30-hour Basic' course available for private study, in the form of a correspondence course or via so-called 'flexi-study' at local colleges of further education.

What of the hardware itself? For £335, you will get a 6502 running at 2 MHz, accessing 32k of dynamic RAM and 32k of ROM, with options to extend the ROM further to include, for example, Pascal. There are eight graphics modes, RGB and UHF colour outputs, a two-speed cassette interface, RS232 output, four-channel 12-bit A/D converter, sound generator, light pen input, parallel printer output and so on.

The ACC's unhappiness with the 6502 is irrelevant when you consider that a second microprocessor can be added, leaving the original 6502 to handle just the I/O. This second processor can be a second 6502 running at 3 MHz, a Z80A (opening up the world of CP/M) or a 16-bit micro, likely to be the 68000.

BBC Basic is very close to Microsoft Basic but with very worthwhile additions, such as multi-line procedures and functions, REPEAT...UNTIL loops and very versatile graphics commands. It will also have an interactive assembler.

My point is that you ought to be supporting the BBC initiative as hard as you can, because of the tremendous impetus it will give to widening the understanding of, and interest in, microcomputing in the general public. The BBC machine has a very good specification, is competitively priced and will be made by ICL. So let's hear it for the BBC!

I G Nicholls, Kidderminster, Worcs

Mods help wanted

I intend to modify the Basic interpreter for the school's RML 380Z. This is an attempt to undermine the maths department's claim on the machine and alert the aforementioned to the fact that we scientists want a look-in.

'Rabid' for 'Ready' and 'Total Cockup' for 'Syntax Error' are two replacements which spring go mind. Your readers can help fire the first salvo in this interdepartmental war by suggesting changes of this nature to fox the mathematicians. The major constraint is that the new commands and responses should have the same number of characters as the words they replace.

Sean Morgan, London NW10

Howler?

I have spotted the most terrible howler on page 39 of the ZX81 Basic programming manual: 'At its most elementary level, "A**B" means "A multiplied by itself B times . . ."

In practice, this means that if A=2 and B=3, then A**B = 2x2x2x2 = 16. Surely the statement should read: '"A**B" means "A multiplied by itself (B—1) times"'. Thus if A=2 and B=3 then A**B = 2x2x2=8, which is correct.

G Sutherland, Farnham, Surrey

*What you have discovered isn't a howler by the manual's author but a semantic irregularity in arithmetic. In your example, the correct answer for A**B with A=2 and B=3 is, as you say, 2x2x2=9; to put it crudely, you count the occurrences of A — two in this case — not the multiply signs — Ed.*

SuperBrain reliability

I noticed a comment in the August issue regarding SuperBrain.

Clearly it is courting disaster to say that one's machine is utterly reliable — as soon as this letter is despatched, no doubt it will give me trouble. However, as a SuperBrain QD user, can I say that I am delighted with my machine and that it has proved extremely reliable. To date, we have put on it some 5000 company addresses for the *Flight International Directory of European Aviation* and printed, using Mailmerge and a Diablo 1650 daisywheel printer, name and address labels for all these companies.

With regard to the failure rate, can I suggest that this might be something to do with the conversion to 240 volts (the brochure says 115 volts) by some of the importers. If this problem is not tackled thoroughly and professionally, obviously the machine is not going to give its best.

My SuperBrain was purchased through KGB Micros at Slough.

Malcolm Ginsberg, New Barnet, Herts

One-liner 1

Here's a Superboard single-line program:

```
0 X=INT(256*RND(1))
:POKE 53383+3* (X AND
192)+2*(X AND 48) +
(X AND 15), 161:RUN
```

Enter and run the program after a cold start. Four rectangles will be displayed. Find someone willing to bet that the second rectangle from the top will be the first to be completed in the next run. Do a warm start, enter RUN and win the bet. This can be done any number of times after a warm start but don't accept bets immediately after a cold start.

Len Wood, Bourne End, Bucks

One-liner 2

After the two one-line programs for the Superboard/UK101 caught my interest, I wrote the following one for the Nascom 2:

```
0 FOR D=1 TO 127 :
FOR C=D TO 255—D :
FOR A=2058 TO 3065
STEP C:
POKE A,C:
NEXT:NEXT:
NEXT:CLS
```

Note that, this can only be fitted on to the Nascom's limited line length by typing in the key character for each command. A list of these is to be found in appendix J of the programming manual.

A Alexander, Stamford, Lincs

Kentucky Fried error

Delighted though we were to note the inclusion in your August issue of a short piece on page 43 about one of our clients, I'm afraid it was not without errors.

The piece, and accompanying photograph referred to a Kentucky Fried Chicken Store using one of our systems. The errors were:

1. Tom Allen is in fact Tim Allen
2. Our phone number is 6792 not 6795

I hope you will be able to correct the above in your next issue. Sorry to ruin the 'Bludners' record set in August!

R F Honeyman,
Chess Consultancies Ltd,
Manchester

Name game

Couldn't resist picking up Guy Kewney on his 'Name Game' piece in *PCW*. Microsoft Basic (Basic-80), in all but the 8k version, supports variable names of any length with the first 40 characters being significant. They can also contain embedded commands, ie:

GOTO.IF.PUT.ON.FOR.
NEXT.GOSUB

is a valid variable name and will not be confused with a command. The only restric-

tions are that the first character must be a letter of the alphabet and the first two characters must not be FN (then a user defined function call is assumed).
Brian S Crank,
Southborough, Kent

Unbeatable?

So, Bob Chappell's Gomoku program (August *PCW*) is unbeatable, is it? Unless I have made some silly typing errors in copying the listing and adapting it for a Tandy, the following short sequence is a winning game:
(You move first)
1 5,4 : 5,5
2. 4,5 : 4,4
3. 3,3,: 6,3
4. 3,4 : 3,5
5. 2,3 : 5,6
6. 4,3 : 5,3
7. 2,6 : 6,5 (!!!)
8. 2,5 : 2,4
9. 5,2 : 6,1
10.1,6 : "You Win"
I would be grateful for his (or anyone else's!) comments on this.
B E Newsam, Sheffield

Speakeasy

I have just read your 'Check-out' review of the Hi-Tech Speakeasy card. I thought your readers would wish to know that our company Wideband Products has been manufacturing a Speech Output device called Speakeasy for quite some time and in fact we have registered the name Speakeasy, which means that Hi-Tech are not allowed to use the name. Furthermore, our Speakeasy is available for any make of computer, is self-powered and costs only £69. It is programmed by the Phoneme access method and so has a virtually infinite vocabulary compared with Hi-Tech's words. We also use a superior high flux loudspeaker which makes a world of difference to speech quality.

The Phoneme access method of speech synthesis opens the door to real computed speech without being limited to the equivalent of a semiconductor tape recorder, which is what the Digitalker system is.
D N Sands, Intelligent Artefacts Ltd, Royston, Herts

ZX80 mountain?

I was amused to see in this week's *Paris Match* that lucky French punters are being tempted with the very wonderful offer by mail-order of the latest thing in microcomputers, the Sinclair ZX80, for the bargain price of 1250 francs, around £125! For another £25 or so they can buy an 8k ROM for it, thus enabling them to have a machine only slightly inferior to the ZX81 for a paltry £150.

Serves them right, I say, for dumping their lousy Golden Delicious on us! Mind you, delivery is promised within 15 days, while I had to wait two months for my ZX81. And goodness knows when I'll get the 16k RAM I ordered last week.

Congratulations on your excellent magazine! I know you've got to strike the right balance but couldn't we have a little section of ZX81 programs each month? After all, it's likely to be the best-selling micro!
Charles Jannaud, Teddington, Middx

We'll certainly print ZX81 programs as and when we receive ones which fulfil our original/interesting criteria — Ed.

'And all the cleaning information you need is at your toe tips!'

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BENCH TEST

OKI if-800 MODEL 20

Chris Sadler and Sue Eisenbach examine a new business micro from Japan.

What springs to mind when you hear the term 'all-in-one micro'? Typically this will be a VDU cabinet incorporated into which is a CPU board, some RAM and a couple of floppy-disk drives — the SuperBrain is probably the most familiar example. All you need for 'the complete business system' is to plug in a printer in the back — and what more could you ask? Well, you could have an integral printer, which brings to mind the range of 'desk-top' computers (between £15,000 and £30,000) which slightly pre-date micros as we know them and of which the Hewlett-Packard 9845 is probably the most prominent example. These tend to be very easy to use as processing tools for executive applications but are not really accessible for development programming, which is why the Oki if800 seems to be an interesting machine, combining the classy desk-top features (integral everything, powerful key functions, colour screen) with the flexibility we expect from a micro system (Z80A, 64k, Microsoft Basic, CP/M).

Hardware

Getting a microcomputer to review can be rather like receiving a package in the post in a plain brown wrapper — you have to get it up the stairs before you open it up. In the case of the if800, weighing in at 40 kg divided between two bulky boxes, it was touch-and-go what was going to get opened up first — the cartons or your intrepid reviewers.

Since it was supposed to be an 'integral system', we were a bit puzzled by the two boxes. The smaller one revealed a keyboard/printer/CPU unit which takes the main power cable. The big box had a screen/twin floppy disk unit, mounted on a plinth which notches very neatly into the keyboard unit, giving the 'all-in-one' effect. Power and data lines are passed up one leg of the plinth so there is no messy wiring and with a mostly metal casing (apart from the keyboard surface and the video frame) and measuring 51 cm high by 68 cm deep by 51 cm across, the assembled system is a most presentable sight.

The keyboard unit contains the only power switch on the system, together with RESET (IPL) and BREAK (NMI) buttons, well down the left hand side of the unit and out of reach from the keyboard. (The initials in brackets are Oki's equivalent titles for these functions.) The front edge of the unit contains a slot for a ROM cartridge, while at the side there are DIN-plug connections for an audio-cassette, a light-pen and a TV monitor, together with a 25-way RS232 port, all fully software-supported (eg, baud rate software selectable, according to the documentation). The top cover pops off (without recourse to screwdriver, Phillips or otherwise) revealing a very tightly-packed interior, starting with the keyboard which is firmly clipped in place (no screws again) followed by the printer mechanism (a Microline 80 — no lower case descenders) behind which, under an aluminium cover, is the slim power supply. The review machine had a 110 V power rating and we were supplied with a transformer. This was a shame as it spoiled the 'all-in-one' effect but there didn't seem to be room in the power-supply case for 240 V type components, so Oki might be stuck with an external unit. To the right of the printer there is a five-slot backplane (on Oki's own bus) which contains a video card and a disk controller card (on the standard system), and the remaining three slots can hold any combination of the following options: a Centronics-type parallel interface card, another RS232 card, a IEEE 488 card, A/D or D/A cards or an additional 8in floppy disk controller card. Beneath all these elements, and covering the whole of the bottom of the unit, is a large printed-circuit board containing all the remaining electronics for the system including the CPU and support logic, 64k of main memory plus 16k of memory for the video system (VRAM). The board looked cleanly designed if fairly tight-packed but it was distressing to see that there wasn't a single socket on the board — this is definitely the type of system one takes out a maintenance contract on!

On switch-on, the 2k bootstrap ROM does a very cunning thing which we have not previously seen on micros — without being told, it interrogates any device which it could possibly find on a system, starting with the ROM cartridge, then each of the disk-drives and finally the audio-cassette. As soon as it finds a system it boots it in with much flashing of colours on the screen, while if it doesn't find a system on any of the devices it exists with a long beep on the speaker and an error message on the screen. We found the boot-up times relatively slow (working off the top floppy drive), clocking 12s to boot CP/M and 16s for the Oki Basic System. Under CP/M, the time and date are displayed on boot-up. There is a real time clock which is maintained by a NiCad battery. The first time we booted up, having just extracted the system from its cardboard boxes, we got a really eerie feeling when it came up with the *correct* date, day and time!

The one thing the Japanese have really had to come to terms with is character sets. Apparently the 'formal' alphabet has several hundreds of characters while the modern, simplified version (Kana) has roughly twice as many symbols as our own alphabet. In computing terms, all character-oriented devices (screens, printers, keyboards) must be able to cope with 7-bit ASCII (128 symbols) but with Kana the Japanese are forced to go to an 8-bit code, thus allowing 256 symbols. As a result one would expect quite a good range of graphics and other characters to make up the numbers, quite apart from screen-addressable graphics. In addition, this flexibility has been built into the matrix-head of the if800 printer which offers a hardcopy facility where the contents of the screen will (at the touch of the key) be faithfully translated onto the printed page (colour excluded). In addition, at the touch of another key the screen can be translated to the printed page reduced to half-size in the vertical or horizontal directions.

However, it is the keyboard which most dramatically demonstrates the fact that the Japanese are happier handling a larger quantity of symbols than we are. In addition to the standard qwerty, numeric pad, editing pad and ten function keys (about which more later) there are a surprising number of SHIFT/CTRL type keys. Firstly, the default is upper case and SHIFT must be depressed to get lower case (this is sensible for programming and useless for word processing; however, pressing CTRL and SHIFT reverses this arrangement). Secondly, there is a Kana toggle key which, if depressed, will give a whole set of Kana characters. Then there is a Graphics key which, when depressed, gives a set of graphics symbols. Finally there is the COMD key which, when depressed and used in conjunction with alphabetic keys, will initiate full Basic keywords, thus:
COMD + I → IF on screen
COMD + T → THEN on screen, etc.

The function keys are preset on boot-up so that, when depressed, they will introduce onto the screen up to 15 characters from a buffer (eg, F3 → 'SAVE', after which the user types 'filename' CR). Since the CR can be inserted in this buffer, it is possible to execute complete commands with one key stroke (eg, F9 → 'LIST' CR). It is a simple matter to alter the values in these buffers and hence create an application-specific set of function keys. Incidentally, these function keys are duplicated by a set of keys along the bottom edge of the screen. This is so that a user does not need to back off from the screen and hunt for the keyboard when using the light-pen -- a *very* superior feature. The repeat function can be generated by holding the key down, at which point a clicking sound is heard, one click for each repetition.

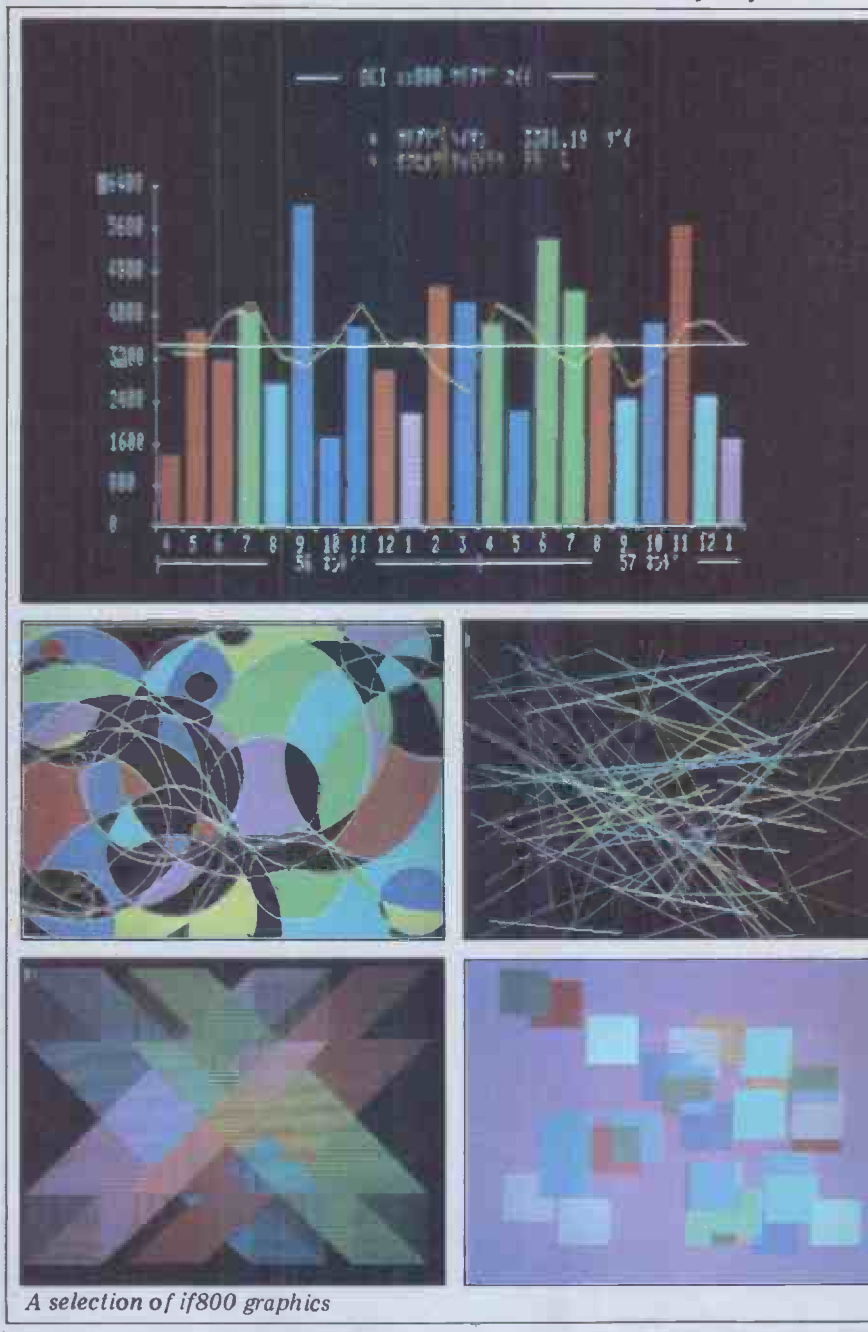
The review system offered the colour video option although there is a cheaper 'green screen' option available. This exploits the 16k of VRAM to give a 640 x 200 dot resolution picture which, for micros, is high-resolution. With the colour card in, the on-board VRAM becomes the blue picture while a further 32k on the colour card itself provides the red and green pictures at the same 640x000 (slightly lopsided resolution to program) dot resolution. This arrangement gives the standard TV colour mix of eight colours: black, blue, red, violet, green, cyan, yellow and white.

In character mode, the screen may (under software control) be used to hold 40 or 80 characters across, 20 or 25 lines down, and similar controls exist over the printer.

Finally, the loudspeaker can be programmed to play over five octaves (not particularly melodiously); the ROM cartridge is a sequential access device which holds 20k (and a set of these cartridges may be used in sequence up to 1Mb); and the diskettes are soft-sectored, double density, double-sided with 280k/disk (two additional 5.05in drives can be connected using the same controller). However, although it is easy to be enthusiastic about the features which this system offers, it would be misleading to be anything but tentative about the availability of any options or technical support as, at the time of this review, only one British dealer had been selected.

Software

The floppy disks supplied with the review system were of two types: those that would boot-up CP/M and those that came up in Oki-Basic. This latter is really Microsoft Basic (version 5), which seems to have been pretty successfully



A selection of if800 graphics

The I/O connectors are grouped together at one side.

Key Code	Buffer Contents	
F1	LOAD	
F2	FILES CR	(Microsoft's directory listing)
F3	SAVE	
F4	END CR	
F5	COLOR	(see later)
F6	DATE$, TIME$ CR	(real- time clock)
F7	CONT CR	
F8	KEY	
F9	LIST CR	
F10	RUN CR	

implemented, given the hardware configuration and is, in fact, the standard supplied software — (the CP/M being very much an optional extra). On boot-up, the query HOW MANY DISK DRIVES (1—4)? appears followed by HOW MANY FILES (0—15)?

Once these questions have been answered, the system displays a copyright notice followed by the date of the creation of the disk, the current date and time, and the amount of user-available memory, on the basis of the answers given to the two questions. On the review system, the exact figure varied from disk to disk (presumably reflecting configuration changes during development), but we found the maximum to lie between 18 and 20 kbytes (on a 64 kbyte system) with reductions of the order of 150 bytes per disk drive specified, and 250 bytes per file specified, presumably for buffer space. The default settings (ie, RETURN in answer to both questions) are for one file and one drive. This sort of interrogation is not very user-friendly and it might have been preferable (if not easier to do) to boot up on the defaults and allow the user to set up the buffer space in a different way.

Microsoft Basic has been described in sufficient detail both in earlier Benchtests and elsewhere so it is unnecessary to devote much space to it here. Suffice it to say that it seems to be a full implementation (ie, nothing memorable left out) to which have been added facilities to enable the user to exploit the hardware features of the Oki, as described in the previous section. Firstly, the different peripheral devices are referenced fairly conventionally; the disks with single digits followed by a colon (eg, 1:); the other devices as follows:

CAS1: cassette
COM1: RS232 (communication) port
LPY1: line printer
PAC1: ROM cartridge

Presumably, if more than one of any particular device is online, the trailing digit can be changed accordingly.

Secondly, the function keys have been primed, on boot-up, such that each key will, on being pressed, discharge a 15 byte buffer onto the screen. This can take the place of a word command or, since CR can be embedded in the buffer, an entire command can be performed by one keystroke. At boot-up, the keys are initialised as in Table 1. Use of the F8 key allows the user to overwrite any of these and insert other commands, for instance, to run a specific applications program or to perform certain editing tasks. Incidentally, F8 followed by F9 (ie, KEY, LIST) will list the current settings of the function keys. We never worked out how to get the system to *boot-up* with user-defined commands in these buffers, but it is obviously possible since one of the applications disks provided with the review system allowed one to insert the disk, boot up and simply press F10 (to initiate the application).

The editing keypad includes the four arrows together with DEL, which deletes the character to the left of the cursor; INS, which inserts after the character to the left of the cursor. Basic programs are edited (much like the PET) by manipulating these keys and pressing RETURN when a particular line of editing has been completed. Initial program creation can be speeded up by means of a single-keystroke 'shorthand' (like Sinclair), the following keywords being available (and inserted in the text) when their initial letters are typed, while the COMD (command) key is depressed: AUTO, BSAVE, CONSOLE, DELETE, ELSE, FOR, GOTO, HEX$, INPUT, KEY, LPRINT, MOD, NEXT, OPEN, PRINT, RETURN, STOP, THEN, USING, VAL, WIDTH, XOR. Not all of these are standard Microsoft keywords, which will be described in due course. As a final word on the keyboard, there is a CAN (for cancel) key which has the effect of a BREAK (ie, returns control to the Basic interpreter), while the ESC key can be used to cause execution to pause, and resume again when any other key is pressed.

The first of the special Oki keywords is CONSOLE which can be used to define some of the display characteristics. It takes four parameters as follows: CONSOLE a,b,c,d, where 'a' defines the top line of a scrolling window (line 0 is the top of the screen); 'b' defines the length of the window (in lines), 'd' defines the 'scroll type' which is basically very jerky (the text jumps up a line at a time as it does on most systems) when d=0 and gets smoother (the text moves incrementally up the


Japanese neatness — but no sockets: a maintenance 'minus'.

screen) as d goes higher (similar to a Digital VT100). We found d=15 to be a comfortable setting and thought that this was the nice ergonomic type of feature which one should expect on an up-market system. Unfortunately, d defaults to zero (ie, ordinary jumpy mode) as soon as a window is set up so smooth scrolling only works on the full screen. Finally, the parameter 'c' is a switch which, when set (ie, c=1), will display the current setting of the function keys in reverse video along the bottom line of the screen — in fact, just above the subsidiary set of function keys installed along the lower edge of the screen frame. To all intents and purposes, this is uncannily similar to the Hewlett Packard 'softkey' scheme.

The second keyword is WIDTH, which takes two parameters as follows: WIDTH a,b. Here 'a' represents the number of characters per line (the only meaningful values are 80 or 40, although other input will be accepted and converted to the nearer of these two); likewise, 'b' defines the number of lines to be displayed on the screen (20 or 25). The characters displayed at the different settings will vary according to these parameters, so WIDTH 40,20 turns the system into a Noddy machine with big friendly letters marching across the screen. The final touch can be brought about by the use of COLOR which takes four parameters in the range 0-7 where: 0 means Black, 1 is Blue, 2 is Red, 3 is Violet, 4 is Green, 5 is Cyan, 6 is Yellow, 7 is White. So COLOR a,b,c,d will cause the characters to be written in colour 'a' against background of colour 'b' with the display area framed by colour 'c'. Colour 'd' defines the 'colour mask' which has the effect of eliminating from the display all objects which do not contain some components of this colour. By this device some wondrous effects are possible — for instance, a picture can be drawn in red, say, (against a black background) and then the command COLOR , , , 1 will cause it to vanish from sight (although still preserved in the RED 16k of video RAM), while a blue picture is drawn. The command COLOR ,,, 4 will cause that to disappear and a third, green picture can be drawn. Then, by selecting different masks, different combinations of these can be superimposed on one another. The default setting for COLOR is 7,0,0,7

The printer can be configured in a similar fashion to the screen by WIDTH LPRINT a,b,c, where 'a' is the number of characters per line (80 or 40 again), 'b' is the number of lines per page (default 66) and 'c' is the printer pitch (default 24). Obviously, both scrolling and colour have no relevance to a printer of this type. However, output can frequently be directed to the printer by prefixing an 'L' to a command which normally produces output on the screen. Thus LPRINT as above, and also LLIST and even LFILES.

Oki-Basic does more than enable colours to be specified on the screen. Firstly, there is a cursor addressing via LOCATE a,b,c where 'a' is the horizontal screen position, 'b' is the vertical screen position and 'c' is a switch which, when off, causes the cursor to disappear from view altogether. Beyond that, there are the graphics capabilities of the 640x200 screen, which include CIRCLE, whose purpose is obvious, and DRAW, which passes a character string coded to enable:

1. Absolute horizontal and vertical movement;
2. Relative horizontal and vertical movement;
3. Colour definition;
4. Scale definition;
5. Angle definition.

In addition, LINE will connect point to point, while PAINT can be used to colour the inside of a figure. Finally, GET@ and PUT@ will enable entire areas of the screen to be saved in named arrays, or accessed from them. Taken together, these constitute pretty powerful graphics facilities. The next step would be to provide more sophisticated, high level graphics capabilities so that pie charts and graphs could be produced with real data with the minimum of programming effort.

All the facilities on the Oki seem fairly accessible from within Basic. A fairly sophisticated, interactive screen-based application, for instance, might require input both from a light-pen and from one of more of the function keys. Such input would normally make itself known to the programmer via an interrupt, generated by the pen or key in question and the routine would deal with it via an interrupt processing routine. Alternatively, another application may require communication with a remote machine and this would also be interrupt driven. Commands exist within Basic (ie, OPEN, ON COM GOSUB, COM ON, COM STOP, COM OFF) for incorporating interrupt processing routines, enabling and disabling them as well as disabling the interrupts themselves.

Only a few items remain — the command COPY produces a screen image on the printer from within a Basic program, just as pressing the HARD COPY key does from the keyboard. The loudspeaker is available via two commands, BEEP, which accepts a character string coded for tempo, pitch, scale, length, rests and relative rises and falls in the scale. Finally, the real-time clock is available via TIME$ and DATE$ which are used both to reference and set these values.

CP/M

After all that, CP/M on the Oki is a bit of a let-down. It boots up all right with a jazzy '52k CP/M' in different coloured, double height characters, but it soon becomes apparent that few of the special features on the Oki are implemented or at least fully implemented under CP/M. For instance, instead of COLOR, it is possible to change the foreground colours or to get reverse video by fiddling with an escape sequence, but that is all. Similarly, we could find no way of programming the function keys and the only one that worked on boot-up (F10 — which gave the time and date) immediately crashed CP/M and converted the whole system into a very expensive digital clock. On the other hand, the width and scrolling functions work (also with escape sequences) as does the hard copy facility, with the added bonus that one can produce a printout of the screen reduced by half, both horizontally and vertically. For those of us who do not rank Basic as our favourite language, full implementation of a high-level graphics package ('turtle' or Gino-F like calls) would allow the user to exploit the hardware.

On the software side, Oki offers two extra utilities under CP/M. These are COPY, which does a track-by-track copy of either the whole disk, or just the system bit, or just the non-system bit; and PRINT, which produces fancy listing (ie, with a heading and the date on each page). On the whole, it looked to us as though CP/M was crammed onto the system in a great hurry and the quality of the documentation bears this out. If Oki could start the project all over again, integrating all the clever bits and pieces into the CP/M environment (and it probably has the low level interface — what else could take up all the space between the 64k of RAM that's sitting in the system and the 52k boot-up message?) and then carefully implementing some of the classic CP/M packages, like Wordstar, etc, then it would have a product to reckon with. As it is, the user is better off sticking to the Basic environment where the system software matches the hardware.

Enough on operating systems! The application software offered with the review system was conspicuously thin on the ground. Apart from some entertaining graphics demonstration programs which were well put together and quite entertaining to watch, there was a troubleshooting sort of utility which offered to test different bits of the system for you and a share analysis program. We had a great deal of trouble with the tester program, particularly the memory test during which it came up with problems and faults and the occasional crash. Our own memory testing program — which admittedly didn't attempt to test the memory it occupied itself — did not show up memory faults. Other options were not always reliable so we gave up on this utility and tried the shares program. This had overall a more impressive feel to it, with a polished user-interface (when you chose an option from the menu, your selection *changed colour* in confirmation) and some nice-looking features. Unfortunately, it crashed when we tried to write some data to a write-protected disk and, having unprotected the disk, we succeeded in destroying the entire data file on the next attempt.

At this point the inquisitive reader may be asking why people who don't back up their disks first (would you believe they didn't supply blank disks? *Excuses, excuses — Ed*) are allowed to be machine users in the first place; but application software should be sufficiently robust that when we answer questions to the best of our abilities the disk doesn't get destroyed.

Benchmarks	
1	2.2
2	6.4
3	16.8
4	16.8
5	17.9
6	31.8
7	50.7
8	5.7

All times in seconds.

Potential

From the user's point of view, the if800 hardware offers a comprehensive set of very up-market features. Unfortunately, the people who can afford

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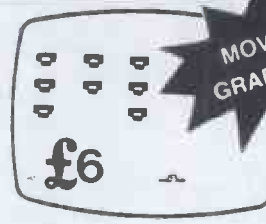

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these accessories tend not to be the average microcomputer enthusiast, still less the dreaded 14-year old junkies whose programming prowess upstages their elders. Instead, we find this sector populated by lab scientists (in both industry and higher education) and (perhaps) status-conscious and undoubtedly busy executives and managers who are interested in a micro in the same way that they are interested in a wristwatch — something to be consulted for the results it can produce rather than for the pleasure afforded by the consultation.

Such users probably resent the amount of time spent keying in their data, let alone the time wasted in learning to program and programming their problems on a machine. Instead they require high quality software, either packages or produced in-house. For people in this market, who would probably be willing to pay for function keys, light pen and fancy colour graphics, there is a gaping hole in the complete Oki picture — substantial quantities of reliable, high quality application software that uses the Oki's hardware potential. The if800 is a machine begging for a good software house to take it in. And they have to be willing to program in Basic (or to do a lot of systems level work).

For the lab scientist who is used to programming a single-user mini (say a PDP11 running RT11) the if800 may offer an inexpensive alternative. Assuming all the interface boards mentioned in the documentation exist, both control and programming should be straightforward, with the colour graphics an added bonus.

Documentation

The documentation supplied with the review machine consisted of a variety of flashy sales brochures and a thick, more serious-looking manila folder. On inspection, this turned out to contain five slimmer manuals covering CP/M, Basic, Installation and Operation, the I/O interface and the disk operating software. There were frequent tables and nicely labelled diagrams and it was only on closer inspection that the poor standard of the English translation emerged. On several counts, the worst one was the CP/M manual which begins, enigmatically and ambiguously: 'No better CP/M could be found than the if-CP/M Digital Research will be surprised to find it.' There follows a brief description of the if800 features which aren't available under standard CP/M, with nothing on standard CP/M, so a user will need a separate manual for these features. Brief and unsatisfactory references are made to tantalisingly important facilities, eg: 'Files such as if-BIOS, RS-232C handling and DISPACH are resident on diskette and they are useful for the changes of BIOS'. At only seven pages long, the CP/M document is clearly inadequate as a user manual. It looks like a rush-job and its shortcomings may have obscured some of the features of the CP/M implementation as we reported in an earlier section.

Fortunately, none of the other manuals appears to have been produced by the writer responsible for translating the CP/M manual and one is seldom unable to extract meaning from the fairly frequent grammatical contortions. The Operations Manual (52 pages) describes how to connect up the system and get it started. There are sections describing the operation of all the special keys; the operation of the commands required to set the size and colour parameters of the display; and a section on Troubleshooting. The next manual is entitled 'I/O Interface for Basic Unit' and it describes every line and signal for every I/O route into the system. As a brief reminder, these include the ROM cartridge, the light pen, the RS232 port, the audio-cassette, colour or mono video, the disk controller and the little motherboard tucked in at the back of the cabinet.

The next manual deals with the disk operating system utilities which are gathered together in a menu-driven program called 'IFUTY'. This covers the usual maintenance and housekeeping chores like formatting and backing up disks. Some of the options are a bit obscure and it's hard to see (and it's certainly not explained) why one would use them.

Finally, the Basic manual consists of a list of all commands, instructions and functions fairly tersely described. This is well below Microsoft's standard of documentation — at worst the descriptions are brief to the point of obscurity. Consider:

'ERROR
Syntax: ERROR error code
Explanation: Makes an error simulated
Example: ERROR 5'

with no listing in any manual of the error codes.

Our overall impression of the manuals was that they were sufficiently detailed to be quite strong on hardware but on software were too sketchy to be much use at all. A rewrite is called for.

Expansion

The review system was nearly fully expanded. From the documentation it appears that a minimal system would have neither CRT nor disk drives. Instead, it would look somewhat like a Teletype 43 but with 64k RAM, the RS232 port, loudspeaker and an attached cassette for backing store. The next step up would be to hook up a domestic TV set, using the 40 characters per line option. After that is the review machine with monochrome display and dual minifloppies, and then the colour display. Moving beyond the review machine and after installing the light pen, perhaps a ROM cartridge full of useful application software would be the next step (although nothing in the documentation suggests that these actually exist in any quantity or that it would be straightforward for a software house to program them). Two more minifloppy drives can be added without using up extra slots on the backplane, but after that all expansion must occur from the three vacant slots. Projected options include a controller for dual 8in double-density double-sided (ie, 1Mbyte per disk) disks and a variety of interfaces including parallel (Centronics), IEEE 488, A to D and D to A converters. The software can recognise only four drives so the 8in drives would be instead of 5in external drives. The bus is Oki's own, so all future options are likely to come only from them, and this is a disadvantage.

On the software side, the if800 comes standard only with Microsoft Basic so it is necessary to look to CP/M to provide the means for a range of software options. It was not clear to us how one went about exploiting all the nice Oki features through CP/M, so there may not be much incentive to undertake this kind of enhancement in the first place.

Prices

At the time of this review the Oki if800 had one distributor, Encotel, in this country. Encotel had not firmly set a price but when pressed thought 'around £4000' for the review machine, with no ideas on what any add-ons would cost. We then asked about maintenance for the machine. The reply to this question was that Encotel would do its best. No arrangements had yet been made with a maintenance company.

In conversation with the Oki representative in Germany, we found that he expected the machine to retail for about $7500.

Conclusion

The Oki if800 is a rather classy looking machine. It comes crammed full of hardware features (integral printer, high resolution colour graphics, function keys, light pen) which are supported in a variant of Microsoft Basic.

If the machine sounds appealing, a word of caution — this is a machine that needs a good dealer network. There are no sockets anywhere and so any hardware failure could be quite expensive to repair. Also currently notable for its absence is a solid software base. There are programmers in this world who would like to be able to access the hardware (especially the graphics) in a language other than Basic in a straightforward manner. An implementation of the UCSD p system with turtle graphics would be a big step forward. And, of course, a few tailor-made application packages would not go amiss.

For any manufacturer worrying about how close the Japanese are to producing machines that will take over the market, the answer must be — very close.

Technical specification

CPU:	Z80A
Memory:	64k dynamic RAM, 48k video RAM, 2k ROM
Keyboard:	100 keys including numeric, editing and function keys 20 or 24 lines of 40 or 80 lines, 640x200, 8 colours, 12inch diagonal
Printer:	Microline 80, 5x7 dot matrix, 80 or 40 chars per line.
Cassette:	43 kbytes per second.
Disk drives:	Double density double sided 5in, 280 kbytes per unit, up to 4 drives.
Ports:	1 RS232 port standard, 1 RS232 port, 1 Centronics port optional.
System software:	CP/M optional
Languages:	Basic 80, Assembler, Bascom

SOFTY 2

CHECKOUT

Neil Cryer reviews the new, British-made EPROM programmer.

Softy2 is an EPROM programmer and ROM emulator for single rail EPROMs of type 2516/2716 and 2532/2732. (Type 2708 requires Softy1.) It is advertised as a complete development system which means that the user can create and modify programs in RAM and then, when satisfied, save them in EPROM. This is achieved by plugging Softy2 into the socket of the host system that will eventually be occupied by the required EPROM, working out the hex code program, typing it in and testing it using Softy to display it, section by section, on a TV screen. Softy has facilities for putting parts of the program onto cassette tape as they are deemed satisfactory and then, once the program is complete, burning it into the EPROM. It can also copy EPROMs.

Softy1, reviewed in *PCW* Vol 3 No 6, June 1980, is still available, by the way.

Construction

Softy2 is about 7in by 9in by 2in and is protected by a rather flimsy plastic case. The majority of ICs are soldered rather than plugged into the the printed circuit board, which might be inconvenient if any had to be replaced. The advertising literature, which states 'no hidden extras', shows a plug and flying lead connected to the output ports. No plug is supplied and soldering it into place would involve completely dismantling the machine from its case and backing. The keyboard is of the flat, plastic, touch-sensitive type and is an integral part of the printed circuit board. A zero insertion force socket is provided for the EPROM to be copied or programmed.

Documentation

Two manuals were supplied with the review machine, both with the name Softy on the front cover. Closer inspection suggested that one was for Softy2 and the other for Softy1, which performs different tasks. I had to read these manuals several times to get the best out of them. The task was made no easier since both had illustrations of the Softy1 model and because general instructions on use were interspersed with information on SC/MP programming. I would recommend that these functions be clearly separated and that illustrations of Softy2 be used for the Softy2 manual.

The documentation assumes a competent programmer who is comfortable with hex code as distinct from assembler language.

Operation

I set up the review machine with three separate televisions which had performed satisfactorily with other computer systems. Two required an adjustment of the horizontal hold which upset normal reception. The third gave a steady picture with the display shifted somewhat to the left.

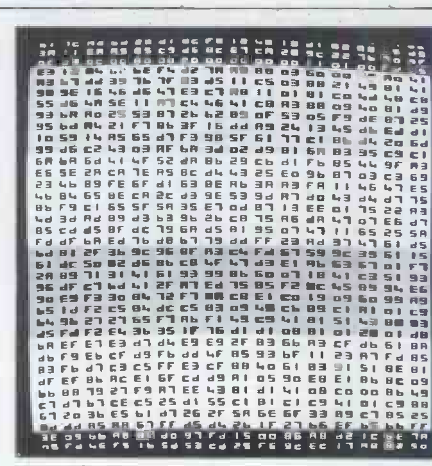
Softy2's keyboard is touch-sensitive and requires firm pressure from a correctly located finger. It thus shares the disadvantage of all such cheap keyboards in that the action can be very hit and miss. The only way the user can be certain that he has made contact is by seeing if the display has changed. This perpetual switching of attention between the screen and the keyboard can be slow and tiring.

The Softy2 display shows the hex contents of memory in lines of 16 bytes. Each block of eight lines is alternately light and dark to make it easier to see how much memory has been used and to judge where relative jumps — so often used in hex code programming — are in order. A cursor, in the form of a highlighted area, can be moved left, right, up and down.

Hex code may be entered at the cursor position merely by pressing the appropriate hex keys. Typing in the two hex digits necessary to fill the current memory location causes the cursor to move onto the next position. There is an alternative cursor for helping with the calculation of relative jumps. The separation between the two cursors is displayed in hex on the top line of the screen.

Softy2's routines are designed in a logical and useful fashion for the programmer who is comfortable thinking in hex. For example: INSERT allows a new block of hex code to be entered in the middle of a previous program. Although the insertion may corrupt some addressing of jumps or calls, there are other routines to help with the correction. DELETE allows a block of code to be removed and the resulting gap to be closed up — which is the inverse of the INSERT routine. MOVE allows a block of up to 110 hex

GOTO page 164



Softy's display.

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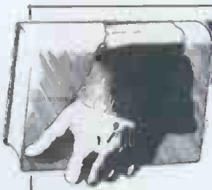


BOOKFARE

Malcolm Peltu gets his teeth into the latest printed words.

A prescription for solutions

One of the golden oldies of computer marketing runs: 'We are not in the computer business. We are in the problem-solving business.' Never was a truer word spoken in zest.

Programs should exist primarily to solve problems (or exploit opportunities, depending on your frame of mind). Too many books on programming and too many programmers, however, seem to regard producing code as an end in itself. *Problem Solving Principles for Basic Programmers* by William E Lewis is therefore a welcome contribution to the ongoing computer literacy situation scenario. And *Brain of the Firm* by Stafford Beer takes the whole concept of problem solving onto a higher conceptual level of complexity by examining the nature of how organisations and information systems behave, using insights based on the study of the human nervous system.

Beer's book is far more important on a global scale and includes the first detailed description of how he tried to use a computing network to assist President Allende's ill-fated regime in Chile. Although Beer's theories are of relevance to managers and computer specialists, it is Lewis's book which is of the most immediate interest to the practical computerist. Lewis's subtitle is 'Applied logic, psychology and grit' which gives a feel for what he is trying to do. He approaches the programming task from the point of view of problem solving, not coding. He examines the logical processes needed, human attitudes to tackling computing and provides some true grit bits of advice.

The book is available in four different flavours. The version I have gives all examples in Basic. Other editions have examples in Fortran, Pascal or a generalised 'interlingua' version for all programmers.

Lewis structures the book around 40 'prescriptions', things like: Make Sure There Is Method In Your Madness and He Who Digs A Pit Will Fall Into It. He admits that at first glance, 'some of the prescriptions may seem trivial or trite and not appear to justify a detailed analysis. However, it is believed that past experience shows that they do indeed provide commonsense panaceas to many of the programming errors constantly repeated every day.' These prescriptions may be something of a gimmick, but they are an effective gimmick because they crystalise programming home truths that are easily forgotten into some memorable 'silver bullets'.

The bulk of the book relates to problem definition, analysis and paths to solution. For each description, there is generally an overview of the ailment the prescription is designed to cure, followed by non-computer and computer examples of what the effects of using the prescription can be. This approach is an excellent one because it shows that programming is just one aspect of general problem solving techniques.

My main criticism is that the computer examples are taken at too rushed a pace, with insufficient description and discussion of the example, either in the text or as comments within the coding. The fault may be due to the format of the book. The nature of the material is ideally suited to a step-by-step approach frequently used in educational texts, particularly in self-instruction courses. It would be helpful, for example, to have the computer problem stated, then the reader asked to consider a solution. The key aspects of the coding could then be analysed on their own before the completed program is shown. As it is, Lewis tends to leap in with coding boots first, presenting the complete programmed solution immediately. His discussion of the program assumes the reader is sufficiently *au fait* with the programming language to appreciate full gist of his message.

This is a pity. The book has greatest value, I believe, to newcomers to programming who might be slightly intimidated by the writer's approach.

For me, the most useful part of the book is on debugging. This is probably the hardest aspect of programming to learn in any formal way. *Why Do You Need A Personal Computer?* by Lance Leventhal and Irving Stafford (which I reviewed in the August 'Bookfare') made a useful stab at discussing debugging, but Lewis does it in a more considered way. He provides 16 debugging prescriptions. Here are just a few to give you the taste of Lewis's style. Debugging Prescription 3 is: Courage Is Grace Under Pressure. Lewis explains: 'This prescription states we must momentarily set aside our ego in the debugging process, for debugging requires the utmost of our logical abilities. When finding a bug proves difficult, we often start blaming the hardware... and other common "whipping boys" like the compiler, assembler, operating system, or the fact the program is someone else's.' He concludes: 'It is essential to concentrate solely on the problem at hand, disdaining facile excuses. It is sometimes helpful to make a game of the process and pretend that you are a detective in search of a suspect.'

In both debugging and general problem solving, Lewis emphasises the crucial role of psychological factors and 'tricks', like game playing, which can help the programmer. But psychological forces, he says, can both aid and inhibit our ability to design and debug programs. Inhibitive psychological forces, according to Lewis, include having a defensive ego, imagining unnecessary constraints, lack of imagination and ignoring known symptoms. Two other psychological factors are covered by Debugging prescriptions 7 and 12. Prescription 7 states: Incubate When Stuck On Bug. Whenever you experience a mental block, incubate the problem by putting it aside, advises Lewis. 'Have a drink, play tennis, watch TV. Sometimes incubation can occur on the way to the coffee machine; it often takes no more than a momentary distraction to make the bug pop out.'

Prescription 12 is Misery Enjoys Company — Brainstorm. 'If our imagination fails, nothing could be wiser than to discuss our problem with others, especially colleagues working on the same project who have a general understanding of the goals of the program. Even if you are the sole programmer, it may be a good idea to seek advice from others. Free of your mistakes, they may have a positive contribution to make. Merely describing the characteristic of the bug will help you to gain a new perspective on the problem.'

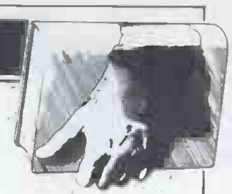
Some of Lewis's prescriptions are good advice but probably impractical in a commercial environment because he argues against trying to force solutions against a deadline. One of his advanced problem solving prescriptions, for example, is Beware of Anxiety — It's Heavy. 'A cause of mental blocks is placing too much importance on obtaining a solution as quickly as possible. Such an attitude can only create additional stress in the problem-solving process.' This may be fine for a personal programmer with no external deadlines. But pressure, deadlines and anxiety are an integral part of the business environment in which so much programming is done.

Despite my reservations about the unreality of some prescriptions and the way in which programming examples are dealt with, I would recommend this book to all programmers and potential programmers. At times it may seem to be stating the obvious, but it provides a chance to carry out one of Lewis's prescriptions: Step Back and View The Forest. 'Often we become so involved with a programming problem that we cannot see the overall picture no matter how hard we try.' This is a valuable reminder to programmers that, whatever language you prefer, whatever size computer you use, the main aim in the overall picture is to solve problems.

Beer refreshes untouched parts

Brain of the Firm by Stafford Beer is a classic work in management sciences, computing, cybernetics, physiology. It is also a tragic book.

Tragic because Beer attempted to implement his computing blueprint to assist left-wing Chilean President Allende between 1971 to 1973. Although he only had two small computers at his disposal, Beer had established a nationwide information network to help monitor and plan the economy. But the best laid plans of mice and men can be gnawed away by rats, the CIA, *et al.* On 11 September 1973 Beer was in London, talking to the Liberal Party in the City. He was due to return to



Chile. As he walked out of the meeting, he saw a newspaper placard stating 'Allende Assassinated'.

Brain of the Firm was first published in 1972 and translations produced in many languages. The latest edition is an update on that first version. As well as a description of the Allende experiment, it includes Beer's retrospective comments on his original work. What is remarkable, however, is not so much the changes he makes to update the work but the fact that the bulk of Beer's ideas remain unchanged, despite the incredible micro revolution in technology which has taken place in the last ten years. In fact, the availability of cheap computing power reinforces Beer's analysis because it makes the technology capable of matching his concept of how organisations behave and should be managed — as a group of interacting autonomous units under central coordination.

The title of the book really says it all. Beer regards a company as one example of a large and complicated system. Other examples are animals and national economic systems. He is interested in applying general theories of organisation control (the main thrust of cybernetics) to practical management. In particular, he sees a close analogy between the way the human brain behaves and the role of management in an organisation. As he puts it: 'The fact is that the firm is very like an animal (let us say a human) body. It has a head, where top direction resides. It has a trunk, housing the vital organs. It has limbs, or branches, services, inputs and outputs of energy linked by a metabolic process, and so on indefinitely.' This analogy is used more than just as a literary metaphor but explores the comparison in scientific detail, in terms of biological, computing and management sciences.

Beer writes from experience. He worked in management for 20 years, has been a managing director and chairman and a consultant to many companies and governments. He writes particularly sharply about the way managers have wasted their greatest ally in trying to come to grips with the increasingly complex task of managing modern organisations — the computer. Computing technology, he says, offers management something which could 'make the managerial world utterly different.' But he believes that managements have used computers merely to improve or 'soup-up' traditional managerial methods and have precluded the emergence of a new management order based on exploiting the technology.

'There is a rather widespread use of computers in the role of new lamps for old,' he says. 'Routine office work is done by machines; sometimes staff have been saved, sometimes not. More and better output has been obtained; sometimes people have known how to make use of it, and sometimes not. A variety of benefits have been sought; sometimes money has been saved but all too often the pay-off has been negligible.'

One of the main problems, he argues, has been the way in which organisation behaviour has been described via conventional organisation charts which bear little relation to the real world. The origins of most large enterprises, he points out, were frequently in small operations under autocratic entrepreneurs. As the firm grew, the boss had to delegate responsibilities. The way these responsibilities were developed depended on the experiences and the whims of the boss rather than an objective analysis of organisational behaviour and requirements. At one time, Beer explains, the control of a firm was a function of the different types of people interacting with each other. The problem he pinpoints is that these natural developments were then described via ad hoc organisation charts which at first related to what actual people were doing but then became abstracted into a generalised organisation structure. 'It would be disastrous if some neurotically disposed chairman or consultant tried to insist that everyone behave like the organisation chart.' He highlights the particular difficulties that the generalised concepts of organisation charts can bring when applied to key functions which do not fit neatly into any particular box and come under the category of 'general management'. Production control and management accounting, for example, are often taken as general management tasks. But as the General Manager cannot be expected to have too many different managers of this ilk reporting to him, these general management functions have usually been squeezed into some existing organisation box.

But when Beer looks at the brain analogy, he identifies these general management activities as analogous to the role played by the part of the anatomy that links the cerebral cortex (the overall control part of the brain) with the brain stem, which is linked to the spinal chord and through that to the rest of the body. All information received by the cortex is filtered through what are called the basal ganglia and diencephalon. The cortex (which Beer compares to top management) makes its decision based on evidence not so much of the facts but the *facts as presented* to it by the level below. Similarly, he insists that staff functions that are often dismissed as general management play the crucial function of filtering information between the 'real' world and the world as perceived by top management.

At a broader system level, he draws a crucial analogy between the 'autonomic' behaviour of an animal and what might very superficially be called 'distributed computing systems'. A body and a firm consists of autonomous units interlinked with each other in a variety of ways but with a central hierarchy leading to the managing director. Beer explains: 'diagnostically, for instance, this means that a pain in the arm is not necessarily to be treated with embrocation; it may well be a symptom of heart disease. And in industry, heavy costs in an office may result in a roomful of people being replaced by a computer while the informational links used by the human beings are cut off because they were not understood.' He then develops his thesis of how a new management order can be involved, using computers, which allow for automatic actions and interactions between parts of the organisation's 'body' but without creating central overboard; or general breakdowns when the brain (or management team) try to make coordinated sense out of the automatic behaviour.

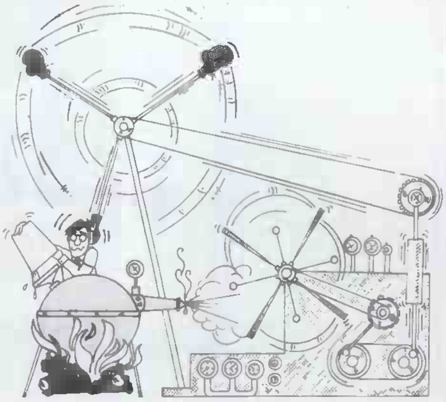
In a review of this length, I do not attempt to reveal anything other than the briefest tip of a significant intellectual iceberg. Although Beer writes lucidly, it isn't an easy book to read. It requires concentration and time to consider and reconsider the implications.

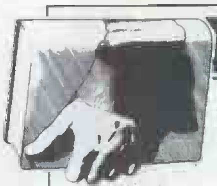
In today's facile world of instant mass media communications and attempts to package complex ideas in easily digested but bland and meaningless packages, asking for such an effort may be too much for some people. But I hope that Beer's work is taken seriously by many *PCW* readers. Most published works leave the mind untouched and unrefreshed; this Beer really does refresh the parts other authors never reach.

Future Kidology

Thames TV's 'Living In The Future' series for young children is one of the gentler attempts to describe the 'micro revolution'. If you missed it, you can get the book of the film by Alan Radnor.

Perhaps 'Tiswas's' plumptious supergirl Sally James misted my eyes but I much preferred the TV film. Or perhaps it is that I saw the TV film before the riots in Toxteth, Brixton, etc, brought home the reality of today and made the picture of a sanitised middle class future difficult to take seriously.





BOOKFARE

Firstly, let me praise the book for what it is good at. It is attractively produced, with lots of illustrations and relatively little text. It is good at explaining chips in kid's terms (but is not very good at software). Radnor also gives refreshing emphasis to non-computer technologies, particularly energy, which is often forgotten in 'impact of micro' scenarios. As in the TV series, the main emphasis, quite rightly, is on the application of the technology at home, school, work, the doctor, etc, rather than on the technology itself.

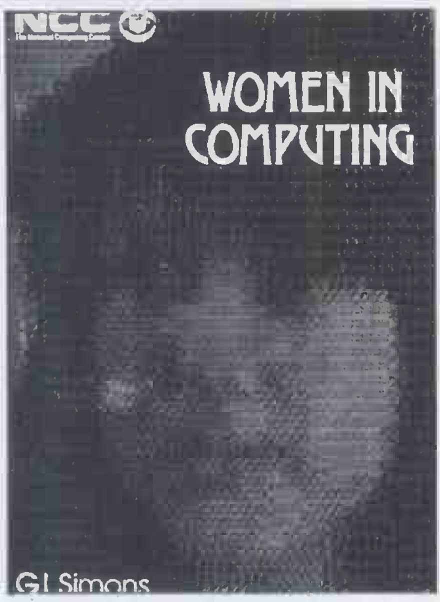
But, as in most pro-technology propaganda, there is little hint of the problems of implementing the technology or of any of the likely negative effects. The accent is definitely on the positive. All the drawings of likely future scenes contain white, middle class families and are worthy of an advert for washing powder or mashed potatoes. The images are of spacious, well designed houses, well cut lawns outside, fitted kitchens, etc; of computers in your own home to take your temperature and give you a medical diagnosis; of schools with advanced computers and cinemascope video screens.

This is matched with a fulsome acceptance and oversell of computing potential. For example, it is said that word processors 'not only type letters but make sure there are no mistakes'. In the future, Radnor says, international communications will be easier. 'There will be fewer problems with understanding and speaking different languages because you will have a pocket electronic dictionary which will speak for you.'

Now I don't expect a book for children to provide a negative critique of the technology. But I do expect it to be practical and realistic. When many children are living in appalling housing condition, where the National Health Service is on the verge of collapse, with the prospect of work for school leavers is poor; and the education system short of money, educational material has duty to avoid blue skies predictions. For most children reading the book, the future is darkened by thunder clouds. New technology may offer a ray of hope but it should not be allowed to artifically dazzle or to alienate.

Provided book is placed in context, *Living In The Future* does offer a reasonable introduction to the use of information technology. But I think that parents, teachers, uncles, big brothers and others should explain that it is a very partial picture of the future.

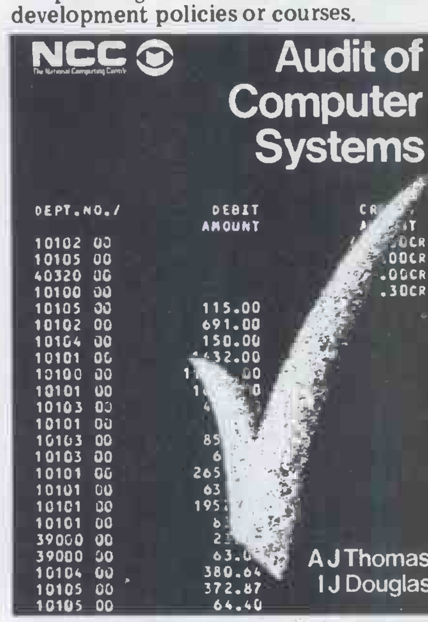
Book shorts



Women in Computing by G L Simons: 'The new consciousness of the rights of women in society has yielded legislation, changed attitudes and pressures for further improvements. There is a need for change in industry and elsewhere. The data processing industry is no exception. There is evidence here of anti-women discrimination and prejudice.'

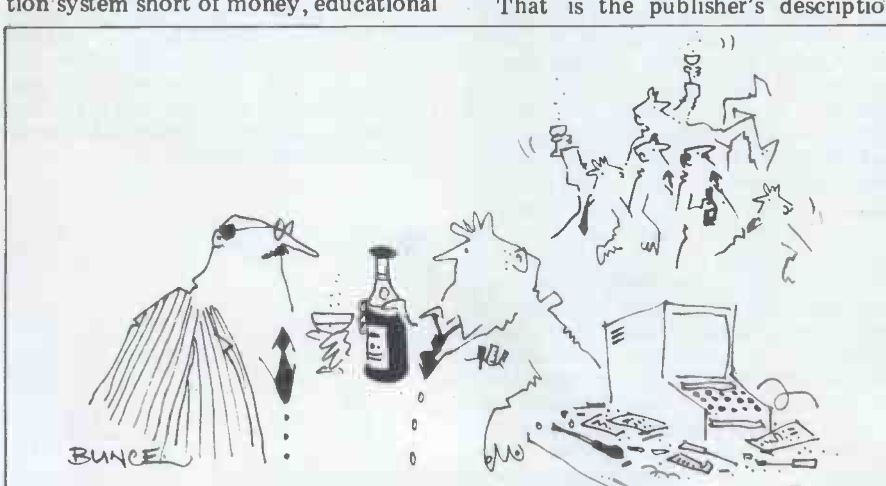
That is the publisher's description of the background to this interesting book (although it may, unfortunately, seem to be interesting only to those already interested in the subject). It provides historical, legal and international perspectives around the core of the book, which offers statistics on what has happened to women in computing.

There are chapters on women in management, in the office environment and home-based freelance programmers. It is a useful reference work and should be particularly valuable to union officials, personnel officers and those involved in employing computing staff or planning education or vocational development policies or courses.



Audit of Computer Systems by Fred Thomas and Ian Douglas is a practical aid to managers, accountants, computer staff and auditors on how to apply basic audit objectives to companies with a computer.

Both authors have experience of computing and accounting and describe clearly any computing or accounting jargon. They pack into less than 200 pages a wealth of practical advice and guideliness covering topics such as auditing implications for systems development, data control, file interrogation, online and distributed systems. Other chapters cover control and standards, organisational and procedural audits, statutory computer audits, risks, losses and frauds.



'We've done it sir! We've developed a system that's completely incompatible with anything in existence!'

This month's Bookfare included:
Problem Solving Principles for Basic Programmers by William E Lewis (Hayden, £7.35);
Brain of the Firm by Stafford Beer (Wiley, £11.50);
Living in the Future by Alan Radnor (ITV Books/MacDonald Phoebus, £3.50);
Women in Computing by G L Simons (National Computing Centre, £6.50);
Audit of Computer Systems by A J Thomas and I J Douglas (National Computing Centre, £9.50).

PATTERNS

Alan Sutcliffe continues his series.

First of all this month, I am continuing my notes on generating sequences of integers with the minimum amount of computing. Laziness is as useful an attribute in programmers as it is in mathematicians; I often spend hours looking for a way just to save a few seconds with a shorter program or a simpler proof. It's partly an obsession with economy, mother of elegance, and it may not be so silly if the program is used often enough.

I then return to the ever-fascinating topic of Knight's tours on a chessboard, and a new problem proposed by a reader. (Which reminds me to say that I would like to get more feedback and, whether it's a comment, question, development, pattern or a downright contradiction of what I've said, let me hear from you.) As well as its inherent interest, I hope that the discussion of Knight's tours throws some useful light on methods of problem-solving with computers. In particular, the balance between analysis on paper, mathematics if you like, and getting results with the aid of a program.

More Fibonacci

Last month I wrote about using the Fibonacci series to generate patterns of integers in an economical way. To recap, the series is: 0 1 1 2 3 5 8 13 21 34. . . defined by

$$F_{n+1} = F_n + F_{n-1}$$

with

$F_0 = 0$ and $F_1 = 1$.

This clearly increases without limit so the trick is to use the remainder on division by some value M, called the modulus. M will be chosen to suit the application: the length of a list from which words are to be chosen, for example, or the size of the plotting area in graphics. It is not necessary to carry out a division — since the values to be added are always less than M, at most one subtraction of M is all that is needed.

This is shown in Program A, which produces two values for each call. This is handy if you can use values two at a time, but even if one of them is discarded, the routine will be much quicker than a call to the RND function on most machines. If you insist on producing only one value at a time, a version of this method is given later, in Program D.

A major drawback of this method, however, is the fairly short cycle of repeating values that it gives. The longest possible cycle is M^2-1. F_{n-1} and F_n define the next value, and each of these is in the range 0 to M−1. So there are M^2 different possible pairs of values for F_{n-1} and F_n. But the series beginning 0 0 will simply repeat itself to give zeros for ever. The remaining M^2-1 pairs of values may or may not form a single cycle — usually they do not. Here is the series for M=3: 0 1 1 2 0 2 2 1 0 1 1. . . This repeats after eight terms = 3^2-1, the maximum possible. To confirm this, note that within the sequence every possible pair of values occurs just once: 01, 02, 10, 11, 12, 20, 21, 22, except for 00.

For M=4 the cycle could be up to 15 terms but it is much shorter: 0 1 1 2 3 1 0 1 1. . . Only six terms. The remaining pairs of values appear in two other sequences having different starting values: 0 2 2 0 2 2. . . and 0 3 3 2 1 3 0 3 3. . .

This situation, where the values break up into several cycles, is the normal one. It is as well, therefore, before using this method with a particular value of M, to check on the cycle length. Program B does this.

So the problem is how to extend the cycle length without too much extra computing. My first thought was simply to increase the number of terms to be added together to 3, 4 or 5, instead of 2. But there is a slightly more economical way than this which has much the same effect. Take the sum of two terms, but not those immediately preceding the new term to be defined. There are two ways we have not yet used of choosing two terms from the last three. In each case it is now necessary to define the first three terms of the series.

$G_0 = G_1 = 0, G_2 = 1$

(a) $G_{n+1} = G_n + G_{n-2}$

0 0 1 1 1 2 3 4 6 9 13 19 28 41 60 88 129. . .

(b) $G_{n+1} = G_{n-1} + G_{n-2}$

0 0 1 0 1 1 1 2 2 3 4 5 7 9 12 16 21 28. . .

Another advantage of using only two terms is that the remainder can be produced with, at most, one subtraction, rather than by repeated subtraction or by division.

Now it does not follow that the cycle of these series for a particular M is going to be longer than for the plain Fibonacci series. But it does have the chance to be longer, for the maximum is now M^3-1, the number of possible triplets, excluding 0 0 0. If it is acceptable to produce these values three at a time, Program C is the way to do it. However, if you insist on producing only one value at a time, look at Program D. The values here have to be shifted down each time, which entails three extra assignment statements and an extra variable. So you can have three values almost for the price of one.

This technique can easily be extended by using two values from earlier still in the series. But notice that not every such pair of values will give rise to a new series. For example, in series (b) above, the next term can also be defined by

$$G_{n+1} = G_n + G_{n-4}$$

This can be proved by a bit of algebra, but it is easy enough to spot duplications like this by inspection. As before, variants of the series can be got by starting with different initial values for the variables.

Another easy way to introduce

```
100 M=10
110 F=0
120 G=1
890 REM SUBROUTINE
900 F=F+G
910 IF F<M THEN 930
920 F=F-M
930 G=F+G
940 IF G<M THEN 960
950 G=G-M
960 RETURN
```

Program A. Simple Fibonacci series (mod M).

```
100 DIM F(2)
110 PRINT "  M","CYCLE","MAX=M*M-1"
120 FOR M=50 TO 60
130 F(1)=0
140 F(2)=1
150 K=2
160 I=1
170 G=F(1)+F(2)
180 IF G<M THEN 200
190 G=G-M
200 IF G=0 THEN 250
210 F(I)=G
220 I=3-I
230 K=K+1
240 GO TO 170
250 G=F(3-I)
260 L=1
270 T=1
280 T=T*G
290 T=T-M*INT(T/M)
300 IF T=1 THEN 330
310 L=L+1
320 GO TO 280
330 PRINT M,K*L,M*M-1
340 NEXT M
350 STOP
```

M	CYCLE	MAX=M*M-1
50	300	2499
51	72	2600
52	84	2703
53	108	2808
54	72	2915
55	20	3024
56	48	3135
57	72	3248
58	42	3363
59	58	3480
60	120	3599

Program B with sample output.

```
100 M=10
110 F=0
120 G=0
130 H=1
890 REM SUBROUTINE
900 F=F+G
910 IF F<M THEN 930
920 F=F-M
930 G=G+H
940 IF G<M THEN 960
950 G=G-M
960 H=H+F
970 IF H<M THEN 990
980 H=H-M
990 RETURN
```

Program C. 3 new values at each call.

PATTERNS

variety is to vary the value of M. This can always be increased without danger but if M is decreased then the sum of the two terms can be greater than 2M, and the values may increase out of control. There is no guarantee that a longer sequence will result and a check should always be made that the cycle length is not unacceptably small.

To sum up, Program E combines some of these methods to make a pattern of squares. The result is shown in Figure 1. I do hope that next time you need some fairly random integers you will try one of these series. How Fibonacci would have loved to have a small computer to experiment with, like this — but, sadly, he never knew what he was missing.

More Knight's tours

In the April and May issues of *PCW* I considered chessboard tours by a Knight in which every possible path between two cells is traversed just once in a single tour. Geoffrey Silver of Mill Hill, London has sent me a list of a complete set of Knight's tours, on an 8x8 board of the more conventional kind, in which each cell is visited just once in a tour. The list is complete in the sense that there is a tour for each different possible pair of starting and ending cells.

```
100 M=10
110 F=0
120 G=0
130 H=1
890 REM SUBROUTINE
900 I=F+G
910 IF I<M THEN 930
920 I=I-M
930 F=G
940 G=H
950 H=I
960 RETURN
```

Program D. One new value at each call.

```
100 PAGE
110 P=1
120 F=0
130 G=0
140 H=1
150 M=51
160 FOR I=1 TO 99
170 GOSUB 900
180 MOVE @P:F,G
190 RDRAW @P:0,H
200 RDRAW @P:H,0
210 RDRAW @P:0,-H
220 RDRAW @P:-H,0
230 NEXT I
240 STOP
900 F=F+H
910 IF F<M THEN 930
920 F=F-M
930 G=G+F
940 IF G<M THEN 960
950 G=G-M
960 H=H+G
970 IF H<M THEN 990
980 H=H-M
990 RETURN
```

Program E: Draws 99 squares.

The problem is in two distinct parts. First, enumerate all possible different pairs of starting and finishing cells. I shall call such a pair of cells a journey, while a tour from one to the other is a route. On an 8x8 board there are 136 journeys. Those which differ only by reflection or rotation are not counted separately. Direction of travel is also ignored: a route and its reverse count as one.

The second part of the problem is to find a route for each journey or, alternatively, to show that no route exists for a particular journey — that is, 'you can't get there from here', not if you're a Knight, anyway. What Silver has done is to show that there is a route for every journey on an ordinary chessboard.

To illustrate the first stage, consider the 4x4 board shown in Figure 2(a). There are three kinds of starting cell: A, a corner; B, an inner; and C, a side.

On such an even-squared board a journey must begin and end on squares of opposite colours, so it is only necessary to look at those starting, say, on a black cell and ending on a white. Figure 2(b) shows the four different ending cells, starting from a corner. The journey can only end on a white cell and there is symmetry about the diagonal through the start. Starting from an inner cell, Figure 2(c) shows the three journeys. As well as the conditions above, corner cells are now ruled out since all journeys starting at a corner have already been counted. Starting from a side cell, Figure 2(d) shows the three remaining distinct journeys. There is no longer diagonal symmetry, but both corner and inner cells are now ruled out. In addition, the journeys to the two side cells marked 2 are identical but for rotation. This gives a total of ten different journeys.

I have worked out the general formula for the number of journeys on a square board, and there are three different cases. On an NxN board:

N even = 2n, giving:
$\frac{1}{2}n^2(n^2+1)$

N odd = 2n + 1, n even, giving:
$n/8(2n^3 + 4n^2 + 13n + 6)$

N odd = 2n+1, n odd, giving:
$1/8(2n^4 + 4n^3 + 13n^2 + 4n + 1)$

Don't ask me how I found this, it's just too complicated to explain here, but I always was good at sums. You are welcome to try to disprove it. It does show that sometimes mathematics is better than computing. A program to enumerate journeys would certainly have taken me longer to produce and that would only have given specific values, not a general formula. The number of journeys for the first few values of N are given in Table 1.

When N is odd there are proportionately fewer journeys. This is because on an odd square, a journey must begin and end on cells of the same colour as the centre and corner cells, say black, since there is always one more black cell than white on such boards.

Figure 3 shows the number of journeys for a 5x5 board. Starting with a corner cell there are 8 cases, then starting with the next cell on the diagonal there are five cases, ending on any black cell except a corner. Starting from the centre there is only one journey, to the centre of a side. Finally, starting from a side there are two further journeys, to an adjacent side and to the opposite side. Thus there are 16 journeys in all.

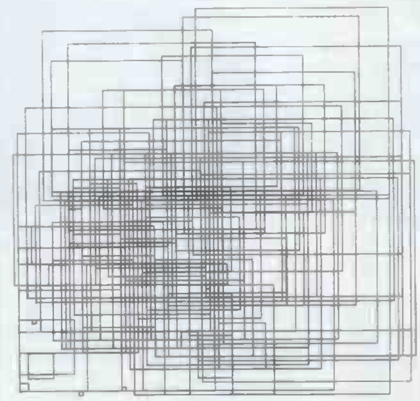


Fig 1 Pattern from Program E, with M=50.

N	No of journeys	Journeys with a route
1	0	0
2	1	0
3	3	0
4	10	0
5	16	8
6	45	?
7	50	?
8	136	136
9	125	?
10	325	?

Table 1

The second part of the problem is to find a route for each of these journeys, or show that none is possible. Geoffrey Silver did this for all 136 journeys on a standard board, using only a small number of basic routes: one for each kind of starting cell. He then developed different endings that reached all the required cells by reversing the route from some point on.

Suppose the cells along a route are numbered 1 to 64. At some point, say cell 45, the route will be a Knight's move away from the existing final cell, 64. Re-route from 45 directly to 64 and trace the rest of the route in reverse: 1... 45 64... 46. Sometimes more than one such switch was needed to form a particular solution.

The last column in Table 1 shows the number of journeys for which there are routes for some values of N. For N=8 this is Silver's result. Clearly there are no routes at all when N=1 or 2. For N=3 no route is possible because the centre cell cannot be reached. It is not difficult to show that there are no routes either when N=4. On a 5x5 just half the journeys have a route, as the following arguments show. For a route to be possible, either the start or the finish, or both, must be corner cells. Suppose this is not so. Then the four corner cells must be somewhere along the route. Each corner has only two possible links, and these must then be joined as in Figure 4 to form a closed loop, which makes a complete route impossible.

This leaves eight journeys which have one or both ends at a corner. I have shown simply by constructing them that there is a route for each of these. I have not studied the cases for other values of N: 6, 7 and > 8. It seems likely that there are routes for all the journeys on the larger boards.

All this has been done without benefit of computer. But it is natural to ask how easy it would be to find routes for particular journeys by program. To help answer this, a little look into history is useful. In 1823, H C Warnsdorff published a method of finding Knight's tours. Today we would call it a heuristic algorithm.

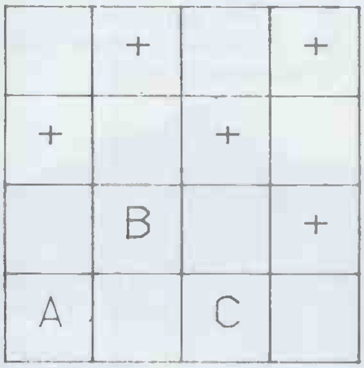


Fig 2(a)
Three possible start cells.

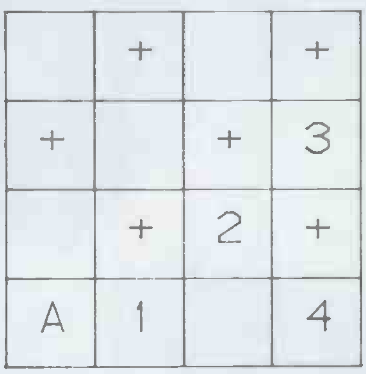


Fig 2(b)
Start at A: 4 end cells.

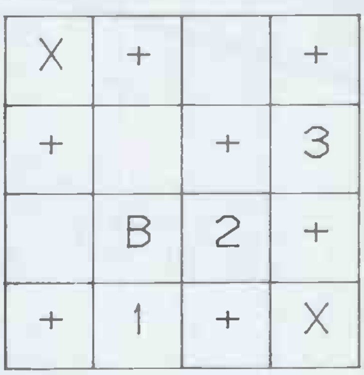


Fig 2(c)
Start at B: 3 end cells.

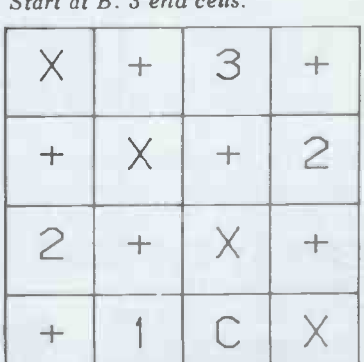


Fig 2(d)
Start at C: 3 end cells.

1. Suppose that X is the last cell reached on a partial path: initially it will be the start cell.
2. For each cell that can be reached in one step from X, compute the number of cells that can be reached in one further step, excluding any which have already been used.
3. Move to the cell with the fewest such exits, but ignoring any with no exit at all. If there are several with the same minimum, choose one at random. This defines the new X.
4. Repeat steps 2 and 3 until the route is complete.

In 1942 that great man of recreational mathematics, Maurice Kraitchik, wrote of this method: 'Although it is laborious to compute every time the number of possible exits, this inconvenience is counterbalanced by the advantage of a surprising property that is very difficult to analyse, namely: the many mistakes that it is difficult to avoid do not prevent one from finishing the tour, except in certain cases.'

A resilient algorithm. Clearly it is based on the sensible idea of using up the scarce options first and leaving multiple options open as long as possible. Using a computer removes the laboriousness and, hopefully, the many mistakes. It also allows a small refinement. In step 3, instead of choosing a cell at random from those with an equal minimum score, each of these can be tested further to see which has the least number of exits at the next step and so on. Either the end of the route will be reached, or a best cell will emerge, or a dead end will be reached. This last hardly ever happens. The method is said to work on boards of any shape or size. An example of its application on a 5x5 board is shown in Figure 5.

What Warnsdorff's method by itself does not do is allow for us to aim for a particular final cell. There are at least two ways of using it to obtain such results. The first is simply to use it for generating lots of solutions, from all possible starting cells, and then use Silver's method of switching the tail to make up any journeys that are still needed.

In the second method, the program is extended to mark as used the final cell until the last move is made. To ensure that it can be reached, a check should also be kept on all the cells one step away from the last cell, so that one of them is kept free until the penultimate move. And similarly for the cells leading directly to this one, until the route is completed or an impasse is reached. It is not clear that this method will always produce a solution: I suspect that it will not. Its chances can be improved by using it repeatedly with random choices put back in step 3, or by formal backtracking — that is, when a dead end is reached go back to the next best minimum in step 3 in the most recent move where there is such a next best possibility. This method will produce all possible routes.

Among the things I have not studied

Fig 3
16 routes by start cell.

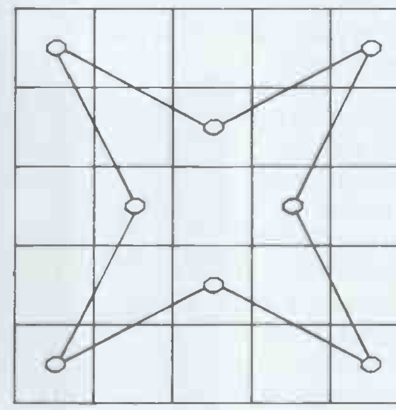


Fig 4
Closed path of corner cells.

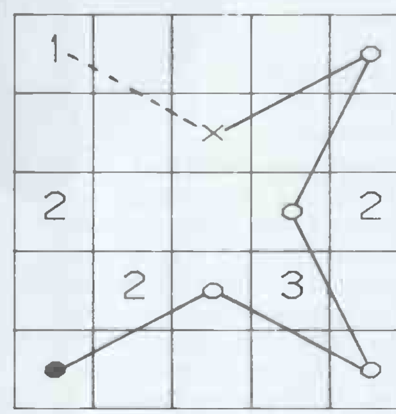


Fig 5
Application of Warnsdorff's rule.

is the number of different routes for a particular journey. Kraitchik states that there are 1728 ($=12^3$) routes on a 5x5 board, but he counts symmetrical cases as distinct. Even so, there must be well over 200 different routes for the eight journeys that have at least one route. Amazing what computations were done without computers: he also says there are 1,213,112 routes on a 4x10 board!

If you get bored with square boards, you can turn to rectangular ones and more fancy shapes. The only other board I have looked at is 3x4. On this there are 13 possible journeys but routes for only three of them. According to Kraitchik, there are no routes at all on the 3x5 and 3x6 boards, just in case you thought of looking.

I will be very glad to receive any further original contributions to this subject, c/o *PCW*, 14 Rathbone Place, London W1P 1DE.

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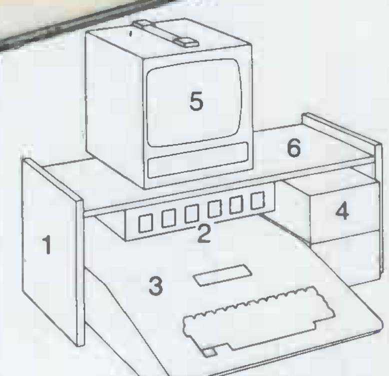

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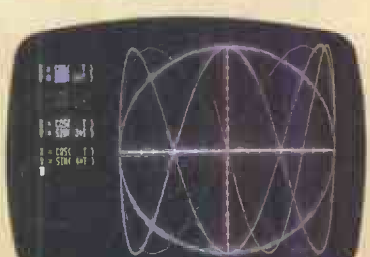

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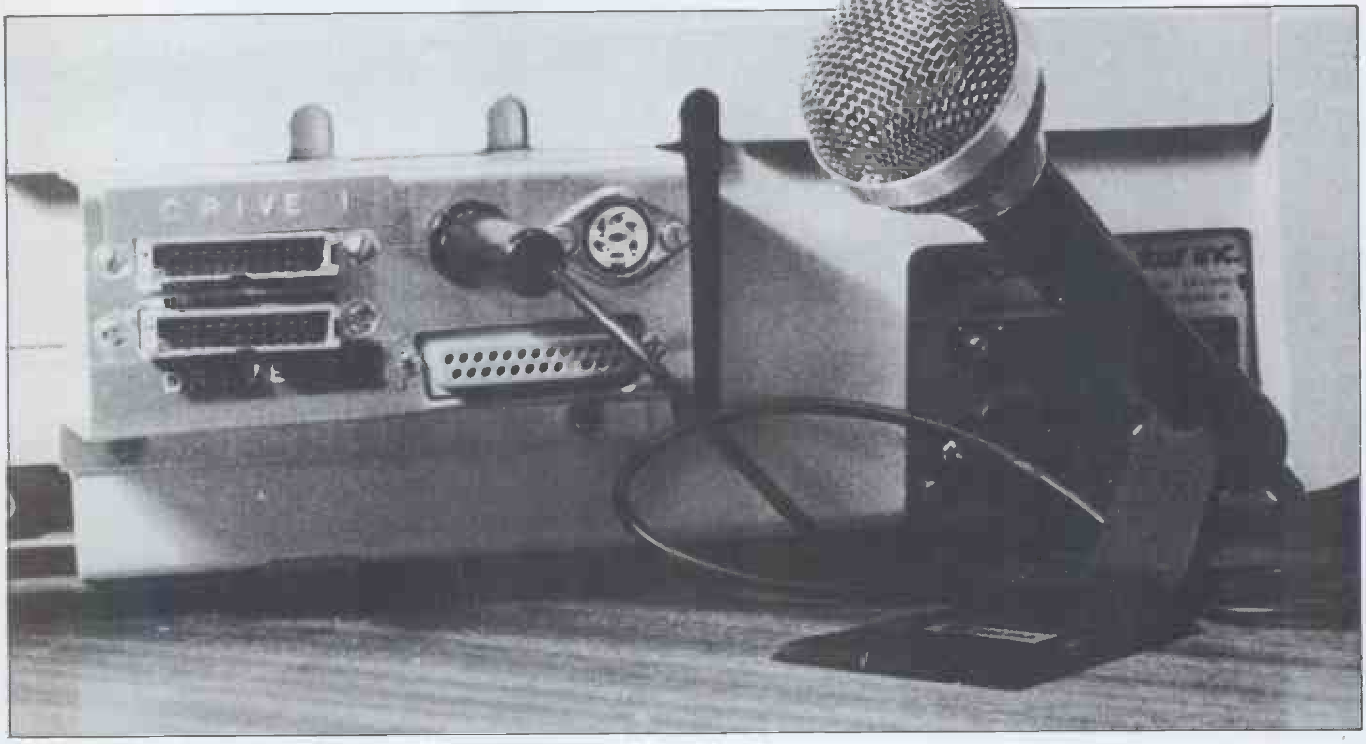


HEURISTICS SPEECH LINK

T R G Green and Gunnel Clark examine the problems of microtechnology speech recognition and test the Heuristics system.

All the best science fiction computers can not only talk in fluent and idiomatic English, but can also understand spoken English with remarkable accuracy. The signs are that this dream, like so many other s-f dreams, is already becoming partially true. Full comprehension is still some way off, but limited speech generation reached children's toys not long ago in the Speak and Spell device from Texas Instruments, and it has been suggested that a limited degree of speech recognition might be seen in the toy shops by Christmas 1981 or 1982.

What we can expect to see is not, however, the unerring comprehension of rapid speech in such adverse circumstances as attacks by klingons, but a rather faltering ability to recognise carefully spoken, pre-trained, isolated utterances. There is a significant difference between 'comprehension' and 'recognition'. Humans deploy massive resources in their comprehension of speech, using their knowledge of the grammar and sound patterns of the language, and their observation of facial expressions and (even in ordinary untrained people) some lipreading. None of that is likely to be seen in near future practical devices. Instead, the computer simply recognises that a given utterance matches tolerably well with one that was previously stored. No attempt is made to decode the sounds received into their phonetic components. A tolerable analogy would be with a machine that 'read' printed text by holding two superimposed pages up to the light: it could recognise that two pages were the same, and therefore that a test page corresponded with a stored page, but the method used would have nothing to do with the linguistic content of the page.

Thus, rather than decomposing 'Polly put the kettle on' into individual words and then parsing the words as a sentence more or less equivalent to 'Please start the process of boiling the water, Polly', near-future practical devices will only be able to match sounds they hear against a number of prerecorded sounds and determine which is the best match. So the vocabularies will be both finite and small.

Recognising isolated utterances looks like a parlour trick at first, a gimmick good for nothing but children's toys and arcade games. But the military are putting considerable research effort into it, it is said, presumably because anyone flying a modern plane already has their hands full of things to twiddle and cannot possibly poke buttons as well. This is called in the jargon a 'hands-busy situation'. In an absorbing article in the IEEE's magazine *Computing*, May, 1980, John R Welch describes at length the pros and cons of entering data by voice in industrial contexts. Although Welch concludes that at present the technology needs further improvement, he cites a wide variety of possible applications. The blind, too, would benefit from being able to give spoken commands to devices — not merely to computers as we usually meet them, but to washing machines and other domestic devices, many of which will soon be available with significant computing power. And it is possible that word processors would be significantly improved if commands could be spoken, especially the word processing packages for use on ordinary micros which often require a multitude of two-key or three-key commands.

In fact, what about robots? Once your computer becomes mobile you cannot possibly expect to run alongside it poking buttons. At Queen Mary College, London, a project in collaboration with ICL is attempting to produce a robot for underwater salvage operations and other hostile environment work. Advanced techniques for voice control are being investigated, based on the recognition of isolated utterances.

Hardware off the shelf

Although research developments naturally enough frequently employ costly and advanced equipment, aiming at very high recognition rates, commercial exploitation (in children's toys, for instance) would need something simpler. A number of devices are now on the market for those wishing to explore this field, selling at present for prices between £45 and £200. For this you get a plug-in device with its own microphone ready to attach to your micro. Of the various devices available, we are closely acquainted with only one, the Heuristics H2000 SpeechLink for the Apple, but many of the questions raised by this one can be applied to all similar devices.

No word sounds exactly the same on two different occasions, and the methods of recognition have to take account of this, looking for those features that remain fairly constant. The SpeechLink operates by identifying the first two formants of the frequency spectrum. Formants are amplified bands in the frequency resonance of the voice as produced by the larynx, and all vowels and some consonants have clearly defined formants. For instance, the vowel 'ee', as in 'see' (written (i:) by phoneticians), is characterised by one low formant and a second very high formant, with not much energy in the frequencies in between, but in the vowel [u:] (as in 'cool') the first two formants are both low. Working from formants helps to reduce the device's sensitivity to the pitch of the voice — obviously one wants to recognise words without forcing the speaker to produce exactly the same pitch each time — and makes it more likely that the device will cope with differences between speakers; nevertheless, at present most devices need to be 'trained' afresh by each different speaker if they are to perform adequately.

The vocabulary sizes are small — 64 words for the SpeechLink 2000, 32 or 128 in other cases — but it must be appreciated that the recognition accuracy falls as the vocabulary increases. The central difficulty is, therefore, to find enough words that are sufficiently different in a reproducible way. This is quite a serious problem, and one needs to consider the characteristics of the particular system used. We shall explain below how to make the most of the SpeechLink recognition system. One may have the option of matching an incoming utterance against a partial vocabulary rather than a complete vocabulary, so that if some utterances seem completely inappropriate in a particular context they can be temporarily left out of account, giving improved chances of recognition with the remaining utterances — whether that is possible depends on the particular device; if it is, one can manage rather ingenious techniques.

Reproducibility presents a subsidiary problem. During a long session, the voice is bound to change from start to finish, especially at moments when the entire galaxy is about to be destroyed by the klingons, and a phrase uttered in the calm of the training session may be totally unrecognisable to the machine later on. Something has to be done about this drift problem if possible.

The H2000

The kit contains a plug-in board with filters, ROM, and logic, a microphone designed to pre-emphasise certain parts of the signal in compensation for the characteristics of the human vocal tract, and a demonstration floppy. The microphone plugs into the board on a socket mounted inside the Apple, as other Apple gear does, but we have found that bringing sockets outside makes the machine far more portable.

The demonstration disk is not well documented but the programs it contains are quite effective. There are some difficulties, though, and the first one arises right away. When you first bring up the main demonstration program (by RUN DEMO INIT) you are asked for identifying initials, so that your voice samples can be taken once for training and then be re-used for subsequent runs. True to American custom you are invited to supply *exactly* three initials. If you only supply two you will be unable to clear off that user to reclaim the space for later ones. (About five users can coexist on one disk.) In case any such gremlins catch you, you should take care to copy the master disk before trying it.

The most useful of the demonstration programs is Voiceplot, which displays a graph of the speech sample as registered by the H2000 using the low-resolution graphics. Unfortunately, the lines and axes are not labelled, a surprising oversight. However, the bottom two lines in Figure 1 can be identified as the first two formants, as registered by SpeechLink. With the help of Voiceplot, it is possible to work out which features of words the SpeechLink can best discriminate and so to construct vocabularies of words that are not easily confused.

The remaining demonstrations are mostly games (Blackjack, Othello, and an enjoyable maze game called Dragon), telephone number finders, etc, relying heavily on the digits or other ensembles of words chosen for their meaning rather than for their discriminability. This does not display the Speechlink to its best advantage. For instance, the Dragon game relies on monosyllabic commands, among which 'left' and 'right' are easily confused, as are 'down' and 'no'; and in all numerical entries the digit 'six' gives trouble. Nor have the programs taken advantage of the full possible sophistication of the equipment they demonstrate. In the Othello game it is quite possible to get trapped, finding that the device refuses to recognise any of the legal moves and refuses to play any of the illegal moves or to let you pass your turn; you can sometimes find yourself frustratedly repeating your chosen move again and again. The program sometimes has to be aborted in the end. However, the equipment is perfectly capable of supporting a better interface.

You will certainly find Dragon more fun if you improve the program a bit. For a minimal start, change the vocabulary to something more recognisable — eg, rising/falling for up/down, raw/lee for right/left (better to have unexpected commands than unrecognisable ones!). You can either simply remember to use these words or others that you devise, or else make simple changes to lines 380-410 of TRAIN DRAGON and lines 1525-1560 of DRAGON. Rather than miss a turn when a word is unrecognised, put in a repetition request; and instead of terminating the game without appeal if the SpeechLink thinks it has heard 'finished', either give the user a second chance or, more drastically, delete line 26080. Numerous other small improvements could be made, such as catching the bug that crashes the program if you try to drive through the ceiling and suppressing 'yes' and 'no' from the vocabulary after they have served their purpose (thereby reducing potential confusions).

It should be noted that all the demonstration programs except one run under Integer Basic, not Applesoft. The same is true of the test program to verify the SpeechLink ROMs. They are also very poorly commented, making them less useful than they might have otherwise been in showing how to program the device. The Applesoft program, FPDEMO, is the most useful for study purposes.

Fortunately the user manual is well written and in most cases the examples work perfectly as long as you make all

HEURISTICS SPEECH LINK

the corrections shown on the errata sheet. It would be useful to have more detail on the operation of the algorithm and on how the data are stored.

Training

The device is controlled mainly by PRINT and INPUT commands with a handful of special signals. To 'train' it, ie, to store a sample against which subsequent utterances will be matched, the command PRINT J$ is used, after using the PR command to address the slot where the board is mounted. The effect of PRINT J$ is to make the device wait until it registers a sound, then to store data about what it heard and also to store the value of J$. After training whatever sounds you want, you can then recognise them by using INPUT J$, this time using the IN command to address the slot, and now the device waits for a sound and training sample. There is no need whatever for the sound to correspond to J$ in any real way: if you tell it to print (ie, train on) 'Hamlet' and then sneeze into the mike, you will need to sneeze again whenever you want it to think it's hearing 'Hamlet'.

If the device finds that no previously stored samples are adequate matches to the sound it hears during an INPUT, it returns the empty string "" so that you can do something about it. The demonstration programs do nothing whatever about it as a rule, which is certainly not the best approach — at the very least the program ought to print a polite request to say it again. Alternatively, after one failure, or maybe two failures, the rejection level could be relaxed inside the device by poking new values into locations specified in the user manual. The rejection level is a criterion of how closely a sound must match one of the training samples before it is 'recognised'; set very low, anything goes, and the device returns the best match regardless of how bad the match might be; set very high, the opposite happens. In visual terms, if the device is trained on a cat, a cow, and an elephant, then it would refuse to recognise an ant if the rejection level were set midway. With the rejection level set very low it might 'recognise' an ant as the cat, that being the best match of a poor lot. With the rejection level set very high it might refuse to recognise a cat unless it was the same colour as the one used for training.

Certain words can be turned off if desired during a recognition trial to eliminate potential mistakes. This is done very simply by writing a zero into a 'suppression vector'. Although the manual uses that term it, is not strictly accurate; the vector actually stores the number of training samples given for each word. Zeroes mean that a word has not been trained at all and is therefore to be ignored during the recognition process. It is also possible to switch vocabularies quite straightforwardly, by changing a pointer in the workspace. This means that at one time the user can be talking to a vocabulary concerned with one topic, and later can be talking to a second vocabulary concerned with another topic, a useful logical extension of the idea of suppressing certain words in certain contexts.

The SpeechLink also has a feature which is invaluable if you hope to set up a friendly system. After hearing a word, it can be used more than once. So if it cannot be matched in one vocabulary, you can set a flag to say 'reprocess that same word', change the workspace pointers to point to a second vocabulary, issue another INPUT command, and then the device will use what it previously heard against the newly-selected vocabulary. Unfortunately neither the manual nor the demonstration programs give a lot of help here.

There are some features that are rather irritating. If working in Applesoft DOS, should you find that a bug in the program makes it necessary to break in when the device is awaiting speech, your program is lost. Unless already saved on disk you will have to retype it. Second, the manual does not tell you how to find out how successful the best match was, which means that fiddling with the rejection level is whistling in the dark.

Vocabulary design

Because the SpeechLink makes extensive use of the first two formants it is advisable to choose words containing long vowels, (as in 'heat' as opposed to 'hit'), which have more distinctive formant structures. The long vowels in English are [i:] (as in 'see'), [a:] (as in 'far), [ɔ:] (as in 'saw'), [ə:] (as in 'fir'), and [u:] (as in 'cool'). The SpeechLink seems to have difficulties with this last vowel, however, possibly because both the first and the second formant will fall within the lower band filter, causing a third, fairly weak formant to be picked up by the upper frequency filter. Turning to diphthongs, [ai] (as in 'fine') and [au] (as in 'cow') are generally identified correctly, whereas [ɛə] (as in 'bear') and [iə] (as in 'beer') are often mistaken for [ə:] (as in 'fir').

Thus, good vowel elements to include are the ones that occur in the words see, far, saw, fir, fine and cow.

The sound produced must be of certain intensity for the SpeechLink to take notice of it. It is therefore important that the beginning of the word is loud enough. On this account, words with non-initial stress (eg, 'impair') should be avoided. For the same reason it may be useful to have a plosive (p, t, k, b, d or g) at the beginning of a word, to ensure that the beginning of the vowel element has enough intensity to register.

Plosive consonants cannot, however, be counted on to distinguish words such as 'it', 'pit' and 'kit'. Their manifestation stretches over too short a time for the SpeechLink to catch them reliably, and although plosives do influence the formant structure, that also generally happens over too short a time to be a reliable feature.

The fricative consonants (s, sh, f, v, th) are often not immediately registered by the SpeechLink at the beginning of words. Sometimes they are not registered at all. Also the duration of an initial 's' seems to be very variable in unpractised speakers, which means that a word like 'six' is not an easy target. Initial fricatives should therefore be avoided. Inside words the presence of a fricative can be useful for recognition, and 's' can generally be identified correctly, since its characteristic high-frequency noise is within the range of the upper filter. Thus 'rising' and 'riding' are reliably distinguished (see Figure 2).

The nasals (m, n, ng) and l and r have low intensity and display fairly similar formant structures. They cannot therefore be relied upon to distinguish words.

Although the instruction manual recommends using multi-syllabic words, because they 'have more information than one syllable words', our experience suggests that two syllables (preferably stressed on the first) is about right. Stuffing the utterance with consonants cuts down the vowels, which are the SpeechLink's best feature.

As a rule-of-thumb summary of vocabulary design, try to choose two-syllable words with stress on the first syllable or else one-syllable words; rely on long vowels or contrasts between the presence or absence of fricative

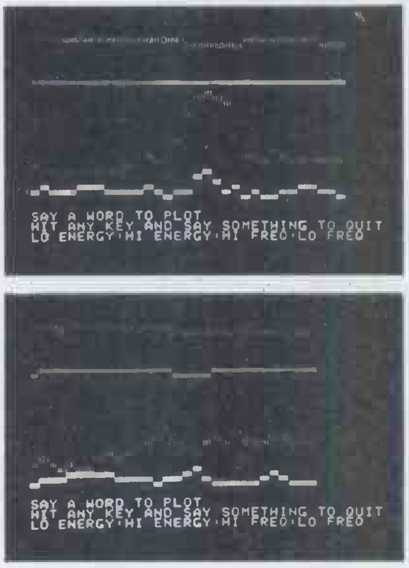


Fig 1. Plots from the Voiceplot demonstration program. The lower two lines are formants — concentrations of energy, in particular frequency bands characterising human speech; the Speech-Link analyses the first two formants, which it regards as lying in the bands 150 to 900 Hz and 900-5000 Hz. These are the most useful for distinguishing between vowels, so vocabulary design should pay particular attention to vowel contrasts. The plots show which frequency (y-axis) contained most energy at each sampling interval (x-axis) for the utterances (a) 'rising' and (b) 'riding'. The fricative 's' shows clearly as a hump in the second formant in (a) while the corresponding 'd' in plot (b) is much less visible, showing that the SpeechLink can easily distinguish between presence or absence of internal fricatives, but would find it hard to tell a 'd' from, say, a 'b'. The slow rise of the second formant before it humps in (a) or dips in (b) characterises the long 'i' diphthong, , and the SpeechLink can readily distinguish this pattern from those of other long vowels.

consonants inside the word to distinguish one word from another; and try to choose words starting with a consonant, especially a plosive. It makes good sense to try out your vocabulary first with the Voiceplot program. Any words that give very similar pictures are likely to be confused with each other.

Vocabulary size and rejection level

The SpeechLink allows the user to control two important parameters, the amount of training and the rejection level, or the minimum acceptable value for accepting a word as recognisable. We made use of the feature that allows a word to be reprocessed to help us investigate these parameters. (Dave Morrison, a student working with Dr Green, did much of the work involved.)

Our program was trained on a vocabulary of whatever size was desired. The list was read a few times by the speaker, usually three or five times. During the first reading, the program stored each word twice in separate tables; during the subsequent readings, one of the tables was left alone, while the other was used to form a merged record of the words. Thus we finished with one table recording singly trained words, and another recording multiply trained words including the very same utterances that had been used for the singly trained table. During the recognition phase, words were uttered by the speaker and were processed six times by the machine: each utterance was recognised against both tables, using three different values for the rejection level.

The first difficulty was that reading a list of words for training the machines produces in most people a flat monotonous diction which differs sharply from normal speech. When a list of 20 words was read five times the effect was very severe. To counteract it, try to arrange the training period so that the machine surprises the reader, waiting a random length of time before asking for another word to be read and then asking for a random word.

The user needs as much training as the computer! As the manual says, you need to hold the mike close and be very consistent with its positioning. Speak firmly, and do pronounce the words correctly: 'move' must not be allowed to degenerate into something almost the same as 'moo', and the diphthongal quality of 'down' should not get lost. Such points will usually have to be explained to first-time users.

Having got past that hurdle, we found that multiple training contributed less than would be expected after reading the manual. A list read five times produced little more accuracy than one read once only. One might well limit oneself to three or even two training trials.

When a word is uttered for recognition, it may or may not be a known part of the previously trained vocabulary. The SpeechLink may correctly recognise a known word (a hit), incorrectly 'recognise' a known word, incorrectly 'recognise' an unknown word, reject a known word (a miss), or correctly reject an unknown word. Ideally one would like to achieve 100 per cent hits and correct rejections. Stiffening the rejection level will certainly decrease the number of incorrect recognitions but it will increase the misses; relaxing the rejection level will increase the hits and decrease the misses, but it will also cause more incorrect recognitions. Especially, relaxing the rejection level will risk more misrecognitions of known words, if the utterance happens to have been poorly enunciated so that it doesn't sound like anything much but happens to sound more like something else than itself.

To our surprise, relaxing the rejection level had a side effect of making the device more likely to recognise an incoming utterance as the last word in its list, whether it was really that one or not. A stiff rejection level meant that the word might quite well not be recognised at all, but was more likely to be correct if it was recognised. One would have expected that the same utterance processed twice through the system with the rejection level changed would be rejected at some levels and recognised at others, but would always have been recognised as the same thing, if it was recognised at all, regardless of the rejection level. It was not clear why this happened. A bit more information in the manual on how the recognition algorithm operates would have been useful here.

Given all this, it is obviously best to work in a quiet room and with well-practised speakers who are unlikely to stumble or to offer invalid words; most of what the device hears will then be what it was meant to, and the rejection level can be tightened up. We found that setting it to −100 was too tight, but −50 seemed about right (more negative numbers give tighter rejection). Under these conditions, most recognitions claimed by the device will be hits, and not many incorrect rejections will occur.

The dynamic interface

Since no amount of tweaking will produce perfect performance, something must be done to make the failures tolerable to users. After all, the whole purpose of speech recognition is to help make computers easier and friendlier to use; how stupid it would be to set out on such an endeavour and then to spoil it at this point! Here are some possible schemes.

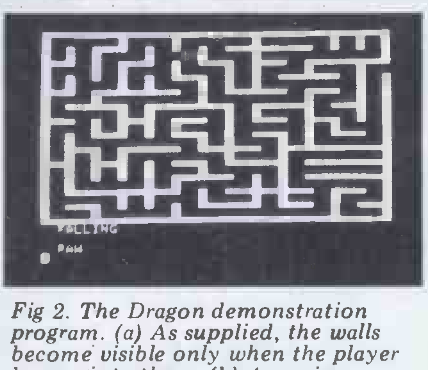
1. Do nothing when the word cannot be recognised. That is what the Dragon demonstration program does — or rather, it makes you miss a turn if your move was unrecognisable. Not recommended;

2. After an unrecognised utterance, have the Apple ask for a repetition. This is less helpful than it might seem, because the user is unlikely to recapture the sound of the original training: one can find oneself getting steadily more irritable, saying the word, whispering it, shouting it, wheedling it . . . The Othello demonstration program uses this method. So does our modified Dragon program, which gives a rising tone on the speaker and displays the word 'PARDON?' as shown in Figure 3;

3. Try recognising first against a tight rejection level. If that succeeds, you probably have a hit, but it increases the chance of not getting a recognition. In that case, now relax the rejection level, and try again, reprocessing the same utterance. If you get a recognition you can no longer be so sure of it, so ask the user to confirm. ('Did you say "COWCATCHER"?' — and the user gives Yes or No.) Continue to relax the rejection level until some sort of recognition is achieved. Unfortunately, as we have noted, when the rejection level is looser than about 100, the last word in the training list is generally 'recognised'; this should therefore be a dummy that is never spoken, and if the SpeechLink 'recognises' it that should be taken as a failure to find a recognition;

4. In some cases, only certain words are valid. All others can be suppressed by poking a bit in the memory table for each unwanted word, and the utterance can be matched to those remaining. If successful, well and good; if not, bring in the suppressed words again and try once more. This scheme is like no 3 in its philosophy, and can indeed be combined with it;

5. If the user fails in the first two attempts, or maybe three, something is obviously wrong; the intonation has drifted away from what it was during training. In even slight stress that is bound to happen. You might just as well give up gracefully and display all words (starting, if possible, with the most likely) asking the user to respond Yes or No. When the Yes is found, ask for it to be said again and keep that as another entry in the vocabulary tied to the same stored string. This may be irritating, but it is better than sitting there bellowing again and again at the



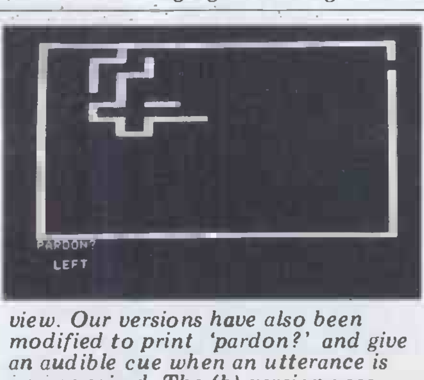


Fig 2. The Dragon demonstration program. (a) As supplied, the walls become visible only when the player bumps into them. (b) A version modified to leave the maze in view. The player steers towards the exit by spoken commands up/down/left/right, trying to evade the dragon. The last two commands spoken remain in view. Our versions have also been modified to print 'pardon?' and give an audible cue when an utterance is unrecognised. The (b) version uses a vocabulary chosen for discriminability, rising/falling/raw/lee instead of up/down/right/left, a revision that dramatically improves recognition accuracy.

HEURISTICS SPEECH LINK

machine and getting 'Please say it again' each time;

6. To avoid the indignity of admitting defeat in the previous approach, the problem of drift ought to be tackled. Each time a word is recognised, the voice sample can be blended in with the previously stored version. This will of course go hopelessly wrong if there is a substantial number of misrecognitions. The snag is that the SpeechLink does not provide any way to form a weighted average of samples, and moreover it objects to receiving more than eight training samples on any one word. Do not despair. The 'suppression vector', as we noted above, contains the number of training samples received by each word. It is therefore quite easy to cheat the device. After training, every entry in the vector is set to, say, 2. Thereafter, each word recognised is also used for retraining, which will give an average weighted 2:1 in favour of the past and against the word just heard, and the entry in the vector will be incremented to 3. Reset the entry to 2, ready for next time, and there it is: the device's stored samples will automatically keep up to date with drifting enunciation.

So a friendly interface would perhaps work like this. After training three or four times on each word, the main task is started, in which the device tries to identify the user's utterances. Each utterance is first tried against a vocabulary of only appropriate words, with a tight rejection level. If no recognition is achieved, it is tried against all possible words, still with a tight level, and now if a recognition is made the response is probably to say that that word is inappropriate. If there is still no recognition, the rejection level is relaxed, and if a match is now found, the user is asked for confirmation before acting on it. If, however, no match is found even with the lowered level, or if the dummy last word of section 3 is 'recognised', the user will have to be asked for a repetition, and the entire process is repeated. Should it once again fail to produce a recognition, there seems nothing for it but to use the desperate measure of 5. But to reduce the likelihood of that, recognised utterances will be blended in with the previously stored versions, in the manner of section 6.

'The computer works out the first class post codes, Fred here works out the second class ones.'

Interface development and the small user

Speech recognition devices are evidently here to stay. The big firms, however, are putting their massive resources into pushing the accuracy of recognition as high as possible. It is up to the rest of the world to find good ways of coping with the inevitable failures of recognition and to create friendly interfaces. The history of micros to date has shown that their great popularity and their appeal to a quite different market from the mainframe has resulted in a new and most welcome concern for friendly, usable systems aimed at the relatively inexperienced user. Quite often these have been developed by small users, and we look forward to the same happening with speech recognition now that the hardware is so cheap. Who will come up with 'Audio-calc'?

TJ's WORKSHOP

This month we introduce a new regular feature to PCW, *designed to cater for everyone who really enjoys getting to grips with their micros — all you 'terminal junkies' in fact. From now on we'll be publishing a wealth of hardware fixes and software tricks for all the popular machines. But we depend on your help in sending us your favourite tips — we'll even pay you for them and* PCW *pays its contributors very well! Send your input to:* **'TJ's Workshop',** ***PCW*****, 14 Rathbone Place, London W1P 1DE**

ZX81 SPACE SAVING

If you own a 1k ZX81 and you've been trying to use programs written for the 1k ZX80, you may have found that some won't fit into RAM, let alone run!

There are two main reasons why programs take up more RAM in the ZX81 than in the '80. First, numbers are stored as five-byte floating point format, rather than two-point integers, which is particularly significant when arrays are used; and second, ZX81 system variables take up 125 bytes, 80 more than in the ZX80, leaving only 899 bytes free for the program, display file, variables, work areas and stack!

Fortunately, it's possible to reduce the size of most programs, using the following tricks. Of course, you can still use these if you have more than 1k to play with — with 16k, you should be able to squeeze in some pretty impressive programs!

1. Common numeric constants may be replaced by variables, each having been assigned the value of a constant. Generally, at least four occurrences of the same constant makes this worthwhile, since each numeric constant takes six bytes of the program area. Other less common numeric constants may be expressed in terms of the common constants, wherever possible. Use may also be made of 0=NOT n (n≠0) and 1=NOT 0.
2. Common statements, which may be adjacent, may be merged into one statement, particularly LET, PRINT and IF, often using conditional terms in expressions. Often this device promotes structured programming as it removes the need for many GOTOs. Examples are shown in Listing 1.
3. Arrays of small valued integers (<256), as are often required for graphic programs, particularly using positions in the display, may be replaced by arrays of characters, thus saving four bytes per element. This requires the use of CODE and CHAR$ when setting and accessing the values, but with any significant size array there can be a considerable saving.
4. Indicators may be stored in string rather than numeric variables; also, saving the numeric constants with which they are tested.
5. Codes in POKE statements and PEEK comparisons may be replaced by CODE 'character', saving four to six bytes as well as making the program more readable.
6. Temporary variables used to evaluate expressions used later only once or twice may be avoided; often saving both the variable and the LET statement.
7. Headings and graphics may often be printed explicitly, rather than in a loop — see Listing 2.
This device saves space for up to at least 24 identical or related characters.
8. There is no need to have superfluous LET statements to pre-declare all variables, as with the ZX80, to fix the start of the display file.
In fact, since the start of display file is fixed once the program is running, the address of the display file may be embedded in a particular program, having extracted it after inputting the program, instead of using in the program: PEEK 16396+256*PEEK 16397, giving a saving of 24 bytes. Extreme care must be taken to alter this address whenever the program is changed.

Colin Clayman

```
100 PRINT ("WIN" AND NOT L) + ("LOSE" AND L)
saves six bytes over

100 IF L = 0 THEN PRINT "WIN"        0 = Ø
110 IF L < > THEN PRINT "LOSE"
and
100 LET P = P + (P < M)
saves 10 bytes over
100 LET P = P + I                    I = 1
110 IF P > M THEN LET P = M
```

Listing 1

```
100 PRINT "0123456789"
saves 14 bytes on
100 FOR N = 0 TO X                   0 = Ø, X = 9
110 PRINT N;
120 NEXT N
130 PRINT
```

Listing 2

ZX81 TIPS

Here are a few tips for those ZX81 owners who have gotten rather behind in the Rampack race:

1. Use only single letter variable names. As you would expect, the name 'EGGS' takes up four bytes and 'E' only one every time it is referred to in the program.
2. Instead of a row of LET statements at the beginning of a program, store the variables with the program (not forgetting, of course, to GOTO instead of RUNning!).
3. Restricting the amount of screen being used at any time for output by the use of CLS will often prevent that annoying report 4, halfway through a run.
4. Surprisingly, the statement LET A=VAL '1' takes up three bytes less than LET A=1! This is because the ZX81, in order to speed up execution, writes every numerical constant twice; once in decimal and once in binary.
5. If a constant is used fairly often in a program, it may be worth assigning it to a variable. Quite a few of my programs begin with:
10 LET A=VAL '0'
20 LET B=VAL '1'
6. For those masochists who will do anything for a byte, it is possible to write a program leaving every numerical variable 0 and then POKEing the appropriate value into the binary. This is, however, not worth doing if you wish your program to be readable or if the number is less than five characters long.

Daran Gill

TJ's WORKSHOP

UK101 SCREEN HANDLING

Here's a collection of very handy screen handling subroutines from Robin Freeman of Tilburg, Holland. They're designed for an 8k UK101. The routines allow you to clear the screen, using a section of code borrowed from the 'old' monitor; before you clear the screen, though, you may want to preserve its contents, so Robin has included a subroutine which does that. Naturally, as there's no point in saving stuff unless you can get it back again, Robin's routine does exactly that.

The routines are in a Basic program which you put onto the front of your program; your program then starts at line 1000 and the routines are used through GOSUBs, as follows:

Clear screen	GOSUB 200
Save screen	GOSUB 300
Restore screen	GOSUB 400

Here's Robin's listing:

```
  10 REM CLEAR SCREEN CODE
  20 POKE 133,63:POKE 134,31:POKE 8026,96
  30 FOR I=65036 TO 65061:J=PEEK(I)
     :POKE I-57036,J:NEXT
  35 REM
  40 REM MOVE SCREEN CODE
  50 READ D:IF D=999 THEN 1000
  60 POKE 7681+C,D
  70 C=C+1:GOTO 50
  75 REM
 100 DATA 169,0,133,225,133,227,168,169
 110 DATA 208,133,226,169,26,133,228
 120 DATA 177,225,145,227,200,192
 130 DATA 0,208,247,166,226,224,211
 140 DATA 240,8,232,134,226,230
 150 DATA 228,24,144,233,96,999
 155 REM
 190 REM CLEAR SCREEN SUBROUTINE
 200 POKE 11,64:POKE 12,31:X=USR(X):RETURN
 205 REM
 290 REM SAVE SCREEN SUBROUTINE
 300 POKE 11,1:POKE 12,30
 310 POKE 7708,211:POKE 7689,208
 320 POKE 7693,26:X=USR(X):RETURN
 325 REM
 390 REM RESTORE SCREEN SUBROUTINE
 400 POKE 11,1:POKE 12,30
 410 POKE 7708,29:POKE 7689,26
 420 POKE 7693,208:X=USR(X):RETURN
 425 REM
1000 REM MAIN PROGRAM STARTS HERE...
```

ZX80 TIPS

POKEing location 16421 with a value over 10 will prevent an error code being printed by the ZX80. This is desirable because the ZX80 will print an error code for the quite legitimate operation of a stop statement and the appearance of a strange number at the bottom of the screen will confuse the inexperienced user.

A radio tuned to long wave at around 200 kHz will play a tone when placed near the ZX80, but don't place it too near the television set. Thus, the ZX80 can be used to play tunes with simple programs.

Dominic Stocqueler

TRS-80 INVERSE VIDEO

Inverse video on the TRS-80 and probably most micros may be accomplished with minimum effort and expense. The following modification may be done in approximately one hour. You will need no more than a switch and some wire.

Carefully unscrew the bottom of your keyboard while noting the screw lengths and locations for reassembly. Remove the top cover. Lift the keyboard to separate it from the main board below. Take care not to twist the short length of ribbon cable that connects the two boards. Remove the small white cushions from the pegs that supported the keyboard, again noting their locations. Lift the lower main board and the keyboard out of the case. It is advisable that you have an extra pair of hands available for the next operation. Carefully separate the two boards and lay them flat so that the keyboard faces upward. Locate the DIN socket end of the main printed board, Z41 and Z24, the former being an eight pin chip, the latter a 16 pin. When you are satisfied that you have found the correct two chips, invert the two boards and try to pinpoint the soldered connections for both chips on the reverse side of the board. When you have located the correct ones, mark both areas with a felt pen.

Now stand facing the board with the power, video and tape sockets nearest to you. Z41 and Z24 should be on the left side of the board. Look closely at Z41 and compare the right middle two pins with the diagram. You should see that the two pins are soldered together and a track leads off away from you. If you are in any doubt about which pins you should be looking at, count clockwise from the bottom left-hand pin, pin one, until you reach pins six and seven, the two in question.

Check once more that you have the correct chip and then cut the track leading away from pins six and seven with a modelling knife. Now locate Z24 and cut the track leading away from the two pins four and five, as shown on the diagram. That's the difficult part over with.

The switch may be mounted anywhere on the cabinet, but if you have a very small switch handy you will find

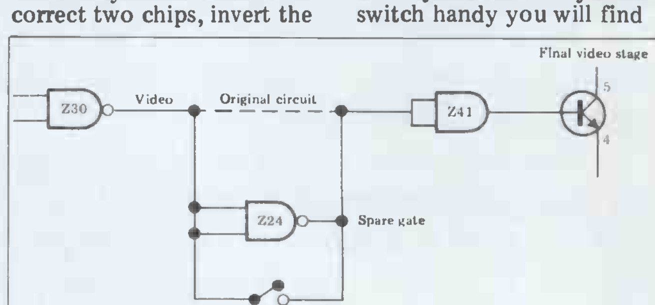


Fig 1 Logic diagram for TRS-80 reverse video mod.

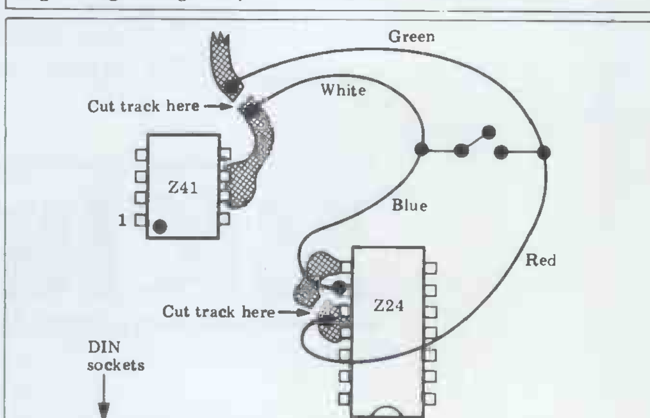


Fig 2 The modifications to the Tandy board. Note that this is a view of the underside.

room to mount it between two of the DIN sockets.

Now for the wiring. The ideal wire to use would be a four-cored screened cable, with the screening earthed to prevent pickup and hence patterning on the display. Whether you are using screened cable or not, wire as per the diagram. You will find it less confusing if you use wire of four different colours. If you have used screened cable then pin seven of Z24 will provide a suitable earth for your screen.

When you have finished, check again the diagram against your work and when you are satisfied that it is correct, reassemble and give it a try.

If you don't own a TRS-80, you might still be able to modify your machine for reverse video. Locate on the circuit diagram the video output stage. You will probably see leading into the circuit two signal lines. One of these lines should be labelled 'sync' and the other 'video'. It is the video line we are interested in. To invert the video to the screen all you need to do is to invert the signal at this position. There will probably be a spare NAND gate somewhere on your micro which you can use. Break the video line and wire your gate in series with the two open lines. To enable switching between normal and inverted video, simply connect your switch across the input and output terminals of the gate.

This modification works perfectly well on the Tandy monitors, but if you are using a standard television receiver, you may find that it suffers a loss of sync when displaying large areas of black.

Note: the ribbon cable joining the keyboard to the main printed board is of very poor quality and the copper track inside is easily broken. The symptoms of a break vary depending on which particular track is broken. If one is broken, you will probably find it impossible to make an entry via the keyboard as random characters will be printed on the screen when you press a key.

C Bolton-Heaton

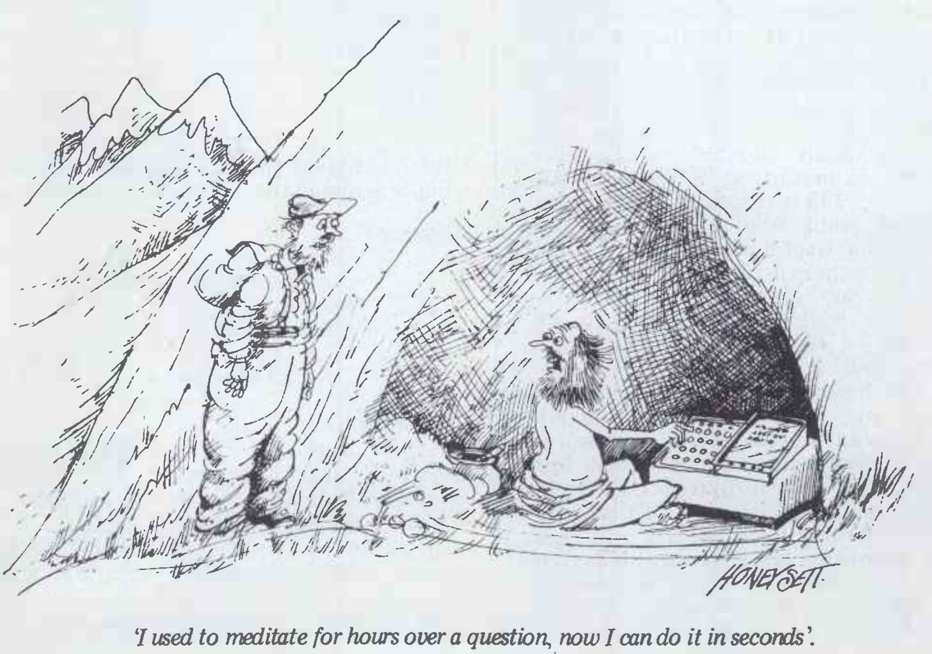
CUSTOMISING NASCOM BASIC

Nascom's ROM Basic contains the non-standard reserved words POINT, SET and RESET. Since these are an addition to the 'standard' Microsoft Basic, they are accessed via reflections in the RAM workspace at 1051H, 1054H and 1057H respectively. It is therefore possible to substitute user-defined Basic commands at these reflections and to call them through a Basic program.

A good example is the use of SET+ and SET– to turn a parallel printer on and off. Below is a source listing of just such a program. The new SET routine (SETT) is activated by DOKE 4181,3500 (ie, replacing the Basic reflection of FF40H at 1055H with 0DACH, the address of SETT — chosen to be an easy decimal number!). Normal SET (X,Y) commands may be used without any special precautions and spaces between, for example, SET and '+' are disregarded by Basic. Obviously, any identifying symbol or symbols, other than '(', may be used to distinguish a user-defined command. The pointer to the next character in a Basic program is in HL. Hence HL must be incremented for each special SET character before returning to Basic. It is sufficient to terminate the user-defined command with RET in order to move onto the next statement of the program. This replaces the RET at the end of the Basic SET subroutine at FF4FH. This routine makes Nascom Basic even more flexible and useful.

Leslie Pettit

```
0DAC  7E       SETT:   LD    A,(HL)  ;Character immediately
               ;                        after SET in Basic
               ;                        program (spaces ignored)
0DAD  FEAC             CP    £AC     ;Is it '+'?
0DAF  CAnnNN           JP    Z,PRTON ;Yes - turn printer on
0DB2  FEAD             CP    £AD     ;Is it '-'?
0DB4  CAmmMM           JP    Z,PRTOFF;Yes - turn printer off
               ;
NNnn  E5       PRTON:  PUSH  HL      ;Save pointer
               ;
               ;  Insert routine here
               ;
      E1               POP   HL      ;Restore pointer
      23               INC   HL      ; and increment it
      C9               RET           ;Back to Basic for
               ;                        next statement
               ;
MMmm  E5       PRTOFF: PUSH  HL      ;Save pointer
               ;
               ;  Insert routine here
               ;
      E1               POP   HL      ;Restore pointer
      23               INC   HL      ; and increment it
      C9               RET           ;Back to Basic for
               ;                        next statement
```



'I used to meditate for hours over a question, now I can do it in seconds'.

FASTER BASIC

Alastair Cairns and Maurice Shepherd show how to speed up your Basic programs by directly accessing the interpreter's subroutines.

Basic interpreters have the reputation of being very slow in comparison with the execution of specifically written machine code. In some respects this reputation is deserved; for example, PEEK and POKE statements appear to be executed very slowly by some interpreters. Obviously, the interpretative process is inherently slower than the direct execution of machine code but how much does a Basic interpreter slow down purely arithmetic computations in number-crunching applications? We shall look at some of the number handling aspects of Basic interpreters in this article, taking specific examples from the 8k Nascom Basic. This Basic interpreter is written in 80.80 code and is fairly representative of many of the smaller Microsoft Basic interpreters currently in use. Directly accessing subroutines in the interpreter is one way to increase processing speed in some applications, as we shall show. Although this article is restricted to arithmetic applications, there is obviously considerable scope for increasing the speed of string handling operations using a similar approach.

Floating point numbers

The arithmetic operations in many Basic interpreters are carried out using binary floating point arithmetic. Floating point numbers consist of a mantissa and an exponent and are similar to numbers written in scientific notation, such as 1.98E+02. The mantissa of a floating point number is, however, always expressed as a fraction. For example, 198 expressed as a decimal floating point number is $.198 \times 10^3$, where the fractional mantissa is +.198 and the exponent is +3. Floating point numbers are generally normalised, ie, the first digit of the fraction is significant — eg, 0.00198×10^5 is not normalised.

The binary floating point numbers used to represent Basic numeric variables and constants are expressed in a similar way and can be stored in four bytes — see Table 1. Byte 1 contains the binary integer exponent which is biased +80H to allow both positive and negative exponents to be represented. Byte 1 = 0 is a special case which is defined to represent numeric zero. The most significant digit of the mantissa (bit 7 of byte 2) is always assumed to be 1 in evaluating the mantissa, ensuring that the floating point number is normalised; the actual value of this bit is used to indicate the algebraic sign of the number (0 = positive, 1 = negative). The four bytes can thus represent zero and signed decimal numbers in the range 0.5×2^{-127} to almost 2^{127} (ie, 2.9×10^{-39} to 1.7×10^{38}) with an accuracy of at least six significant decimal numbers. The examples shown in Table 1 illustrate the conversion of binary floating point to decimal.

In principle, floating point numbers can be added by equalising the exponents (making the necessary shifts in the mantissas) and then adding the mantissas. Multiplication involves multiplying the mantissas and adding the exponents. A little thought shows that these apparently simple operations require quite complex software and will have relatively long execution times, in comparison with integer addition and multiplication. There is also an inherent lack of precision in operations with floating point numbers which causes rounding errors. These two limitations of floating point arithmetic, speed and precision, can be minimised by good software — generally by trading one off against another — but they cannot be eliminated.

Binary Exponent. Offset +80H	24 bit Binary Mantissa		
BYTE 1	BYTE 2 MSB	BYTE 3	BYTE 4 LSB

Bit 7 of byte 2 indicates algebraic sign (0 = +, 1 = —) but is assumed to be 1 in evaluating the mantissa.

Example a:

Bytes 1-4	84 C0 00 00	
Binary exponent	= 84 — 80 = +4	
Byte 2	= 11000000	ie Negative sign
Binary mantissa	= — .11	
	= — .75 decimal	
Decimal number	= —0.75 x 2 = — 12.0 decimal.	

Example b:

Bytes 1-4	78 60 00 00	
Binary exponent	= 7E — 80 = — 2	
Byte 2	= 01100000	ie Positive sign
Binary mantissa	= + .111	
	= + .875 decimal	
Decimal number	= + 0.875 x 10 = + 0.21875 decimal.	

Table 1 Binary floating point numbers

Arithmetic subroutines

The Basic interpreter contains the necessary subroutines to perform addition, subtraction, multiplication, division and the evaluation of various functions using floating point arithmetic. These subroutines are called whenever the interpreter encounters a byte corresponding to +, —, SIN, LOG, etc, in the stored program. Without resorting to detective work on disassembled listings, there is usually no direct means of finding the call addresses of these subroutines.

The Nascom interpreter uses four bytes in RAM (10E4H — 10E7H) as a floating point accumulator (FPA) and also makes use of the two Z80 16-bit registers BC and DE to hold floating point numbers. Table 2 shows the format of FPN in these two pseudo 32-bit registers. Note that, following Z80 convention, the four bytes are stored in reverse order in memory.

The call addresses of the subroutines for addition, subtraction, multiplication and division of the contents of these two registers are:

F5CDH	BCDE + FPA
F5CAH	BCDE — FPA
F708H	BCDE * FPA
F769H	BCDE / FPA

The results are returned in the FPA. The call addresses of other subroutines are given below; in each of these cases the argument is entered in the FPA and the result is returned in the FPA.

ABS	F838H
ATN	FC7CH
COS	FC00H
EXP	FAFAH
INT	F8E6H
LOG	F6C7H
SIN	FC06H
SQR	FAACH
TAN	FC67H

There are also interpreter subroutines for conversion between FPN and 16-bit complementary two's binary integers. A subroutine call to E98BH returns the integer value of the FPA in the DE register pair — the FPN must be in range or an error is flagged. The converse may be achieved, in a rather more complicated way, by zeroing the A register, loading 98H into the B register and calling F82AH; the complementary two's number initially in DE is returned as a floating point number in the FPA.

The conversions between ASCII coded decimal and FPN are discussed after the section on variable and array tables.

How fast?

The execution times, T(sub), of some of these subroutines are given in Table 3 and exclude the slight looping overheads involved in making the measurements. The execution times of the add, subtract, multiply and divide subroutines are very dependent on the relationship between the numbers in the FPA and BCDE registers. For example, special cases arise if one of the numbers is zero or if the exponents are very different; multiplication by zero is much more rapid than the example given in Table 4. These subroutine execution times may be compared with the times required for the same operations within a Basic program, T(Basic). The values of T(Basic) were determined using the program,

```
A=9.2:FOR N=1 TO 5000
B= (relevant function) : NEXT : END
```

and include the time required (0.98ms) for the FOR. . . NEXT loop. It is worth noting that this is an optimised Basic program in the sense that the interpreter does not have to search a large variable table. In a long Basic program, the corresponding times could be significantly higher, especially if array elements have to be accessed.

The ratios t(Basic)/t(sub) give a useful indication of the Basic interpreter overheads in carrying out these operations and are independent of the microprocessor clock rate. In the evaluation of square roots and the transcendental and trigonometric functions, the interpreter overhead is relatively small since these routines have relatively long execution times. There would therefore be no real advantage in directly calling these subroutines.

The ratios for add, subtract, multiply and divide do, however, indicate that significant decreases in processing time could be achieved by calling these subroutines directly. This, of course, is because these subroutines have relatively short execution times in comparison with the corresponding interpreter overheads. It can also be seen from Table 3 that SQR and TAN have particularly long execution times and the run time of a Basic program can obviously be optimised by omitting such functions whenever possible.

F P Number	Byte 1	Byte 2	Byte 3	Byte 4
	< LSB —	Mantissa	— MSB >	< Exponent >
FPA	10E4	10E5	10E6	10E7
Register	E	D	C	B

Table 2 The storage of floating point numbers in the floating point accumulator and the registers BC and DE.

SUBROUTINE	T (sub)	T (Basic)	T (Basic)/T (sub)
ADD	0.21	2.85	13.6
SUBTRACT	0.23	2.86	12.4
MULTIPLY	1.11	3.75	3.38
DIVIDE	2.40	5.03	2.10
(The above figures refer to A+A, A—A, A*A and A/A)			
LOG	10.9	13.3	1.22
SIN	14.0	16.3	1.16
COS	14.5	16.7	1.15
EXP	15.4	17.8	1.16
ATN	18.9	21.3	1.13
SQR	28.3	30.5	1.08
TAN	31.2	33.2	1.06
4 MHz Z80 clock with wait states added.			

Table 3 Execution times of Nascom Basic subroutines.

Variable table format. For example, the variable AB = 12.75 is stored as:

	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6
	Variable name		Mantissa LSB -------		MSB	Offset exponent
Hex	42	41	00	00	4C	84
	< ASCII >		< FLOATING POINT >			

Array table format. For example, the array AR(1,2,3) is stored as:

	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5
	Array name		Displacement to next array		Number of dimensions
Hex	52	41	67	00	03

This is followed by 04 00 03 00 02 00, the numbers of elements in each dimension (in reverse order), and then by 24 floating point numbers giving the array element values (see Table 5) starting with AR(0,0,0)

Table 4

Variable and array tables

The Nascom interpreter stores the values of numeric variables and arrays in two contiguous tables in RAM and maintains pointers to (i) the start of the variable table (10D6H), (ii) the start of the array table (10D8H) and (iii) the end of the array table (10DAH). Each numeric variable occupies six bytes (Table 4) — the first two bytes contain the two initial characters of the variable name (in ASCII) and the following four bytes the value in floating point.

The format of the array table is rather more complicated. Two bytes are used for the array name and the two following bytes give the displacement to the next array or to the end of the array table if no further arrays exist in the table. This is followed by a byte giving the number of dimensions of the array, say N, and then 2N bytes indicating the number of elements (including the zeroth element) in each dimension, as 16-bit integers. This is shown in Table 4 for the array AR(1,2,3), which occupies 107 bytes of RAM. The elements of the array are stored in a logical sequence which is illustrated for AR(1,2,3) in Table 5. A DIM statement sets up the relevant entry in the array table and initialises all the array elements to zero.

Every time that the interpreter encounters a variable in the program it searches the variable table to find the value using a subroutine which we shall call FIND. If the variable is being declared for the first time and therefore is not already in the variable table, a new entry is made; this involves shifting the entire array table six bytes higher in memory to make space.

The interpreter can therefore spend a considerable time searching tables; this can be minimised by ensuring that commonly used variables are declared early in a Basic program so that they are located near the beginning of the table.

Finding variables

The variable/array search subroutine, FIND, is called at EF2D. Its use can

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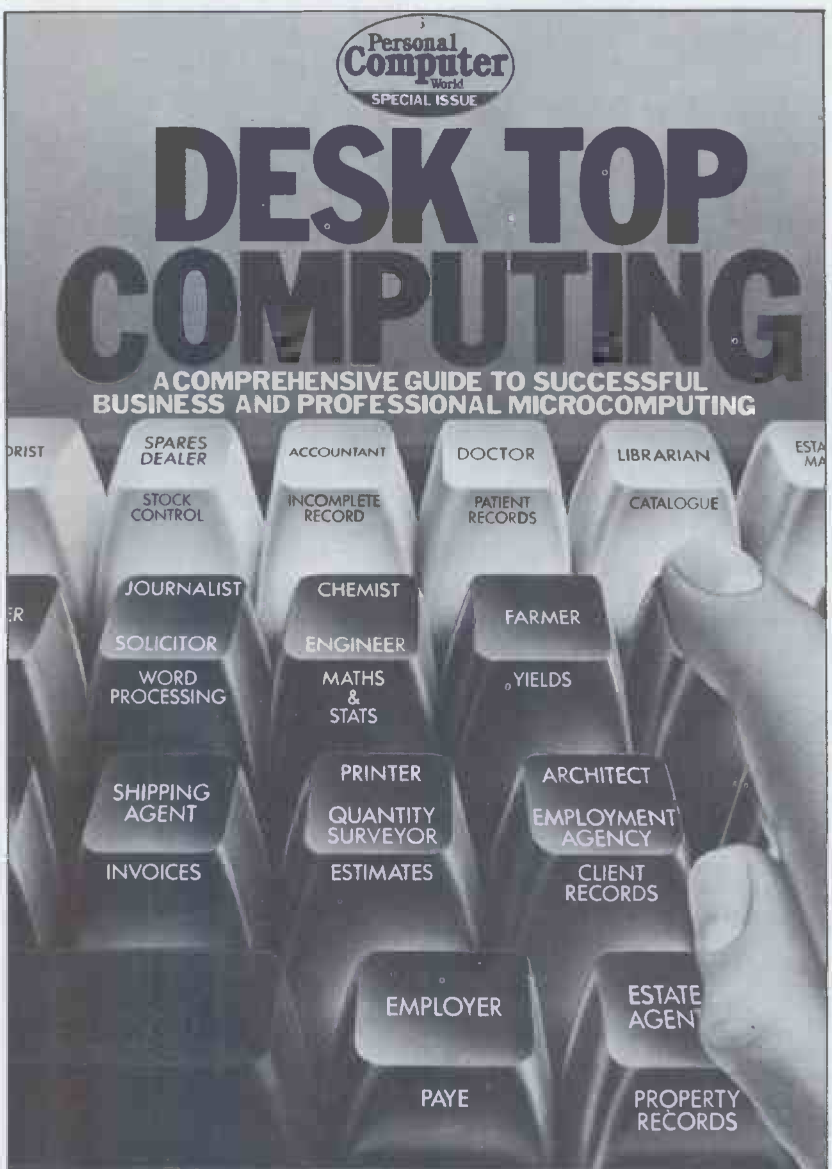

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best be illustrated by an example which would normally form part of a USR-called subroutine.

```
START:   LD HL, STRING   ; HL points to
         CALL FIND       ; variable name
         RET
STRING:  DEFB AB         ; variable name
```

Assume that one requires the value of the variable AB or, if it is not in the variable table, to make an entry for it. The HL register pair is loaded with a pointer to memory location where an ASCII string of the variable name is stored. This string is terminated with, for example, a colon. The subroutine FIND will return with DE pointing to the least significant byte of the value. If AB was not already in the variable table, then an entry will have been made and the value set to zero. The array table may be searched in a similar way but the ASCII string (eg, AR(1,1,1):) must specify the array element required and the array must have been previously dimensioned. The interpreter has to call FIND every time that it encounters a variable even though the location of that variable remains fixed throughout the execution of a particular program. Similarly, provided that all the variables have been declared, the array entries remain in fixed locations. Obviously a more intelligent use could be made of FIND from a USR added subroutine, ie, by calling FIND once to locate a numeric variable or array and then storing the relevant pointer for further use.

Direct access

We now have the necessary information to access certain Basic subroutines directly rather than through the interpreter. The only good reason for doing this is to increase speed since it involves writing additional machine code routines. The most effective way to do it is via USR routines from a Basic program. This gives a hybrid system in which one retains the capability of the interpreter but can accelerate specific sections of the program.

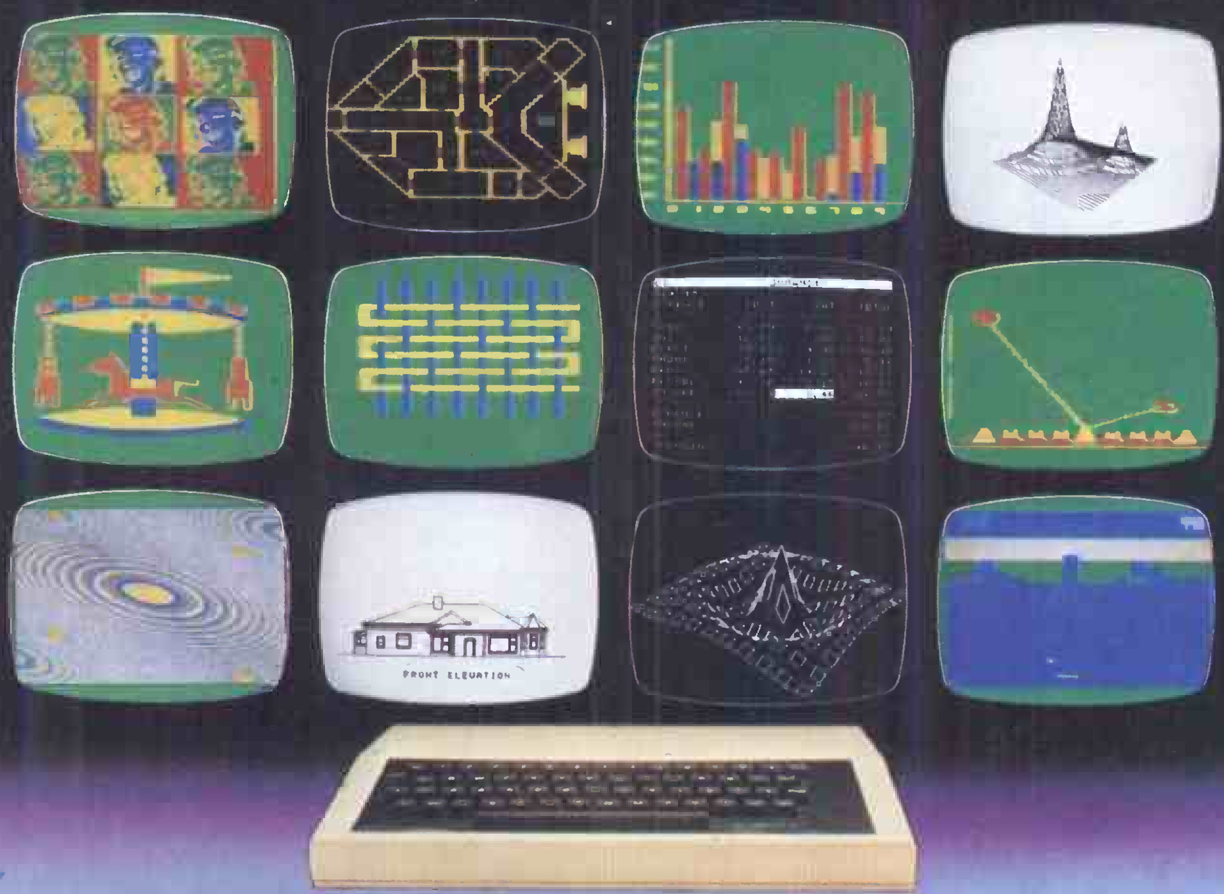
Provided that the variables that will be used in the USR routines have been previously declared in the main Basic program, their values are available in the tables in floating point. Their locations may be obtained using FIND and direct arithmetic operations carried out on them in the USR routine by calling the relevant Basic subroutines. On returning to Basic the new values may be obtained in decimal by PRINTing. The decimal to floating point conversions are thus left to the interpreter.

The class of programs which benefit most from this approach are those involving a large number of simple arithmetic calculations, preferably on relatively few variables. Matrix manipulations are a particularly good example. The speed of matrix multiplication can be increased by more than a factor of 10 over that of a pure Basic program by directly calling Basic subroutines. This has obvious applications in graphics, for example. Another area where increased speed is useful is that of Fast Fourier transformations.

An order of magnitude increase in speed can therefore justify the extra effort of writing specific USR routines in a large number of applications. The other software approach of starting from scratch in assembler language would certainly involve a great deal more work and it is unlikely that the final result would be appreciably faster than that obtainable using the hybrid method.

1.	0, 0, 0
2.	1, 0, 0
3.	0, 1, 0
4.	1, 1, 0
5.	0, 2, 0
6.	1, 2, 0
7.	0, 0, 1
8.	1, 0, 1
9.	0, 1, 1
23.	0, 2, 3
24.	1, 2, 3

Table 5 The ordering of array elements in memory, in this case the array AR(1,2,3).



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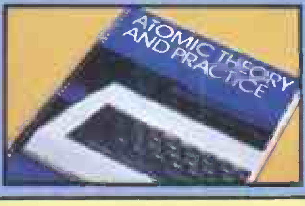

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THE REAL CHALLENGE OF THE CHIP

Jeff Taylor is a researcher currently studying micro awareness and computer literacy projects in Britain and the USA. He spent this summer travelling across the States visiting the various projects there and comparing them to UK efforts. In this, the first of these reports, he gives an overview of computer literacy; the views he expresses are his own and are not necessarily those of PCW. *We would welcome responses from readers, but advise that you read all three of his articles first.*

In its revolutionary potential for changing society, microtechnology has been likened to a multitude of fundamental technologies throughout history, from the harnessing of fire to the electric motor. Two models in particular are useful to bring into sharp focus the confliction potentials of this new technology: the development of writing and the printing press. Writing can be shown to have led to the development of a stratified society, in which those who controlled the written word could, for example, record history to their own advantage; the printing press eventually instigated a democratising influence. Significant concern with both the negative and positive social implications of microtechnology scarcely exists in the United States, whereas Britain has at least begun to realise the crucial need for an informed public that can direct, rather than be merely persuaded to accept, the impact of this and other new technologies.

In Britain, the simple-but-classic 'Computer Revolution' has diversified into the 'Microcomputer Revolution', the 'Second Industrial Revolution', the 'New Industrial Revolution', the 'Microelectronics Revolution', the 'Information Revolution', the 'Microrevolution', etc. It has been said that Britain's only growth industry is talking about the chip and the rate at which names are added to this list is matched in spirit only by the changes in social conditions with which it interfaces so provocatively: the demise of traditional industry and the sharp rise in unemployment. Hence the keen attention paid to it by practically all sectors in Britain, who see microtechnology as a crucial variable in projecting the future course of society.

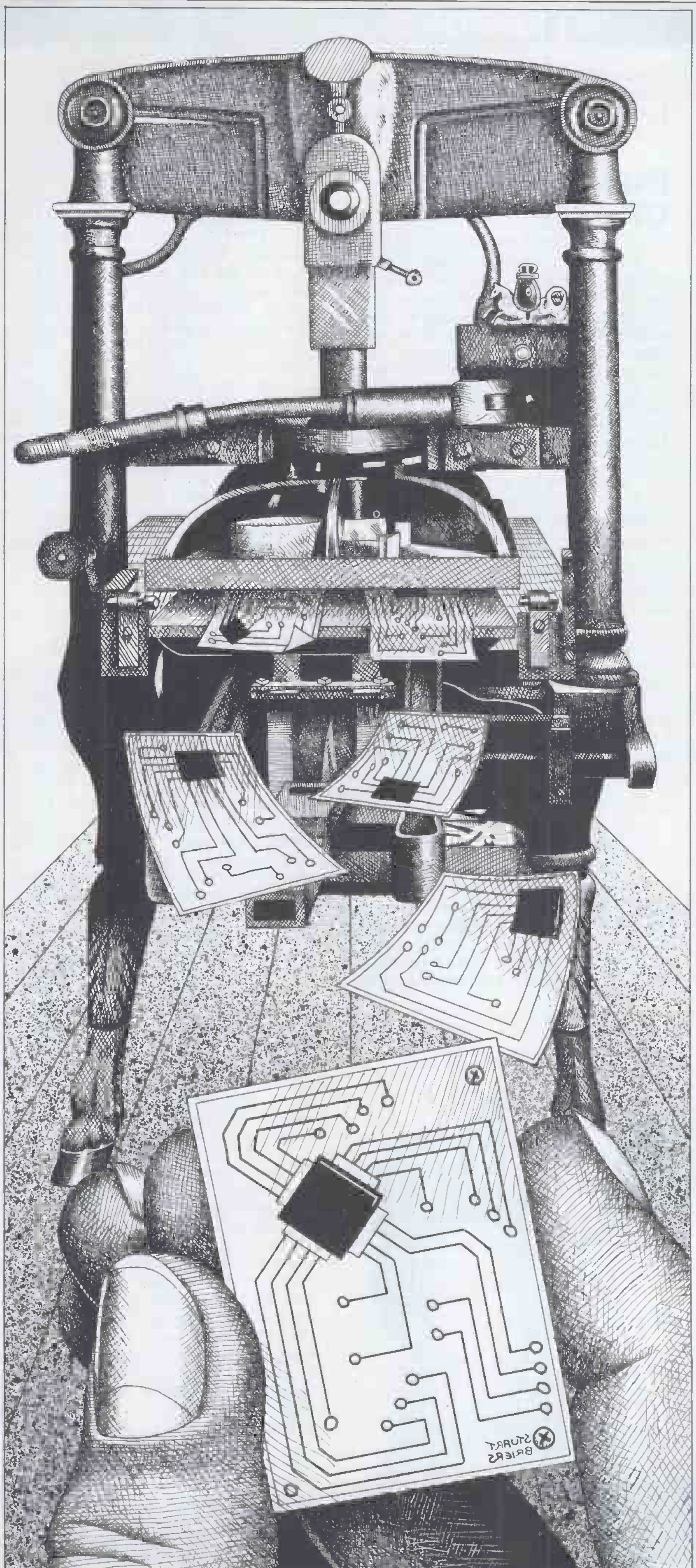
The media and the micro

Popular British awareness of the microrevolution has been fed by, and in turn spawned, a plethora of media response, of which the supermarket bestseller, Chris Evans' *The Mighty Micro* (known in the US as *The Micro Millenium)*, is but the soft tip of the microberg. The level of current public receptiveness to the airing of micro-social issues in Britain was optimistically gauged by ITV when it ran a prime-time six-part series based on 'The Mighty Micro', narrated by the late Dr Evans. Poor ratings for its first showing indicate that the mass audience was not yet a viable market. Yet, that commercial broadcasting took the early risk is a valuable indicator. Its judgement was based on the phenomenal success of the early 1978 BBC2 documentary 'Now the Chips are Down' which provoked a mass doubletake by shouting bold and problematic questions concerning automation, unemployment and government apathy. The program startled then-Prime Minister James Callaghan to announce overnight a £500 million microelectronics development program for the UK. Indeed, it shocked me into resigning as primary school teacher in bucolic Derbyshire in favour of full-time London-based research into the educational and social implications of microtechnology.

Since 'Now the Chips are Down' and *The Mighty Micro*, the debate has been enriched by a host of books, articles, television and radio programs, conferences, etc. Even computing journals have widened their scope to participate in the dialogue over the social implications of microtechnology. Concerning school micro-education, Margaret Thatcher's government has echoed, albeit belatedly, Callaghan's early response by committing funds to develop a national network of regional centres for software development and exchange, and for in-service teacher training, the 'Microelectronics Development Programme for Schools and Colleges' (consultative paper, DES, 1979). There is also a new commitment to subsidise the purchase of British microcomputers for secondary schools, the micro-related areas being the only exceptions to the general government policy of drastic cuts in educational spending. Concerning out-of-school education, the BBC is hastily assembling its computing skills television course, set now to be aired starting January 1982, licensing the British computing firm Acorn to produce the BBC computers that will receive software via teletext, for home and school-based study. The Science Museum in London has decided to extend indefinitely its exhibit 'The Challenge of the Chip', which attempts to lead the visitor on from the nature of silicon through to applications in sewing machines, missiles, etc. Although the presentation is Department of Industry sponsored, and therefore neglects mention of negative social implications, it at least represents free public access to an understanding of the technology and the potential ubiquity of its applications. Finally, initiatives such as the Nottingdale Technology Project in Hammersmith, and the far-sighted efforts of Robin Bradbeer working through the North London Computer Club, are beginning to provide access to computing to a wide range of people.

'Awareness' and 'Literacy' – The choice

The British government choice of emphasis on the more potentially pervasive 'microelectronics' rather than on 'computers' is reflected in the two early discussion documents issued by the Department of Education and Science in which the past and present governments announce the Microelectronics Development Programme for Schools and Colleges, mentioned above. Throughout these documents the word 'computer' does not appear, an omission more than just semantic. It is indicative of the government's sudden awakening to microtechnology and, in fact, the original document must be seen as a hasty and self-conscious response to the tremendous jolt given by the airing of 'Now the Chips are



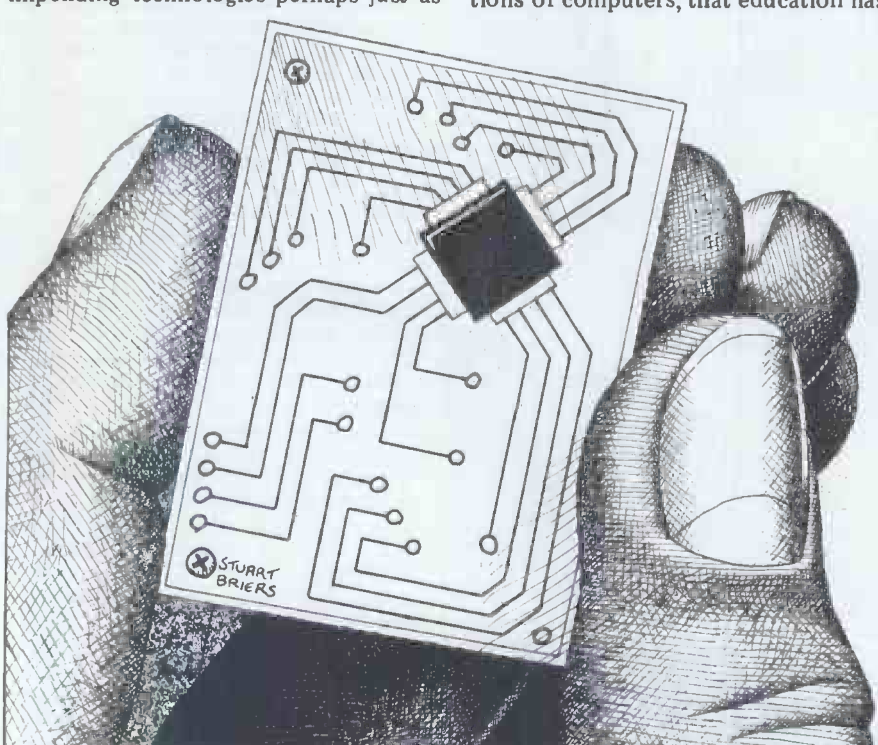
Down'. In that document was included the statement: 'Education, together with training, has a major part to play in producing the skills and qualifications to enable the new technology to be exploited to best advantage; and in preparing society for its full consequences.' Clearly, that government was hedging its bets, vaguely directing education to meet the wide range of needs that the microrevolution *might* imply for society. Note, however, the bureaucratic Catch-22 planted within this document by the Labour government, whereby funds were to be made available to prepare society for the 'full consequences' of the microrevolution, yet it is specifically stated that *no funds* were to be made available by the DES *to research just what these consequences might be.*

In America, sponsorship efficiently blocks mass media from ever being so impudent and informative as to awaken government and populace to the imminent arrival of one of mankind's most fundamental and problematic techno-social revolutions; the 'microelectronics' emphasis has, therefore, never arisen. Instead, here we are experiencing a tidy flip-flop from a stress on the need for 'computer awareness', an early 70s pre-micro concept liberally sprinkled with a social awareness that has gone out of fashion, to a mechanistic and easily-measured 'computer literacy', completing yet another patch in the back-to-basics educational security blanket. (Of the two major opposing views of computer literacy in the US, MECC — the Minnesota Educational Computing Consortium — supports the 'softer' 'computer awareness' approach, fast being superceded by the 'hard' functional approach, supported most notably by Arthur Luehrmann, formely of Lawrence Hall of Science, now heading his own computer literacy firm.)

Media coverage of micro-related subjects in the US is usually confined to non-mass audience networks and geared to cultivating computer consumers rather than informed citizens. When social implications are raised, they are whitewashed with dainty and superficial optimism. These programs are invariably sponsored by major computing companies whose multinational futures depend on spreading just enough carefully diluted computer awareness to ensure ever-expanding markets for their products. It's not merely the familiar reluctance to associate one's name with controversial subject matter that could prove remotely offensive to anyone, it's also the danger that an informed public might be more selective in its applications of new technology than a company's sales projections would allow. It's rather like expecting a producer of mouthwash to sponsor a documentary that attempts to prove that not only is mouthwash ineffective, but that it might cause cancer. Americans spent $300 million on mouthwash last year. They are projected to spend $2 billion on computers in the next five years (*Computer Business News*, 17 Nov 1980).

At a recent US national conference on microcomputers and education, I had the opportunity to voice my dismay before the assemblage of speakers at their support for a hasty and largely unquestioned transition from the provision of a more socially responsible computer awareness to a largely functional computer literacy in public education, which invariably means learning to program in Basic — programming, a skill which may well soon be automated, and Basic, a language whose future is even more dubious. My argument was and is that *the* major and most immediate social implication of microtechnology is the crucial need for people to be made aware of the remaining potential social implications so that they may be motivated to become quickly informed about how to *direct* the impact of this technology rather than being pacified into accepting decisions taken by the few. Just as a dictator might decide that his country is not yet ready for democratic elections, that the people are not literate and are therefore uninformed and ineligible to make decisions to take control of their collective future, so, as our society becomes ever more closely dependent on increasingly complex technologies, the public is deemed technologically illiterate and ineligible to control its own technological, and therefore social future, leaving decisions by default to the few.

This initial awareness should not be merely concerned with computers, but with the conglomeration of technology that microtechnology makes possible, interfacing computers and robot systems, with their fast-growing artificial intelligence, with telecommunications in general — an awareness of *la telematique*. as the French call it. This is the first important step towards creating the vigilant citizenry essential to direct the impact of this and other new technologies. Through microtechnology itself comes the potential for providing unprecedented access for all people, at their own entry level, to information not just about it, but about other new impending technologies perhaps just as fundamental, such as biotechnology. Imagine what an impact an informed public might have had on the development of nuclear technology.



Public access: UK v US

The technology for public access is with us now — we do indeed have the technology: 'The case of the Wells encyclopaedial or a modern derivative is the extreme case. We do not suggest that an enterprise *should* be undertaken, rather than it *could* now be practically undertaken were the demand for access to that information to be there' (Sam Fedida and Max Malik, *The Viewdata Revolution*, Associated Business Press, London 1980, pp 167-8; see also Ted Nelson's Xanadu Project, as described in his new book *Literacy Machines*).

What is not with us is a public informed enough of its own needs to make certain that such access systems will be implemented, equally available to all, and as basic a right as libraries. What is as crucially lacking is a public motivated to *use* such systems, even if available, especially when the same technology will offer as competition exponentially more titillating diversions and dilutions via the same medium. What percentage of US TV viewers at present watch the Public Broadcast Service? Far smaller than the mere 50 per cent of citizens who use libraries, or the equally pathetic 50 per cent who voted in the last national US election — but I digress.

The assembled response of experts on micros and education to my plea for a more, not less, interdisciplinary technological component in education was ironically montonous. I was informed that the American media are doing a 'splendid job' of educating the public with regard to the social implications of computers, that education has a duty to concentrate on providing technical and employment-related skills. If that is their considered analysis of the present quality and role of the American mass media, then one must question seriously the awareness level of these experts regarding the revolutionary potential of microtechnology.

I have alluded to some of the reasons why there is more urgent preoccupation with the microrevolution in Britain than in the US, why in America there has arisen no effective mechanism that can be widely heard to inform that 'now the chips are down': a) unemployment in Britain is already highest since the Depression; b) strength of British unions, far greater than US counterparts, can easily sensitise the workforce to work-related implications; c) Britain's dire need for economic revitalisation through the exploitation of new technology, for productivity through automation; d) Britain's freer and more socially responsible media; e) Britain as a more sociologically mature nation than America, eg, the National Health Service.

Innovation and regression

Yet, it would be false to say that things are really much better in Britain. Despite the media assault in the UK despite government input to schools, despite out-of-school initiatives to provide microelectronics education to a wider public, there seems little hope through present mechanisms of providing even the utilitarian computer literacy necessary for new technological revitalisation of British industry, much less of educating the general public so they are informed enough in time to take part in making decisions that will guide the impact of this technology for the greater good. Only media concerns with educating beyond a more technical computer literacy offer a spark of hope, yet this spark seems small indeed when it is realised what a tiny percentage of the public are ever exposed to media science education. BBC2, for instance, on which most serious micro-based programs have been aired, captures only a small percentage of the viewing audience.

While these debates still rage in England among academics and through the media, traditional v progressive educational philosophies translated broadly now by the extremes of education for vocation or for permanent vacation, the form in which government educational policy has congealed has become distressingly clear. The pressures on public education to return to basics and heed the short-term needs of industry at the expense of the long-term needs of society, and the politically contentious issues that a wider discussion of the social implications of microtechnology brings with it, ensures that, as in America, British education will dilute the microrevolution to the attempted provision of easily testable skills, such as programming and microprocessor applications, along with the use of CAI (Computer Aided Instruction) to reinforce traditional skills, some of whose value the microrevolution places in doubt. Signs are that this model is being widely adopted in recent out-of-school British initiatives as well, either confined to providing skills that will ensure competent industrial fodder, or towards cultivating the micro-consumer base, following the role of the US media. Note the new BBC educational initiative is titled 'computer literacy', yet it is designed to promote programming and to sell BBC computers, hence affirming the most functional definition of computer literacy.

So, after a brief flirtation with a potentially far-sighted and enlightened approach, the British seem to have succumbed to importing yet another technology with labels and values intact; the American utilitarian computer literacy, which, though emphasising hands-on activities, allows (under Luehrmann's interpretation) no exposure to the broader social issues as a basis for facilitating informed citizens. (A balanced view of the arguments supporting commuter literacy and computer awareness can be found in Daniel H Watts's article, 'Computer Literacy: What Should Schools Be Doing About It?', *Classroom Computer News*, November-December 1980.)

Yet, who could feign surprise at this regressive rationalisation, par for a government course hell-bent on reducing social obligation in so many other spheres? Indeed, from the outset it was implicit in its careful revision of the inherited Labour Party discussion document previously quoted, in which the Tories deleted the clause about preparing society for its full consequences, while elsewhere stressing the need to exploit microelectronics for its economic potential. It should not be unexpected that Thatcherism should reveal itself unconcerned with creating an informed citizenry, or with the unemployment implications of new technology, or that it should clinically display its only interest in micro-technology and education as exploitable means to revitalise the flagging economy in such a way that it reinforces the status quo. Meanwhile, the consequences of this mentality that increasingly governs the West are beginning first to appear in Britain, with unemployment just now reaching the three million mark, nearly 13 percent of the working population and as high as 60 percent in disadvantaged areas.

As the present lack of micro-foresight in Western government policy allows the gap between the haves and the have-nots to increase rapidly, corresponding to the fall in price-per-chip component and concomitant explosion in automation and automatic unemployment, the critical flashpoint will have been reached throughout the West, as it has just been reached in Britain, where outbreaks of rioting have occured. But whereas it is a bayonet-point society of short, sharp shocks that is now imminent in that formidable bastion of democracy, future troublesome elements of the Western displaced and unplaced workforce will be crushed by sophisticated micro-surveillance. Note Reagan's recent move to create extensive databanks on all welfare recipients, as part of his rationalisation of social programs (as reported in a syndicated *Washington Post* feature which appeared on 1 May 1981 in the *Arkansas Democrat*).

ComputerTown UK! and USA!

Yet, in the midst of all this gloom, a faint glimmer is being issued forth from the British horizon. A new media-initiated effort also stating as its aim the spreading of 'widespread computer literacy' seems to embody just the sort of mechanism necessary to drive a subtle wedge of micro-awareness deep enough within the British society to reach a significant cross-section of the public. ComputerTown UK! (CTUK!) is a nation-wide network of voluntary computer literacy centres with its own monthly notice board, *ComputerTown UK! News'*. In elaborating its aims, CTUK! states flatly that the intent is not to produce a 'nation of programmers', but to do something 'on a very wide scale to introduce the public to some basic truisms of computers' (ComputerTown UK! was introduced through *PCW* in the November 1980 issue, from where all of the CTUK! quotations that appear here were taken). CTUK! relies on 'computer enthusiasts who are prepared to spend a little time spreading computer literacy within their own communities,' and in so doing offers the potential for early, wide, free public access to computers and education about them.

The purpose of spreading this 'awareness' is not so very different from other British initiatives I have mentioned: it is needed to overcome the 'poor public image' of computers which they see as the roots to upcoming 'widespread social unrest' which micro-induced unemployment will trigger off. It is noteworthy that CTUK! sees this investment in automation as essential to Britain's economic future, an imperative that must not be blocked by the hostility of unemployment. In this CTUK! sees its role as removing 'fear of the unknown', namely computers, in order to remove a great 'barrier' to change, in other words, to placate a potentially hostile public by endearing them to the technology that threatens them. It does not see its role as one of involving the public in becoming informed enough to *direct* this transition into a future that respects the quality of life by first making known to it the alternatives. CTUK! identifies the most fearful unknown as the technology, whereas it could be argued that the most obviously fearful unknown to a public is the future itself, especially when the public feels that its future is governed not by it, but by technology out of control.

Another part of CTUK!'s purpose in spreading computer literacy is also not very different from other British initiatives: to prepare citizens to 'help create the new industry that this country requires'. Yet, CTUK! describes itself as 'subversive'. It is subversive in its mechanism, designed to appeal first to children, 'the weak point in society's anti-technology block', getting them 'well and truly hooked', so they will, in turn, involve their parents.

It has the potential to subvert public apathy to matters social *and* technological, not merely to placate, feed industry, or create a consumer base which represents its present direction. Its phenomenal success indicates its potential as a carrier of social evolution and the need to look more closely at its origins.

As one might have guessed, CTUK! represents yet another American *technique* imported by Britain, another triumph of American know-how. As such, it becomes all-the-more essential that the goals for which the 'tool' was originally designed, and its history of success and failure, be carefully examined so that the technique can be appropriately adapted to meet local needs. In this case, the needs are as I have already outlined: for a public motivated to question and seek answers regarding the social implications of new technology.

The concept ComputerTown USA! was originated by Bob Albrecht in Menlo Park, California, with the stated aim of 'bringing computer literacy to the entire community.' (this motto is the subheading of every CTUSA! news bulletin). Activity began in April of 1979 with Albrecht and Ramon Zamora manning personal computers in strategic places in the community, such as local schools, pizza parlours, book stores, community centres, parks, and the eventual home base of CTUSA!, the Menlo Park Library. They managed to attract the support of a local representative of a computer manufacturer who was able to provide the project with three machines, and from then on, as the *CTUSA! News Bulletin* No 1, May 1980, from which I learned all this states, 'the project was an instant success'. An important measure of that success is that in September 1980 CTUSA! was granted $250,000 from the National Science Foundation to put together an implementation package over three years to aid in the replication of CTUSA! in other libraries. The project was funded just prior to Reagan's cuts which no place in jeopardy the future of much of the NSF.

What information I could learn about CTUSA! from England I found vague and intriguing. These two California pied pipers would apparently attract loads of children and, after a brief micro-initiation, each child would go away with a 'My Computer Likes Me' badge as graduation certificate. Yet, beyond spreading 'computer literacy', a term that the bulletin leaves undefined, there are no clearly stated aims, no demystification to counteract the anthropomorphic myth which the badge seems to reinforce.

Through good fortune, it soon became possible for me to visit the US to research CTUSA! and other US micro-education initiatives in context. What follows in the next two months, then, is an impressionistic diary of micro-encounters of all kinds along a 6000-mile drive, meandering ever west, in search of other ComputerTowns enroute to CTUSA!

DESIGNING PROGRAMS THE WARNIER WAY

Here's a really neat way to design programs quickly and logically, described by Paul Overaa.

There's a lot more to writing a program than the physical effort of putting it into code, whether you're using Basic, Pascal or any other programming language. Unless the program is very short and simple, your first action must be to *design* it — work out the underlying sequence and logic. Without doing this, you can end up in a frightful mess.

The program design stage can often be more difficult than the actual coding; or, put another way, by properly designing the program before you start coding, the coding itself becomes very much easier because you have a clear mental picture of what you're doing at each stage in the program. Producing logical, well-structured programs which actually do exactly what you wanted them to thus hinges around good program design.

A program design technique must, if it is to be useful, satisfy several criteria: it must produce consistent results of high quality; it must be quick; it must allow easy program maintenance and it must be simple enough for anyone to use it and produce good results.

If these criteria look as though we're waiting for some really handy program design technique of the future, then relax — just such a technique is here already.

Fig 1

Warnier-Orr techniques were pioneered by Jean-Dominique Warnier in France and their use has been expanded and publicised by Kenneth T Orr in the US. The method is a major step forward in the design of logically structured programs.

Before we look in detail at the techniques, I should emphasise that during the design stage, it's vital to forget about your computer completely — and the programming language you're going to use! These are things which will affect how you code your program but they should not influence your logical solution to the problem.

Programmers are using Warnier-Orr techniques to design programs which are then written in Basic, Cobol, Fortran, APL and assembler languages as well as many other languages; all agree that the techniques result in easy to understand, well-structured programs (yes, even in assembler!).

The technique uses diagrams — called Warnier Diagrams — that are basically a series of hierarchical 'curly brackets'. The best way to learn to understand these diagrams is to see them being used in specific cases, so let's consider a very simple example.

For some purpose or other, we have to print a report comprising the contents of a disk file. The Warnier diagram of this is shown in Figure 1. Notice that the bracket is read from top to bottom and that the word 'report' on the left-hand side identifies what we're doing in the bracket. Notice also that we explicitly state at the top and bottom of the bracket that there is a beginning and an end to the operation.

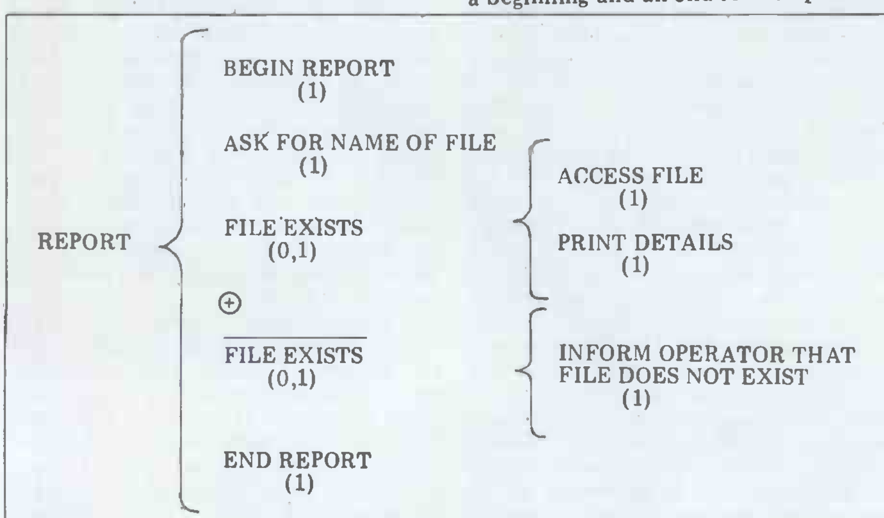


Fig 2

To explain some further conventions, let's now introduce a minor complication to the problem: the user will wish to access a file of his own choosing and obtain a printed report of details present. Such a file may not in fact exist and if this is the case, the user should be informed.

Figure 2 shows the problem in Warnier diagram form. The following conventions are used: the ⊕ sign is used to separate mutually exclusive operations — in this example, a file either exists or doesn't; the logical opposite of a statement is written with a bar over it — $\overline{\text{FILE EXISTS}}$ means that the file does *not* exist; brackets written to the right of an item or statement indicate the operations to be carried out; underneath each item or statement is a number in parentheses which indicates how many times the operation is to be performed — (1) tells us that the operation is performed once and (0,n) tells us that the operation is to be performed any number of times from not at all to n times.

Having now dealt with the basic conventions of Warnier diagrams, we can express in plain language exactly what the diagram tells us: we are dealing with a certain procedure called REPORT which starts by asking us for the name of a file. If the file exists then we can access it and print out the details; if it does not exist then the operator is informed of that fact.

To appreciate the elegance and speed with which this technique can accommodate changing requirements within a particular problem, let's place some additional restrictions on our example: the user must be able to access a file of his own choosing and a report of the contents of this file is to be printed; such a file may not exist and if this is the case, the user must be so informed. In addition to this, there are within our hypothetical system various files containing sensitive information, such as wages or personnel details, which must only be made available to those users with the proper authority — users are therefore issued with access code numbers. If a user tries to access a file which he has no right to examine, two operations must be carried out: the user must be informed that he has tried to access data to which he is not permitted access; and the system security officer must be informed of a possible attempted illegal access.

The Warnier diagram for this new condition is shown in Figure 3; pay particular attention to the layout of this diagram and compare it to Figure 2, the example without the additional restrictions.

Notice that as we redefine the problem and add more details, we don't have to re-arrange the complete diagram, as we would have to with a flowchart. All we do, in fact, is superimpose the new details and restrictions onto the existing diagram, which grows as we successively modify the requirements. In addition, the diagram is documenting and expressing the logic of the problem in a way which will actually make the transition to a language-coded equivalent very straightforward.

The ability of these Warnier diagrams to display, help formulate and to grow with the changing logic of a problem is of great importance. Once the quite simple conventions have been learned, these diagrams can be read just like the written plain-language equivalent but, unlike the plain language form, a Warnier diagram contains within its apparently simple notation the complete logical solution to the problem!

I don't intend to discuss the coding of the solution in this article, other than by giving a very general pseudo-Basic type of program based on the example we have developed.

The secret in transforming the Warnier diagram into the finished program lies in treating all of the brackets containing more than one operation as subroutines! If this is done, then it's very easy to code the program by working from the largest bracket as a 'main block'. Lower-level brackets are called as subroutines and these may themselves call further subroutines. The pseudo-code in Figure 4 should give you the general idea.

This has been a somewhat brief introduction to this very important technique. If you want to experiment, then try the ideas with small programs at first, gradually increasing the complexity of the problems. I think you'll be very surprised at how quickly your programming assumes a more professional approach.

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Warnier, J D: *Logical Construction of Programs*, 3rd edition, trans B M Flanagan, New York, Nostrand Reinhold, 1976.

Orr, K T: *Structured Systems Development*, New York, Yourdon Press, 1977.

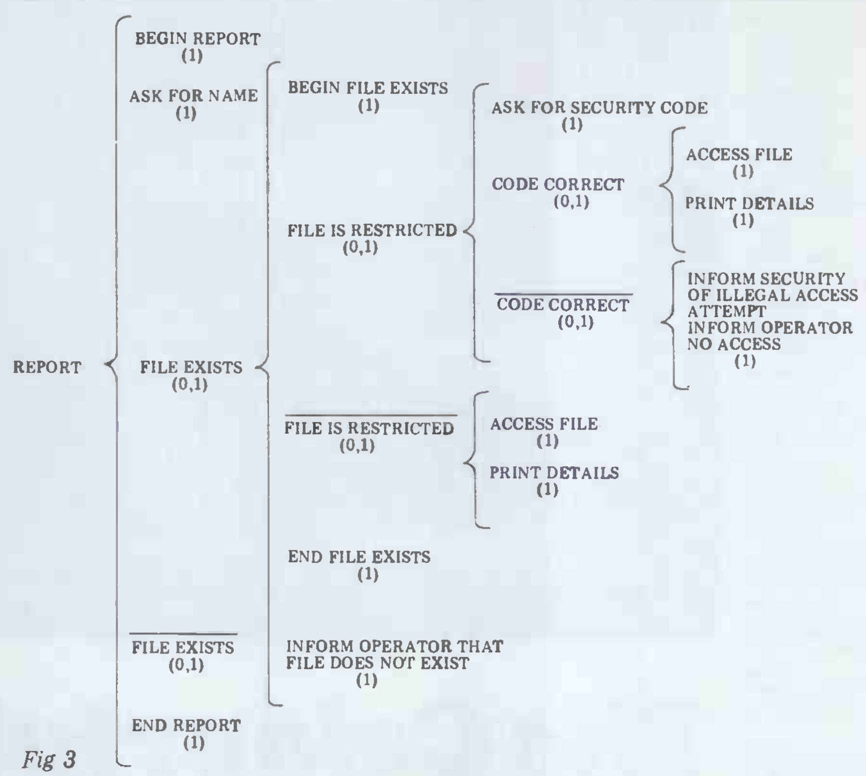

Fig 3

```
REM     REPORT MODULE
    INPUT NAME OF FILE
    IF   FILE EXISTS THEN GOSUB "FILE EXISTS" ELSE
         PRINT "FILE DOES NOT EXIST"
    END

REM     SUBROUTINE FILE EXISTS
    IF   FILE IS RESTRICTED THEN GOSUB "RESTRICTED
         FILE" ELSE GOSUB "ACCESS"

REM     SUBROUTINE RESTRICTED FILE
    INPUT SECURITY CODE
    IF   SECURITY CODE=CORRECT CODE THEN GOSUB
         "ACCESS" ELSE GOSUB "ILLEGAL ACCESS"
    RETURN

REM     SUBROUTINE ILLEGAL ACCESS
    WRITE TO ILLEGAL ACCESS FILE THE TIME OF ACCESS
         ATTEMPT AND USER CODE
    PRINT "THIS IS A RESTRICTED FILE — YOUR ACCESS
         CODE DOES NOT PERMIT YOU ENTRY"
    RETURN

REM     SUBROUTINE ACCESS
    (This would access whatever data the file contained
         and display it on a terminal, printer, etc)
   RETURN
```
Fig 4

WRITING FOR PCW

PCW welcomes approaches from would-be writers, even those who may never have appeared in print before. In this game it is often those with practical experience who have important things to say so we don't mind too much if their prose is less than perfect. Providing that submissions have a sensible structure and follow a logical sequence, we can take care of the polishing. Here are some tips:

If the article is already written, simply send it in, making sure that your name, address and 'phone number appear on both the article and the covering letter. If you have submitted the same work to other magazines you should tell us — it would be embarrassing (to say the least) if the same article appeared in more than one.

If you have an idea for an article or a series, write us a letter outlining your ideas. A one or two page synopsis giving the proposed structure, sequence and content will give us a sound basis for discussion. Please give us a daytime 'phone number if possible.

If you have nothing specific in mind but feel qualified to conduct case studies, Benchtests or whatever then drop us a line saying what you'd like to do and why you think you're qualified to do it. We're not particularly looking for strings of academic qualifications — experience carries just as much weight.

Dick Pountain is always on the look-out for interesting calculator features and we wouldn't mind seeing one or two readers getting on their soapboxes but remember: even articles such as this need a structure.

Reading *PCW* will give you a good idea of the style we prefer. You may notice that we try to avoid pomposity at one extreme and flippancy at the other (except in 'Chip Chat', that is).

Finally, have a look through back issue indexes and try not to re-invent any wheels. Oh, we almost forgot — *PCW* does pay for all published work.

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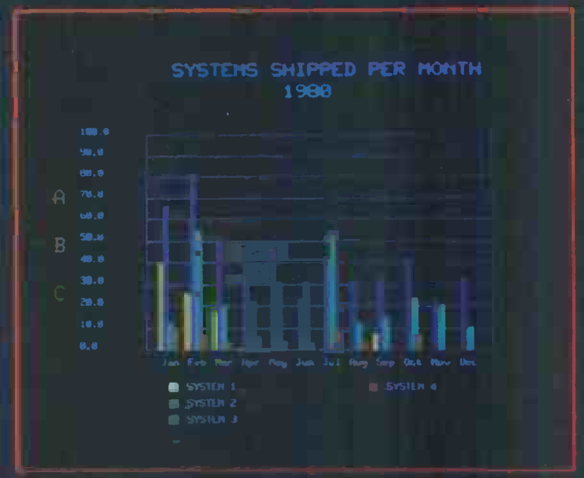

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Cromemco brought High Resolution, broadcast quality colour graphic systems onto a new price/specification level with the SDI System. They gave a wide colour pallete, up to 4096 colours, and a wide variety of functional development; area infill, rotation, — a true professional graphics capability.

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MICRO FOCUS

Your COMPUTER WORLD

Compiled by Derrick Daines

Fibonacci series

A reader wrote to colleague Sheridan Williams recently, asking why there was no function available for factorials. If you're not sure what they are, let me explain. Factorial 2 is written as 2! and is understood to mean 2 x 1. Factorial 3, written as 3!, means 3 x 2 x 1; 4! is 4 x 3 x 2 x 1; and so on. Factorial numbers obviously get very big very quickly but they are of great interest to statisticians as well as to humbler folks who like a flutter on the football pools. Try permutating any eight from 32 matches and you'll see what I mean!

Now, at first sight, it is not immediately obvious why anyone should want a *function* to produce factorials. One would think that all you have to do is access a subroutine:

```
9000 F=1
9010 FOR X=1 TO Y
9020 F=F*X
9030 NEXT X
9040 RETURN
```

where Y is the desired factor to be returned in F — but three variables and five lines are used up and if space is restricted, this can be serious. Besides, it's not nearly as satisfying as having a neat function to call.

I had this little problem at the back of my mind the other day when I was working on a program that called for the use of the Fibonacci series, an interesting series of numbers in which the next element is obtained by adding together the previous two: 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, and so on. (Some authorities start it off as 1, 1, 2, 3, etc, while others begin 0, 1, 1, 2, 3.) As before, it is easy to construct a subroutine:

```
9000 F=1: F2=0
9010 FOR X=1 TO Y
9020 F1=F2+F
9030 F2=F
9040 F=F1
9050 NEXT X
9060 RETURN
```

where Y is the element of the series to be returned in F.

Here four variables and seven lines are used up, although of course with multiple-statement lines there would be some saving. Even more to the point, it is intellectually unsatisfying, like an unsolved crossword puzzle. It was a tantalising challenge to reduce it to a single equation. My program was put away and I devoted a couple of days to solving the problem.

What I finally came up with was the following:

```
F=INT((1.618036↑(X+1)+.5)/2.23614)
```

which will produce the first 26 elements of the series before rounding errors affect the result. The variable X is the desired element — fourth, tenth, or what-have you.

Remember you saw it here first!

If I get some time, I might get around to doing the same for the factorials problem — or can you beat me to it? I would be interested to hear from anyone with a solution, or anyone with a better answer than mine for the Fibonacci series.

Programs received

Square and Cube Roots (TRS-80) by Jonathan Sumpster (14) of Maidenhead.
Alphon Invaders (Video Genie) by Alex Mackow (13) of Margate.
Golf (PET) by Mark Cochrane (13) of Gerrard's Cross.
Old Glory and Horse Race Predictor (ZX81) by Kevin Kirkland (16) of Newport, Salop.
Spacefighter (Video Genie) by Jason Bell (12) of Prestwood, Bucks.
Defender (MZ-80K) by Basil Zimms (16) of Edinburgh.
Berk's Defence (PET) by Stewart Sargaison (15) of Berkhamsted.

That's another good month for programs. Thank you all!

I've also had mugtraps from Shaun Dunmall of Maidstone, Andrew Freudenberg of Taunton, David Lomax of Manchester, Alistair McLuckie of Gwynned, Phillip Watson of Hartlepool and this one from J P Jiggins of Greenwich:

```
10 PRINT "ENTER NUMBER";
20 INPUT N$
25 N=0
30 C=CODE (N$)—28
40 IF C<0 OR C>9 THEN GOTO 20
50 IF N>3275 THEN GOTO 20
60 N=N*10+C
70 N$=TL$(N$)
80 IF NOT N$="" THEN GOTO 30
90 PRINT N
```

Mr Jiggins wins this month's book-token.

Program listings

No fewer than four people have written to me this month, asking for copies of listings that I have mentioned but not published. I have explained the situation on this page already but I'll do it again for new readers. I cannot send out listings because those that are not published are returned to their rightful owners. Besides, if you think about it, you will realise that it would be illegal for me to send copies here, there and everywhere, unless we had previously paid the owner — and that would imply that we should pay for each and every program sent in! It's not on, mates!

As to why we publish a list of those that we have received, well, that's just to encourage you. Even if your listing is not published, at least you get the thrill of seeing your name and program mentioned.

What I can and will do is to put enquirers in touch with authors. I keep a fat and growing file of names and addresses of all those who write to me. If you're interested in a listing mentioned, drop me a line at *PCW* and an SAE and I'll send you the address of the author. Fair enough?

Project packs

'Dear sir, my school is doing a project on computers. Please send me full information.' Roughly speaking, that is the gist of dozens of letters received by *PCW* every year — and it's sending the Editor prematurely bald! He doesn't know how to answer it, you see. Well, do you?

If you are guilty of sending such an enquiry, then take heart — help is at hand. I am proud to announce the formation of MAPE — Micros and Primary Education — an organisation of practising teachers and educationists dedicated to 'spreading the word' among all 22,000 primary school in these islands. The first meeting of the steering committee was held in London recently under the chairmanship of Ron Jones, Headmaster of Upwood Co Primary School, Huntingdon, Cambs, following the Easter international conference held at Exeter University. Committee membets from Land's End to Sheffield (does nobody live North of there?) gathered to begin work on establishing a national body espressly for primary computing.

My own view is that on sheer numbers of machines and schools represented, primary computing will eventually become bigger than any other sector in education — but I may be wrong. The point is that word 'eventually' — so far, MAPE is in its infancy. One thing they have started work on is an information pack for newcomers, but it's not ready yet. I'll keep you informed. Since, for my sins, I too am on the committee, it'll be the 'inside dope'.

Another source of information is Newman College, University of Birmingham, who have started a primary computing magazine *Microscope*, and are devoting space to the fledgeling organisation. Write to Roger Keeling, Newman College, Genners Lane, Bartley Green, Birmingham B32 3NT.

A sub-committee is already at work planning next year's conference at Exeter. Judging by this year's, it will be a sell-out and early booking is advisable. Write to Roy Garland, College of Education, St Luke's, University of Exeter.

Trumpet voluntary

What can you do if you want to know about schools computing and want to get 'stuck in' right away? Well, one thing you can do is to turn to the back issues of *PCW* and read my series, 'Gateways to Logic', which began with the July 1980 issue. (I regret that it is not available in book form, and if any publisher is interested, so am I!)

If all that isn't enough, interested

UP THE SHARP END

A USER'S VIEW OF SOFTWARE PIRACY

From Richard Waller of The Management Centre Ltd

In the good old days BM (Before Micros) we didn't have software piracy. We wrote programs for ourselves. If anyone else wanted to use our programs we gave them to him, with whatever documentation there happened to be, 'as is', warts and all. And good luck to him — let him be ten years behind as well.

Then user groups came into fashion and with them formalised software sharing. IBM identified three classes of software. As I recall, Type 1 was from IBM laboratories and came with super documentation and always worked. Type 2 came from IBM staff working with customers and had some standard documentation and the programs sometimes worked. Type 3 was sent in by customers who either contributed to the well-being of the industry or just wanted to get their name in print. The documentation varied alarmingly and again, the programs sometimes worked, at least on the author's own system.

Came the great IBM price unbundling and things ceased to be free. Suddenly all software cost money. On mainframe computers the average cost of a software package now is said to be $14,000. Surely it should be possible to acquire one cheaper than this from a friend? So was invented software piracy and, in order to try and protect the shattered remnants of their revenue, the authors invented software protection.

First line of defence is the source code. In the new suspicious environment the author keeps the source; all you get is the compiled object code. You can still have some changes; the software house will configure your system for you with a whole range of available user options. But once set up and running, any change means going back to the author again. But this technique doesn't work with interpreted languages like Basic. Quite a lot of users know Basic and we have a protection problem even when the Basic code looks a right dog's dinner with not a remark statement to help you in the entire listing.

The second line of defence is the contract. Every purchaser signs a contract in which he finds he hasn't bought the software — he only has a perpetual lease. And he accepts a more or less open-ended commitment to damages if the software he is using falls into the hands of an unauthorised party.

This worked for a time. With only about 8000 mainframes in the UK and minis not being at that time very significant for their packaged software, a contract seemed a good protection. When I was with CAP we heard, via a man we wanted to employ, of a user who had our software. So we sent him a bill to pay and a contract to sign and he did both without a murmur. No problem.

Documentation was the third kind of protection. The documentation is copyright (not that anyone seems to care about that) but these products were large and full of bugs. And the user manuals were the only communication the user had to keep him in touch with reality. Unless the new releases kept coming, the bugs bit him faster than his boys could fix them. A steady stream of Program Temporary Fixes was a must. Allied with this, most computer users were the larger companies and even if they took a package they also paid a lot of money for customising and for installation consultancy. The actual cost of the software package was trivial by comparison. This still applies for the more complex applications like production control and inventory control.

Now we have maybe 120,000 micros installed, of 140 different types. All the world and their wives are writing software packages. Most are relatively simple and thus easy to install; this up-front, immediate benefit, retail image is a large part of the new micro appeal and suddenly having to pay £95 for a program like Visicalc stops you in your tracks.

Would it be the bicycle shed syndrome? The accountant suddenly queries the £95 (plus VAT) for a program. 'But you bought a program last week', he says. And the money you would have to pay suddenly has to compete with other items of small spending like continuous stationery, an upgrade of the printer — even with important things like beer money.

Everyone tells you that it is foolish to pay the full price. A lot of dealers offer discount on everything — why can't I get discount on Visicalc? So you look for a bootleg copy and pay, say, £40 plus the hidden cost of photocopying the manual.

So nothing is quite as easy any more. The product is more complex and probably more expensive because of the security. You have to see your legal people before you sign the contract; you cannot change anything yourself because you haven't got the source; and if you go back to the author it takes a month and you have to explain your simple requirement to the thickest programmer in the kingdom, and he keeps asking you why you want to change his product when it's obviously perfect.

You cannot even make a backup copy; the authors have put a load of cunning code onto the floppy disk on which the program is supplied so that the copy program will not run. The author has promised a 24 hour turnaround if you send him a corrupt disk, but you want it now.

And there is another nasty. If I have multiple terminals on my computer then I can, of course, use the program at each. If I have several micros with single screens, the best I can do is to pass the program disk around; I cannot use the program simultaneously, which seems unfair.

Now there are some neat ways to protect software. Unfortunately, these are nearly always in addition to the above (no-source code, the contract clause, officious documentation/upgrade service, program copy booby traps). The fashionable thing to do today is to use a 'dongle'; you buy a small box to fit on the cassette port for each machine you want to run your package on and you can make as many copies of the software as you need. It is a much better solution than the PROM chip that came with some earlier products which got bent if you kept picking it in and out of the printed circuit board.

Next in line is user personalisation. The author configures the software for your particular computer model, memory size, printer display and disks and it will not run on any variations of this set pattern. This is not so good for

the user for portability or back-up but it does at least ensure that the buttons are all functional. But then the author can go on and put the purchaser's name on the copyright system welcome message. And on each output display screen. And on each report printed. And on the user manuals. You name it, your name is on it. So unauthorised users have an identity problem.

Third in line is a software maintenance contract. Some companies are now offering software maintenance for life at no extra cost. Whose life is not always clear, but an aggressive sales campaign on the back of this to issue upgrades perhaps for 'the cost of reproduction' like £40(!) could tie the user into his contract in a mutually attractive way.

The objective is to ensure that revenue accrues to software package authors. It is hard enough for package authors to stay solvent without ripping them off. Oh, that everyone was as ethical as you or I. If it is profitable to write software than there will be lots of exciting new products available at nice low prices.

HARD CHOICE

'Sharp End' has until now been mostly concerned with software. For a change, here's a hardware manufacturer's description of the problems involved in equipment design. The author, Hal Hardenbergh, is president of California-based Digital Acoustics Inc.

We at Digital Acoustics have been using the 6502 since 1976 in various instruments, primarily battery powered noise level meters, or environmental noise monitors; it seems if you wrap some pretty aluminium around the 6502 you can sell it for $8000!

I am sure that we are not alone in seeing that the 6502 is approaching the end of its useful life (the first microprocessor that we used here at Digital Acoustics was the Intel 4040, which has been out of production for some time now).

We are astonished that some persons with like views see the Motorola 6809 as the 6502 successor. Perhaps these persons are unfamiliar with some of the characteristics of the 6809. For example, to perform a 32-bit add it is necessary to perform the usual succession of four LDA, ADC, STA sequences since the 16-bit add in the 6809 is not an add with carry. Further, the above sequence will run more slowly than a 6502 at the same clock speed because the 6809 is not pipelined and therefore requires four clocks for a zero page reference as opposed to three for the 6502.

I am not trying to say that the 6809 is not overall a better general purpose computing device than the 6502, what I *am* saying is that, for a chip which came along five years later than the 6502, the relative performance advantage seems slight.

If we want to look at chips with a very high performance to price ratio we would have to consider the 8088 which is now under $15 at the 100 level, or the Z8002 which is under $20 at the 100 level. The 8088 is source code compatible with the 8080, and has considerably superior computational throughout compared to the 6809. The Z8002 has 16 general 16-bit registers and has vastly superior computational throughput as compared to the 6809.

However, if we can ignore the current $198 one-off price for an 8 MHz part, anyone who has been reading the numerous articles and advertisements for the Motorola 68000 is aware that this is by far the fastest of the available microprocessor chips.

Because our environmental noise monitors are manufactured in relatively small quantities the cost of software is by far the single most expensive ingredient of the instrument. Had we had a choice of using a $5 6502 or a $198 68000 developing our latest model, I would have immediately chosen the 68000 because it is far easier to program and requires far fewer lines of code to perform a particular function. This would have benefitted our company in two ways. First, the lessened cost of software would more than offset the additional cost of the integrated circuit. Secondly, the time saved by our engineering staff could have been put to better use developing additional instruments for sale. Of course, this is purely hypothetical because the 68000 was not in fact available at that time!

We did purchase two sample 8 MHz 68000s (at $249 each) when the chip finally became available in a bug-free version last November. Until very recently we had not done anything with the 68000 for the simple reason

UP THE SHARP END

that all of the application literature put out on this chip by Motorola (and not much of it at that!) suggests that the circuit cannot be turned on without the use of fewer than 574 integrated circuits to support it! A processor of this complexity is completely inappropriate to the sort of instrumentation we manufactured.

On trying to get clarifying information on this matter through Motorola I discovered that the Motorola sales people were remarkably uncommunicative once they discovered you were not a prospect to purchase their $28,000 Exormacs system. Although I was convinced that it was possible to make a far simpler system using the 68000, there was no information available in such detail as to make it practical to lay out a circuit board with any expectation that the resulting system would work. For these reasons, until a month ago the 68000 chips had literally never been removed from the plastic cartons they came in.

We now go back about 3½ years to a time when a 3M salesman dropped by to show me a new breadboarding system. The sample he had with him was a circuit board about 3x5in and both 14- and 16-pin sockets were available for use with this system. At that time I told him that I loved the concept but could not use the system since all of the circuits that we would like to breadboard would require a board much larger than 3x5in, and sockets with 20, 24 and 40 pin size among others. You are not going to believe this but the very same salesman came back less than two months ago with a brochure outlining exactly what I had asked for. I immediately ordered about $500 worth of breadboarding equipment that included two kits, three circuit boards and a number of various odd sized sockets. In three weeks a partial delivery was made, including one of the two kits and one of the three circuit boards.

The kit was delivered on Friday afternoon, and by noon Saturday I had a fully wired up breadboard which included a Motorola 68000, 16k static RAM and 1k of bipolar PROM, plus the necessary clock generator and decoder and interface circuits to my recently-purchased Commodore 8032. The wiring of this breadboard took about four hours. I then realised that with all of those wires in place it would be virtually impossible to add the necessary +5 V and ground lines, plus the necessary bypass capacitors. I stalled two days over this impasse and then ripped out all of the wires, installed the ground and VCC wires (these needed to be soldered) and a large number of miscellaneous ceramic bypass capacitors. Then the system was rewired; apparently I had learned a little bit about the prototyping system, since it took only a little over three hours the second time through.

I decided to interface the board through the memory expansion port of the 8032 and was rather surprised to discover that Commodore, through its memory decoding procedures, had arranged matters so that the memory expansion port was completely unusable! After examining my alternatives I decided to cut one line and install a single $\overline{OR}$ gate (one fourth of a 74LS32) so that the upper half of the 4k display area, $8800 through $8FFF could be accessed via the memory expansion port. Since I needed only a few bytes to interface to the 68000, I decoded 2040 of the possible 2048 bytes into an additional static RAM so that I now have about 2k RAM that nobody knows about, including Commodore, Wordpro or Toolkit!

It took about two weeks of debugging both the hardware and the bootstrap PROM software before we finally got the 68000 working reliably. Once the basic hardware and software was debugged, two further changes proved necessary to achieve a completely reliable handshake. First, since the 68000 was operating on its own regulated 5 V supply which didn't have a line filter, it proved necessary to protect the 68000 from line transients. The most convenient means of doing this proved to be the use of a Sola harmonic neutralising regulating transformer which we happened to have on hand. Once we plugged this in we were able to transfer an average of four million bytes before the handshake would hang up. We then modified the software in the 8032 to set the interrupt mask before data transfer and then enabling interrupts after the transfer was complete. After making this software modification we ran the instrument overnight without any hang up. During this time the two instruments exchanged about one gigabyte. I have no idea why it is necessary to set the interrupt mask because, from my knowledge of how the 6502 works, no such problem should occur.

Since that time we have modified the 8032 Basic by replacing 12 bytes so that both entrance points to the floating point multiply and the floating point divide routine jump to a user EPROM which we installed in the A000-socket. At this point the integer portion of the two operands is sent to the Motorola 68000 for processing and the result retrieved. The 6502 does most of the necessary computations involving the exponent while the 68000 is handling the integer portion of the arithmetic.

The elapsed time (for multiply) between the start of the data transfer of the 68000 and the end of the data retrieval from the 68000 is about 250 µs, of which 180 µs is devoted exclusively to data transfer. The integer portion of the divide routine takes a little bit longer but not much. The net result is a saving of between 2.1 and 2.3 ms each time a floating point multiply or divide takes place. If a simple FOR. . .NEXT is written wherein a particular transcendental function is performed (eg, arc tangent), the net performance improvement ranges from 2.6 times to 3.0 times depending upon the particular transcendental function involved.

Now about the 68000 hardware; this system was designed for maximum simplicity rather than for smallest chip count. For this reason LSTTL was used for interfacing rather than PIA chips since an oscilloscope can be used to determine the content of the TTL chips, but not the PIAs! (Now that I have the system debugged I might be inclined to try PIAs on a future attempt.) The complete board contains 25 ICs including the 68000. There are nine 2kx9 static RAMs, one of which is used by the 8032. There are two 512x9 bootstrap PROMs containing a mini-monitor, plus the multiply and divide code. The remaining chips are used for decoding and interfacing purposes. I believe this proves conclusively my contention that it is possible to build a simple system using the 68000 microprocessor!

The point of all this is that I believe the 68000, not the 6809, is the logical successor to the 6502. After all, the 6502 was noted for being significantly faster than the other microprocessor chips of its day. On the other hand the 6809 bears the dubious distinction of being unquestionably the slowest microprocessor of its generation, while the 68000 is the fastest. Like the original 6502 very simple yet useful systems can be built using the 68000. The 68000 even has a zero page addressing mode which, like the 6502, operates significantly faster and uses less memory space than the longer forms of addressing. Further, the zero page in the 68000 is 64 kbytes wide!

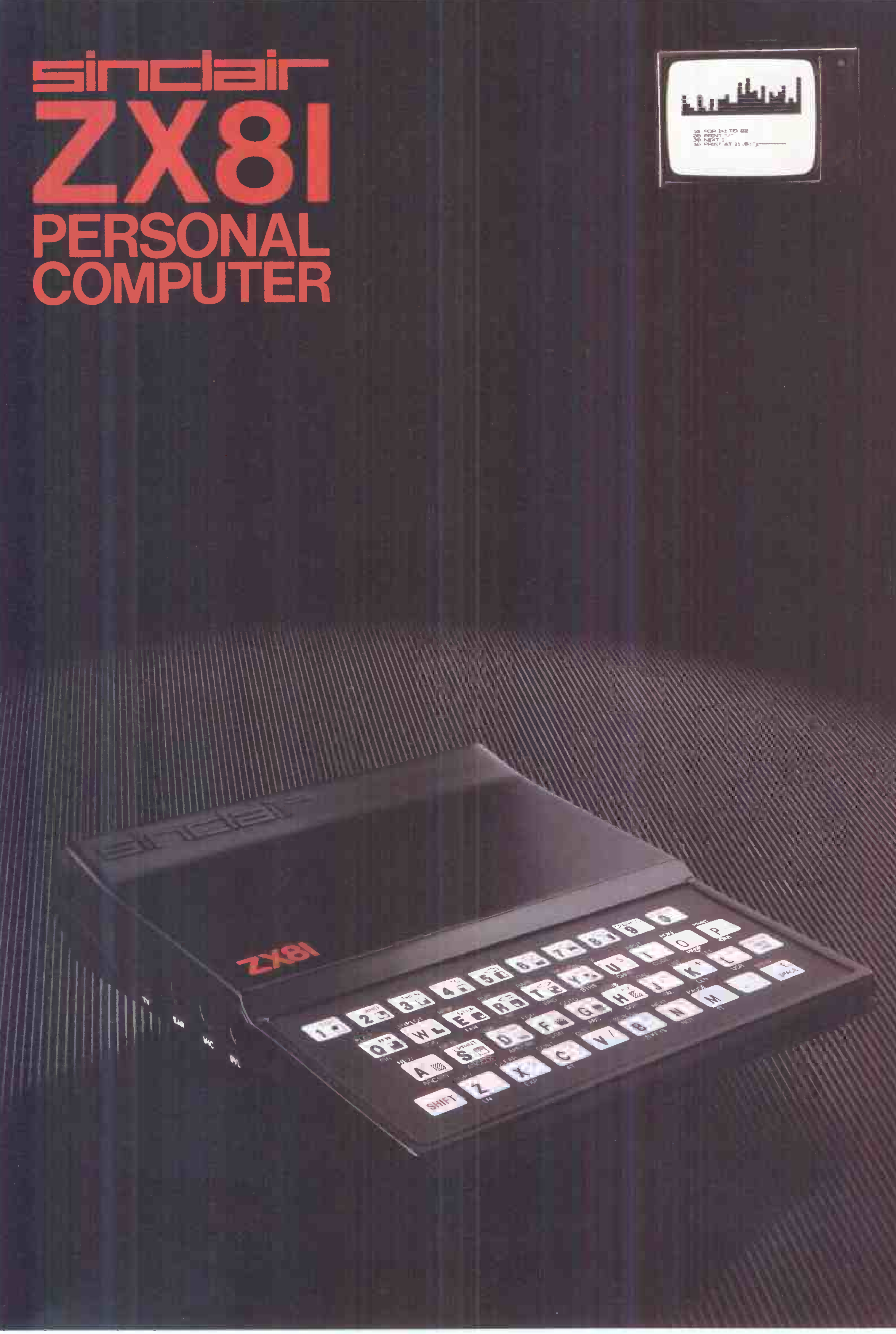
I predict that it will be some time before home computer enthusiasts will complain about the lack of zero page space in the 68000 as they now complain about the lack of such space in 6502 systems.

The currently high price of the 68000 is a temporary inconvenience which will surely be cured as a number of second sources are now coming on line. The 68000 has been available from Hitachi for some time now, and Rockwell will be selling parts shortly. There are a number of other second sources for this part and it is possible that some of these are already on line without my knowledge. In any event, how cheap must a processor be for use with a system including a 24x90 CRT, a dual floppy disk drive, and a good quality printer?

I would be very much interested to hear of other persons' experiences with the 68000 and I am very willing to exchange software and other information on the 68000 with anyone who does not plan to compete with us by manufacturing environmental noise monitors! (I emphasise the word *exchange*.)

(Since writing this, Hal has gone on to develop an add-on board which gives 68000 power to the 8032 SuperPET; he's selling this for $600 in the States but it's not yet available in this country. If you want to contact Hal, write directly to him at Digital Acoustics Inc, 1415 E McFadden, Suite F, Santa Ana, CA92705, tel (714) 835 4884 —Ed.)

sinclair ZX81 PERSONAL COMPUTER



Sinclair ZX81 Personal Comp
the heart of a system that grows with you.

1980 saw a genuine breakthrough – the Sinclair ZX80, world's first complete personal computer for under £100. Not surprisingly, over 50,000 were sold.

In March 1981, the Sinclair lead increased dramatically. For just £69.95 the Sinclair ZX81 offers even more advanced facilities at an even lower price. Initially, even we were surprised by the demand – over 50,000 in the first 3 months!

Today, the Sinclair ZX81 is the heart of a computer system. You can add 16-times more memory with the ZX RAM pack. The ZX Printer offers an unbeatable combination of performance and price. And the ZX Software library is growing every day.

Lower price: higher capability
With the ZX81, it's still very simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same micro-processor, but incorporates a new, more powerful 8K BASIC ROM – the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays.

And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, *and* to drive the new ZX Printer.

New BASIC manual

Every ZX81 comes with a comprehensive, specially-written manual – a complete course in BASIC programming, from first principles to complex programs.

Kit: £49.95

Higher specification, lower price – how's it done?
Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80!

New, improved specification

- Z80A micro-processor – new faster version of the famous Z80 chip, widely recognised as the best ever made.
- Unique 'one-touch' key word entry: the ZX81 eliminates a great deal of tiresome typing. Key words (RUN, LIST, PRINT, etc.) have their own single-key entry.
- Unique syntax-check and report codes identify programming errors immediately.
- Full range of mathematical and scientific functions accurate to eight decimal places.
- Graph-drawing and animated-display facilities.
- Multi-dimensional string and numerical arrays.
- Up to 26 FOR/NEXT loops.
- Randomise function – useful for games as well as serious applications.
- Cassette LOAD and SAVE with named programs.
- 1K-byte RAM expandable to 16K bytes with Sinclair RAM pack.
- Able to drive the new Sinclair printer.
- Advanced 4-chip design: micro-processor, ROM, RAM, plus master chip – unique, custom-built chip replacing 18 ZX80 chips.

Built: £69.95

Kit or built – it's up to you!
You'll be surprised how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9 V DC nominal unregulated (supplied with built version).

Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.

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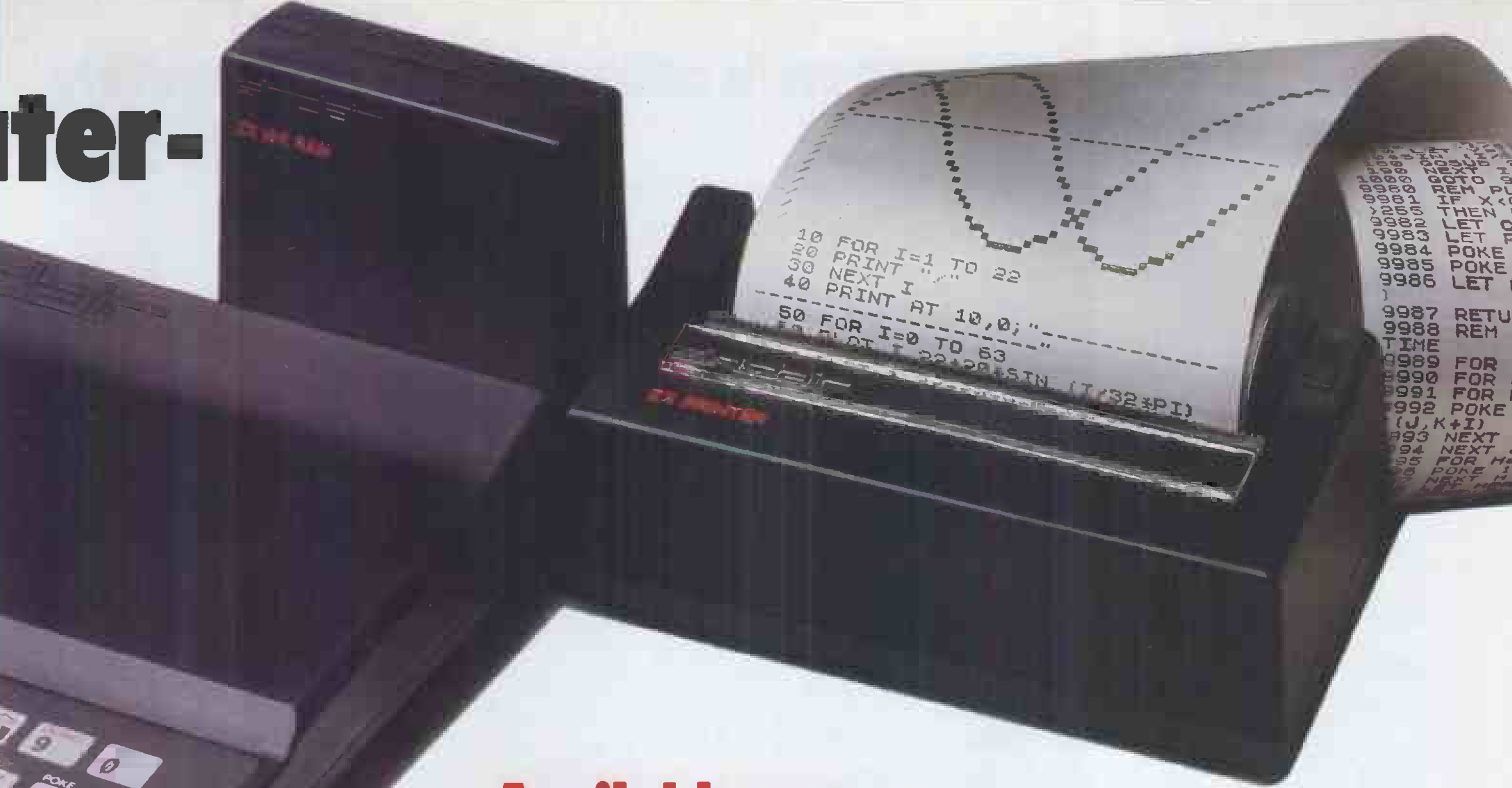

Available now-
the ZX Printer for only £49.95

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alpha-numerics *and* highly sophisticated graphics.

A special feature is COPY, which prints out exactly what is on the whole TV screen without the need for further intructions.

At last you can have a hard copy of your program listings – particularly useful when writing or editing programs.

And of course you can print out your results for permanent records or sending to a friend.

Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your computer – using a stackable connector so you *can* plug in a RAM pack as well. A roll of paper (65 ft long x 4 in wide) is supplied, along with full instructions.

16K-byte RAM pack for massive add-on memory.

Designed as a complete module to fit your Sinclair ZX80 or ZX81, the RAM pack simply plugs into the existing expansion port at the rear of the computer to multiply your data/program storage by 16!

Use it for long and complex programs or as a personal database. Yet it costs as little as half the price of competitive additional memory.

With the RAM pack, you can also run some of the more sophisticated ZX Software – the Business & Household management systems for example.

How to order your ZX81

BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day.

BY FREEPOST – use the no-stamp-needed coupon below. You can pay by cheque, postal order, Access, Barclaycard or Trustcard.

EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

To: Sinclair Research Ltd, FREEPOST 7, Cambridge, CB2 1YY. **Order**

Qty	Item	Code	Item price £	Total £
	Sinclair ZX81 Personal Computer kit(s). Price includes ZX81 BASIC manual, excludes mains adaptor.	12	49.95	
	Ready-assembled Sinclair ZX81 Personal Computer(s). Price includes ZX81 BASIC manual and mains adaptor.	11	69.95	
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	10	8.95	
	16K-BYTE RAM pack.	18	49.95	
	Sinclair ZX Printer.	27	49.95	
	8K BASIC ROM to fit ZX80.	17	19.95	
	Post and Packing.			2.95

☐ Please tick if you require a VAT receipt TOTAL £______

*I enclose a cheque/postal order payable to Sinclair Research Ltd, for £______

*Please charge to my Access/Barclaycard/Trustcard account no.

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Name: Mr/Mrs/Miss | | | | | | | | | | | | | | | | | | | |

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FREEPOST – no stamp needed. PCW 10

sinclair ZX81

6 Kings Parade, Cambridge, Cambs., CB2 1SN. Tel: (0276) 66104 & 21282.

How the ZX81 compares with other personal computers

SYSTEM IDENTIFICATION		ZX81	ZX80	ACORN ATOM	APPLE II PLUS	PET 2001	TRS 80 LEVEL I	TRS 80 LEVEL II
ROM		8K	4K	8K	8K	14K	4K	12K
GUIDE PRICE	Basic unit – inc. VAT	£70	£100	£175	£630	£435	£290	£375
	Unit plus 16K RAM (*12K RAM)	£120	£150	£285*	£630	£530	£360	£375
COMMANDS	LIST, LOAD, NEW, RUN, SAVE	●	●	●	●	●	●	●
STATEMENTS	PRINT, INPUT, LET, GOTO, GOSUB/RETURN, FOR/NEXT IF/THEN	●	●	●	●	●	●	●
	STEP	●		●	●	●	●	●
	TAB	●			●	●	●	●
ARITHMETIC	ABS, RND	●	●	●	●	●	●	●
FUNCTIONS	INT	●			●	●	●	●
	ATN, COS, EXP, LOG, SGN, SIN, SQR, TAN	●			●	●		●
	ARCSIN, ARCOS	●						
STRING	CHR$	●	●		●	●		●
FUNCTIONS	LEN	●		●	●	●		●
	ASC(CODE), STR$, VAL, INKEY$	●				●		●
NUMBERS	FLOATING PT $\pm 10^{\pm 38}$	●			●	●	●	●
	INTEGERS		●	●	●	●		●
NUMERIC	A-Z			●			●	
VARIABLES	AA-ZØ				●	●		●
	An-Zn, n=any alphanumeric string	●	●					
STRING	A$ & B$						●	
VARIABLES	A$ to Z$	●	●	●				
	An$ to Zn$ n=any alphanumeric character				●	●		●
NUMERIC	SINGLE DIMENSIONAL		●	●			●	
ARRAYS	MULTI DIMENSIONAL	●			●	●		●
DISPLAY	ROWS	24	24	16	24	25	16	16
	COLUMNS	32	32	32	40	40	64	64
	LOW RES GRAPHICS (<7000 pixels)	●	●	●	●	●	●	●
	HI RES GRAPHICS (>40000 pixels)			●	●			
SPECIAL	USR (CALL, LINK)	●	●	●	●	●		●
FEATURES	PEEK, POKE (OR EQUIV)	●	●	●	●	●		●

Sinclair software on cassette.

The unprecedented popularity of the ZX Series of Sinclair Personal Computers has generated a large volume of programs written by users.

Sinclair has undertaken to publish the most elegant of these on pre-recorded cassettes. Each program is carefully vetted for interest and quality, and then grouped with others to form single-subject cassettes.

Software currently available includes games, junior education, and business/household management systems. You'll receive a Sinclair ZX Software catalogue with your ZX81 – or see our separate advertisement in this magazine.

The ultimate course in ZX81 BASIC programming.

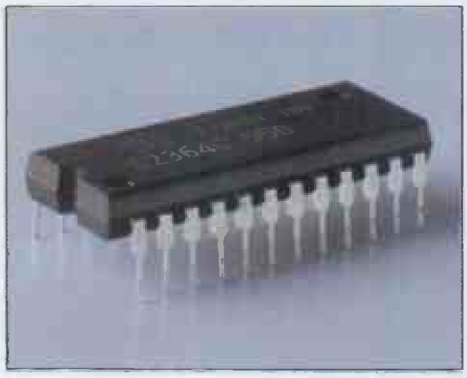
Some people prefer to learn their programming from books. For them, the ZX81 BASIC manual is ideal.

But many have expressed a preference to learn *on* the machine, *through* the machine. Hence the new cassette-based ZX81 Learning Lab.

The package comprises a 160-page manual and 8 cassettes. 20 programs, each demonstrating a particular aspect of ZX81 programming, are spread over 6 of the cassettes. The other two are blank practice cassettes.

Full details with your Sinclair ZX81.

If you own a Sinclair ZX80...



The new 8K BASIC ROM used in the Sinclair ZX81 is available to ZX80 owners as a drop-in replacement chip. (Complete with new keyboard template and operating manual.)

With the exception of animated graphics, all the advanced features of the ZX81 are now available on your ZX80 – including the ability to drive the Sinclair ZX Printer.

sinclair
ZX81

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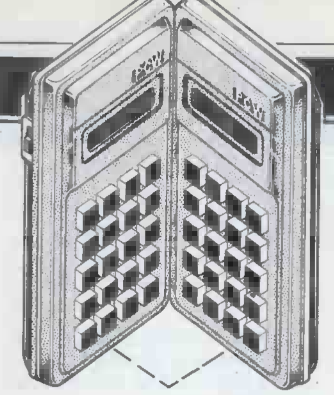


CALCULATOR CORNER

Compiled by Dick Pountain.

Yet more from Casio

A veritable deluge of new product from Casio this autumn continues with the fx-702p and fx-9000p.

The 702p is Casio's reply to the Sharp PC1211. The sales literature shows a machine of similar 'sideways' format to the PC1211, but with an alphabetical order rather than QWERTY keyboard. The language is Basic, memory is 1888 bytes and many of the stats and maths functions are carried over from the calculators, including regression analysis. A printer will be available and the price will be around £115.

The fx-9000 is a microcomputer with built in VDU, but may interest calculator users since it works to calculator precision, unlike most micro Basics. It, too, has many built in maths and stats functions; a direct calculator mode plus program storage by removable CMOS RAM modules and an optional matrix handling Basic make it clear that Casio is aiming at scientific rather than hobby or business users. The price is expected to be PET-like. See Benchtests on both machines here soon.

500 Fanfare

A user group has been formed for Casio fx-501/502p owners, and the first issue of its newsletter *500 Fanfare* has just reached me. It contains several games programs plus a nice gossip column and I hope it will go far, which seems likely given the volume of mail I receive from 500 owners.

The first issue contains amusingly slighting references to my good self, speculating on my existence or otherwise, due to my poor record of answering letters and/or publishing readers' programs. To set the record straight, I do exist after a fashion, but lack of time prevents my answering letters, and of space my publishing any but the most unusual of programs.

Get your copy by sending a stamped addressed envelope to: Max Francis, 38 Grymsdyke, Great Missenden, Bucks HP16 0LP. Tel: 02406 5436.

Texas quirk

The Texas TI-51-III is a budget-priced (£20.25) and programmable calculator, which is also subject to alphanumeric quirks, as discovered by Iain Stewart of Alva, Scotland. Here is his own account of how to extract the alphas from it.

Enter the number — 1858 into memory 9 and then (even though there is nothing in the (program) press 2nd R/S, the run/stop instruction, and a capital 'A' will appear on the screen! Now switch off/switch on, and repeat the above with:
−1648 which gives a small 'b'; or − 1748 which gives a capital 'C'; or − 1848 which gives a small 'd'.
More interestingly, after whichever one of the above four sequences you want, press CE and *then* press any random string of numbers. . . eg, 4418365. Sure enough, the A or b or C or d will be pushed along the screen — just as if it was a legitimate number! It is also easy to get several letters on to the screen at once — in fact, even to fill the screen with letters.

Let's say that you want 'bbC' on your screen, for instance. Well, first I must digress a little. These four numbers above (−1858 for A, etc) have the following values, ignoring the −1 at the beginning and the 8 at the end: −85 for A; 64 for b; 74 for C; and 84 for d. Henceforth I will refer to these middle portions as the 'codes' for each letter.

Digression over; no for the crucial point. *The codes can be strung together to give character strings.* Thus the code for bbC, which was my example above, is simply 646474. Now re-attach the −1 and the 8 to this code. . . to get, in the case of bbC, the number −16464748. Switch off/switch on and enter *this* number into memory 9; press 2nd R/S as before and — hey presto — the string bbC appears on the screen! Now press CE and *then* press 3 — and the screen now reads bbC3, the channel on TV which we're all hoping will come soon. (Continue pressing some more numbers and you can have bbC37582 if you want.)

I'll come back later to how you can fill the whole screen with letters. At the moment, I know, it seems impossible; after all, to get (say) ACbbCdAb you would have to enter −1857464647484-85648 into memory 9, which is far too long. All will be revealed below.

Just why does all this happen? If you enter learn mode at step 00 (by pressing 2nd RST *then* 2nd LRN), and step through the program, then it seems totally empty, hardly surprising since you never touched it! — *until* you reach step 17 or thereabouts, when suddenly you are confronted with the keycode for INV (inverse), followed by a lot of nonsense like 2nd DEG (degree mode, of all things!) or 2nd FIX (fix-decimal format key). This garbage usually continues until roughly step 20, the last piece of the garbage invariably being 2nd COSH (hyperbolic cosine key); from then on the program is empty. Why this should cause letters to appear on the screen is quite beyond me.

It seems plausible that the hexadecimal machine-code ROM has somehow been tapped, although I have never managed to get E or F; perhaps some readers will find a way. Incidentally, if you leave out the minus signs in front of the memory 9 inputs above, then the output is the same sequence of letters, except that there is a number '1' before them; for instance, while − 17485648 gives CAb as expected, 17485648 gives 1CAb. Another point: the terminator number does not *have* to be 8. . . 9 works too. Similarly, in the *positive case only* (ie, without minus sign), the first digit does not *have* to be 1. . . anything except zero works, in which case the chosen digit dutifully appears before the letter string — just as the 1 did, in fact.

I have had no success in unravelling this, but by bashing lots of numbers into memory 9 and running, I have come up with more and more intriguing results. By far the most surprising result I have come across so far is this: enter 1.2374858 STC 9, then enter 3.78 EE 8 +/− SUM 9. Thus 1.0374858378 is now in memory 9. Now press CLR, then press 2nd R/S. Unbelievably, the calculator switches off! There is no way to switch it back on again except to 'really' switch it off and *then* to switch it on again. Do so quickly, because the battery is drained at a terrific rate in the artificial switched-off state.

To fill the screen with letters, proceed as follows: I will use ACbbCdAb as an example. The first four letters in this string are ACbb; code 85746464. Throw in the −1 and 8 as usual, to get −185-7464648; and now throw in a decimal point as well, between the eighth and ninth digits, to get −18574646.48. Store this in memory 9. (Do this by putting −18574646 in first, then pressing .48 INV SUM 9). Similarly, the required number for the second half (CdAb) of the letter string is −17484856.48; store this number in memory *eight* (8). Now enter learn mode at step 00, by pressing 2nd RST 2nd LRN, and *replace* all the empty steps, *and* both the 2nd COSH keys (there will be two of them) by INV — *until* you get to the batch of empty steps after your second encounter with a 2nd COSH. Do *not* replace these with INV; rather, replace the first two of them with 2nd R/S 2nd RST.

Now, after all this, simply press 2nd LRN 2nd RST 2nd R/S. The required letter string will appear on the screen at last.

Trails of leading zeroes are possible — eg, C0000144. I will use this number as an example. To obtain it, press 985 STO 9 — which simply stored 985 in memory 9 — and then press 2nd SST 2nd SST 2nd SST. . . on and on and on like this. After some time (about 20 steps), '9A' will built up on the screen. Keep going; the 9A will soon disappear, leaving a string of zeroes. But don't stop now; keep going until there is a string of *five* zeroes, as required. Then press 144. The display screen will now read 00000144, as was wanted.

For all I know, these discoveries may be only a tiny fraction of the quirks which can be exploited. Perhaps readers will spot more.

Computer world

Kraftwerk's new album 'Computer World' has a track called 'Pocket Calculator' which uses the 502p music facility to good effect. The album is recommended, except to those of nervous disposition.

NEWCOMERS-START HERE

This is our unique quick-reference guide, reprinted every month to help our readers pick their way through the most important pieces of (necessary) jargon found in PCW. While it's in no way totally comprehensive, we trust you'll find it a useful introduction. Happy microcomputing!

Welcome to the confusing world of the microcomputer. First of all, don't be fooled; there's nothing complicated about this business, it's just that we're surrounded by an immense amount of necessary jargon. Imagine if we had to continually say 'numbering system with a radix of 16 in which the letters A to F represent the values ten to 15' when instead we can simply say 'hex'. No doubt soon many of the words and phrases we are about to explain will eventually fall into common English usage. Until that time, *PCW* will be publishing this guide — every month.

We'll start by considering a microcomputer's functions and then examine the physical components necessary to implement these functions.

The microcomputer is capable of receiving information, *processing* it, storing the results or sending them somewhere else. All this information is called *data* and it comprises numbers, letters and special symbols which can be read by humans. Although the data are (yes, it's plural) accepted and output by the computer in 'human' form, inside it's a different story — they must be held in the form of an electronic code. This code is called *binary* — a system of numbering which uses only 0s and 1s. Thus in most micros each character, number or symbol is represented by eight binary digits or *bits* as they are called, ranging from 00000000 to 11111111.

To simplify communication between computers, several standard coding systems exist, the most common being *ASCII* (American Standard Code for Information Interchange). As an example of this standard, the number five is represented as 00110101 — complicated for humans, but easy for the computer! This collection of eight bits is called a *byte* and computer freaks who spend a lot of time messing around with bits and bytes use a halfway human representation called *hex*. The hex equivalent of a byte is obtained by giving each half a single character code (0—9,A—F): 0=0000, 1=0001, 2=0010, 3=0011, 4=0100, 5=0101 . . . . . . E=1110 and F=1111. Our example of 5 is therefore 35 in hex. This makes it easier for humans to handle complicated collections of 0s and 1s. The machine detects these 0s and 1s by recognising different voltage levels.

The computer processes data by reshuffling, performing arithmetic on, or by comparing them with other data. It's the latter function that gives a computer its apparent 'intelligence' — the ability to make decisions and to act upon them. It has to be given a set of rules in order to do this and, once again, these rules are stored in *memory* as bytes. The rules are called *programs* and while they can be input in binary or hex (*machine code* programming), the usual method is to have a special program which translates English or near-English into machine code. This speeds programming considerably; the nearer the *programming language* is to English, the faster the programming time. On the other hand, program execution speed tends to be slower.

The most common microcomputer language is *Basic*. Program instructions are typed in at the keyboard, to be coded and stored in the computer's memory. To *run* such a program the computer uses an *interpreter* which picks up each English-type *instruction*, translates it into machine code and then feeds it into the *processor* for execution. It has to do this each time the same instruction has to be executed.

Two strange words you will hear in connection with Basic are *PEEK* and *POKE*. They give the programmer access to the memory of the machine. It's possible to read (PEEK) the contents of a byte in the computer and to modify a byte (POKE).

Moving on to *hardware*, this means the physical components of a computer system as opposed to *software* — the programs needed to make the system work.

At the heart of a microcomputer system is the central processing unit (*CPU*), a single microprocessor chip with supporting devices such as *buffers*, which 'amplify' the CPU's signals for use by other components in the system. The packaged chips are either soldered directly to a printed circuit board *(PCB)* or are mounted in sockets.

In some microcomputers, the entire system is mounted on a single, large, PCB; in others a *bus system* is used, comprising a long PCB holding a number of interconnected sockets. Plugged into these are several smaller PCBs, each with a specific function — for instance, one card would hold the CPU and its support chips. The most widely-used bus system is called the *S100*.

The CPU needs memory in which to keep programs and data. Microcomputers generally have two types of memory, *RAM* (Random Access Memory) and *ROM* (Read Only Memory). The CPU can read information stored in RAM — and also put information into RAM. Two types of RAM exist — *static* and *dynamic*; all you really need know is that dynamic RAM uses less power and is less expensive than static, but it requires additional, complex, circuitry to make it work. Both types of RAM lose their contents when power is switched off, whereas ROM retains its contents permanently. Not surprisingly, manufacturers often store interpreters and the like in ROM. The CPU can only read the ROM's contents and cannot alter them in any way. You can buy special ROMs called *PROMs* (Programmable ROMs) and *EPROMs* (Eraseable PROMs) which can be programmed using a special device; EPROMs can be erased using ultra-violet light.

Because RAM loses its contents when power is switched off, *cassettes* and *floppy disks* are used to save programs and data for later use. Audio-type tape recorders are often used by converting data to a series of audio tones and recording them; later the computer can listen to these same tones and re-convert them into data. Various methods are used for this, so a cassette recorded by one make of computer won't necessarily work on another make. It takes a long time to record and play back information and it's difficult to locate one specific item among a whole mass of information on a cassette; therefore, to overcome these problems, floppy disks are used on more sophisticated systems.

A floppy disk is made of thin plastic, coated with a magnetic recording surface rather like that used on tape. The disk, in its protective envelope, is placed in a disk drive which rotates it and moves a *read/write head* across the disk's surface. The disk is divided into concentric rings called *tracks*, each of which is in turn subdivided into *sectors*. Using a program called a *disk operating system*, the computer keeps track of exactly where information is on the disk and it can get to any item of data by moving the head to the appropriate track and then waiting for the right sector to come round. Two methods are used to tell the computer where on a track each sector starts: *soft sectoring* where special signals are recorded on the surface and *hard sectoring* where holes are punched through the disk around the central hole, one per sector.

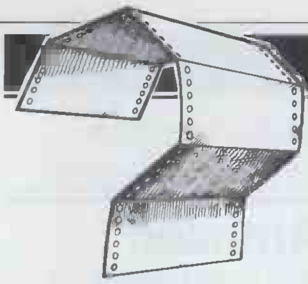
Half-way between cassettes and disks is the *stringy floppy* — a miniature continuous loop tape cartridge, faster than a cassette but cheaper than a disk system. *Hard disk* systems are also available for microcomputers; they store more information than floppy disks, are more reliable and information can be transferred to and from them much more quickly.

You, the user, must be able to communicate with the computer and the generally accepted minimum for this is the visual display unit *(VDU)*, which looks like a TV screen with a typewriter-style *keyboard;* sometimes these are built into the system, sometimes they're separate. If you want a written record *(hard copy)* of the computer's output, you'll need a *printer*.

The computer can send out and receive information in two forms — *parallel* and *serial*. Parallel input/output *(I/O)* requires a series of wires to connect the computer to another device, such as a printer, and it sends out data a byte at a time, with a separate wire carrying each bit. Serial I/O involves sending data one bit at a time along a single piece of wire, with extra bits added to tell the receiving device when a byte is about to start and when it has finished. The speed that data is transmitted is referred to as the *baud rate* and, very roughly, the baud rate divided by ten equals the number of bytes being sent per second.

To ensure that both receiver and transmitter link up without any electrical horrors, standards exist for serial interfaces; the most common is *RS232* (or *V24)* while, for parallel interfaces to printers, the *Centronics* standard is popular.

Finally, a *modem* connects a computer, via a serial interface, to the telephone system allowing two computers with modems to exchange information. A modem must be wired into the telephone system and you need British Telecom's permission; instead you could use an *acoustic coupler*, which has two obscene-looking rubber cups into which the handset fits, and which has no electrical connection with the phone system — British Telecom isn't so uppity about the use of these.



COMPUTER ANSWERS

Send your queries to: Sheridan Williams, 35 St Julian's Road, St Albans, Herts. Please note that Sheridan can no longer answer questions on an individual basis, so please don't send an SAE with your query.

Atom memory

I have heard a serious criticism of the Atom, that it isn't possible to have more than 21k of continuous memory. Is this true? Also could you tell me the Atom's maximum amount of memory and are the 1k RAM sets merely pairs of 2114s? Finally, would it be possible to use the Atom for word processing?
Mark Dunn, London.

Taking your questions in order, it is not true that you are limited to 21k RAM. The maximum continuous RAM is in fact 38k. Of this, most of the bottom 1k is used by the Basic interpreter; 7k is assigned for memory-mapped peripherals, although there is absolutely no reason why you should not put RAM here; the next 2k is used by the DOS if present — otherwise it is unused — followed by 256 bytes of floating point variables; a further 22k is available for Basic programs and the last 6k by the VDU, of which some may be unused, depending on which graphics mode you are using.

The RAM sets are indeed pairs of 2114s. They are, in fact, 450 ns low power devices. It is probably not practical to use the Atom as a word processor at the moment due to the small screen size (16 lines of 32 characters), the lack of true lower case letters, the relatively small memory capacity on board and the current lack of disks. However, Acorn does have an 80 by 24 VDU card which is compatible with the Atom, although as yet there is no software to drive it, and it says that disks are on the way.
Richard Meredith, Atom User Group.

Atom for business

In your review of the Atom you implied that the Atom is not much use for business applications. Why is it unsuitable? Is it lack of RAM or what? Which book would you recommend to assist me in programming for business applications?
S R Wyndham, Reading, Berks.

The main drawback to the use of the Atom in business applications is the non-standard Basic, which makes it very difficult to transfer packages originally intended for other machines to the Atom. Other drawbacks are the small screen size, which makes it difficult to display large amounts of information simultaneously, in a coherent manner and the lack of disks.

These are all problems which can be overcome but the question is, is it worth the complications when compared to other systems, which don't have them to start with?

From the specifications that I have seen, the BBC micro looks as though it will have potential in this area for considerably less cost than it would take to bring the Atom up to the same level.

With the non-standard nature of Atom Basic it is difficult to recommend a suitable book; however, it is the principles involved that are important so any book that deals with this, rather than the actual details of programming, should be helpful.
Richard Meredith, Acorn Atom Users Group.

Acorn produces extension memory boards and many other peripherals, possibly the most useful being the disk interface. It s a very well thought out system that allows direct access files; additionally, any file can be locked under software control. The DOS is particularly impressive.
Alan Taylor

Sorcerer software source sought

I have an Exidy Sorcerer which I have modified to interface with my amateur radio equipment. The mods involve the UART, parallel port, keyboard scan and a tremendous amount of screening.

I have mastered the hardware and written quite lengthy machine code programs but am suffering from a distinct lack of information when it comes to software in general — monitor entry points for example. Can you give me a source of information specifically on Sorcerer software?
F J Mellish, Horsham, W Sussex

There are two parts to your question. Firstly, you need sources of Sorcerer software information, and secondly, amateur radio enthusiasts who have mastered the same problems. Protolec Electronics, 34 Pier Avenue, Tankerton, Whitstable, Kent CT5 2HJ is interested in the Sorcerer and may be able to help. The European Sorcerer Club is C Morle, 32 Watchyard Lane, Formby, Liverpool L37 3JU. Also Liverport Data Products, The Ivory Works, St Ives, Cornwall TR26 2HF, tel 0736 798157, has offered to help. I would have thought that the Radio Society of Great Britain, 35 Doughty Street, London WC1N 2AE might also have been of help.
SW

Sharper Basic

Please could you advise me on how to execute double precision arithmetic from Basic on a Sharp MZ-80K microcomputer?
A I Carruthers, Preston, Lancs.

This is a similar question to one published in the July edition of *PCW* and I will repeat myself; why, if you want to do double precision arithmetic, did you buy a MZ-80K? There are excuses for hobbyists but a serious computer user should have written a specification, *before* he bought a system and chosen a system that met that spec. Anyway, I approached Knight's TV & Computers, 108 Rosemount Place, Aberdeen AB2 4YW (0224 630526), where Graham Knight informed me that he was leaving for Japan to bring back a 16-digit Basic for the MZ-80K and it will be available by the time that you read this.
SW

Chain chance

Could you tell me if it's possible to CHAIN or overlay Microsoft Fortran programs running under CP/M?
R D Redman, Bristol

If you wish to call a variety of subroutines then Microsoft Fortran will readily let you do this, as with mainframe Fortran. However, all these subroutines must reside in memory along with the calling program.

If your objective is to use an overlay technique to run programs too long to fit into memory, the problem is more difficult and is not catered for by Microsoft Fortran on its own. However, Lifeboat Associates has advised that this can now be achieved by using Phoenix Software Associates' Plink-II linkage editor along with the Microsoft Fortran, when operating under CP/M.
P L McIlmoyle

TRS-80 upgrade

How can I upgrade my TRS-80 expansion to 32k from 0k?
Stephen Wood, Blackburn, Lancs

Just plug the RAM chips into the sockets provided. No track cutting is required. Expanding by only 16k means putting the RAM into sockets 9 to 16; trust Tandy to get it back to front.
S Bird, Oxford Micro Club

Insurance with a micro

As an insurance broker I am planning to computerise my office to the extent of a full accounts package and a full range of programs to cover producing documents, statements, reports, etc. The only microcomputers available here in Athens with sufficient support for business use seem to be the Apple II and the full range of Ohio Scientific.

I am contemplating either an Apple or an Ohio C4P or C8P with dual 8in floppies:

a. Are these systems reasonably comparable for my use, or what are the significant differences?

b. Would it be worth paying the extra for a C3 system allowing the use of CP/M? Would the Apple CP/M conversion be just as useful?

c. Could you comment on the use of a Microperipherals 99G matrix printer and a 'refurbished' IBM I/O 735 typewriter for general use and letter quality respectively?

d. A cheap multi-user facility with terminals for the Chief Executive, the accounts department, and a word-processing desk in addition to the central unit sounds attractive. Is this being over ambitious?
E T Moore, Nasco Hellas Ltd, Athens

a. The major difference which strikes me is that the Ohio Scientific machines are part of a large family of computers and associated peripherals, while the Apple II has only the Apple III as stable mate and that is not yet readily available outside the US. So there is perhaps greater scope for moving to bigger machines with Ohio. On the other hand, there is a very wide range of equipment and accessories available for the Apple.

b. In your kind of application there is much to recommend being able to run CP/M, as this makes available a wide range of effective and often competitively priced serious commercial software, either written in machine code (like the very popular WordStar word-processing package) or in one of the wide range of languages for which interpreters or compilers are available to run under CP/M. This includes Cobol, Basic, Pascal, Fortran and APL.

The Apple CP/M conversion should also be effective, as this works by adding a Z80 microprocessor to the Apple! Apart from the wide range of software available, CP/M also makes a file handling simpler.

c. I am sorry that I cannot track down any information on the Microperipherals printer, but any reasonable quality dot-matrix printer should be suitable. It is always good practice not to buy too cheap a printer for serious business use, as quality of the printing and reliability will both be important to you.

While an IBM typewriter can certainly be used for letter quality output, daisywheel printers are more popular, despite their greater price, as they will print at 45 or even 55 characters per second, compared with about 15 cps for the IBM typewriters.

d. If your system will run CP/M and take 'bank-switching' memory cards, a four station multi-user system should be possible. However, it would be wise to leave this until your initial installation has settled down, so as not to try too much at once. Also you should get more reliability, as the multi-user version of CP/M (MP/M) has been withdrawn and is being re-written.

Ohio Scientific's agents should be able to give you advice as to whether other equipment in its wide range can provide such a multi-user system without using MP/M.

P L McIlmoyle

Help with Mael

I have recently parted company with my 16k PET because of its limitations for business use and have acquired a Mael 2000 with a suite of programs suitable for my business.

The Mael is working very well, but I would like a way to put my limited knowledge of programming the PET to work in writing small programs for general use in the office. Could you recommend material to suit the assembler language on the Mael? The manual gives the full instruction codes but it is a far cry from Microsoft Basic!

Patrick J Morrissey, Athlone, Co. Westmeath, Ireland

If indeed you are not being over modest as to your 'limited' knowledge of programming in Basic, assembler language programm programming may well cause many headaches when writing even small business programs. After all, that's exactly why one of the first major 'high-level' languages (Cobol) was invented! It is unfortunate that there are no high level compilers or interpreters available for the Mael 2000, particularly as the Mael 5000 range supports Cobol, Fortran, RPG II and Basic.

While I'm not aware of any books which help directly with writing assembler language programs for the Mael 2000, I can recommend *How To Program Micros* by W Barden Jr. While written around the 8080, 6800 and 6502 microprocessors, this gives much practical advice on programming which, taken together with your Mael manual, should set you on the right road.

Should you decide that you would like certain programs written for you, or to explore a range of ready-written commercial programs for the Mael 2000, then you could contact M and O Business Systems and Software Ltd, Unit 55, Milton Trading Estate, Abingdon, Oxfordshire; as well as writing software, this company is the UK agent for the Mael 2000 (The Mael 5000 range is handled by Dicoll of Basingstoke.)

P L McIlmoyle

Random reward

Could you suggest a method for obtaining a convincing 'RND' product on MBasic 5.03? MBasic has been altered so that a 'seed' input is now required. My kids know the effect of various seeds and the fun is spoiled as a result.

R Reason, 24 Mitchell Rd, Camborne, Cornwall TR14 7JH.

Mr Reason has promised a £10 reward for the best answer, which will be published. Send your answers directly to him at the above address.

SW

Just to pre-empt the wise guys, we published two machine code subroutines to obtain random numbers in 'Sub Set'. The routine on page 136 of April's issue (Vol 4 no 4) works on the Z80 only and gives a number in the range 0-127; that on page 145 of July's issue (Vol 4 no 7) gives a 16-bit random number and works on the Z80 and 8080/85. It might be possible to patch one of these into MBasic — or maybe someone has a better solution? — Ed.

A/D for '80?

Does anyone make a multi-channel A-to-D converter for the TRS-80 level II?

R H Walker, Cheadle Hulme, Cheshire.

Yes, you can get one from Magnus Microcomputers, 139 The Moors, Kidlington, Oxford OX5 2AF.

S Bird, Oxford Micro Club

Amazed

I was amazed by your comment in the May issue of *PCW* that for a simple word-processing system you would prefer a TRS-80 to a 'widescreen Superboard C1E with CECMON.

Which of the features of the TRS-80 make it superior for this application, bearing in mind the restricted display area, the quality of the lower case letters and the cassette loading problems of the Tandy? Not to mention the more reliable keyboard and greater speed of the Superboard!

S Graham, Belfast

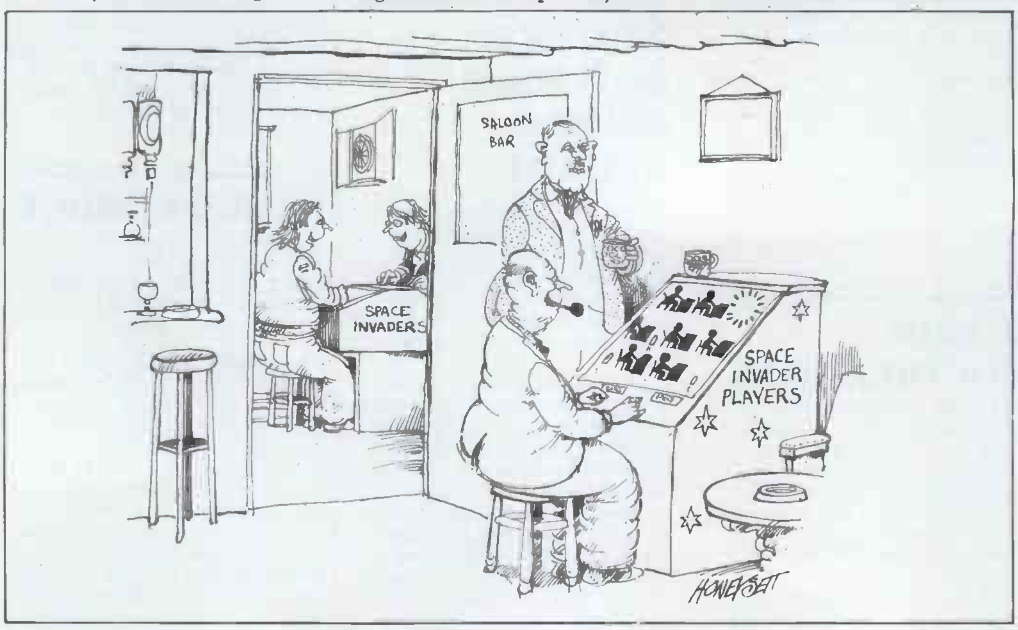
Please remember that I said that my personal preference was for the TRS-80, not that I was making a recommendation.

So far as I am concerned the Tandy scores particularly on ready expandability. I use the genuine Tandy lower-case conversion and find the lower-case letters on the screen to be all that can be desired, with true-descenders, and a clear font. As I use disks, I avoid the admitted problems with tape-loading. I find it hard to see that serious business word-processing could be done using tapes alone.

I use Newdos as the disk operating system overcomes all problems with keyboard bounce. The speed of the TRS-80 model one seems quite adequate for word-processing but it can be upgraded if you wish.

Finally, I like the word-processing packages available for the TRS-80, in particular Electric Pencil and Scripsit.

P L McIlmoyle



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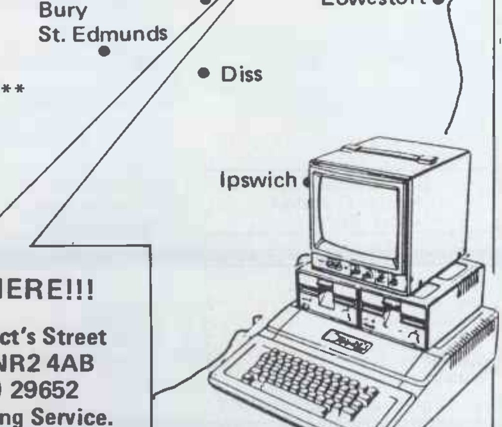

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the correspondent

by R. Wagner

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DIRECT ACCESS

IN STORE

'In Store' has been completely updated this month to bring you the very latest from the micro marketplace. I would like to thank all distributors listed for their prompt and comprehensive responses to our enquiries, an indication of the confidence invested in PCW *as a shop window. Any additions or alterations should be addressed to me,* Dick Olney, *PCW*, 14 Rathbone Place, London W1P 1DE.

Machine (Price from)	Main Distributor/s (No. of Dealers)	Hardware	Software	Miscellaneous (Documentation)
ABC 80 (£738)	Datormark Ltd: 97 44896	16-40k RAM; Z80A; C; 12", 16 x 40 b&w VDU; 4680 bus; IEEE 488; RS232 port.	DOS; Basic (16k ROM; *Fortran; Pascal; A; Multi user Basic.*	Colour video graphics with UHF output. Viewdata compatible. Loudspeaker. Numeric keypad. Options: dual 5¼" F/D (320k) £895; dual 8" F/D (2 Mb). BT 1/80. (I)
ACT Series 800 (£3495)	ACT: 021-501 2284 (50)	48k RAM: 6502; dual 5¼" F/D (800k); 12", 30 x 64 VDU; 1 S/P; 1 P/P; Multi-screen int. Option: 10-20 Mb H/D	MDOS; Basic; A; *CBasic;* PL/M; *Forth; Fifth; Cesil; Pilot; Fortran.*	IBM compatible K/B. High resolution graphics. Available with dual 8" F/D (2.4 Mb) £4950 — 4.8 Mb maximum. BT 2/80 (E).
Adler Alphatronic (£1600)	Adler 01-250 1717	48k RAM: 8085Asingle 5¼" F/D (160k): 12", 24 x 80 VDU: S/P: P/P	*CP/M: Basic: CBasic: Fortran: Cobol*	With 80 cps printer and dual F/D £2345 (inc CP/M). (S)
Alpha Micro (£5650)	Alpha Micro (UK) Ltd: 01-250 1616 (TBA)	64k — 1 Mb RAM; 16 bit; dual 8" F/D (2.4 Mb); 6 S/P.	Multi-user OS; Basic; M/A; Pascal; U. *Fortran: Cobol*	Modular. Expands to 1200 Mb, 24 terminals or multiprocessor system. (E)
Altos ACS 8000 (£3398)	Logitek: 02572 66803 (33)	64k RAM; Z80; 1k EPROM; dual 8" F/D (1 Mb); 2 x RS232 ports; 1 P/P.	CP/M; *Basic; CBasic; Cobol; Pascal; Fortran.*	Expandable to 4-user system with 58 Mb H/D. Maintenance contracts avail; BT 5/80 (S&H).
APL Signet (£1750 or £130pm)	Micro APL: 01-834 2687	64k RAM: Z80A: dual 5¼" F/D (380k): 2 x RS232 ports.	CP/M: APL: *Basic: U: Fortran: Cobol: Algol: Forth*	Desktop APL computer with self teaching course. (S)
Apple II (£695)	Microsense: 0442 41191 (190)	16-48k RAM; 6502; 8 I/O slots.	OS; Basic; *Pascal; Fortran: Cobol: Pilot*	280 x 192 high resolution graphics; Integer Basic in 6k ROM; Option: single 5¼" F/D (116k) £349.
Atari 400 (£345-16k)	Ingersoll: 01-226 1200 (40)	16k RAM; 6502; C int; cartridge slot; 12 x 20 TV int; RS232C port; touchpad k/b; Opt: C £40.	OS (10k ROM); Basic (8k ROM). *Pilot: Forth.*	High resolution colour graphics. 4-channel sound. Four games controller/light pen sockets.. BT 10/80. (I/B).
Atari 800 (£645-16k)	As above.	16-48k RAM; 6502; C int; 4 x cartridge slots; 12 x 20 TV int; RS232C port. Opt: single 5¼" F/D (90k) £345; 16k RAM £65.	As above.	As above. Software & RAM on cartridge modules. Up to 4 disk drives. BT 10/80. (I/B).
Athena 8285 (£5694)	Butel-Comco Ltd: 0703 39890 or 01-202 0262 (TBA)	64k RAM; 8085A; dual 5¼" F/D (644k); 12" 25 x 80 VDU; 150 cps printer; RS232 port.	AMOS; T/E; Basic; *Cobol; Fortran; Pascal; APL; M/A.*	Extended ASCII K/B with numeric pad; graphics. Options: dual 8" F/D (2 Mb); up to 1200 Mb H/D.
Atom (£120)	Acorn: 0223 312772 (35)	2-12k RAM; 8-16k ROM 6502; Full K/B: C int; TV int; 20 I/O lines; 1 P/P.	Basic in 8k ROM; A Cass O/S.	High resolution graphics on bigger model; colour monitor O/P. Loudspeaker. Note also, systems based on Acorn SBC. BT 7/80 (B).
Attache 201 (£8000)	COLT 01-572 3784 (10)	64k RAM; Z80; dual 8" F/D (2.4 Mb); 12" 24 x 80 VDU; 180 cps printer.	Basic; *Fortran; Cobol.*	Upgradable to multiuser system with 18 Mb H/D. Full range of business packages included software dealers TBA. (S)
BASF 7120 (£3600)	BASF: 01-388 4200 (12)	64k RAM; Z80A; 3 x 5¼" F/D (480k); 12", 24 x 80 VDU; RS232 port; P/P.	DOS;(OASIS) *Ex Basic; Cobol U. A: CP/M*	H/D available soon. Also 7125 with 930K F/D £4280 and 7130 with single F/D (430k) & 5Mb H/D £4950. Disk controller has own Z80A. BT 9/80
Billings BC-12 FD: (£3995)	Mitech: 04862 23131 (TBA)	64k RAM; Z80A; dual 5¼" F/D (640k); 12", 24 x 80 b&w (or b&g) VDU.	DOS; Basic; *Fortran; Cobol; A.*	With dual 8" F/D (2 Mb) £5995. Additional dual 8" F/D £3000 option: 50MB H/D. (S).
C/09 (£3975)	SWTP Ltd: 01-491 7507 7507 (16)	56k RAM; 6809; dual 8" F/D (2 Mb); 8", 16 x 80 VDU; 1 S/P.	TSC FLEX; *Basic; Pascal; A; Dis A; T/E; U.*	VDU is intelligent. Option: 15 Mb H/D £3575; with dual 5¼" F/D (350k) instead of 8", £3000. (H)
Canon BX-1 (£3850)	Canon Business Machines (UK) Ltd: 01-680 7700.	64k RAM; 6800; Single 5¼" F/D (65k); 12", 25 x 80 VDU; 5 x V24 ports.	DOS; Ex Basic; A.	Also supplied with integral thermal printer instead of VDU. (S&H)
Challenger 1P & C4P (£220 & £395)	CTS: 0706 79332. Millbank Computing: 01-549 7262. Mutek: 0225 743289. U-Microcomputers: 0925 54117 (18)	4-32k RAM; 6502; C int; RS232 port. Options: dual 5¼" F/D (160k) £550; for C4P dual 8" F/D (1.15 Mb) and 20MB H/D	O/S; Basic (8k ROM) *Ex Basic;* A.	D/A conv; colour capability. Runs OSI business software on 8" F/D Plato educational software avail. soon. BT 4/80. (S).
Challenger 2 (£1500)	As above	48k RAM; 6502; dual 8" F/D (0.5 Mb); RS232 port.	OS65U; Ex Basic; A.	Designed as low cost business system (S).
Challenger C3 (£2334)	As above	32-56k RAM; 6502; 6800; Z80; dual 8" F/D (1.15 Mb); 2-16 S/P.	OS65U; Basic; *CP/M; Fortran; Cobol.*	Expandable to multi-user (8) system. Options: C3B & C3C H/D units. 74 Mb for about £8500. (S&H).
Clenlo Conqueror (£2475)	Clenlo Computing Systems Ltd: 01-670 4202 (TBA)	64k RAM; Z80; dual 8" F/D (1 Mb); 3 S/P; 2 P/P.	CP/M; CBasic-2; Pearl 1; *U. Fortran: Cobol: Pascal*	With 2.4Mb F/D £2950. Also H/D systems with 10 Mb H/D & tape drive £5430.

List of Abbreviations

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C	Cassette	H/D	Hard disk	N/P	Numeric pad	T/E	Text editor
E	Extensive	I	Introductory	O/S	Operating system	TBA	To be announced
F/D	Floppy disk	Int	Interface	P/P	Parallel port	U	Utility

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IN STORE

DIRECT ACCESS

Machine (Price from)	Main Distributor/s (No. of Dealers)	Hardware	Software	Miscellaneous (Documentation)
Comart Communicator (£1995)	Comart 0480 215005 (25)	64k RAM: Z80A: daul 5¼" F/D (780k): 2 S/P: P/P.	CP/M: *Basic: Cobol: Fortran: Pascal*	With 1.5 Mb F/D £2295. Option: 18 Mb H/D. £3395 (S)
Compucolor II (£1175)	Dyad Developments: 08446 729 (TBA)	16-32k RAM; 8080; 13" 32 x 64 8-colour VDU; single 5¼" F/D (51k); RS232 port.	DOS (ROM); Ex-Basic (ROM); A. *M/A: T/E: Fortran: U*	32k version £1295. High resolution graphics. 6-month subscription to user magazine inclusive BT 9/79. (S)
Compucorp 625 (£6000)	Compucorp: 01-952 7860 7860 (17)	48-60k RAM; Z80; dual 5¼" F/D (630k); 9". 16 x 80 VDU; 40 col printer; RS232 port, P/P.	Basic: A; *Fortran; Pascal;* U.	IEEE-488 Controller and S100 int. Many applications packages avail. (E)
Compucorp 655/ 665/675/685 (from £5050)	As above	60k RAM; Z80; Up to 4 x 5¼" F/D (160k-2.4 Mb); 9", 20 x 80 or 12" 20 x 80 or 20" 60 x 80 VDU; 40-col printer; RS232 port.	As above	Prices incl installation and training. Opt: 10-20 Mb H/D
Computermart 2000 DS (£1500)	Computermart: 0603 615089	32-256k RAM. 8085; dual 8" F/D (1-2 Mb); S/P; P/P.	CP/M; *Cis Cobol; Basic; Fortran*	Expandable to multi-user, multi-tasking, multi-processor 96 Mb H/D system (around £15000).
Cromemco System 2, System 3, System Z2H. (£2900/ £4400/£6000)	Datron: 0742 585490. Comart: 0480 215005. MicroCentre: 031-556 7354 (18)	64k RAM; Z80; dual 5¼" F/D (346k) on System 2 & Z2H; dual 8" F/D (1.2 Mb) on Sys 3; 10 Mb H/D on Z2H; S/P; P/P.	CDOS; *Basic; Cobol; Fortran; RPG II; Lisp; A; W/P; Multi-user Basic.*	All systems expandable to multi-user (max 6) Options: dual 8" F/D (996k); 11-22 Mb H/D. BT 10/79 (E).
DAI (£998-48k)	Data Applications (UK): 0285 2588 (7)	48k RAM; 8080; C int; 24 x 60 VDU int; RS232 port; over 20 industrial ints.	Basic (ROM); U.	Colour graphics up to 255 x 335; 3 notes & noise generator; PAL O/P to TV; Paddle int; H maths option. (I). BT 10/80
Diablo 3000 (£6950) (TBA)	Business Computers Ltd: 01-207 3344	32k RAM; 8085; dual 8" F/D (1.3 Mb); 12", 24 x 80 b&w VDU; 45 cps printer.	DOS; Basic; DACL; A; U.	Selection of business packages included (S).
Digital Micro-systems DSC-3 (£3530)	Modata: 0892 41555 (14)	64k RAM; Z80A; dual 8" F/D (1.14 Mb); 4 x RS232 ports; EIA port.	CP/M; CBasic: *Cobol; Fortran: Pascal: PL/I*	Expandable to multiuser system with 10-28 Mb H/D. Extensive software avail. (S)
Digital Micro-systems DSC-4 (£4395)	As above	128k RAM; Z80A; single 8" F/D (500k); 11 Mb H/D; 4 x RS232 ports; 2 P/P.	CP/M; Basic-E; CBasic; *Cobol; Fortran; Pascal.*	Also DSC-3 with 64k RAM. Options; 128k RAM £1295; up to 4 Mb F/D and 20 Mb. H/D. (H).
Durango F-85 (£4995)	Comp Ancillaries: 0784 36455 (12)	64k RAM; 8085; dual 5¼" F/D (1 Mb); 9", 16 x 64 green VDU; 132 col 165 cps printer; N/P.	O/S; DBasic; *CP/M; CBasic; Micro Cobol.*	Up to 5 work stations; fully integrated system. Options: additional dual 5¼" F/D (1 Mb); 12-24 Mb H/D. (S).
Dynabyte 5200 5900 (£2600)	Metrotech 0895-57780 (15)	64k RAM; Z80; S100 bus; 2 ser ports; 1 par port; any com of 5¼" F/D (630k), dual 8" F/D (1Mb), 9/27/45 Mb H/D, 32/64/96 Mb Cart Module Disk.	CP/M; MP/M; CP/Net, CBasic, MBasic Cobol, Fortran, Pascal, PL/1-80	All systems expandable to multi-user and net working; CP/M inc in base price for F/D systems, MP/M for H/D systems.
Equinox 200 (£7500)	Equinox: 01-739 2387 (N/A)	64-512k RAM; Z80; 10 Mb-1200 Mb H/D; 6 x S/P; 1 P/P.	CP/M; CBasic; *Cobol; Fortran.*	Multi-user MVT/FAMOS available in place of CP/M. 16-bit version (Equinox 300) £10,000. (S&H).
Exidy Sorcerer (£695)	Liveport Data Products: 0736 798157 (27)	48k RAM; Z80; RS232 port; 1 P/P; S100 connector; 30 x 64 VDU int. - N/P	O/S; Basic (ROM); *T/E; A; CP/M; Algol; Fortran; Basic; 80. Pascal: W/P*	High-resolution graphics capability; user programmable character set. Option: single 5¼" F/D (316k) £600
Gemini 801 (£1075)	*Gemini: 02403* 22307 (7).	*64k RAM; Z80A; Single 5¼" F/D* (315k); 25 x 80 VDU int; RS232 port. P/P.	*CP/M Basic; Cobol; Fortran; Pascal; A; T/E.*	Up to two integral & two exterrial F/D. Graphics. With no F/D and C int. £750. (S)
Gimix System 68 (£2000)	SEED: 05433 78151: Windrush 0692 405189	16-64k RAM: 6800/6809: dual 5¼" F/D (500k): 2 x RS232 ports.	OS-9: Flex *Basic: Pascal: A; Dis A: T/E: U*	With dual 8" F/D (2 Mb) £2900. Designed as development system for industrial control. (H).
Haywood 3000 (£1925)	Haywood: 01-428 0111. (TBA)	32-64k RAM; Z80A; dual 5¼" F/D (800k); RS232 port; P/P. Opt: 15" 28 x 80 VDU £799.	CP/M; *Basic; Cobol; Fortran; Pascal; W/P.*	Also system 7000 with 48-65k RAM and 8" F/D /2.5 Mb) £2999. (S)
HP 85 (£1830)	Hewlett Packard Ltd: 0734 784774 (16)	16-32k RAM; C.P.U.; 5", 16 x 32 VDU; C (200k): 64 cps printer; 4 P/P. Options: dual 5¼" F/D (540k) £1408; dual 8" F/D (2.4 Mb) £3744.	Basic (ROM)	Full dot matrix graphics. Complete range of interfaces, peripherals and application packages avail. 16k RAM £222. (S).
IMS 5000 (£1500)	Equinox: 01-739 2387 (20)	16-56k RAM; Z80; dual 5¼" F/D (320k); 2x S/P; 1 P/P;	CP/M; C/Basic; *Cobol, Fortran.*	3 drives option: (S&H).
IMS 8000 (£2500)	As above	64-256k RAM; Z80; dual 8" F/D (1 Mb); 2 x S/P; 1 P/P	CP/M; CBasic; *Cobol; Fortran; MicroCobol.*	Multi-user MVT/FAMOS available in place of CP/M. (S&H).
Intecolor 8000 (£2999)	Dyad Developments: 08446 729(TBA)	8-32k RAM: 8080: 19", 80 x 48 colour VDU: single 5¼" F/D (90k): Option: up to 26 Mb H/D.	DOS(ROM): Ex-Basic: *A: M/A: T/E: Fortran: U*	High res graphis avail: Many options including size of F/D and VDU. (S).
ITT 2020 (£867)	ITT: 0268 3040 (15)	16-48k RAM; 6502	Monitor; A; ExBasic; Dis A.	360 x 192 high res graphics. Ex-Basic in 6k ROM; Options: single 5¼" F/D (116k), £425; 16k RAM, £110; RS232 port, £96; 32k system, £931: 48k system. £995. (B).
Ithaca DPS1 (£3995)	Ithaca: 01-341 2447 (10).	64k RAM; Z80; dual 8" F/D 1 Mb); 2 x RS232 ports; 4 x P/P. Opt: H/D.	CP/M; *Basic; Cobol; Fortran; Pascal; A; U.*	Z8000 16-bit processor board avail. IEEE/S100 (8 or 16 bit) compatible. (E).
LX-500 (£3500)	Logabax Ltd: 01-965 0061 (13)	32k RAM; Z80; dual 5¼" F/D (180k); 12" 25 x 80 b&w VDU; 100 cps printer.	DOS; Basic; A.	Other printers available. (S).

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IN STORE

Machine (Price from)	Main Distributor/s (No. of Dealers)	Hardware	Software	Miscellaneous (Documentation)
LSI M-One (£4200)	LSI Computers: 04862 23411 (20)	8-16k RAM; 8080; dual 8" F/D (1.2 Mb); 12", 24 x 80 b&w VDU	FMOS; A	Choice of standard business packages included in price. (S).
LSI M-Two (£7900)	As above	64-128k RAM; 8085A; dual 8" F/D (1.2 Mb); 12", 24 x 80 VDU; 60 cps printer	Elsie; *CP/M; Basic; Cobol Fortran; Pascal; A; U*	Max 8 VDUs and 4 printers. Many applications packages available. Option: 10 Mb H/D £2600. (S)
Macro 1 (£3950 or £294 pm).	Micro APL Ltd. 01-834 2687 (TBA)	64k RAM; Z80A; dual 8" F/D (1 Mb); 4 x RS232 ports.	CP/M; APL; U; *Basic; Fortain; Cobol; Word-2star Algo*; **Pascal; Forth**.	Designed as timesharing replacement. Macro 2 with 2 Mb F/D £4750 or £334 pm.
Megamicro (£6080)	Bytronix: 0252 726814(5)	56k RAM; Z80; dual 8" F/D (500k); 12", 20 x 80 green VDU; 180 cps printer; 2 S/P; 2 P/P.	CP/M; U; *Basic; A; M/A*.	Range of bus. packages now avail. from Ludhouse of Streatham. (H&B).
Micro Trainer 1 (£650)	Hewart; 0625 22030 (N/A)	16-32k RAM; 6800/6809; 10" 16 x 24 VDU; 2 x C int; Opt: dual 5¼" F/D (160k) £595; 8k RAM £17.	Basic; A; *Pascal; PL/M; W/P*	SS50-based system. Graphics avail. Int card with real time clock £17. (I)
Microstar 45 Plus (£4800)	Data Efficiency Ltd: 0442 63561 (30)	64k RAM; 8085; dual 8" F/D (1.2 Mb); 3 S/P; RS232 port	Stardos; CP/M; Basic; *Cobol; Fortran*	(E)
Microtan 65 (£69)	Tangerine: 0353 3633 (6)	2k RAM; 6502; T Mint; Exp up to 277k RAM.	2k TANBUG monitor; 2k A, disassembler, cassette firm ware; *10k Microsoft Ex Basic*.	Options: bulk I/O modules, hi-def graphics, CP/M, system racking, ASCII keyboard. Prestel adaptor (S&H)
Millbank Sys 10 (£2995)	Millbank: 01-788 1083 (6).	65k RAM; Z80; dual 5¼" F/D (700k; 12", 24 x 80 VDU; 2 x RS232 ports; RS4449 port; P/P.	CP/M; *Basic; Cobol; Fortran; Pascal; PL1; W/P*	One high level lang. included. 12-month warranty. Mainframe comm. package. H/D avail. soon. (S&H)
MS5001 (£7450)	BMG Ltd: 0793 37813 (N/A)	64k RAM; 8085; dual 8" F/D (1 Mb); 12", 80 x 24 VDU; 80 cps printer; RS232.	CP/M; *Basic; Cobol; Fortran; MP/M*.	Price includes desk mounting and one computer. Hardware & software support. Leasing arrangements available. (E)
MSI 6816 (£1200)	Strumech: 05433 4321 (5)	16-56k RAM; 6800; dual 9" 16 x 64 b&w VDU; C int; 1 S/P; 1 P/P.	Basic; A.	Graphics & PROM programmer available (S&H)
MSI System 12 (£8000)	As above	56-184k RAM; 6800; 10 Mb H/D; single 8" F/D (500k) 24 x 80 VDU; 1 S/P; 1 P/P.	SDOS; Basic; CBasic; U.	As above. Business packages avail. Up to four terminals (H & S).
NEC PC 8001 (£450)	NEC(UK)	32k RAM; Z80A: RS232 port: P/P Option: dual 5¼" F/D (574k) £675	*CP/M: Basic N: Fortran Cobol: Pascal*	Colour monitor £250 (low res) or £480 (high res) both 12", 25 x 80(E) BT 6/81
Newbrain MB £219	Newbury Labs: 021-707 7170. Newbear: 0635 30505 (N/A)	2-4k RAM; Z80A; Nat 420; 14x 16 VDU; 2 x C int; TV int; V24 port. Option: C (50k) £60.	C Basic (16k ROM)	Graphics. Battery or mains. Mains only with 16k RAM £269. (low power battery version £299). (I).
North Star Horizon (£2230)	Comart: (7) 0480 215005. Comma: 0277 811131. Equinox : 01-739 2387 (20)	48-56k RAM; Z80A; dual 5¼" F/D (360k); 15", 24 x 80 VDU; 150 cps printer; 2 S/P; 1 P/P.	DOS; Basic; CP/M; *Cobol; Fortran; Pascal*.	Options: 18 Mb H/D.
Onyx C8000 (£6875)	Onyx Dist Ltd: 0734 664343 Colt 01-577 2150. (TBA)	64k RAM; Z80; 12 Mb Cartridge; 10 Mb H/D; 4 S/P; P/P	CP/M; *MP/M Oasis: Unix; Fortran; Pascal; W/P*	C8001 with 128k RAM £8220. Multi-user version avail. using Oasis. (E) BT 3/81
Oscar (£2560)	IDS Ltd: 0908 313997 (30)	64k RAM; Z80; dual 5 ÷ F/D (800k); 12", 25 x 80 VDU; RS232 port; 1 P/P	CP/M: *Basic; Pascal Fortran; Cobol; W/P; A*	Also avail. with daul 5¼" F/D (1.6 Mb) £2905 and dual 8" F/D (2 Mb) £3380. Advanced video board. (S + H).
Panasonic JD 800U, JD840U (£4275, £4950)	Panasonic Business Equipment: 0753 75841 (10 regional dist)	56k RAM; 8085A; 2-4k PROM; dual 8" F/D JD800 U (500k), JD840U (2 Mb); 12", 24 x 80 green VDU; 3 x RS232 ports.	CP/M; Basic; *Micro-Cobol.*	Also available with 5¼" F/D; JD740U (570k) £4095. H/D avail soon. BT 3/80 (S).
Pascal Microengine (£2295)	Pronto Electronic Systems Ltd: 01-554 6222	64k RAM; MCP 1600; 2 x RS232 ports: 2 P/P.	Pascal.	CPU instruction set is P-code; no interpreter needed. Available with dual 8" F/D (2 Mb) £3900.
Pasca 640 (£3700)	Westrex Ltd: 01-578 0957 (TBA)	64k RAM; Z80A; dual 8" F/D (512k); 12", 24 x 80 VDU; RS232 port; P/P.	CP/M; *Basic; Cobol; Fortran; Pascal; A; W/P; U*	Maintenance contracts avail. 10 Mb H/D avail. soon. (S) BT 5/81
Periflex 630/64 (from £1995)	Sintrom: 0734 85464 (5)	64k RAM; Z80; dual 5¼" F/D (630k); 2 x RS232 ports; 1 P/P	CP/M; *Basic; Fortran; Cobol; A*.	One-day installation training on site included in price. Option; dual 5¼" F/D (630k) £464, dual 8¼" F/D (1 Mb) £1025. BT 6/80 (S&H)
Periflex 1024/64 (from £2750)	As above	64k RAM; Z80; dual 8" F/D (1.2 Mb); 2 x RS232 ports; 1 P/P.	As above	As above.
PET 16k, & 32k (£550, £695)	Commodore: 0753 79292 (150)	16-32k RAM; 6502; C; 9" 25 x 40 VDU; IEEE-488 port; Options: dual 5¼" F/D (353k) £695; same but (950k) £895	O/S; Basic (in 8k ROM); *Forth; Pilot; Pascal; Comal; Lisp; A*	8032 with 80-col screen (32k) BT 12/80. £895 Field service avail. (I)
Powerhouse 2 (£1125)	Powerhouse Micros: 0422 48422 (TBA)	32-64k RAM; Z80A; 5" 29 x96 VDU; RS232 port; external bus.	4k Monitor; *FDOS; Basic; ExBasic (14k EPROM)*	VDU has flexible screen logic. Options; FDOS & Basic £210; graphics card £200. (H)
Powerhouse 3 (£2600)	As above	32-64k RAM; Z80A; dual 5¼" F/D (350k); 5", 29 x 96 VDU; RS232 port; external bus.	As above.	VDU as above. With 1.2 Mb F/D £3500. ExBasic & FDOS in 14k EPOMs £300. (H)
Prince (£3045)	Digico: 04626 78172 (TBA)	48-64k RAM: 2 x Z80: dual 5¼" F/D (800k): 2 x RS232 port: 12", 24 x 80 VDU	CP/M: *Basic: Pascal: Fortron: Cobol: W/P: A:* T/E: U	High res graphics. Options: single 5¼" F/D (400k) £600: dual 8" F/D (2 Mb) £2000. Rentals avail. (S).

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Raannd SP1 (£4500).	Raannd: 0506 33372 (TBA)	64k RAM; MCP 1600; dual 8" F/D (2 Mb); 12", 24 x 80 VDU; RS232 port; P/P.	Pascal *ADA: Basic*	Based on Microengine (with integrated P-code). Up to 4 F/D drives. 64k RAM expansion avail. BT 12/80. (S)
Rair Black Box III (£2750)	Rair; 01-836 6921 (N/A)	64-512k RAM; 8085; dual 5¼" F/D (260k); 2 x RS232 ports.	CP/M; Basic; Cobol; Fortran; M/A	16k RAM expansion £500 10 Mb H/D £2500.
Research Machines 380Z (£895)	Research Machines: 0865 49791 (N/A)	16-56k RAM; Z80A; 2 x C; RS232 port. P/P	ExBasic; A; T/E; U; *CP/M; Fortran; Cobol; Algol; Cesil: Pascal.*	High res colour graphics. Many possible systems. With 48k RAM & dual 8" FD (1 Mb) £3394.
S/09 (£5350)	SWTP Ltd: 01-491 7507 (16)	128k RAM; 6809; dual 8" F/D (2 Mb); 8", 21 x 92 VDU 2 x S/P; 1 P/P	TSC FLEX; *Basic; Pascal; A; Dis A; TIE; U.*	VDU is intelligent. Expands to Option: 15 Mb H/D £3575. 60 Mb H/D multi-user system. Maintenance contracts. (S&H).
Saracen (£1925)	Bytronix 0252 726814 (TBA)	32-64k RAM; Z80; dual 5¼" F/D (800k); 2 x RS232 ports.	CP/M; *Basic; Cobol; Fortran; Pascal; A.*	Applications packages & maint. contracts avail. With dual 8" F/D (2 Mb) and 64k RAM, £2676. (E)
SBS 8000 (£1449)	Manhattan Skyline Ltd: 0801 3442; C Itoh 01-353 6090 (TBA)	64k RAM; Z80A; 12", 16 x 64 VDU; 1 P/P; RS232 port (extra £133).	ExBasic (24k ROM); *DOS*	Options: disk control card £237; dual 5¼" F/D (368k) £795; dual 8" F/D (2 Mb) £1400. BT 11/80. (S)
SEED System 1 (£2000)	Strumech: 05433 4321 (5)	32-56k RAM; 6800; various disk options: 12", 24 x 80 VDU: RS232 port: P/P	DOS; Basic U; *Fortran; A; Pilot; Strubal; T/E*	Graphics. PROM programmer Also system 19 multi-user (£3000). (E).
Sharp MZ-80K (£460-34k)	Sharp Electronics (UK) Ltd: 061-205 2333 (22)	6-34k RAM; Z80; C; 10" 24 x 40 VDU; Option: dual 5¼" F/D (289k) £695.	Basic (14k ROM); A. *CP/M: Pascal.*	Graphics; loudspeaker. BT 10/79 (B)
Sharp MZ-80B (£1095)	As above	64k RAM: Z80A: C: 9", 25 x 80 VDU: RS232 port: P/P.	Basic: *A: Pascal: FDOS*	High res graphics. Options: dual 5¼" F/D (560k) £800: 80 cps printer £415. (S)
Sharp PC3201 (£2995)	As above *CP/M: Cobol.*	64k RAM; Z80A; dual 5¼" F/D (500k); C int; 12", 25 x 80 VDU; 70 1pm printer.	DOS; U; Basic. *CP/M: Cobol.*	Various expansion cards avail. (I&B) (I&B)
Sinclair ZX81 (£50-kit, £70-built - prices inc VAT).	Sinclair: 0276 66104	1-16k RAM: Z80A: C int: TV inb: full K/B: 44-pin expansion port.	Basic (8k ROM).	Advanced 4-chip design. Printer avail soon BT 6/81
Smoke Signal Chieftan (£1800)	Windrush 0692 405189: Seed 05433 78151 (TBA)	32-64k RAM; 6800/6809; dual 5¼" F/D (500k); 2 x RS232 port.	DOS; *68/FLEX; Basic; Fortran; Cobol; A: Dis A: Pascal: U.*	With dual 8" F/D (2 Mb) £2600. Designed as development system for industrial control. (H)
Solitaire WP & BS200 (£6750 & £8200)	Solitaire KPG: 01-995 3573 (TBA)	64k RAM; 8085; 14" VDU (with own CPU); 45 cps printer; CPU port; dual 5¼" F/D (700k) 8" F/D (1.02 Mb) with BS200.	DOS; Basic	All solitaire systems are compatible; and can be upgraded to multi-user H/D system. (S)
Sord M100 ACE (£2339)	Midas Computer Services Ltd: 0903 814523 Exleigh Bus. Mach. 0736-66577.(10)	48k RAM; Z80; 8k ROM dual 5¼" F/D (246k): 24 x 64 green VDU; RS232 port: N/P	O/S; Basic; *A; Fortran; Pascal.*	Up to 3 drives possible. Colour graphics avail. Option S100 bus. (I)
Sord M223 Mk II-VI (£4078)	As above	64k RAM; Z80; 8k ROM; dual 5" F/D (700k); 12", 24 x 80 green VDU; RS232 ports; S100 bus; N/P	*O/S;* Ex Basic; *CBasic; Multi-User Basic; Fortran; Cobol.*	Expandable to 4 Mb F/D. 32 Mb, H/D, 5 screens, 2 printers. M243 with 192k RAM & 1.4 Mb F/D £5087.
SPC/1 (£3770) (TBA)	Digital Data: 01-573 8854	64-1024k RAM; 8085A-2; dual 5¼" F/D (90k); 12", 24 x 80 VDU; 2 x RS232 ports; Option: single 8" F/D (1 Mb) £1090: 20 Mb H/D £7000.	Mikados, Comal; Pascal; A.	With 32k RAM and single F/D (Comal only) £1995. Expandable to multi-user system (8 users). BT 7/80 (S).
Superbrain (£1950)	Icarus: 01-485 5574 (45)	64k RAM; 2 x Z80; dual 5¼" F/D (320k); 12" 25 x 80 VDU; 2 x RS232 port.	CP/M; A; *Basic; Cobol; Fortran; APL, Pascal.*	Limited graphics, Mainframe int avail. Full range of application packages avail. Also avail with 700k & 1.5 Mb F/D. BT 8/80. (S&H).
System 10 (£2995)	Millbank 01-788 1083 (TBA)	64k RAM; Z80; dual 5¼" F/D (700k); 12", 24 x 80 VDU; 2 x RS232 port; P/P	CP/M; *Basic; Fortran; Pascal; Cobol; PL/1; W/P.*	12 month warranty. Maint contracts. Applications packages avail. Choice of high level language in price. (E)
System 20 (£3500)	Extel: 01-739 2041 (TBA)	64-512k RAM; Z80A: dual 8" F/D (1 Mb); 12", 24 x 80 VDU; 3 x V2	CP/M:E Basic; *M Basic; Pascal; Cobol; Fortran*	Maintenance contracts avail (132 field service engineers). Expands to multi-user system. Options 13.7 Mb H/D £5799; 27.4 Mb H/D £6674.(S)
System 80 (£1355-48k)	Nascom: 02405 75155 (32)	16-48k RAM; Z80A; dual 5¼" F/D (560k); TV int; RS232 port.	CP/M; Basic (8k ROM)	EPROM firmware avail. Colour graphics card £165. Many configurations possible. (S&H).
Tandberg EC10 (£4000)	Tandberg: 0532 774844 (N/A)	64k RAM; 8080A; single 8" F/D (250k); 12", 25 x 80 VDU; 7 x RS232 ports; printer int.	CP/M; ExBasic (24k) *Multi-user Basic; Pascal; Cobol;* A; U;	Up to 7 terminals. Includes V28 comms port. (S & H).
Tandberg TG 8450 (£2200)	As above	64k RAM; 8085; single 5¼" F/D (77k); C int; 12", 24 x 80 VDU; RS232 port; P/P	TDOS; *Basic; Cobol; Fortran; Pascal.*	TDOS is CP/M compatible. Opt: single 5¼" F/D (77k) £250 (up to four); dual 8" F/D(2 Mb) £1800. (S&H)
Tandy TRS-80 Model I (£289)	Tandy: 0922 648181 (200)	4-48k RAM; Z80; C; 12", 16 x 64 VDU: RS232: P/P	Basic (4k ROM); A.	Fully expandable. Option: single 5¼" F/D (175k) £339 (up to 4). Many extras available. (I)
Tandy TRS-80 Model II (£2499)	As above	64k RAM; Z80; single 8" F/D (500k) 12" 24 x 80 VDU; 2 x RS232 port; P/P	Basic; *M/A Fortran; Cobol*	Option: single 8" F/D (500k) £899 (subsequent £450, up to 4). 32k RAM £344.

List of Abbreviations

A	Assembler	G/C	Graphics card	M/A	Macro assembler	S	Software
BT	Bench Tested	H	Hardware	N/A	Not available	S/P	Serial port
C	Cassette	H/D	Hard disk	N/P	Numeric pad	T/E	Text editor
E	Extensive	I	Introductory	O/S	Operating system	TBA	To be announced
F/D	Floppy disk	Int	Interface	P/P	Parallel port	U	Utility

Please note: Software items listed in *italic* are not included in the basic price of the equipment. All prices are *exclusive* of VAT.

DIRECT ACCESS

IN STORE

Machine (Price from)	Main Distributor/s (No. of Dealers)	Hardware	Software	Miscellaneous (Documentation)
Tandy TRS 80 Model 3 (£500-£1700)	As above	See Model I Levels I and II		Fully intregral unit. Up to 2 integral and 2 external 5¼" F/D.
Tandy Pocket Computer. (£119)	As above	2k RAM: 2 x 4-bit proc: 24 char LCD; K/B: Option: C int £18: C £50	4k Monitor (ROM); 7k Basic (ROM).	Various software packages avail. Runs on mercury batteries. (I).
TECS (£1200)	Technalogics Computing Ltd: 061-793 5293 B&B Computers Ltd: 0204 26644 (TBA)	4-56k RAM; 8k PROM; 6800/ 6809; 2xC; TV int; 2xRS232 ports; internal viewdata modem & printer port.	FLEX: Basic; *Pascal; TDOS; A; T/E; Pilot; Fortran; Cobol.*	Fully viewdata compatible. Options — dual 5¼" F/D (320k) £850; dual 8" F/D £120 £1200. (S&H).
Terodec CPC-100 0 (£4095)	Terodec: 0734 664343 (8)	80k RAM: Z80A: single 5¼" F/D (819k): 2 S/P: 3 P/P	CP/M: CBasic; *Fortran: Pascal: Cobol.*	System with Okidata 80 printer: TVI 910 VDU: W/P and various appliation packages £5995 (S + H).
Terodec DPS 64/2M (£3598)	As above	64k RAM: Z80A: dual 8" F/D (2 Mb): 2 S/P: 3 P/P. Options: 10 Mb H/D: Tape.	CP/M: *MP/M: CP/Net: CBasic: Fortran: Pascal: Cobol: Basic.*	2 user system with 10 Mb H/D £7400 4 user system with 34 Mb H/D & tape backup £11981. (S + H).
TI 99/4 (£750)	TI: 0234 67466 (TBA)	16k RAM; 26k ROM; 9900; 24 x 32 VDU; 2 x C int; TV int; RS232 port.	OS: Basic.	Can run 16-colour TV screen. BT 5/80 (S).
Tuscan CP/M Starter (£999)	Transam: 01-405 5240 (N/A)	24k RAM: Z80: single 5¼" F/D (190k): Cint: TV int: RS232 port: P/P: N/P.	CP/M: *Basic: Fortran: Pascal: Cobol:*	options: single 5¼" F/D (190k) £155: single 5¼" F/D (370k) £285: 8k RAM £50. (S + H)
UDS 3000 (£2300)	Kemitron: 0244 21817. (TBA)	64k RAM; Z80A; dual 8" F/D 2 Mb; 2 x RS232 ports. Option: 10 Mb H/D	CP/M; *Basic; Cobol; Fortran; Pascal.*	Full range of industrial support cards, and applications software. (E)
Vector MZ (£2595)	Almarc: 0602 62503 (3)	56k RAM; Z80A; dual 5¼" F/D (630k); 3 S/P; 2 P/P.	CP/M; Basic; *Algol; Cobol; Pascal; Fortran; Coral; CBasic; A.*	High resolution graphics. Also system B with video board & terminal £3195. (E).
Vector System 2800 (£4195)	As above	56k RAM; Z80A; dual 8" F/D (2.4 Mb); 3 S/P; 2 P/P.	As above	High-res graphics. Also System 3030 with 32 Mb H/D and single 5¼" F/D £7500. (E)
Vic 20 (£200)	Commodore: 0753 70292 (150)	5-32k RAM: 6502: Cint: 22 x 23 TV int: S/P: P/P: Games int.	Basic	Graphics 3 tone sound generator. Will interface to PET. Option: single 5¼" F/D (170k). (S).
VIP (£2125)	Almarc 0602 62503 (3)	64k RAM; 3k ROM; Z80A; single 5¼" F/D (315k); 12", 24 x 80 VDU; RS232 port; 3 x P/P	CP/M; *Basic; Fortran; Cobol; Pascal; A.*	Up to 3 additional F/D drives. Options: dual 8" F/D (2 Mb) £1063, 32 Mb H/D (TBA). (H&S). BT 2/81
Video Genie EG3003 (£300)	Lowe Electronics: 0629 4995 (N/A)	16k RAM; Z80; 500bps C; 16 x 64 TV int; extra C int; 1 P/P	Basic (12k ROM); *Pascal: A M/A; Fortran*	Graphics available with ex-Basic (13.5k) £350.
WH8 (£352)	Heath 0452 29451 (N/A).	16-64k RAM; 808A (or Z80); 4 S/P. Option: single 5¼" F/D (102k) £241.	OS; HDOS; CP/M; *Fortran; Pascal; Basic*	Kit. 3 drives max. Colour graphics avail. (S&H) BT 2/80.
Zentec (£4838)	Zygal Dynamics: 02405 75681 (TBA)	32-64k RAM; 2 x 8080; dual 5¼" F/D (256k); 15", 25 x 80 VDU; RS232 port.	O/S; A; U; *Basic;* Cis Cobol.	User programmable character set. Option: dual 8" F/D (1 Mb). (S).
Zenith WH-11A (£2673)	Heath Ltd: 0452 29451 & 01-636 7349 (N/A)	LSI 11; 16-32k RAM; 25 x 80 VDU; S/P; P/P.	O/S; *Basic; Fortran;* A: U.	PDP 11-compat. Option: 2 x 8" F/D (1 Mb). £1717 (S&H).
Zenith Z89 £1570-£1710	As above	16-48k RAM; Z80; single 5¼" F/D (102k); 12" 24 x 80 b&g vdu; RS232.	*Basic; A; HDOS;* CP/M; *MBasic; CBasic; Fortran.*	3 x 5¼" F/D possible. Options: dual 8" F/D (1 Mb) £1717, 20 Mb H/D.
Zilog MCZ 1/05 (portable): MCZ 1/20A (£3250)	Micropower: 0256 54121. Memec; 084421 5471 (N/A)	64k RAM; Z80; dual 8" F/D (600k); RS232 port; MCZ 1/20A only 1 P/P; Option: 10 Mb H/D £7100	RIO; O/S; *Cobol; Basic; Fortran; Pascal; M/A; U.*	Available desk top or rack mounted. Debug in 3k PROM. 1/20A runs multi-user Cobol, up to 5 terminals with 40 Mb H/D. (S&H).
Z-Plus (from £4000)	Rostronics Ltd: 01-870 4805(16).	64k RAM; Z80A; dual 8" F/D (0.5/1 Mb); 12", 24 x 80 VDU; 4 S/P; 1 P/P	CP/M: MP/M; A; U; *Basic; Cobol; Fortran; Pascal; APL; PL/1; Algol.*	Complete with furniture. Various business packages avail. Option; 20 Mb H/D £4000. BT 12/79 (S&H).

SINGLE BOARDS

Machine (Price from)	Main Distributor/s (No. of Dealers)	Hardware	Software	Miscellaneous (Documentation)
Acorn System 1-5 (£65-£1600)	Acorn: 0223 312772 (35)	11/8k RAM; 6502; EPROM socket; Hex K/B; C int; 8-digit LED display; up to 16 ports. Options: Eurocard 64-way connector; VDU card; full K/B card.	½k monitor; *Basic. Pascal: Forth: DOS.*	Kit. Programmable address linking. On-board 5 V regulator. Available assembled £79. Cn be expanded to disk-based system. (S&H)
Aim 65C (£259)	Pelco: 0273 722155(7)	1-4k RAM: 6502; 4-20k; ROM; Full K/B 2 x C; 20 char LED; 20 char thermal printer; RS232 port.	A. Dis A; T/E; 8k monitor; *Basic (8k ROM); PL65. Forth*	Expandable using RM65 models to full disk systems (E).
Bigboard. (£450)	Maclin-Zand 01-837 1165 (N/A)	64k RAM; Z80; F/D controller; 24 x 80 VDU controller	2k monitor; *CP/M; Basic; Fortran; Cobol; Pasal; A.*	Many options. Will support up to four 8" F/D drives. BT 3/81. (E)
Biproc (£119)	B L Micros: 0494 443073. (TBA)	1k RAM; Z80; TV int; RS232 port. Opt: 4k RAM £8; K/B £30.	2k Monitor; A.	With 9980 instead of Z80 £155 as well as Z80 £180. Kit. (H)
Cromemco SC (£355)	Comart: 0480 215005 (25)	1k RAM; Z80A; 8k EPROM sockets; RS232 port; 3 P/P. Option: S100 bus.	Monitor; *Basic.*	5 program interval timers. Can put own Basic program in EPROM. (E).

List of Abbreviations

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F/D	Floppy disk	Int	Interface	P/P	Parallel port	U	Utility

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SINGLE BOARDS

Machine (Price from)	Main Distributor/s (No. of Dealers)	Hardware	Software	Miscellaneous (Documentation)
Elf II (£50)	Newtronics: 01-348 3325 (N/A)	¼-64k RAM; RCA 1802; Hex K/B; 2-digit LED; TV int; C int; RS232. Options: Full K/B; VDU card.	1k monitor; A; Dis A; T/E; Elf-bug; *Tiny Basic; Basic,*	TTY N-line decoders. Low resolution graphics (high res avail). Kits or built. Full range of peripherals. (H).
Explorer (£82)	As above	4-64k RAM; 8085; Full K/B; RS232 port; 6 x S100 bus; C int; 1k video RAM.	2k monitor; *Basic (8k) CP/M: Basic Fortron: Cobol.*	Supplied in kit or built. Full range of peripherals including F/D. (H).
Hewart 6800S (£299)	Hewart: 0625 22030 (N/A)	16k RAM; 6800; full K/B VDU int; 2 x C int; 1 S/P; 2 P/P; Option: 16k RAM £90	1k monitor; A; T/E.	Can be upgraded with 6809. (H).
Hewart 6800 Mk III (£152)	As above	1k RAM; 6800; VDU board	1k monitor.	Options: single 5¼" F/D (75k) £350; PROM programmer £32. (H)
Microaxis I (£250)	Micro Design 0296 86866 (N/A)	1k RAM; 1-8k PROM; 6809; 8 channel A-D system; 12 optically isolated I/O lines.	1k monitor	Designed for industrial control. Can be expanded to F/D system. (H)
MPC 09 (£750)	As above	17k RAM; 48k PROM; 6089; RS232 port; 50 I/O lines; 4 timers; 1 W audio amplifier.	1k monitor; *Multi-tasking OS.*	As above. New 64k version avail.
Microtan 65 (£69)	Tangerine: 0353 3633 (6)	2k RAM; 6502; 16 x 32 TV int; Options; 64 Pixel graphics £6.50;	2k monitor, *Basic*	TANEX expansion kit with 7k RAM; 4k EPROM sockets; 10k Basic; 4 S/P; 32 P/P £145. (E)
Nascom 1 (£125)	Nascom: 02405 75155 (20)	4k RAM; Z80; Full K/B; TV int; 2 P/P; 1 S/P. Options; 16k RAM £140; single 5¼" F/D (250k) £240 (4 disk controller £127).	2k monitor; *B Basic; Tiny Basic; A; T/E; U.*	Kit. Built version £140. Also Nascom 2 with 8k Microsoft Basic in ROM £225 (no RAM). (S&H)
77/68 (£90)	Newbear; 0635 30505 (N/A)	4k RAM; 6800; LED; C int; VDU int.	1k monitor; *Basic*	Expandable to 64k RAM with F/D. (B)
79/09 (£65)	As above	1k RAM: 6809; P/P; S/P	2k Monitor.	Designed to upgrade 77/68. (H).
SBC 100 (£135)	Airamco: 0294 57755 (TBA)	1k RAM; Z80; 8k ROM; S100; 1 S/P; 1 P/P.	*1k monitor; DOS in ROM.*	Kit. Available assembled £196. (E).
Superboard (£188)	(as Challenger)	4-8k RAM; 6502; 10k ROM; full K/B; VDU int; C int.	Basic (8k ROM)	Options; RS232 port; single 5¼" F/D (100k) £316; 8k RAM £188. (S&H).
Smoke Signal SCB 68 (£181)	Windrush 0692 405189 (TBA)	1k RAM; 6800/6809; 8k EPROM; 1 S/P.	2k monitor	Fully expandable to 64k RAM with F/D. (H)
SYM-1 (£160)	Newbear; 0635 30505 (N/A)	1-4k RAM; 6502; C int; VDU int; 2 x 6522 ports. Option: TV int.	4k monitor; *Basic A.*	Expandable to 64k RAM with F/D. (B).
Tuscan (£299)	Transam 01-405 5240 (N/A)	8k RAM; 8k ROM; Z80A; 5 x S100 slots; RS232 port; TV int; C int; 1 P/P.	*2k monitor; 8k Basic; CP/M; Pascal.*	High res graphics available. Can be expanded to F/D system. BT 1.81. (S&H)
UK101 (£149)	Comp Shop: 01-441 2922 (4)	4k RAM; 6502; full K/B; 16 x 48 VDU or TV int; C int: RS232 port, Options; 4k RAM £16.	2k monitor; 8k Basic; *Dis A; U.*	Graphics. Expansion & colour avail. Kit or fully assembled. (S&H).
Windrush 6801 (£175)	Windrush: 0692 405189	2k RAM: 6801/3/5: 12k EPROM: S/P: 3 P/P	2k Monitor	Designed for industrial control & dedicated small systems. (H)
ZCB (£260)	Almarc: 0602 625035 (3)	1k RAM; Z80A; 3 PROM sockets; RS232 port; 3 P/P	*Will take any 2708/ 16/32 software.*	S100 bus compatible. Expandable to full system. (E).

TRANSACTION FILE

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PET 32k. . . 8 months old, new ROMs, C2N cassette, Toolkit, Sound box, cover, progs, private usage, £575. PET 3022 tractor printer, IEEE connector, dust cover, as new, £395. Tel Heathfield (04352) 2499 day.

Acorn Atom. . . Fac. built, 12k + 12k inc f.p, manual, PSU, leads, many progs. inc space invaders, spare keys & carrying case, £195 ono. Tel Stalham 81247, eve.

Fed up. . . waiting for Uncle Clive to deliver? 1 Sinc built 1k ZX81 inc leads, PSU & manual, for quick sale, £60. Phone (0262) 70451 (Bridlington)

Acorn Atom. . . 12k RAM 12k ROM, fully checked by Acorn, + newsletters & 3 games cassettes, many programs, £199 ono. 5 volt, 3amp power supply in handsome metal case, £25. Acornsoft games packs 1 and 4 and soft VDU, £7 each. All excellent. Steve, 0792 51762.

UK101. . . 8k Basic, new and old monitor, assembler, editor, complete in case, £25 worth of progs, inc super Space Invaders, £230. Phone 01-679 4525.

Hewlett-Packard. . . printer for HP41, model 82143A, brand new, unused, complete with chrger, cables, paper, instructions, unwanted gift, any offers considered. Tel: 01-960 1404.

Microtan 65. . . graphics, L-case, Tanex, keypad mini-motherboard and 2A power supply in 19" Verd rack, £150. Tel: 0203 29361.

Two. . . 19" Vero Racks 2V and 3V, £10 each; Elizabethan portable TV weak RF gain but super monitor, circuit supplied £30; 20A/5V SM power supply with spares, £15. Tel: 0203 29361.

ITT 2020. . . 48k, colour, disk drive and controller, Applesoft in ROM, cassette and disk software inc integer Basic and DOS 2.2. Computer £595, disk drive £295. Tel (0462) 54241.

Computhink. . . 400k disk drive complete with toolkit on disk, £450 ono. Trendcom 40-col thermal printer + PET interface, £100. D Stringer, 124 Grangemouth Rd, Radford, Coventry CV6 3FE.

Sharp MZ-80K. . . 36k RAM, 9 months old, Basic plus Knight Commander enhancements, manuals, PET manuals included to allow easy conversion of listings, various games, £395 ono. Tel: Brighton 509097.

PET 2001. . . 8k old ROM, with built in cass deck and small keyboard, in good condition complete with manual, space invaders, Basic tutuorial tape and other software, £275 ono. Tel: 01-602 3608.

ZX80. . . Sinc built, complete with 16k RAM pack, manual, PSU, leads, three books (about 130 progs) and Space Invaders, good cond, cost £170, accept £110. Tel: Steve, Halifax 69356.

TRS-80. . . 16K Level II, numeric keyboard, VDU, PSU, cassette recorder, and games progs, had little use, £390 ono. Tel: Sedgley 76131 (West Midlands) after 6.

8k PET. . . 24k expandemem, new ROMs, external keyboard, toolkit, £450. Computhink 400k dual disk drive, £450. Free with above system, 300 PET programs. Tel: 01-894 7149.

ZX80/81 keyboard. . . full size qwerty keyboard, 1 stroke rubout and cursor control key, numerical keypad, etc, £25. 4k RAM expansion board (1k fitted), £18. 9v power supply with cassette to ZX80 switches (saves swapping jack plugs), £18. Tel: 0947 2095.

ZX80. . . complete, 30 progs, pocket book, Starship cassette, cost £115. Sell £70. Q Vandervell, 12 Monk St, Monmouth, Gwent, NP5 3NZ.

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PET 2001-8 or 3008 8k. . . large keyboard, new ROM, green screen, cass deck, any manuals, few progs, £325 ono. Tel: Vic, home 01-543 2379, work 01-977 3222 ex 3966.

Cheap 6800 system. . . may be non-worker, ideally SS50 bus but consider anything. G Everett, 104 Junction Rd, Burgess Hill, Sussex, Tel: 44583.

5" disc drive + interface. . . One drive and 16k expansion interface wanted, £325 max. R Jacobs, 19 Vine Way, Brentwood, Essex.

Video Genie. . . wanted for school use, new keyboard preferred, internal cassette use not required. Write FHG, 19 Grayson Drive, Lowestoft, Suffolk NR33 7BA.

Practical Computing. . . 1981 Volume 4 issue numbers 1 (January) and 3 (March). Must be good condition. Reasonable prices paid. Ring 01-866 5160.

USER GROUPS INDEX

These are updates/new entries received since our last full listing. The next complete list will be printed in our November issue.

INTERNATIONAL

DENSPET: group specifically for exchange or original programs for MTU 200x320 dot matrix hi-res PET add-on. Send sample of your work or £2.50 ($2.50) & receive sample in return plus newsletter sub & lists of available programs. Contact: DENSPET, Rock House, Ballycroy, Westport, Co Mayo, Eire.

KAOS — the official 6502 users' group of Australia. Has a range of projects within special interest groups: hardware, software, amateur radio, Pascal, education. Publishes monthly newsletter. Contact: Mr Ian Eyles, 10 Forbes St, Essondon, Victoria, Australia 3040.

DAInamic: European DAI personal computer users' club. Has over 500 members, publishes a bi-monthly newsletter with most articles in English. Contact: DAInamic, Heide 98, 3171 Westmeerbeek, Belgium.

REGIONAL

Merseyside Nascom Users' Group. Now independent, with 150 members. Meets 1st Mon monthly, 7.30pm at Mona Hotel, James Street, Liverpool. Contact: T Searle, 14 Hawkeshead Close, Maghull, Liverpool L31 9BT.

Merseyside TRS-80/Video Genie Users' Group. Contact: Peter Tootill, 101 Swanside Rd, Liverpool L14 7NL, tel 051-220 9733.

Wirral Microcomputer Users' Group. Meets at Mons at Birkenhead Technical College. Contact: J Phillips, 14 Helton Close, Nocturum, Birkenhead, Merseyside L43 9HP. Tel 051-652 0268.

East Anglian Computer Users' Group. Meets: Crane Community Centre, Telegraph Lane East, Norwich. Contact: Gill Rijzl, 88 St Benedict's St, Norwich NR2 4AB, tel: (0603) 29652.

TOWN

Southampton Amateur Computer Club. Meets 2nd Wed monthly, Medical Sciences Building, Bassett Crescent East, Southampton (alternative venue Aug & Sept). Contact: P Blitz, 'Gardenways', Chilworth Towers, Chilworth, Southampton, tel: 0703 766161.

Beford Amateur Computer Club. Recently started, no further details as yet. Contact: Mr R Bird, 7a High Street, Great Barford, Bedford MK44 3LB, tel 0234 870763.

Leeds Microcomputer Users Group. Meets fortnightly on Thurs eve in Leeds, new members welcome. Contact: Paul O'Higgins, 20 Brudenell Mt, Leeds 6, tel (0532) 742347 after 6.

Manchester Atom Users' Group. Meets last Tues monthly during school terms at Abraham Moss Centre, Crescent Rd, Manchester 8. Contact: John Ashurst, 061-370 5121 ext 27 (day), 061-681 4962 (eves).

Medway Atom Users' Group. Meets last Tues monthly during school terms at St John Fisher School, Ordnance St, Chatham. Contact: Clem Rutter, (0634) 42811 (day).

Would anyone interested in fprming a computer club in the Portsmouth area please contact Dave Cocker on Portmouth 751156.

Brunel Computer Club: meets alternate Wednesdays, 1900-2200 hrs at St Werburgh's Community Centre, Contact: Mr R Sampson, 4 The Coots, Stockwood.

Worle Computer Club: meets alternate Mondays 1900-22.30 at Woodsprings Inn Function Rooms. Contact: S Rabone, 18 Castle Rd, Worle, Weston-Super-Mare, Avon, tel: 0934 513068.

NETWORK NEWS

Here is a list of all British (and one Dutch) personal computer networks. As more networks appear — and as more facilities are added to existing ones — we'll report them in this section, which appears monthly.

Forum-80 Hull. . . Operator: Frederick Brown, tel 0482 856169. Facilities: electronic mail, software up/down loading, Forum-80 Users' Group, PET users' section, shopping list. Hours: 7 days/week, midnight-0800, Tues & Thurs 1900-2200, Sat & Sun 1300-2200.

Forum-80 London. . . Operator: Leon Jay, tel 01-286 6207. Facilities: electronic mail, program downloading. Hours: Tues, Fri, Sat & Sun 1900-2300.

80-NET . . . Operators: Leon Heller & Brian Pain, National TRS-80 Users' Group, tel 0908 566660. Facilities: electronic mail, software for downloading, newsletter, TRS-80 information. Hours: 7 days/week, 1900-2200.

CBBS London. . . Operator: Peter Goldman, tel 01-399 2136. Facilities: electronic mail, program downloading. Hours: Wed 0700-0930 & 1900-2200, Fri 1900-2200, Sun 1600-2200.

Forum-80 Holland. . . Operator: Nico Karssemeyer, tel 010 313 512 533. Facilities: electronic mail, program up/downloading, shopping list. Hours: Tues-Sat 1800-0700 nightly, continuous from 1800 Sat — 0700 Tues.

DIARY DATA

Readers are strongly advised to check details with exhibition organisers before making travel arrangements to avoid wasted journeys due to cancellations, printer's errors, etc.

London	(Wembley Conf Centre) Viewdata '81. Contact: Online, 09274 28211	6 — 8 Oct
Friedrichshafen, W Germany	Euro Congress for Word Proc-Intertext. Contact: Int Bodensee-Messe, Meistershofener Str 25, 7790 Friedrichshafen.	21-25 Oct
Stuttgart, W Germany	Hobby Electronics & Minicomputers Exbn. Contact: CES, 01-236 0911	21-25 Oct
London	(Bloomsbury Centre) Computer Graphics Exbn. Contact: Online, 09274 28211	27-29 Oct
London	(West Centre Hotel) Viewdata Exbn. Contact: IPC Exbns, 01-643 8040	4-6 Nov
Madrid, Spain	Int Office Equip & Computers Exbn. Contact: CITEMA, Plaza de conde de valle Suchil 8, Madrid 15	13-20 Nov

PCW SUBSET

Alan Tootill presents more useful assembler — language subroutines. If you'd like to contribute your routines (for any of the popular processors), send them to: Sub Set, PCW, 14 Rathbone Place, London W1P 1DE.

Text handling

Most applications need some text handling, so any general purpose routines you have developed for this will be very welcome. Many of our home micros are still without the amount of memory and direct access storage we would like, so we start this section off with a routine to economise on space. It can both pack characters, in the range 20H to 5FH, into 6-bit portions of contiguous memory and expand such blocks of 6-bit characters into 8-bit bytes.

Called PAC/UNPAC, the Datasheet brings us back to the Z80 processor. It is submitted by two readers, Dave Yeomans of Halifax and Dave Barrow of Hemsworth, brought together through 'Sub Set'. Routines to do a similar job in M6809 code are given in the *MC6809 Preliminary Programming Manual*.

Datasheet

```
;= PAC/UNPAC — Compress and expand characters
;/ CLASS: 1
;/ TIME CRITICAL? No
;/ DESCRIPTION:  When entered at PAC, converts a string of 8-bit
;/               characters, in the range 20H to 5FH, to a string
;/               of 6-bit characters. When entered at UNPAC,
;/               converts 6- into 8-bit characters.
;/ ACTION: Not given
;/ SUBr DEPENDENCE: None
;/ INPUT:    HL holds the address of the 1st byte of source data
;/           DE holds the address of the 1st byte of the destination
;/           buffer
;/           BC = Number of characters to be packed/unpacked
;/ OUTPUT:   HL holds end of string + 1 address
;/           DE holds end of destination + 1 address
;/           BC = zero
;/ REGs USED: AF HL DE BC
;/ STACK USE: 4
;/ LENGTH: 64
;/ PROCESSOR: Z80

PAC:     LD    A,80H     ; clear A & set PAC flag.          3E 80
         JR    BINC      ;                                  18 01
UNPAC:   XOR   A         ; clear A for byte indicator.      AF
BINC:    INC   B         ; adjust BC for queer decrmnt.     04
LOOP:    PUSH  BC        ;                                  C5
         PUSH  HL        ;                                  E5
         INC   A         ; get next byte sequence no.       3C
         LD    C,A       ; and save in C.                   4F
         ADD   A,A       ; PAC or UNPAC flagged by carry    87
         LD    B,A       ; & no of bits to shift in B.      47
         LD    A,(HL)    ; get next source byte and         7E
         JR    C,DOPAC   ; jump if PAC.                     38 0D
         DEC   HL        ; else get other part of           2B
```

```
          LD    H,(HL)     ; packed byte in H and                66
RISH:     RR    H          ; shift right until                   CB  1C
          RRA              ; in bits 0-5,A.                      1F
          DJNZ  RISH       ;                                     10  FB
          AND   3FH        ; mask out unwanted bits and          E6  3F
          ADD   A,20H      ; convert to ASCII.                   C6  20
          JR    LODE       ; jump to common part.                18  0C
DOPAC:    SUB   20H        ; adjust ASCII to bits 0-5,A          D6  20
          LD    L,A        ; and copy into                       6F
          LD    H,+0       ; HL.                                 26  00
LESH:     ADD   HL,HL      ; shift left by twice the byte        29
          DJNZ  LESH       ; sequence number.                    10  FD
          LD    B,L        ; move lowest bits into B.            45
          DEC   DE         ; point to lowest avail dest.         1B
          LD    A,(DE)     ; byte, get in A, merge any bits      1A
          OR    H          ; from current source byte.           B4
LODE:     LD    (DE),A     ; converted byte to destination.      12
          POP   HL         ; restore source pointer.             E1
          LD    A,C        ; byte indicator to A.                79
          AND   83H        ; do a "mod 4" on it.                 E6  83
          JR    Z,DINC     ; skip if UNPAC, byte 4.              28  09
          CP    81H        ; test to split PAC, bytes 1-3        FE  81
          JR    C,HINC     ; off & skip if UNPAC 1-3/PAC 4.      38  04
          INC   DE         ; lowest bits of PAC 1-3              13
          EX    DE,HL      ; with trailing reset bits            EB
          LD    (HL),B     ; into next empty                     70
          EX    DE,HL      ; destination byte..                  EB
HINC:     INC   HL         ; point at next new bytes.            23
DINC:     INC   DE         ;                                     13
          POP   BC         ; restore count                       C1
          DEC   C          ; and test for                        0D
          JR    NZ,LOOP    ; last byte and                       20  C9
          DJNZ  LOOP       ; repeat if not.                      10  C7
          RET              ; else return.                        C9
```

A detail worth noting in PAC/UNPAC is the way the Daves decrement BC and jump if not zero (DEC C; JR NZ, LOOP; DJNZ LOOP) having earlier, at label BINC, incremented B to adjust BC for the queer decrement. This code might (or might not) be preferred on occasions to the code we have used previously (DEC BC; LD A,C; OR B; JR NZ, LOOP) since it does not use the A register.

Random numbers

Giving Knuth, *Art Of Computer Programming*, Vol 2, Ch 3 as his reference, Brian Steel of Kingston-upon-Thames writes:

'There are two points I think should be made about the Random Number routines in July's "Sub Set".

Firstly, in a mixed congruential sequence:

$X_{i+1} = aX_i + C \bmod M$

it is important that 'potency' is high. Potency is the power to which (a—1) must be raised before it is directly divisible by M (which it always will be eventually, if your other criteria are met); 257 is a bad 'a', since a—1 = 256 and 256^2 = 65536 or 2^{16}: thus potency is only 2. If you choose a = 5 mod 8 you will ensure higher potency (eg, 5, 13, 21 etc).

Secondly, 'a' should be greater than 0.01M but less than 0.99M for good results. 257 is less than 0.01×2^{16} and therefore fails here, too.

By observing these guidelines you have a better chance of getting a good PRANG, but sadly it can't be guaranteed on these (plus your) criteria alone. However, *no* good PRANG has a potency of less than 3, and 5 or more is desirable for this measurement.'

In fairness to the contributor of our original Datasheet RAND, he did suggest better 'a's than 257 and two of them were ≡ 5 mod 8, greater than 0.01M and less than 0.99M. Still, Brian's remarks present a challenge waiting to be met in 8080, Z80, 6502, and M6800 code. Nothing with a potency of less than 5 will be considered. June's arithmetic routines might help Z80 users to calculate potency.

Andrzej Filinski, of Vedbaek, Denmark, became the fourth reader to give the optimum improved code for RAND as printed last month.

6502 find

We mentioned how June's FIND could be made equivalent to FOWIA (find out where I'm at) and give in Y,X the current program address on return from the call thus:

```
PLA   ;  pull ret addr    68
TAX   ;  low byte to X.   AA
```

```
PLA       ; high byte          68
TAY       ; to Y.              A8
PHA       ; hi byte to stk.    48
TXA       ; lo byte to A.      8A
PHA       ; lo byte to stk.    48
INX       ; adjust to addr     E8
BNE,L1    ; of next            D0 01
INY       ; instruction.       C8
L1: RTS   ; return.            60
```

Vincent Fojut from Salford, a member of the Manchester Computer Club and local Atom Users' Group, offers a different approach to the same task in our next Datasheet, GETLOC. He puts the program address in some of the page zero memory we agreed last month to reserve for 6502 datasheets. GETLOC is two bytes more but 6–7 T states less than the amended FIND and does not use the X or Y registers.

Datasheet

```
;= GET LOC — Get current program address
;/ CLASS: 2
;/ TIME CRITICAL? No
;/ DESCRIPTION:  Gives in consecutive zero page locations the
;/               address of the instruction it is at, after
;/               returning to the code that called it.
;/ ACTION:  CY ← 0
;/          ↑A
;/          A ← A+1
;/          M0 ← A
;/          ↑A
;/          A← A+Cy
;/          M1 ← A
;/ SUBr DEPENDENCE: None
;/ INTERFACES: None
;/ INPUT:   Processor must be in binary mode (ie, decimal flag reset)
;/ OUTPUT:  M0 contains the low order and M1 the high order byte
;/          of the address of the current program instruction
;/          (ie, the instruction immediately following the call
;/          to GETLOC). The carry flag is always unset.
;/ REGs USED:   A, M0 and M1.
;/ STACK USE:   None
;/ LENGTH: 14
;/ TIME STATES: 25
;/ PROCESSOR: 6502
;
GETLOC:  CLC               ; prepare to add with no carry.   18
         PLA               ; pull return address (low).      68
         ADC   £01         ; increment address by 1          69  01
         STA   M0          ; and save.                       85  ZZ
         PLA               ; pull return address (high).     68
         ADC   £00         ; add in carry                    69  00
         STA   M1          ; and save.                       85  ZZ
         JMP   (M0)        ; return.                         6C  ZZ  00
```

Vincent demonstrates GETLOC in action with a 6502 version of our old friend the 4-bit binary to Gray Code conversion, one byte shorter than the Z80 and two bytes shorter than the M6800 version. This 6502 version has the most significant nibble of the Y register zero and the least significant nibble giving the value to be converted on input and returns the Gray Code conversion in the least significant nibble of the register — see Listing 1.

```
GYCON:   JSR   GETLOC                     20  XX  XX
         TYA            ; add table       98
         ADC   £07      ; displacement    69  07
         TAY            ; to no. in A.    A8
         LDA   (M0),Y   ; get conversn    B1  ZZ
         RTS            ; value & ret.    60
TABLE:                                    00  01  03  02
                                          06  07  05  04
                                          0C  0D  0F  0E
                                          0A  0B  09  08
```

Listing 1

Calculate v look-up

When he first saw that way of converting binary to Gray Code in Z80 code, Dave Barrow was against using a look-up table for something that is shorter and quicker when computed, especially if the Gray Code is extended from four to eight bits.

He spotted that, when converting from binary to Gray, each Gray bit has a different state to the corresponding binary bit if the next higher binary bit is set, ie, each Gray bit is the result of XORing the corresponding binary bit with the binary bit's left-hand neighbour. There are hardware circuits to do this or all eight bits of a byte can be done in the software:

```
LD      C,A
SRL     C
XOR     C
```

This code repeated three or seven times converts 4-bit or 8-bit Gray Code back into binary. Dave Barrow has based the next Datasheet, BGCB, on this principle. Both Z80 and 6502 code is given.

Datasheet

```
;= BGCB — Gray Code to and from binary
;/ CLASS: 1
;/ TIME CRITICAL?: No
;/ DESCRIPTION: Converts binary value to Gray Code in input
;/               count is 1. Converts Gray Code to binary if
;/               input count is 3 (4-bit value) or 7 (8-bit value)
;/ ACTION: A ← Input Value
;/          Iterate for input count
;/               A ← A/2 (unsigned)
;/               A ←     Input Value
;/ SUBr DEPENDENCE: None
;/ INTERFACES: None
;/ INPUT: Z80: Value in A, count in B
;/       6502: Value in A, count in Y
;/ OUTPUT: Z80: Converted Value in A, B = 0
;/        6502: Converted Value in A, Y = 0, X = stack pointer −2
;/ REGs USED:  Z80: A B F       6502: A Y P X
;/ STACK USE:  Z80:  2          6502:  1
;/ LENGTH:     Z80:  9          6502:  11
;/ TIME STATES: Z80  — B to G: 55, G to B (4-bit) 97, (8-bit) 181
;/              6502           23                45          89
;/ PROCESSOR: Z80  6502
;  Z80 version
BGCBZ:    PUSH   HL       ;                               E5
          LD     L,A      ; store input value.            6F
          OR     A        ; clear carry.                  B7
LOOPZ:    RRA             ; shift right.                  1F
          XOR    L        ; exclusive OR with input value. AD
          DJNZ   LOOPZ    ;                               10  FC
          POP    HL       ;                               E1
          RET             ;                               C9
;
;  6502 version
;
BGCBS:    TSX             ; index stack.                  BA
          PHA             ; store input value             48
LOOPS:    LSR    A        ; shift right.                  4A
          EOR    $0100,X  ; exclusive OR with input value. 5D  00  01
          DEY             ;                               88
          BNE L  LOOPS    ;                               D0  F9
          TXS             ; remove input value from stack. 9A
          RTS             ;                               60
```

Look-up v calculate

Jan Beckman, from Ashstead, writes that we should never overlook the power of look-up tables when it comes to getting things done speedily. To illustrate this, he uses a look-up table to divide four BCD digits in HL by two in 52-61 T states against our previous best (not printed) of 82-93 T states. Jan's routine does not give a carry signal for any remainder and takes rather a lot of space with its 154-byte table in addition to its 15 bytes of code. It is also highly position-dependent since the table must start on a page boundary. But it is fast. Here is the code:

```
HALFHL: LD   D,H                 54
        LD   H,table hi addr     26 nn
        LD   E,(HL)              5E
        LD   L,D                 6A
        LD   D,(HL)              56
        BIT  0,L                 CB45
        EX   DE,HL               EB
        RET  Z                   C8
        LD   A,50H               3E50

        ADD  A,L                 85
        LD   L,A                 6F
        RET                      C9
```

The table looks like this:

```
TABLE:  ORG     nn00H
        DEFW    0000H
        DEFW    0101H
        DEFW    0202H
        DEFW    0303H
        DEFW    0404H
        DEFS    6
        ...............
        ...............
        ...............
        DEFW    4444H
        DEFS    6
        DEFW    4545H
        DEFW    4646H
        DEFW    4747H
        DEFW    4848H
        DEFW    4949H
```

LEISURE LINES

Well, we had a fairly mediocre response to July's puzzle, proving once again that the computer would prefer numerics to alphanumerics. Only 11 entries were received for the word/prime number puzzle and one of those was withdrawn when its originator found that his solution wasn't a prime number after all!

There were some very strange words, too. We decided to ban 'interestingness' and although 'disintegrating' looked good, it's not a prime. The largest word which fulfilled all conditions was 'assassinating', corresponding to the number 2,772,776,528,653, which we verified as a 13-digit prime. This came from Mr Brian Stuart of Neubiberg, Germany, whose prize will be on its way soon.

Prize puzzle

Write down eleven thousand, eleven hundred and eleven. It doesn't divide exactly by seven — agreed?

Quickie

The members of a philanthropic family decided to donate £2000 to a group of worthy charities. Each member contributed an equal portion of the money and then allocated it among the agreed charities so that:
a) each charity received a donation of at least £1 but no more than £12 from each family member;
b) no two charities received the same amount from the same family member;
c) no two family members followed the same donation pattern. Finally, all donations were in whole pounds and all the money was distributed.

How many family members were there and how many charities?

Answers on a *postcard* please to: October Prize Puzzle, Leisure Lines, *PCW*, 14 Rathbone Place, London W1P 1DE, to arrive no later than 31 October.

PROGRAMS

TRS-80 Sailing Simulation

by Frank Hope

This program simulates sailing various types of dinghy to varying standards. As far as possible, it follows good sailing techniques. All the knowledge required to use the program is included in the glossary of technical terms and you are strongly advised to study this carefully, since normal club practice can differ from the RYA's recommendations. The program occupies 20k.

```
1 POKE16396,23:GOTO290
2 J1=0:J2=0:J3=0:J4=0:J5=0:J6=0:J7=0:D1=0:D3=0:D5=0:D6=0:D7=0:P2=0:B1=0:Q4-0:P01
=0
3 IFNC=1THEN278
4 GOSUB118:PRINT@259,"STUDY THE TECHNICAL DATA.";:PRINT@323,S7$;:PRINT@451,"A. C
AST OFF.";:PRINT@515,"B. SEE A DOCTOR.";:PRINT@579,"C. WAIT FOR FINE WEATHER.";:
PRINT@643,"D. HAVE A REST PERIOD.";:PRINT@707,"E. SEE THE GLOSSARY.";:GOSUB112
5 GOSUB123:IFNN$<>"A"ANDNN$<>"B"ANDNN$<>"C"ANDNN$<>"D"ANDNN$<>"E"THENGOSUB99ELSE
7
6 GOTO5
7 IFNN$="A"THEN8ELSEIFNN$ "C"THEN16ELSEIFNN$="D"THEN19ELSEIFN
N$="E"THEN24
8 IFN1=1ANDC1>3ORN1=2ANDC1>4ORN1=3ANDC1>5THENQ2=1
9 IFQ2<>1THEN36ELSEGOSUB110
10 GOSUB83:GOTO2
11 IFP1=1THENP9=1:GOSUB110
12 IFP1=1THEN2
13 IFP1=2THENGOSUB107ELSEIFP1=3THENGOSUB108
14 P9=1:GOSUB112
15 GOTO2
16 IFN1=1ANDC1<4ORN1=2ANDC1<5ORN1=3ANDC1<6THENQ4=1ELSEQ4=2
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PROGRAMS

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17 GOSUB110:GOSUB83
18 GOTO2
19 IFP1=1THENP9=1
20 IFP9=1THENGOSUB110
21 IFP1=1THEN2ELSEIFP1=2THENGOSUB107ELSEIFP1=3THENGOSUB108
22 P9=1:GOSUB112
23 GOTO2
24 GOSUB118:IFN1<2THEN25ELSEPRINT@452,"YOU SHOULD'NT NEED IT.";:Q5=1:GOSUB110:GO
TO2
25 PRINT@259,"SPRING = VERY HIGH/LOW.";:PRINT@D,"NEAP   = SMALL HIGH/LOW.";:PRIN
T@387,"FLOOD  = COMING IN.";:PRINT@451,"EBB    = GOING OUT.";:PRINT@515,"FORCE
= WIND SPEED.";:PRINT@581,"3 IS ENOUGH FOR YOU.";
26 PRINT@643,"WIND DIR. = WHERE IT COMES";:PRINT@712,"FROM. E.G. THE EAST.";:GOS
UB120
27 GOSUB101:PRINT@258,"BAROMETER = WEATHER GUIDE.";:PRINT@322,"FALLING   = BAD W
EATHER.";:PRINT@386,"RISING    = GOOD WEATHER.";:PRINT@450,"BEATING   = 45' TO T
HE WIND.";:PRINT@514,"REACHING  = ACROSS THE WIND.";
28 PRINT@578,"RUNNING   = FROM THE WIND.";:PRINT@642,"C.BOARD   = A MOVING KEEL.
";:PRINT@706,"(CLOSE HAULED = FULLY DOWN).";:GOSUB120
29 GOSUB101:PRINT@258,"REEFING   = REDUCE SAIL.";:PRINT@322,"MAINSAIL = BIGGEST S
AIL.";:PRINT@386,"RUDDER    = STEERING GEAR.";:PRINT@450,"FLATTEN   = TIGHTEN SAIL
.";:PRINT@514,"FULLNESS = SLACKEN SAIL.";
30 PRINT@578,"JIB       = SMALL FRONT SAIL.";:PRINT@642,"TRANSOM  = BACK VERTICAL
";:PRINT@717,"SECTION OF BOAT.";:GOSUB120
31 GOSUB101:PRINT@67,"  TIDAL CALCULATIONS.";:PRINT@194,"D. OF W. = HW-LW/12*TR+
CDW";:PRINT@322,"TWELFTH RULE (TR) :-";:PRINT@452,"1 HR. AFTER LW  = 1";:PRINT@5
16,"2 ND.    -:-       = 3";:PRINT@580,"3 RD.    -:-       = 6";:PRINT@644,"4 TH.    -:
-        = 9";
32 PRINT@708,"5 TH.    -:-       = 11";:PRINT@772,"6 TH.    -:-       = 12";
33 GOSUB120:GOSUB101:PRINT@67,"  SPEED CALCULATIONS.";:PRINT@323," IF WITH THE T
IDE THEN";:PRINT@387,"SAILING TIME = T/(BS+TS)";:PRINT@515,"IF AGAINST THE TIDE
THEN";:PRINT@579,"SAILING TIME = T/(BS-TS)";:GOSUB120
34 GOSUB101:PRINT@67," BEARING CALCULATIONS.";:PRINT@322,"IF V. = EAST ADD IT TO
 C.B.";:PRINT@386,"IF D. = EAST ADD IT TO C.B.";:PRINT@514,"IF V. = WEST TAKE FR
OM C.B.";:PRINT@578,"IF D. = WEST TAKE FROM C.B.";:GOSUB120
35 GOTO2
36 GOSUB139
37 GOSUB87
38 GOSUB134:GOSUB119:PRINT@194,"YOU MUST TRAVEL ":R$;
39 PRINT@322,"ARE YOUR SAILS SET FOR :-";:PRINT@390,"A. BEATING.";:PRINT@454,"B.
 REACHING.";:PRINT@518,"C. RUNNING.";:PRINT@642,S8$;
40 GOSUB121:IFNN$<>"A"ANDNN$<>"B"ANDNN$<>"C"THENGOSUB99ELSE42
41 GOTO40
42 IFNN$="A"THEN43ELSEIFNN$="B"THEN44ELSEIFNN$="C"THEN45
43 S1=1:N1$="  CLOSE HAULED ":GOTO46
44 S1=2:N1$="   REACHING     ":GOTO46
45 S1=3:N1$="   RUNNING      "
46 V=V7:GOSUB106:GOSUB119:PRINT@258,"CENTRE BOARD POSITION.";:PRINT@386,"SHOULD
IT BE :-";:PRINT@455,"A. NEARLY UP.";:PRINT@519,"B. FULLY DOWN.";:PRINT@583,"C.
HALF DOWN.";:PRINT@706,S8$;
47 GOSUB121:IFNN$<>"A"ANDNN$<>"B"ANDNN$<>"C"THENGOSUB99ELSE49
48 GOTO47
49 IFNN$="A"THEN50ELSEIFNN$="B"THEN51ELSEIFNN$="C"THEN52
50 M1=1:N1$="   ALMOST UP    ":GOTO53
51 M1=2:N1$="   FULLY DOWN   ":GOTO53
52 M1=3:N1$="   HALF DOWN    "
53 V=V8:GOSUB106:IFQ1=1ANDR1=1ANDS1=1ANDM1=2ORQ1=1ANDR1=2ANDS1=3ANDM1=1ORQ1=1AND
R1=3ANDS1=2ANDM1=3ORQ1=1ANDR1=4ANDS1=2ANDM1=3THEN59
54 IFQ1=2ANDR1=2ANDS1=1ANDM1=2ORQ1=2ANDR1=1ANDS1=3ANDM1=1ORQ1=2ANDR1=3ANDS1=2AND
M1=3ORQ1=2ANDR1=4ANDS1=2ANDM1=3THEN59
55 IFQ1=3ANDR1=3ANDS1=1ANDM1=2ORQ1=3ANDR1=4ANDS1=3ANDM1=1ORQ1=3ANDR1=1ANDS1=2AND
M1=3ORQ1=3ANDR1=2ANDS1=2ANDM1=3THEN59
56 IFQ1=4ANDR1=4ANDS1=1ANDM1=2ORQ1=4ANDR1=3ANDS1=3ANDM1=1ORQ1=4ANDR1=2ANDS1=2AND
M1=3ORQ1=4ANDR1=1ANDS1=2ANDM1=3THEN59
57 P2=1:GOSUB110
58 IFNC=1THEN278
59 GOSUB112:KJ=0
60 LO=1:GOSUB118:PRINT@455,"HERE WE GO !!!";:GOSUB138
61 GOSUB229:IFD3=1THEN63ELSEIFD2=1ORNC=1THEN278ELSEGOSUB243:IFD3=1THEN63ELSEIFD2
=1ORNC=1THEN278ELSEGOSUB254:IFD3=1THEN63ELSEIFD2=1ORNC=1THEN278ELSEGOSUB264:IFD3
=1THEN63ELSEIFD2=1ORNC=1THEN278
62 GOSUB133:GOSUB148:GOSUB129:GOSUB102:GOSUB92
63 IFD2=1ORNC=1THEN278ELSEIFD3=0THEN65ELSEIFD3=1THENGOSUB118:PRINT@E,"WE ARE GOI
NG ASHORE !!";:GOSUB138:GOSUB74
64 PRINT@625,O$;:PRINT@689,O$;:PRINT@753,O$;:GOSUB83:GOTO2
65 IFD2=1ORNC=1THEN278ELSEGOSUB118:PRINT@262,"YOUR DOING WELL !!";:PRINT@324,"WE
 ARE OUT ON THE OPEN";:PRINT@387,"SEA. FROM NOW ON YOU NEED";:PRINT@456,"TO KEEP
ALERT.";
66 KJ=1:LO=0:PRINT@579,"STUDY THE TECHNICAL DATA..";:GOSUB120
67 D3=0:J1=0:J2=0:J3=0:J4=0:J5=0:J6=0:D1=0:D5=0:P2=0
68 GOSUB83:IFRND(10)>6THENGOSUB158
69 GOSUB229:IFN1=1ANDD3<>1ANDC1>5ORN1=2ANDD3<>1ANDC1>6ORN1=3ANDD3<>1ANDC1>7THENG
OSUB97
70 IFD3=1THEN63ELSEIFD2=1ORNC=1THEN278ELSEGOSUB243:IFD3=1THEN63ELSEIFD2=1ORNC=1T
HEN278ELSEGOSUB254:IFD3=1THEN63ELSEIFD2=1ORNC=1THEN278ELSEGOSUB264:IFD3=1THEN63E
LSEIFD2=1ORNC=1THEN278ELSEGOSUB133:GOSUB94
71 IFD2=1ORNC=1THEN278ELSEIFD3=1THEN63ELSEGOSUB129:GOSUB102:GOSUB112
72 IFKL=1THEN284
73 GOTO67
74 GOSUB122:PRINT@709,STRING$(19,191)::POKE16068,139:PRINT@644,STRING$(6,143);:P
RINT@581,STRING$(5,191);:PRINT@518,STRING$(4,191);:PRINT@455,STRING$(3,191);:PRI
NT@392,STRING$(2,191);:POKE15689,191:POKE15625,170
75 PRINT@651,STRING$(10,143);:PRINT@587,STRING$(9,191);:PRINT@523,STRING$(8,191)
;:PRINT@459,STRING$(6,191);:PRINT@395,STRING$(4,191);:PRINT@331,STRING$(2,191);:
POKE15627,191:POKE15627,191:RETURN
76 PRINT@241,O$;:PRINT@305,O$;:PRINT@369,O$;:PRINT@433,O$;:PRINT@497,O$;:PRINT@5
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PROGRAMS

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61,0$;:PRINT@625,0$;:PRINT@689,0$;:PRINT@753,0$;:PRINT@817,0$;:RETURN
77 H$="":NN$="":PRINTCHR$(15);
78 H$=INKEY$:PRINTCHR$(143);:FORX=1TO10:NEXTX:PRINTCHR$(8);
79 IFH$=""ORH$=CHR$(10)THEN78
80 IFH$=CHR$(13)THENRETURN
81 PRINTH$;:NN$=NN$+H$
82 GOTO78
83 C1=RND(8):FORZ =1TO3:PRINT@V5,0$::GOSUB135:PRINT@V5,"  FORCE ":C1;:PRINT"
";:GOSUB135:NEXT
84 V=V3:Q1=RND(4):IFQ1=1THENN1$="  NORTHERLY    "ELSEIFQ1=2THENN1$="  SOUTHERLY
  "ELSEIFQ1=3THENN1$="  EASTERLY     "ELSEIFQ1=4THENN1$="  WESTERLY     "
85 GOSUB106:V=V4:D1=RND(3):IFD1=1THENN1$="  FALLING      "ELSEIFD1=2THENN1$="  R
ISING      "ELSEIFD1=3THENN1$="  STEADY      "
86 GOSUB106:RETURN
87 IFE5>7THENZ1=RND(2)ELSEZ1=0
88 IFE5<8THENZ2=RND(2)
89 IFZ1=1THENN1$="  SPRING FLOOD "ELSEIFZ1=2THENN1$="  SPRING EBB   "
90 IFZ2=1THENN1$="  NEAP FLOOD   "ELSEIFZ2=2THENN1$="  NEAP EBB     "
91 V=V9:GOSUB106:RETURN
92 GOSUB136:GOSUB118:P=RND(100):IFP>95THEN167ELSEIFP>90THEN178ELSEIFP>84THEN181E
LSEIFP>80THEN219ELSEIFP>70THEN205ELSEIFP>65THEN217ELSEIFP>50THEN225
93 RETURN
94 GOSUB136:GOSUB118:Y=RND(100):IFY>93THEN174ELSEIFY>88THEN181ELSEIFY>78THEN185E
LSEIFY>70THEN189ELSEIFY>60THEN191ELSEIFY>55THEN197ELSEIFY>45T54145ELSEIFY>35THEN
205
95 IFY>30THEN208ELSEIFY>25THEN210ELSEIFY>20THEN212ELSEIFY>15THEN217ELSEIFY>10THE
N221
96 RETURN
97 GOSUB136:GOSUB118:U=RND(100):IFU>90THEN174ELSEIFU>70THEN185ELSEIFU>50THEN191E
LSEIFU>30THEN205ELSEIFU>15THEN212ELSEIFU>0THEN217
98 RETURN
99 GOSUB100:PRINT@L,"INCORRECT INFORMATION PLEASE TRY AGAIN. "::GOSUB136:GOSUB10
0:RETURN
100 PRINT@898,CHR$(31):RETURN
101 SS$=STRING$(28,32):PRINT@194,SS$;:PRINT@258,SS$;:PRINT@322,SS$;:PRINT@386,SS
$;:PRINT@450,SS$;:PRINT@514,SS$;:PRINT@578,SS$;:PRINT@642,SS$;:PRINT@706,SS$;:PR
INT@770,SS$;:RETURN
102 IFB1=1THENY2=5ELSEIFB1=2THENY2=8ELSEIFB1=3THENY2=12ELSEIFB1=4THENY2=15ELSEY2
=20
103 FORX=1TOR4:A2=A2+1:PRINT@121,A2;:FORY1=1TOY2:NEXTY1:NEXTX:B1=0
104 IFKJ=1ANDA2>500THENKL=1
105 RETURN
106 FORZX=1TO3:PRINT@V,0$;:GOSUB135:PRINT@V,N1$;:GOSUB135:NEXT:N1$="":RETURN
107 V=V6:P1=1:N1$="  HEALTHY      ":GOSUB106:09$=0$:RETURN
108 V=V6:P01=2:P1=2:N1$="  POORLY       ":GOSUB106:09$=0$:RETURN
109 V=V6:P01=3:P1=3:N1$="  VERY POORLY  ":GOSUB106:09$=0$:RETURN
110 IFP2=1THEN09$=00$ELSEIFQ3=1THEN09$=01$ELSEIFQ4=1THEN09$=02$ELSEIFW01=1ORW02=
2ORW03=1ORQ5=1THEN09$=03$ELSEIFQ4=2THEN09$=04$ELSEIFQ2=1THEN09$=05$ELSEIFP9=1THE
N09$=06$ELSEIFP01=2ORP01=3THEN09$=07$ELSEIFP3=1THEN09$=08$
111 FORZX=1TO3:PRINT@817,09$;:GOSUB135:PRINT@817,0$;:PRINT@881,0$;:GOSUB135:NEXT
112 IFW01=1ORW02=2ORW03=1ORQ2=1ORQ3=1ORP9=1ORQ4=1ORQ5=1ORP2=1ORP01=2ORP01=3THENA
1=A1+20:PRINT@114,A1;:GOTO114
113 A1=A1+1:PRINT@114,A1;
114 IFW01=1ORW02=2ORW03=1ORQ2=1ORQ3=1ORP51=1ORQ4=1ORQ5=1ORP2=1THENSC=SC+1
115 IFN1=1ANDSC>4ORN1=2ANDSC>3ORN1=3ANDSC>2THENNC=1
116 P2=0:Q3=0:Q4=0:W01=0:W02=0:W03=0:Q5=0:Q2=0:P9=0:P3=0:P01=0:09$=0$
117 RETURN
118 GOSUB101:PRINT@A,"  READ THE FOLLOWING    ";:RETURN
119 GOSUB101:PRINT@A," ANSWER THE FOLLOWING  ";:RETURN
120 GOSUB100:PRINT@L,"TO CONTINUE PRESS <ENTER>  "::GOSUB77:GOSUB100:RETURN
121 GOSUB100:PRINT@L,"TYPE A LETTER FROM A -- C  ";:GOSUB77:GOSUB100:RETURN
122 GOSUB101:PRINT@A,"  STAND BY FOR ACTION    "::RETURN
123 GOSUB100:PRINT@L,"TYPE A LETTER FROM A -- E  ";:GOSUB77:GOSUB100:RETURN
124 GOSUB100:PRINT@L,"TYPE A LETTER FROM A -- D  ";:GOSUB77:GOSUB100:RETURN
125 P2=1:GOSUB110:RETURN
126 P2=1:GOSUB118:PRINT@452,"YOUR NOT GOOD ENOUGH.";:GOSUB110:RETURN
127 P2=1:GOSUB118:PRINT@452,"IT DOES'NT HAVE ONE !";:Q5=1:GOSUB110:RETURN
128 P2=1:GOSUB110:RETURN
129 09$=0$:GOSUB74:IFS1=2ANDJ1=0ANDJ2=0ANDJ3=0ANDJ5=0ANDJ7=0ANDC1>2THENB1=1ELSEI
FN1=1ANDS1=1ANDC1>2ORN1=2ANDS1=1ANDC1>3ORN1=3ANDS1=1ANDC1>4THENB1=4ELSEIFS1>1AND
Z1<3ANDC1>2THENB1=2ELSEB1=3
130 IFB1=1THEN09$=S4$ELSEIFB1=2THEN09$=S2$ELSEIFB1=3THEN09$=S3$ELSEIFB1=4THEN09$
=S1$
131 GOSUB110:09$=0$
132 RETURN
131 GOSUB110:09$=0$
132 RETURN
133 GOSUB118:PRINT@259,"STATUS REPORT :---";:PRINT@387,"DIRECTION. = "R$;:PRINT@
451,"MAINSAIL.  = "T1$;:PRINT@515,"JIB.       = "T3$;:PRINT@579,"SPINNAKER. = "T
4$;:PRINT@643,"TRAPEZE.   = "T2$;:PRINT@707,"RUDDER.    = "T5$;:GOSUB120:RETURN
134 R1=RND(4):IFR1=1THENR$="NORTHWARD."ELSEIFR1=2THENR$="SOUTHWARD."ELSEIFR1=3TH
ENR$="EASTWARD."ELSEIFR1=4THENR$="WESTWARD.":RETURN
135 FORX=1TO350:NEXT:RETURN
136 FORX=1TO1000:NEXT:RETURN
137 FORX=1TO3000:NEXT:RETURN
138 FORX=1TO1500:NEXT:RETURN
139 I1=RND(10):I2=I1+RND(20):I3=RND(8):I4=RND(12):I5=I4+RND(6):I6=(I5-I4):E5=(I2
-I1)
140 IFI6=1THENH1=1ELSEIFI6=2THENH1=3ELSEIFI6=3THENH1=6ELSEIFI6=4THENH1=9ELSEIFI6
=5THENH1=11ELSEIFI6=6THENH1=12
141 E1=RND(2):IFE1=1THENC1$="A.M."ELSEC1$="P.M."
142 W7=(((I2-I1)/12)*H1)+I3+.5
143 GOSUB101:PRINT@67,"  TIDAL CALCULATIONS.";:PRINT@258,"HIGH WATER (H.W.) =";:
PRINTUSINGL1$;I2;:PRINT" M.";:PRINT@322,"LOW WATER (L.W.)  =";:PRINTUSINGL1$;I1;
:PRINT" M.";:PRINT@386,"DEPTH OF WATER AT";:PRINT@450,"CHART DATUM.(CDW) =";
144 PRINTUSINGL1$;I3;:PRINT" M.";:PRINT@514,"TIME OF LOW WATER =";:PRINTUSINGL1$
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PROGRAMS

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;I4::PRINT" ";C1$;:PRINT@643,"CALCULATE THE DEPTH OF";:PRINT@706."WATER AT";I6;"
HR/S AFTER L.W.";
145 PRINT@900,"STATE THE DEPTH OF WATER (DOW).  ";:GOSUB77:GOSUB100
146 IFVAL(NN$)=W7THENQ4=2ELSEP2=1
147 GOSUB110:RETURN
148 IFZ1>2THENR1=RND(2)ELSER1=RND(3)+1:R4=RND(20)+10:R2=RND(2)
149 IFR2=1THENB$="WITH"ELSEB$="AGAINST"
150 IFN2<3ANDC1<3THENR3=R1+RND(2)ELSER3=R1+RND(3)+1
151 IFR2=1THENG7=R4/(R3+R1)+.5
152 IFR2=2THENG7=R4/(R3-R1)+.5
153 GOSUB101:PRINT@67."  SPEED CALCULATIONS.";:PRINT@258,"BOAT SPEED (BS) =";R3;
"KNOT/S.";:PRINT@322."TIDAL RATE (TS) =";R1;"KNOT/S.";:PRINT@390."SAILING ";B$;"
 TIDE.";:PRINT@579,"YOU MUST TRAVEL";R4;"MILES.";
154 PRINT@707,"(T = THE NUMBER OF MILES)";
155 PRINT@900,"STATE YOUR ESTIMATED SAILING TIME (ST).  ";:GOSUB77:GOSUB100
156 IFVAL(NN$)=G7THENQ4=2ELSEP2=1
157 GOSUB110:RETURN
158 D1=60+RND(300):D2=RND(12):D3=RND(12):D4=RND(2):IFD4=1THEND4$="E"ELSEIFD4=2TH
END4$="W"
159 D5=RND(2):IFD5=1THEND5$="E"ELSED5$="W"
160 IFD4=1ANDD5=1THEND6=(D1+D2+D3)ELSEIFD4=1ANDD5=2THEND6=(D1+D2)-D3
161 IFD4=2ANDD5=1THEND6=(D1-D2)+D3
162 IFD4=2ANDD5=2THEND6=(D1-D2-D3)
163 GOSUB101:PRINT@67,"  LETS TAKE A BEARING.";:PRINT@258,"COMPASS BEARING = ";:
PRINTUSINGL1$:D1;:PRINT"'";:PRINT@322,"DEVIATION (D)   = ";:PRINTUSINGL1$;D2;:PR
INT"'";D4$;:PRINT@386,"VARIATION (V)   = ";:PRINTUSINGL1$;D3;:PRINT"'";D5$;
164 PRINT@578,"CALCULATE THE TRUE BEARING.";:PRINT@900,"STATE THE TRUE BEARING "
;:GOSUB77:GOSUB100
165 IFVAL(NN$)=D6THENQ4=2ELSEP2=1
166 GOSUB110:RETURN
167 PRINT@322,"COLLISION IN THE HARBOUR.";:GOSUB138:X=RND(5):ONXGOTO168,170,172,
170,168
168 D3=1:PRINT@393,"DINGY SUNK.";:PRINT@452,"YOUR HEALTH SUFFERED.";:PRINT@515,"
TAKE 20 DAYS FOR REPAIRS.";:P9=1:GOSUB112:GOSUB109
169 RETURN
170 D3=0:PRINT@389,"NO DAMAGE. CARRY ON";:PRINT@458,"SAILING.";:GOSUB138
171 RETURN
172 IFW1<>1ORW2<>1THEN170ELSEPRINT@386,"YOU COULD NOT MAKE IT";:PRINT@450."TO DR
Y LAND.";:PRINT@514,"YOU DROWNED !";:GOSUB138:D2=1
173 RETURN
174 IFN1=1ANDC1>3ANDJ1=0ORN1=1ANDC1>3ANDJ2=0ORN1=1ANDC1>3ANDJ7=0THEN178
175 IFN1=2ANDC1>3ANDJ1=0ORN1=2ANDC1>3ANDJ2=0ORN1=2ANDC1>3ANDJ7=0THEN178
176 IFN1=3ANDC1>4ANDJ1=0ORN1=3ANDC1>4ANDJ2=0ORN1=3ANDC1>4ANDJ7=0THEN178
177 GOTO191
178 D3=0:PRINT@325,"TOO MUCH SAIL SET.";:GOSUB137:PRINT@388,"BOAT CAPSIZED BUT Y
OU";:PRINT@452,"MADE IT. HOWEVER, YOUR";:PRINT@515,"HEALTH MAY HAVE SUFFERED.";:
GOSUB138
179 IFP1=3THEND2=1
180 GOSUB109:RETURN
181 D3=1:PRINT@325,"REGATTA IN PROGRESS.";:PRINT@387,"TAKE A DAY OFF TO RACE.";:
GOSUB137:X=RND(2):IFX=1THENPRINT@515,"UNFORTUNATELY YOU LOST.":ELSEPRINT@517,"WE
LL DONE YOU WON.";:GOSUB113
182 GOSUB138:RETURN
183 IFS1<>3THEN185ELSEPRINT@327,"ACCIDENTAL GYBE !!";:GOSUB138:PRINT@452,"NO DAM
AGE DONE. CARRY ON";:PRINT@523,"SAILING.";
184 RETURN
185 IFC1>3THEN187ELSEPRINT@327,"GEAR FAILURE !!";:GOSUB137:PRINT@453,"ONLY MINOR
 DAMAGE.";:PRINT@516,"MAKE RUNNING REPAIRS.";:GOSUB138
186 RETURN
187 D3=1:PRINT@324,"DINGY SERIOUSLY DAMAGED.";:PRINT@450."20 DAYS NEEDED FOR REP
AIRS.";:P9=1:GOSUB112:GOSUB138
188 RETURN
189 D3=0:PRINT@389,"SAIL SLIGHTLY RIPPED.";:PRINT@453."MAKE RUNNING REPAIRS.";:G
OSUB113:GOSUB138
190 RETURN
191 D3=1:PRINT@197."A FREAK GUST HIT YOU.";:GOSUB138:H=RND(4):ONHGOTO189.187.189
,192
192 PRINT@327,"MAN OVERBOARD !!";:IFW1=1ORW2=1THEN193:H=RND(5):IFH>1THEN195
193 GOSUB138:PRINT@453."YOU LOST YOUR CREW !!";:PRINT@582."IT'S ALL OVER NOW.";:
GOSUB138:D2=1
194 RETURN
195 D3=0:PRINT@456,"YOU GOT HIM !!";:PRINT@582,"BUT HE CUT HIS LEG.";:GOSUB109:G
OSUB138
196 RETURN
197 PRINT@327,"PASSING LINER !!";:GOSUB138:H=RND(5):IFH>3THEN200
198 PRINT@455,"YOU MISSED HIM.";:GOSUB138
199 RETURN
200 D3=1:PRINT@390,"COLLISION AT SEA !!";:GOSUB138:H=RND(8):IFH<2THEN203
201 D3=0:PRINT@517,"ONLY SLIGHTLY DAMAGED.";:PRINT@581,"MAKE RUNNING REPAIRS.";:
GOSUB138
202 RETURN
203 PRINT@516,"YOUR HOLED & GOING DOWN.";:PRINT@582,"NOBODY SAW YOU HIT.";:PRINT
@710,"IT'S ALL OVER NOW.";:GOSUB138:D2=1
204 RETURN
205 PRINT@325,"SICKNESS ON BOARD !";:IFP1=3THEND2=1
206 IFD2=1THENRETURNELSEPRINT@454,"NO NEED TO WORRY";:PRINT@517."ONLY A TUMMY UP
SET.";:GOSUB108:GOSUB138
207 RETURN
208 D3=1:PRINT@322,"YOU HAD A GOOD PARTY.";:PRINT@387,"TAKE A DAY TO SLEEP";:PRI
NT@456."IT OFF.";:GOSUB113:GOSUB138
209 RETURN
210 IFC1<3ORE5>6THEN227ELSEPRINT@325,"YOUR IN A TIDE RACE.";:GOSUB138:PRINT@451,
"YOU HAVE MADE GOOD TIME";:GOSUB138
211 RETURN
212 D3=0:PRINT@325,"YOU ARE LOST IN FOG.";:GOSUB138:IFW3<>1THEN215
213 PRINT@389,"YOU WANDER FOR 1 DAY.";:GOSUB113:GOSUB138
214 RETURN
```

PROGRAMS

```
215 PRINT@390,"LIFE BOAT COMES TO";:PRINT@454,"FIND YOU. ALL HELL";:PRINT@521."L
ETS LOOSE.";:GOSUB138:D2=1
216 RETURN
217 D3=1:PRINT@324,"PORT SHROUD SNAPPED.";:PRINT@391,"CREW INJURED !";:PRINT@453
,"TAKE 1 DAYS REST.";:GOSUB113:GOSUB109:GOSUB138
218 RETURN
219 PRINT@324,"REGATTA IN PROGRESS.";:PRINT@388,"MAKE A DIVERSION TO";:PRINT@457
,"AVOID IT.";:GOSUB113:GOSUB138
220 RETURN
221 IFC1>4THEN200ELSEPRINT@323,"BEACHED ON A LEE-SHORE.";:D3=1:PRINT@390,"HAVE A
 DAYS REST.";:GOSUB113:GOSUB137
222 RETURN
223 PRINT@324,"ARGUE WITH YOUR CREW.";:PRINT@388,"LOSE 1 DAYS SAILING.";:GOSUB11
3:GOSUB138
224 RETURN
225 D3=1:PRINT@323,"YOU LEFT YOUR WATERPROOF";:PRINT@390,"CLOTHING BEHIND.";:PRI
NT@452,"LOSE 1 DAYS SAILING.";:GOSUB113:GOSUB138
226 RETURN
227 IFN1=1THEN183ELSEIFD1=1THEN185ELSE191
228 GOTO191
229 D2=0:D3=0:Q4=0:T1$="UP.":T2$="NOT IN USE.":T3$="UP.":T4$="NOT IN USE.":T5$="
DOWN."
230 GOSUB119:PRINT@259,S7$;:PRINT@387,S5$;:PRINT@451,"B. REEF THE MAINSAIL.";:PR
INT@515,"C. USE THE TRAPEZE.";:PRINT@579,S6$;:PRINT@706,S8$;
231 GOSUB124:IFNN$<>"A"ANDNN$<>"B"ANDNN$<>"C"ANDNN$<>"D"THENGOSUB99ELSE233
232 GOTO231
233 IFNN$="B"THEN237ELSEIFNN$="C"THEN239ELSEIFNN$="D"THEN241
234 IFLO=1THENQ5=1
235 IFQ5=1THENGOSUB110ELSED3=1
236 RETURN
237 IFN1=1ANDC1<3ORN1=2ANDC1<4ORN1=3ANDC1<5THEN125
238 J1=1:T1$="REEFED.":RETURN
239 IFN2=1ORN2=2THEN127ELSEIFN1=1THEN126ELSEIFC1<2THEN125
240 D7=0:T2$="IN USE.":RETURN
241 IFN1=1ANDC1>2ORN1=2ANDC1>3ORN1=3ANDC1>4ORN1=2ANDS1<3ANDC1>1ORN1=3ANDS1<3ANDC
1>1THEN125
242 RETURN
243 GOSUB119:PRINT@259,S7$;:PRINT@387,S5$;:PRINT@451,"B. LOWER YOUR JIB.";:PRINT
@515,"C. LOOSEN YOUR MAINSAIL.";:PRINT@579,S6$;:PRINT@706,S8$;
244 GOSUB124:IFNN$<>"A"ANDNN$<>"B"ANDNN$<>"C"ANDNN$<>"D"THENGOSUB99ELSE246
245 GOTO244
246 IFNN$="B"THEN248ELSEIFNN$="C"THEN250ELSEIFNN$="D"THEN252ELSED3=1
247 RETURN
248 IFN1=1ANDC1<4ORN1=2ANDC1<5ORN1=3ANDC1<6THEN125
249 J7=1:T3$="LOWERED.":RETURN
250 IFJ1=1ORC1>1THEN125
251 J5=1:T1$="SLACKENED.":RETURN
252 IFN1=1ANDC1>3ORN1=2ANDC1>4ORN1=3ANDC1>5ORC1<2THEN125
253 RETURN
254 GOSUB119:PRINT@259,S7$;:PRINT@387,S5$;:PRINT@451,"B. USE THE SPINNAKER.";:PR
INT@515."C. LOWER YOUR MAINSAIL.";:PRINT@579,S6$;:PRINT@706,S8$;
255 GOSUB124:IFNN$<>"A"ANDNN$<>"B"ANDNN$<>"C"ANDNN$<>"D"THENGOSUB99ELSE257
256 GOTO255
257 IFNN$="B"THEN259ELSEIFNN$="C"THEN261ELSEIFNN$="D"THEN262ELSED3=1
258 RETURN
259 IFN1=1THEN126ELSEIFN2=1ORN2=2THEN127ELSEIFS1>1ANDN1=2ANDC1<5ANDJ1=0ORS1>1AND
N1=3ANDC1<6ANDJ1=0THEN260ELSE125
260 D6=1:T4$="FLYING.":RETURN
261 IFJ7=1THEN125ELSEIFN1=1ANDC1<4ORN1=2ANDC1<5ORN1=3ANDC1<6THEN125ELSEJ2=1:T1$=
"DOWN.":RETURN
262 IFN1=2ANDS1>1ANDC1<5ORN1=3ANDS1>1ANDC1<6ORN1=1ANDC1>4ORN1=2ANDC1>5ORN1=3ANDC
1>6THEN125
263 RETURN
264 GOSUB119:PRINT@259,S7$;:PRINT@387,S5$;:PRINT@451."B. ANGLE THE RUDDER.";:PRI
NT@515,"C. FLATTEN YOUR MAINSAIL.";:PRINT@579,S6$;:PRINT@706,S8$;
265 GOSUB124:IFNN$<>"A"ANDNN$<>"B"ANDNN$<>"C"ANDNN$<>"D"THENGOSUB99ELSE267
266 GOTO265
267 IFNN$="B"THEN269ELSEIFNN$="C"THEN271ELSEIFNN$="D"THEN274ELSED3=1
268 RETURN
269 IFS1<>3THEN125
270 J3=1:T5$="SLIGHTLY UP.":RETURN
271 IFJ1=1THEN125ELSEIFJ2=1ORP2=1ORS1=3ORS1=2ANDC1<3ORS1=1ANDC1<2THEN125
272 IFS1=3THEN125
273 J4=1:T1$="FLATTENED.":RETURN
274 IFS1=3THEN125
275 IFJ1=1ORJ2=1ORJ7=1THEN277
276 IFJ1=0ANDC1>2ORJ2=0ANDC1>2ORJ7=0ANDC1>2THEN125
277 RETURN
278 FORM=1TO4:GOSUB118:PRINT@267,CHR$(191);CHR$(131);CHR$(131);CHR$(131);CHR$(19
1);:PRINT@335,CHR$(191);:PRINT@398,CHR$(131);:PRINT@397,CHR$(188);:PRINT@461,CHR
$(143);:PRINT@525,CHR$(143);
279 PRINT@645."PROBLEMS. PROBLEMS.";:GOSUB135:NEXT
280 GOSUB135:GOSUB118:PRINT@325,"YOU ARE EITHER VERY";:PRINT@387,"UNLUCKY OR ELS
E YOU HAVE";:PRINT@452,"MADE TOO MANY MISTAKES.";:PRINT@515,"EITHER WAY YOU HAVE
 JUST";:PRINT@588."LOST !!";:GOSUB138::O9$=O8$:GOSUB110:GOSUB120
281 IFA1=0THENA1=1ELSEIFA2=0THENA2=1
282 LO=((A2*100)/A1):GOSUB118:PRINT@322,"YOUR COMPETENCE RATING IS";:PRINT@460,L
O;:PRINT@900,"FOR ANOTHER TRY PRESS <ENTER> ";:GOSUB77
283 CLEAR:GOTO1
284 GOSUB118:FORM=1TO3:GOSUB74:GOSUB135:NEXT
285 IFA1=0THENA1=1
286 IFA2=0THENA2=1
287 LO=((A2*100)/A1)
288 GOSUB118:PRINT@328,"WELL DONE !!";:PRINT@387,"YOU HAVE COMPLETED THE";:PRINT
@457."WHOLE TRIP.";:PRINT@517,"YOUR RATING IS";LO;:PRINT@642,"FOR ANOTHER TRY HI
T <ENTER>":
```

PROGRAMS

```
289 GOSUB12O:CLEAR:GOTO1
290 CLS:F$="DINGY RACER":FORX=70TO833STEP64;P1$=MID$(F$,(X-1)/64,1):PRINT@X.CHR$
(23);P1$;" ";:PRINT@X+59,CHR$(23);P1$;" ";;FORC=1TO30:NEXTC:NEXTX:PRINT@208.CHR$
(23);"COPYRIGHT F. HOPE. 1981.";:PRINT@338."ALL RIGHTS RESERVED.";:PRINT@474,"VE
RSION 6.6";
291 PRINT@602,"************";;GOSUB138
292 CLEAR150:RANDOM:DEFINTC-Z
293 O0$="  RUBBISH !!   ":O1$="  CHICKEN  !!  ":O2$="   FEEBLE     ":O3$="  NAU
GHTY !!   ";O4$="  WELL DONE !! ":O5$="  TOO RISKY !! ";O6$="  LAZY DEVIL   ":O7
$="  HAVE A REST  ":O8$="  BAD LUCK !   "
294 S1$="IT'S HARD WURK ":S2$="YOUR GOING WELL":S3$="SAILING SLOWLY ":S4$=" YOUR
 PLANING !":S5$="A. GO ASHORE.":S6$="D. CARRY ON SAILING.":S7$="DO YOU WISH TO ;
---";S8$="SELECT A LETTER FROM A -- C":V1=241;V2=305;V3=497;V4=561:V5=433:V6=369
:LP=0
 295 V7=689:V8=753:V9=625:SC=0;O$=STRING$(15.143);A=67;B=195:C=259:D=323:E=387:F=
451;G=515:H=579:I=643;J=707:K=772:L=900:M1=0:NC=0
 296 CLS:X=0:FORY=0TO39STEP2:SET(X.Y):NEXT:X=60:FORY=0TO39STEP2:SET(X,Y):NEXT:Y=0
:FORX=0TO60STEP2:SET(X,Y):NEXT:Y=39:FORX=0TO60STEP2:SET(X,Y):NEXT
 297 PRINT@32,"TECHNICAL DATA.";:PRINT@96,STRING$(16,43);:PRINT@50,"DAYS.";:PRINT
@57,"MILES.";:A1=0;L$="££.£":L1$="£££":PRINT@114,A1;:A2=0:PRINT@121,A2;
 298 PRINT@224,"SAILING SKILL.";;PRINT@288,"TYPE OF BOAT.";:PRINT@352,"HEALTH STA
TUS.";:PRINT@416,"WIND FORCE.";:PRINT@480,"WIND DIRECTION.";:PRINT@544,"BAROMETE
R.";;PRINT@608,"TIDE STATUS.";:PRINT@672,"SAILING POINT.";:PRINT@736,"CENTRE BOA
RD.";
 299 PRINT@800,"COMMENTS.";:FORX=239TO930STEP64:PRINT@X,STRING$(1,42);:NEXT:PRINT
@864,STRING$(16,42);
 300 PRINT@241,O$;:PRINT@305,O$::PRINT@369,O$;:PRINT@433,O$;;PRINT@497,O$;:PRINT@
561,O$;;PRINT@625,O$;;PRINT@689,O$;:PRINT@753,O$;:PRINT@817,O$;:PRINT@881,O$;
 301 PRINT@131,STRING$(23,42);:PRINT@67,"    INTRODUCTION !!    ";
 302 GOSUB101:PRINT@C,"YOU ARE ABOUT TO EMBARK";:PRINT@D,"ON A SAILING TRIP INTO"
;:PRINT@E,"UNFAMILIAR WATERS.";:PRINT@F,"SOME DEGREE OF ERROR IN";:PRINT@G,"ANSW
ERING THE QUESTIONS";:PRINT@H,"WILL BE ALLOWED BUT, THE";
 303 PRINT@I,"AMOUNT WILL DEPEND UPON";:PRINT@J."YOUR SAILING STANDARD.";;GOSUB12
0
 304 GOSUB101:PRINT@C,"IF YOU ARE A BEGINNER";;PRINT@D,"SELECT THE STANDARD OF";:
PRINT@E,"NOVICE. THIS WILL THEN";:PRINT@F,"ALLOW YOU TO USE THE";:PRINT@G,"GLOSS
ARY OF SAILING TERMS.";
 305 PRINT@643,"IF YOU SELECT  ADVANCED";:PRINT@707,"YOU HAD BETTER BE GOOD !";;G
OSUB120
 306 GOSUB101:PRINT@C-1,"ALL CALCULATIONS SHOULD BE";;PRINT@D+1,"ROUNDED TO THE N
EAREST";;PRINT@E-1,"WHOLE NUMBER E.G. 6.5 AND";:PRINT@F."ABOVE = 7  BUT, 6.4 AND
";:PRINT@G+5,"BELOW EQUAL 6";
 307 PRINT@I-1,"A PENCIL & PAPER OR EVEN";:PRINT@J-1,"A CALCULATOR MAY BE USEFUL.
";
 308 GOSUB120:GOSUB74
 309 GOSUB135:GOSUB101:PRINT@262,"SAILING STANDARDS.";:PRINT@386,"HOW GOOD ARE YO
U ?";:PRINT@457,"A. NOVICE";:PRINT@521,"B. INTERMEDIATE";:PRINT@585,"C. ADVANCED
";:PRINT@709,"(SELECT A LETTER)";
 310 GOSUB121:IFNN$="A"N1=1:IFN1=1N1$="  NOVICE        "
 311 IFNN$="B"N1=2:IFN1=2N1$="  INTERMEDIATE "
 312 IFNN$="C"N1=3:IFN1=3N1$="  ADVANCED     "
 313 IFN1<>1ANDN1<>2ANDN1<>3THENGOSUB99ELSE315
 314 GOTO310
 315 V=V1;GOSUB106:GOSUB101:PRINT@258,"SELECT YOUR DINGY ;-";:PRINT@395,"A. WAYFA
RER";:PRINT@459,"B. ENTERPRISE";:PRINT@523,"C. 420";:PRINT@587,"D. FIREBALL";:PR
INT@651,"E. 470";
 316 GOSUB123:IFNN$="A"N2=1;IFN2=1N1$="  WAYFARER      "
 317 IFNN$="B"N2=2:IFN2=2N1$="  ENTERPRISE   "
 318 IFNN$="C"N2=3:IFN2=3N1$="  420          "
 319 IFNN$="D"N2=4:IFN2=4N1$="  FIREBALL     "
 320 IFNN$="E"N2=5:IFN2=5N1$="  470          "
 321 IFN2<>1ANDN2<>2ANDN2<>3ANDN2<>4ANDN2<>5THENGOSUB99ELSE323
 322 GOTO316
 323 V=V2:GOSUB106:IFN1=1ANDN2>2ORN1=2ANDN2>4THEN324ELSEIFN1=3ANDN2<3THEN326ELSE3
27
 324 N2=0:Q2=1:GOSUB110
 325 GOTO316
 326 Q3=1:GOSUB110
 327 GOSUB74:GOSUB112:GOSUB107:GOSUB83
 328 GOSUB119:PRINT@260,"HOW FAR CAN YOU SWIM ?";;PRINT@393,"NOT AT ALL";:PRINT@4
57,"25 METRES.";:PRINT@521,"50 METRES.";:PRINT@585,"100 METRES.";:PRINT@649,"200
 METRES.";
 329 PRINT@L,"TYPE THE NUMBER OF METRES. (0 = CANNOT SWIM) ";:GOSUB77
 330 IFNN$<>"0"ANDNN$<>"25"ANDNN$<>"50"ANDNN$<>"100"ANDNN$<>"200"THENGOSUB99ELSE3
32
 331 GOTO329
 332 GOSUB100:W1=0;IFNN$="50"ORNN$="100"ORNN$="200"THEN334
 333 WO1=1:W1=1
 334 GOSUB119:PRINT@330,"CRASH ON !";:PRINT@450,"WHAT PERSONAL SAFETY GEAR";:PRIN
T@518,"ARE YOU WEARING ?";;GOSUB112
 335 PRINT@L,"STATE THE EQUIPMENT  (0 FOR NONE) ";;GOSUB77
 336 GOSUB100:W2=0:IFNN$="0"THEN338
 337 IFNN$="LIFE JACKET"ORNN$="BOUYANCY AID"ORNN$="BOUYANCY JACKET"ORNN$="LIFE BE
LT"THEN340ELSE339
 338 WO2=2:W2=2:GOTO340
 339 GOSUB99:GOTO335
 340 GOSUB119:PRINT@327."READ ON SAILOR !";;PRINT@F+4."WHO DO YOU WISH";:PRINT@G.
"TO INFORM BEFORE YOU GO ?";;GOSUB112
 341 PRINT@L,"STATE THE PERSON ( NO-ONE = 0 ) ";;GOSUB77:GOSUB100
 342 W3=0:IFNN$<>"0"THEN344
 343 WO3=1:W3=1:GOTO4
 344 IFNN$="COAST GUARD"ORNN$="HARBOUR MASTER"THENGOSUB112
 345 IFNN$<>"COAST GUARD"ANDNN$<>"HARBOUR MASTER"ANDNN$<>"0"THENGOSUB99ELSE347
 346 GOTO341
 347 GOTO4
```

SOFTY 2

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bytes to be moved from one position to another, shifting the surrounding code accordingly and leaving the rest of the program unaltered. STORE and REPLACE together allow a block of hex of up to 110 bytes to be lifted out and placed in a temporary store to be later called back to any place in memory. This is particularly useful for routines which frequently need to be repeated; they can be copied to wherever the cursor is located at the mere press of a button.

In the ROM emulator mode, Softy2 can aid in debugging programs. The screen behaves as a window into the contents of 512 bytes of memory. The correct functioning of any part of a program can be checked by running the program in the host system and arranging that any results or changes occur in the area of memory into which this window is looking. A page facility allows the window area to be moved through the whole of the 2k RAM.

Various other necessary facilities exist, like clearing all of the memory either in front of or behind the cursor. Such clearing means that FFs are written to every location rather than zeros, as this is the cleared condition for EPROMs. Softy2 also has the facility whereby the contents of an existing EPROM can be copied in, first for modification and then for re-burning into a clean EPROM. Another facility allows the contents of an EPROM to be compared with whatever is within Softy2.

Softy2 is provided with two parallel ports for connection with a more sophisticated micro, to allow downloading of a hex program, perhaps from an assembler to Softy2, or to connect a printer for a permanent record of the contents of an EPROM. The user would have to provide his own connector and solder it in place himself.

Conclusion

The choice between a ROM emulator and a more complete computer system must be a trade-off between cost and time: Softy2 has the advantage of being at the cheap end of the market but must invariably take longer to operate than would a more sophisticated system with an assembler.

On a chip-by-chip comparison with personal computers, ROM emulation systems seem rather expensive but this probably reflects their relatively smaller volume of production. At £169 +VAT, Softy2 is significantly cheaper than any competitors I know.

Young COMPUTER WORLD

Continued from page 131

schools should get in touch with their nearest CTUK! centre, or go along to any one of the hundreds of computer clubs and user groups. Failing all that, have you tried contacting the local Education Authority? Everyone now has an Advisor or Inspector charged with the responsibility of advising on computer matters!

Restrictions removed

I'll say one thing about the DOI and DES — they're listening. You can't say that in the computing field they don't respond to opinion, judging by some recent dope to come my way. One of the loudest complaints from schools was that those who had previously taken the plunge and bought their own computers were to be excluded from the plan to install machines in every secondary school during 1982. Apparently this restriction is to be lifted, which appears natural justice and will pacify many. I also hear that there is to be the removal of the restriction on choice of machines, but more of that in another issue.

BANKS' STATEMENT

Continued from page 71

particular marketplace requires, have the facility to tailor a standard microcomputer system to meet such requirements?

It could well happen and would perhaps mark the biggest nail in the coffin of semiconductor industry design leadership, which is already under threat from existing trends in gate array products. The semiconductor industry now stands every chance of becoming what has already been called a 'silicon foundry', manufacturing other people's designs on contract.

The other development in the integrated circuit business that I mentioned ealier will also have its effect on the microcomputer manufacturers and perhaps to a greater extent the systems houses and distributors/dealers. That development is firmware.

In its simplest form, this is software in a hardware form, and has been around for some time. The read-only memory and programmable ROM are good examples. There are developments here, however, that will greatly extend their influence in system design.

Firstly, there is the area of system utilities. Already there are CRT controllers and keyboard controllers that incorporate both the software and the hardware in a single chip. There are numeric processors that give a hardware implementation of a software floating point maths routine. Intel, with its iAPX 432 32-bit processor, is using a kernel operating system in ROM. This trend will continue, and more utilities will start appearing as firmware modules. But why stop there? Why not start putting common program sub-routines into ROM? Why not have a module that provides the software linking for these sub-routines? Why not edge towards complete applications packages in the same way?

As the circuit complexity increases, so the memories will get bigger and be able to store more code, so there is no real technical brake. The main one will be marketing — which programs or sub-routines to go for. Another potential brake will be the proliferation of bugs in programs. Put an infested program into ROM and it is stuck — there will be no chance to patch. The whole production run of ROMs would have to be chucked. One way round this to use PROMs instead, for the capacity of these devices is also increasing rapidly. The other alternative is better programming, but. . .

Now suppose all this is in existence, what happens then? Well, it would be possible for the systems house/distributor/dealer to configure a system (both in hardware and software) to more nearly suit the exact requirements of a user with simplicity, reliability and low cost. Simplicity, because the task would tend towards the 'pick-a-chip-off-the-rack-and-insert-in-board' approach. Reliability, because semiconductor devices have a high inherent reliability. Low cost, because when made in high volume, the little beasties are usually cheap.

Bear in mind something once said by Gerry Sanders, president of Advanced Micro Devices: 'At the first level of approximation, the semiconductor industry has made memory free. At the second level we have made logic free. Now we are going for the third level, and make software free as well.' The industry can and probably will do it, so think about the implications now.

BLUDNERS

In June's 'Calculator Corner' we wrongly referred to Jan 81 *PCW* as containing the first Casio Quirks article — it was actually Feb 81. The less said about the mystery disappearance of August's 'Calculator Corner' the better — we were as puzzled by it as everyone else, but it's reprinted in this issue.

A few bugs crept into Adrian Stokes' HMSOS review last month. Figure 1 should have looked like this: ▼

```
NON-BANK SWITCHED:                          BANK SWITCHED
SYSTEM MEMORY    :                          USER MEMORY

0   1   2   3   4   5   6   7   8   9   A   B   C   D   E   F
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0

SYSTEM MEMORY..:USER MEMORY.............................  DISK
               :                                          CONTROLLER
---------------:-------------------------------------------

               :---------------------------------------  USER 1 (56K)
               :
DOS.BASIC......:-------------------------------          USER 2 (48K)
---------------:
               :----------------                         USER 3 (32K)
               :
               :----------------                         USER 4 (32K)
```

The subroutine call towards the end of the software section should have stated 'I=CALL' and the last sentence in the paragraph before the summary should read: '. . . if a single-user system were marketed at a very much lower price. I have discussed this proposal with Hotel Microsystems and. . . '

Finally, last month's edition was Volume 4 No 9, not 7 as on the contents page.

BACK ISSUES SERVICE

Here is a complete guide to all available back issues of *PCW*. A quick guide to their contents is shown below. Check the coupon overleaf for the issues you require.

ABC 24: Vol 4 No 4

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The 77-68/Practical hints on kit building/Nascom 1/Charity case study/Flowcharting/Pontoon flowchart

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Volume 2 No 3
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Basic or Pascal?/The Sorcerer/Z8000/Chess programming/Graphics for the TRS-80/Applevision — part II/

Volume 2 No 4
Apple medical application/North Star Horizon/Word processing/High speed cassette interface/Sorting/Buying a computer for a small business

Volume 2 No 5
September 1979
Benchtest: Compucolor II/Checkout: Heuristics Speech Lab/Testing Precognition/Pascal series — Part I/Programs: 6800 Time response, Apple memory test, Fx 201p spaceship, PET Orbit sim, PET digital clock, Acronyms.

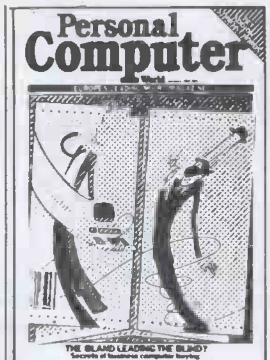
Volume 3 No 5
May 1980
Benchtest: Texas TI 99/4 / Benchtest: ACS 8000-2/ Benchmark round-up/Benchtest: HP85/Viewdata — Part 2/Checkout: Microdata UV8 EPROM Eraser/DIY teleprinter conversion feature/Nascom music/T159 accountancy application.

Volume 3 No 6
June 1980
Benchtest: Tandy TRS-80 Model II/Benchtest: Sintrom Periflex 630/48 / Staff case study/Checkout: Softy Intelligent EPROM Programmer/Checkout: Exatron Stringy Floppy/Practical examples of the IEEE-488 bus use/Programs: Naming Nascom files, 380Z Pictures, Fuel tank calculations — PET, PET large numeral generator, PET tank battle, Basic string handling routines/Pascal: Final instalment.

Volume 3 No 9
Setember 1980
Benchtest: BASF 7120/Checkout: Hi-Tech S100 colour VDU board/Secrets of systems analysis — Part 1/Sub set — part 1/Benchtest: CBM's 'SuperPET'./Programs: PET Dots & boxes, PET Bloobers, PET Demolition, Apple Showpiece, PEEK & POKE for Apple & Pascal, PET Giant Slalom, Speed & Acceleration.

Volume 3 No 10
October 1980
3-D graphics/Benchtest: Atari 400 & 800/Benchtest: DAI/Robotics/Benchmarks/Programs: PET Racer, PET Fighter Pilot, UK101 Graphics, Apple Plotting, UK101 Gunfight, PET Algebraic evaluation, ZX80 Breakout

Volume 3 No 12
December 1980
Benchtest: Microwriter/Printerfacing: Series — Part 1/Sharp PC-1211 speed-up/Programs: TRS-80 Tarot, PET Cat & Mouse, PET Rebound, MZ-80K Alligator Swamp, PET Connect, UK101 Minefield, PET Simon

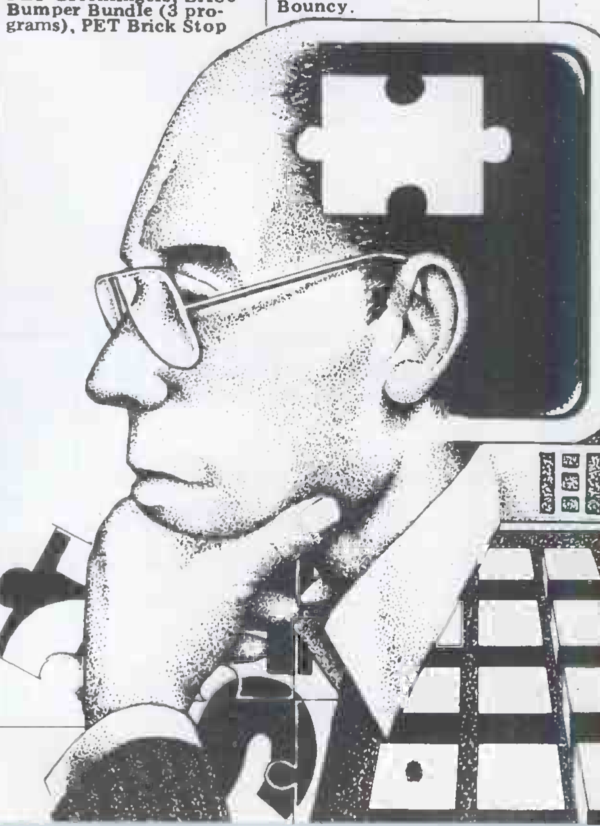


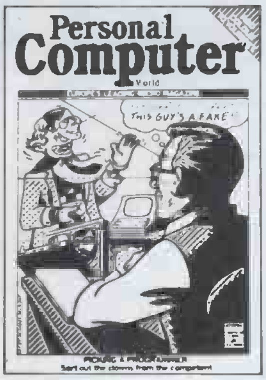
Volume 4 No 1
January 1981
Benchtest: Transam Tuscan/Real-time control using trains — part 1/Recover from a data tape disaster/PET Music/Multi-user systems — part 1/Programs: TRS80 Four in a row, TRS80 Target Practice, PET Convoy, PET Wire, PET Maze Chase, PET Android Attack, PET Anagram

Volume 4 No 2
February 1981
Benchtest: The Vector Graphics VIP/Patterns — Part 1/The last one/Real time control — part 2/Multi-user systems part 2/ZX80 Printer/Programs; PET Greenfingers, ZX80 Bumper Bundle (3 programs), PET Brick Stop

Volume 4 No 4
April 1981
Benchtest: ABC 24/Slow scan TV/IDPM/Word processing: Benchtests/ZX80 books/Commons report/Casio fx 3500p/Programs: ZX80 Maths Test, ZX80 Calendar, PET Link Index, ZX80 Moon Lander, TRS-80 Rocket Attack, TRS-80 Dropout, PET Giant Trap.

Volume 4 No 3
March 1981
Benchtest: Onyx C8002/Benchtest: Bigboard/Micro music software package/ALC circuit/Commons report/HP 34C/Programs: TRS80 Show Jumping, PET Grand Prix, PET Aircraft landing, PET Bouncy.





Volume 4 No 5
May 1981
Benchtest: Pasca 640/ WP Benchtest: Magic Wand/PET colour/Low-cost digital tape system/ Using calculator printers on micros/Apple music-making/Multi-user Benchtest: MVT-Famos/Programs: PET Grand Prix, PET Aircraft Landing, PET Bouncy.

Volume 4 No 6
June 1981
Benchtest: NEC PC-8001/ Multi-user Benchtest: MP/M/Benchtest: Sinclair ZX81/West Coast Faire report/Radio Teletype/ WP Benchtest: Wordpro 4 Plus/Budget tape interface/Further Casio quirks/ Programs: UK101 Zor, PET Chords.

Volume 4 No 7
July 1981
Benchtest: Sharp PC-3201/

Multi-user Benchtest: Acorn Econet/ Case study: Accident investigation on TRS-80/Zilog Z8 family/ WP Benchtest: Format-80/ Pascal Benchmarks: readers' letters/Quicker Casio computations/Programs: ZX80 Sliding Letters, UK101 Car Rally, TRS-80 Calendar, UK101 m/c code to Basic converter, PET Exam Questions, MZ-80K Designer, ZX81 Sketch Pad.

Volume 4 No 8
August 1981
Benchtest: Tandy Model III/Viewdata update/WP Benchtest: Spellbinder/ Printer survey/Microholism/Programs: ZX80 Othello; Easter Sunday; Apple Mondrian; MZ-80K Duck Shoot; PET Gomoku; MZ-80K Football.

Vol 4 No 9
September 1981
Benchtests: Tandy Color Computer, Commodore VIC/Checkouts: Hi Tech Speakeasy, Tantel/ Multi-user Benchtest: HMSOS/ WP Benchtest: Memorite III/Word proc program for PET/Apple dealership run by spastics/Printer-facing extra/Calc Corner: Casio fx602p review/ Programs: PET Arithmetic test, ZX80 Eldorado, 380Z Memory test.

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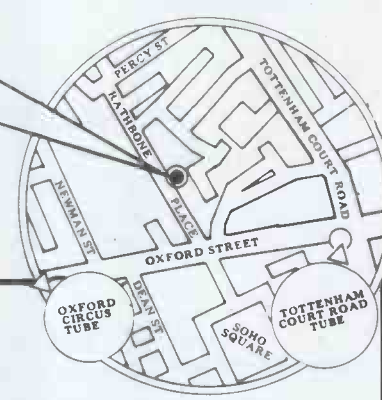

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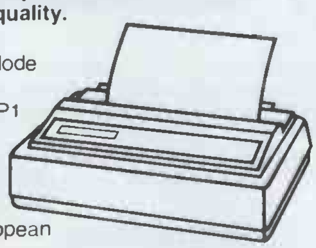

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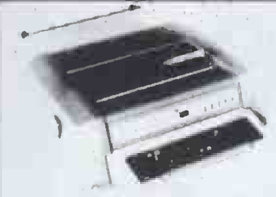

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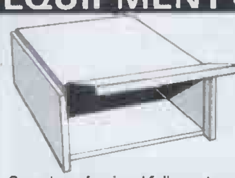

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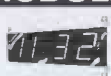

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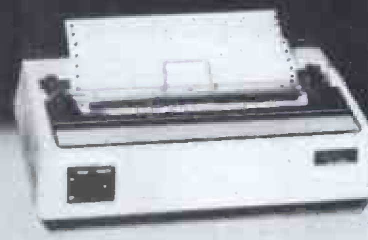

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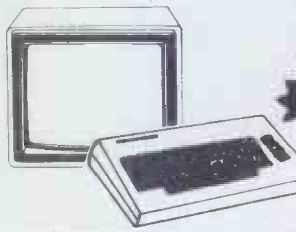

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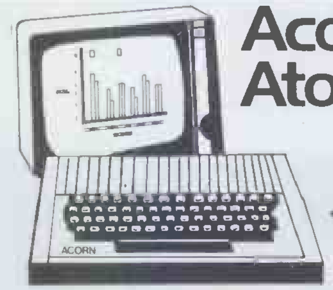

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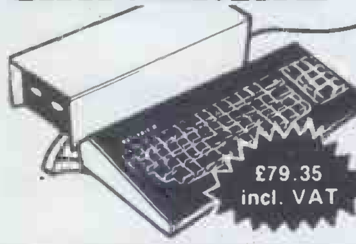

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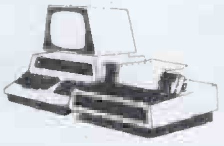

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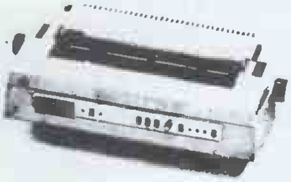

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Each Constellation host multiplexer links 2-8 micros in star configuration to 5Mb, 10Mb or 18Mb of Corvus hard disc drive. Up to 8 host multiplexers can be connected together, allowing up to 64 micros to use four disc drives for a total system capacity of 72 Mb.

Inexpensive back-up for the hard disc system is provided by the unique Corvus Mirror. It interfaces the data signals on the disc with a 100Mb capacity video tape system; and the entire contents of a 10Mb disc can be archived in about 15 minutes.

Applications software

Miracle can make use of a comprehensive range of languages, from BASIC, COBOL and FORTRAN to PASCAL, ALGOL and APL.

PASCAL-written applications software packages include: Accounting Systems, Payroll and Stock Control (fully integrated with order processing/invoice generator); Addressing/Mailing; Database Management; Incomplete Records; Job Costing; Time Records; Graphics; Critical Path Analysis.

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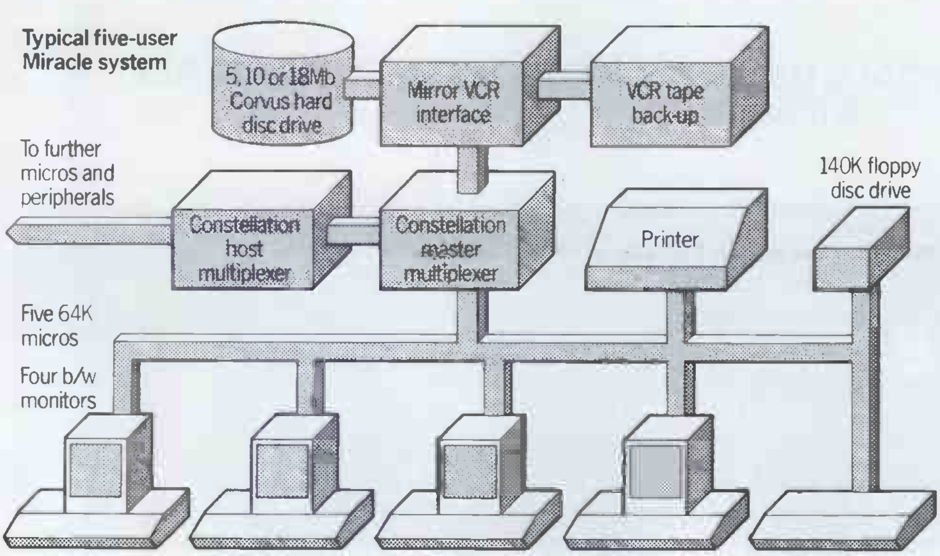
Keen Computers

Typical five-user Miracle system



Please send me details of:
Miracle with the following micros ______

Applications software packages (please state) ______

Name ______
Position ______
Company/Establishment ______
Address ______
______ Tel ______

Please post to Keen Computers, Marketing Department, 5 Giltspur Street, London EC1A 9DE

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Because reliability is the first principle we build into all our computers.

One fault a year per computer is our mean average (including minor faults like a blown fuse).

That's almost unheard of in the computer industry.

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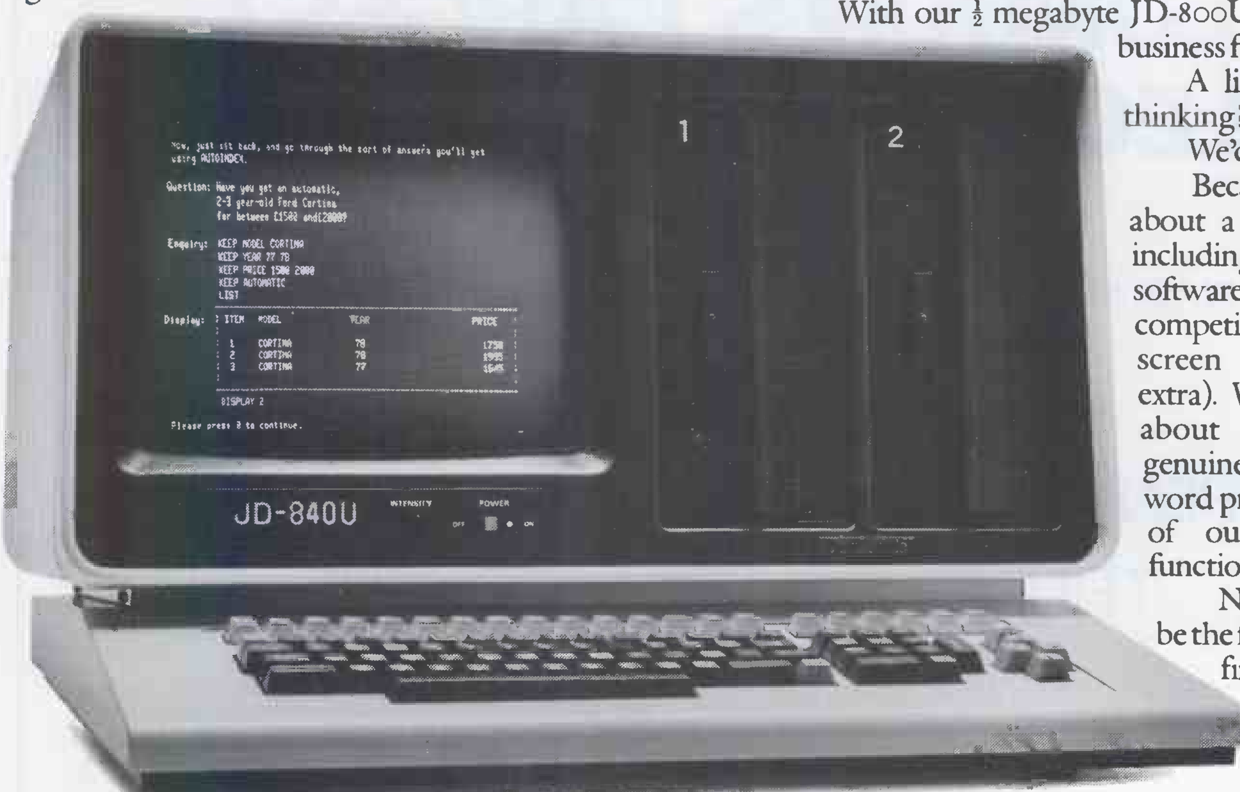

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Another key difference about our computers is that we developed them specifically for business use.

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And, to show you we really mean business, all our computers support Microcobol.

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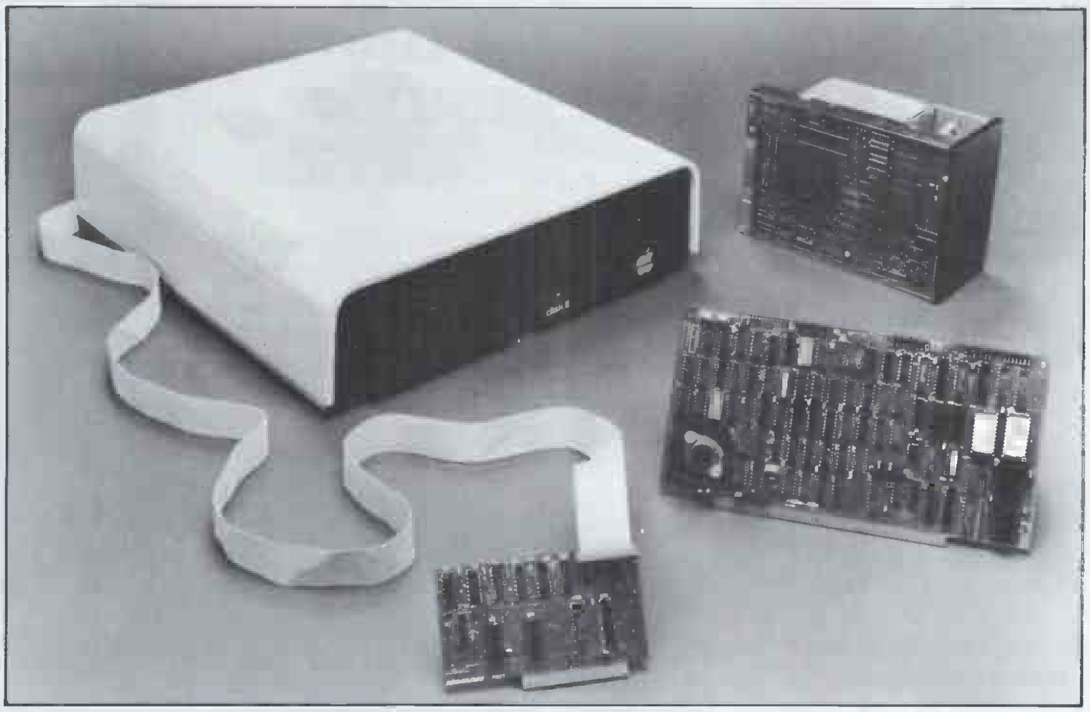

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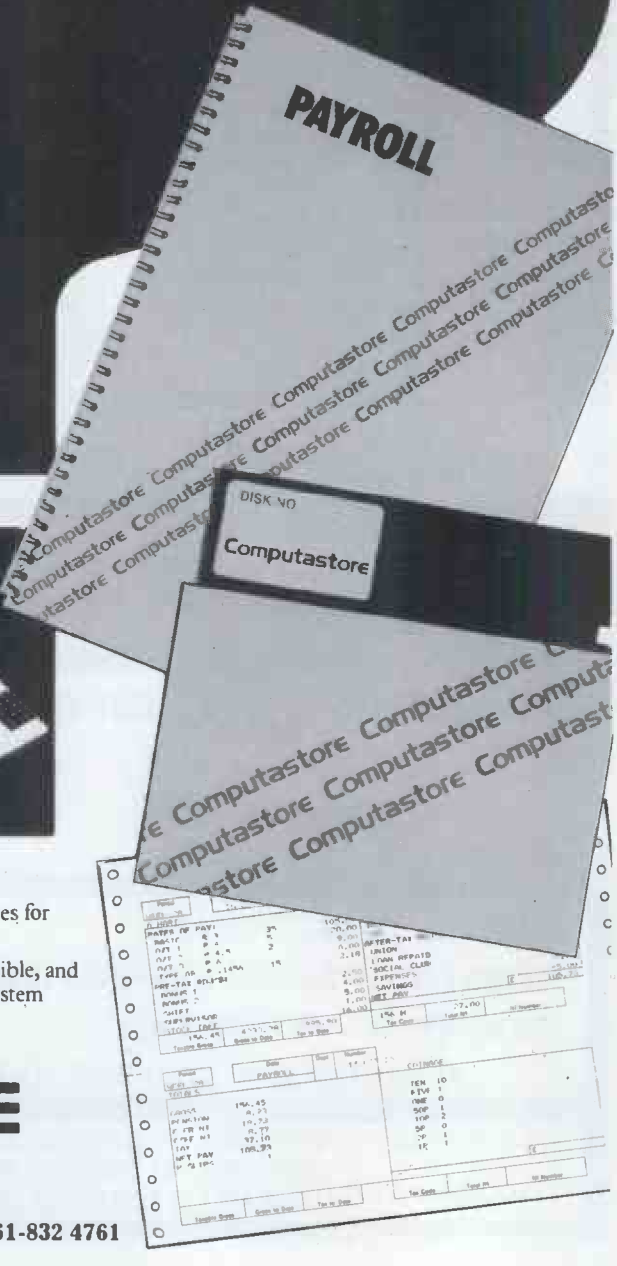

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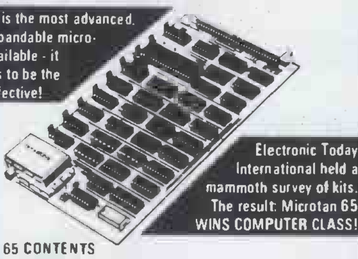
MICROTAN 65

Microtan 65 is the most advanced, powerful, expandable micro-computer available - it also happens to be the most cost effective!



Electronic Today International held a mammoth survey of kits. The result: Microtan 65 WINS COMPUTER CLASS!

MICROTAN 65 CONTENTS
High quality, plated thru hole printed circuit board, solder resist and silk screened component identification. 6502 microprocessor. 1K monitor TANBUG. Now with 'V' Bug. 1K RAM for user programme, stack and display memory. VDU alphanumeric display of 16 rows by 32 characters. MICROTAN 65 system file binder. 136 page, bound, users hardware/software manual with constructional details and sample programmes. Logic and discrete components to fully expand MICROTAN 65.

The MICROTAN 65 kit has won widespread acclaim for its superb presentation. We pay attention to detail!

KIT FORM **£69.00** + £10 35 V.A.T. total £79 35.

MICROTAN 65 assembled and tested.
Specification as above, but assembled and fully bench tested by ourselves.
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MICROTAN 65 OPTIONS

LOWER CASE PACK
Two integrated circuits which connect into locations on MICROTAN allowing 128 displayable characters
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MINI MOTHER BOARD
Used to connect Microtan to Tanex.
Built **£10.00** + VAT

GRAPHICS PACK
Five integrated circuits which connect into locations on MICROTAN allowing the display of chunky graphics (64 x 64 pixels). What are chunky graphics? Well, imagine a piece of graph paper with 64 squares vertically and 64 squares horizontally, a total of 4096. Each square can be made black on white.
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Inexpensive means of getting up and running. Uses 'Schoeller' key-switches, and connects to MICROTAN through a 16 pin D.I.L. plug on ribbon cable. Black anodised escutcheon, with TANGERINE legends, finishes off what must be the best value for money keypad available. Available assembled and tested.
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'Space Invaders game (for use with keypad only)
£15.22 + V.A.T. £2 28 total £17.50.

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MPS 1: Input 120 or 240V AC. Output 5 Volts at 3 Amps Regulated. MPS 1 will power both MICROTAN and TANEX fully expanded. Built on the same size printed circuit board as MICROTAN etc. Available as a fully built and tested unit
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For the man that has everything! 19 inch wide system rack which accepts MICROTAN 65, TANEX, TANRAM, SEVEN FURTHER EXPANSION BOARDS, TANDOS and THE SYSTEM POWER SUPPLY. Available in many formats, e.g. Individual front panels, full width hinged front panel, back panel with or without connectors.
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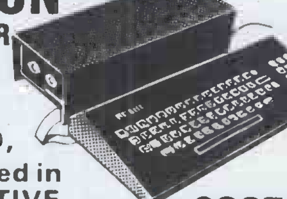
MICRON COMPUTER

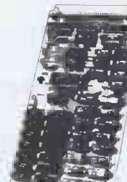
FULLY BUILT, TESTED, and housed in ATTRACTIVE CASES.



£395 inc V A T P&P

6502 based microcomputer VDU alpha numeric display. Powerful monitor TANBUG. 8K RAM. 32 parallel I/O lines. 2 TTL serial I/O lines. Four 16 Bit counter timers. Cassette interface. Data bus buffering. Memory mapping control. 71 key ASCII Keyboard, including numeric keypad. Includes power supply. Also includes the first '10K MICRO SOFT BASIC' available in the U.K. All the usual BASIC commands.

TANRAM



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40K RAM CARD with 16K DYNAMIC RAM £76 + VAT

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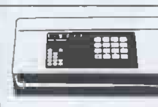

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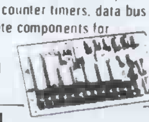
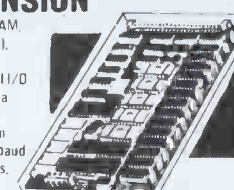


TANEX (Minimum configuration) Assembled
£53.00 + V A T £7 95, total £60 95

TANEX EXPANSION



Expanded, TANEX offers 7K RAM, locations for 4K EPROM (2716), locations for 10K extended MICROSOFT BASIC, 32 parallel I/O lines, two TTL serial I/O ports, a third serial I/O port with RS232/20mA loop, full modem control and 16 programmable baud rates, four 16 bit counter timers, cassette interface, data bus buffering, and memory mapping.

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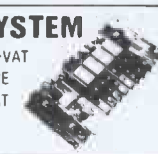

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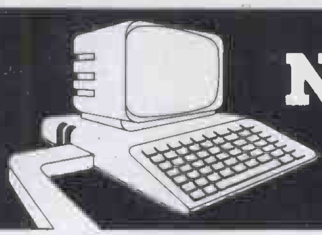

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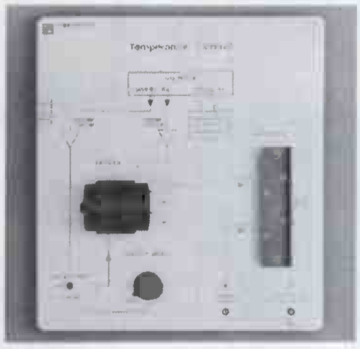

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MAGIC WINDOW is a Apple II word processing/text editing system that is designed to increase your office productivity—those time-consuming typing tasks can now be done quickly and efficiently.

The simplest and best-known word processing machine is the standard typewriter. We have retained the simple operating features of the typewriter while providing complete editing facilities.

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MAGIC WINDOW

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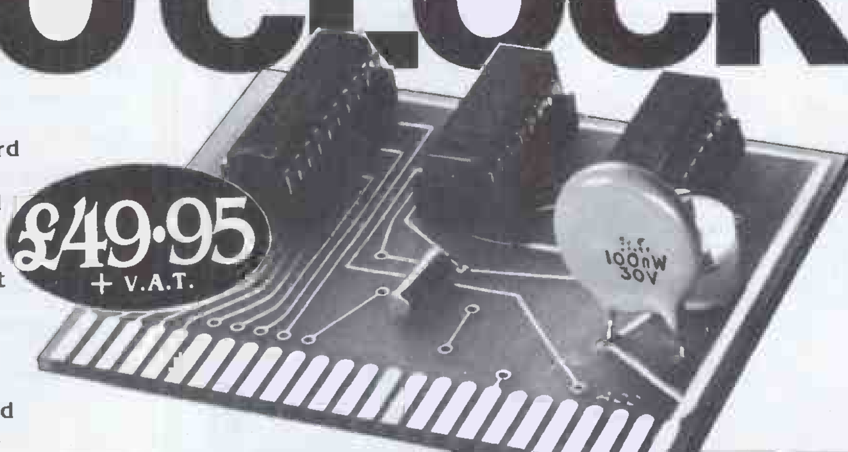

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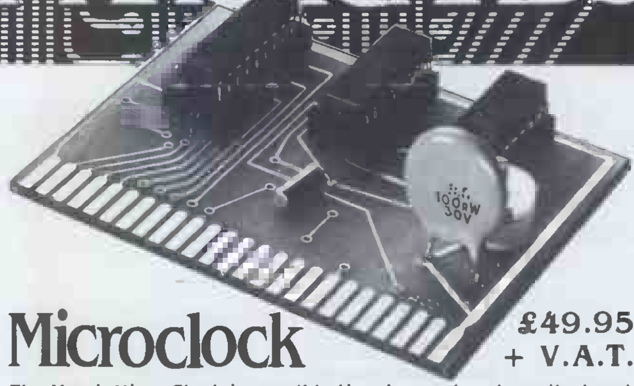

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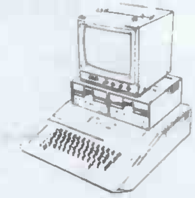

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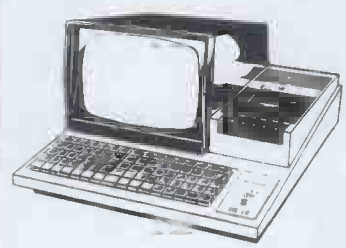

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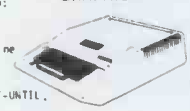

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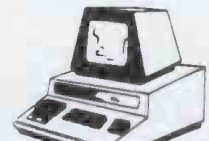

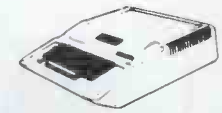

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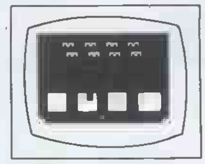

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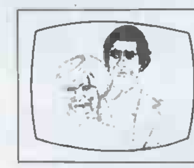

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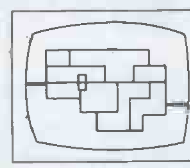

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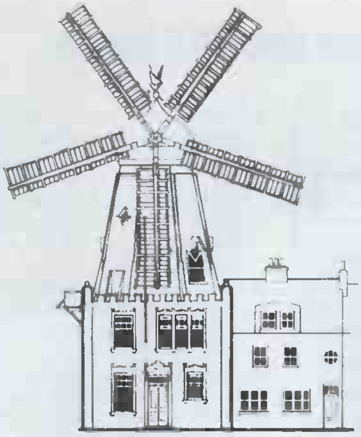

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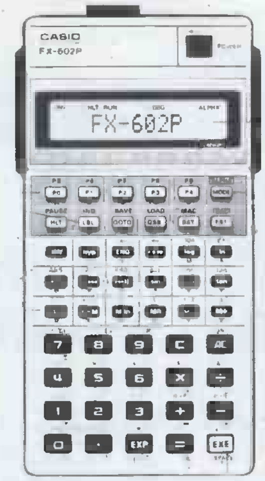

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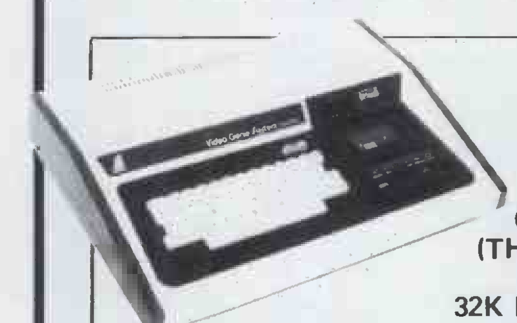

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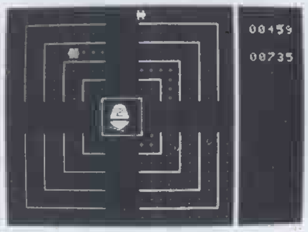

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Zombie Land on Zombie island; try to lure all the zombies into the swamp. In desperation jump into hyper-space! Program 3K, graphics ½K. COLOUR

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Rat Trap Move your rats without colliding with the trails left. Entangle your opponent before he entangles you! High-speed rat action-replay. Program 4K, graphics 6K.
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Green Things An alien life-form has invaded your space-craft; discover a way of destroying it with the weapons available on the ship Program 5K, graphics 2K. COLOUR
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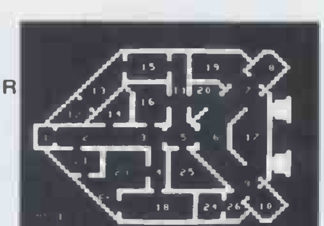
Snake Grow yourself a snake by guiding it towards digits which it eats. Program 2K, graphics ½K.



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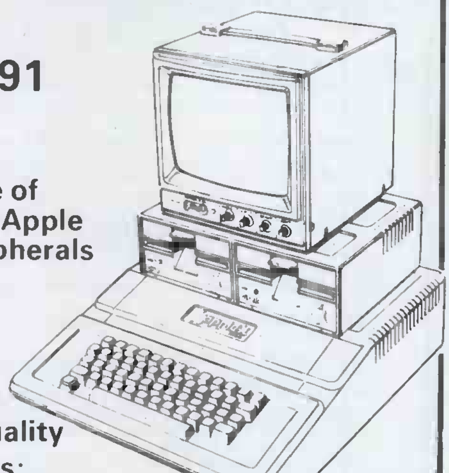

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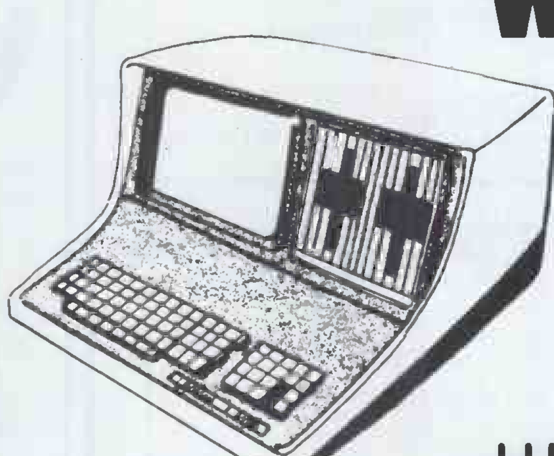

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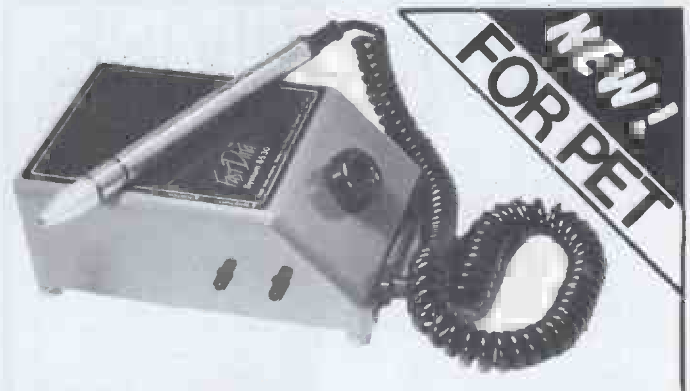

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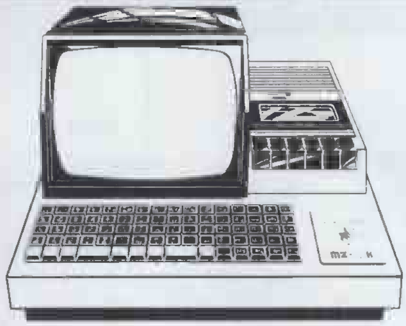

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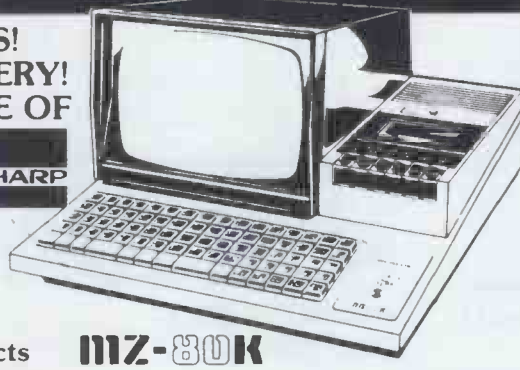

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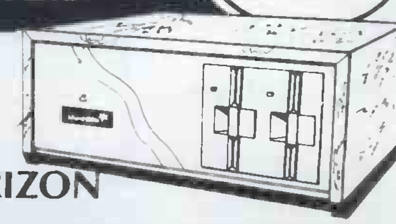

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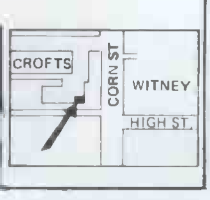

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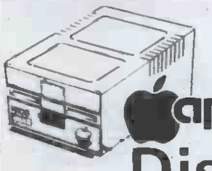

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ChipChat

Our friend Les Solomon of *Popular Elecronics* called in recently with news of a Japanese pocket micro which incorporates a full keyboard and a TV-quality flat LCD display. There's also a real TV, using the same screen, apparently. Les also told us about his latest robot which he's trained to go to the fridge and fetch a can of beer. He went strangely quiet when we asked what else he's trained it to do... Talking of robots, 'Squire' Allason has been buying up all those unwanted ZX80s and using them to control his latest toy, a multi-armed robot with an '80 in each joint. Rumour has it that once he's found a way of fitting it with legs, he'll let it run *Printout*.
Then we'll *really* have to smarten up our act... Julian calls his robot 'Bradbeer', by the way. We can't print what it calls him... News from other mags time: Henry of *Toady* has moved into what he calls a 'spanking' new office — so that's what you and Tina get up to, Henry; Richard Pawson of *Printout* has a policewoman for a girlfriend — we think we'd better not say any more about that; and Dennis Jarrett was going to start up a trade newsletter until people started trying to bribe him *not* to do it... If you've seen our new section, 'TJ's Workshop' and you still don't know what it stands for, then, for the last time, TJ means terminal junkie... Editor Rodwell has now taken to going round in disguise since a ridiculous photo of him appeared in our sister publication *Which Bike?* (page 83 of its August issue if you want a good snigger)... We spotted a car outside a particularly sleazy Soho strip joint the other day — with an Alphatronic set up on the back seat. Odd. And no, we won't explain what we were doing *outside* a sleazy Soho strip joint... This was written just before the *PCW* Show, which is why it's short and sweet — stand by for a bumper bundle next month, starring 'Bumper' Harris and 'Legless', among many others!

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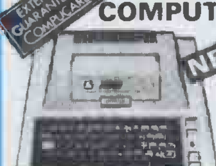

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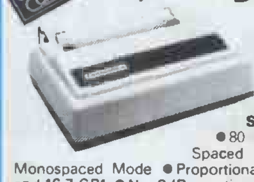

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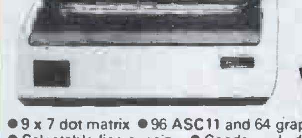

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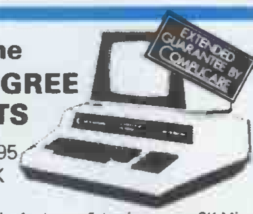

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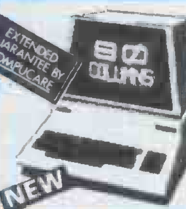

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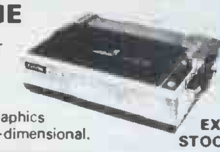

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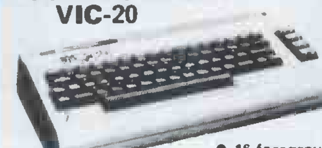

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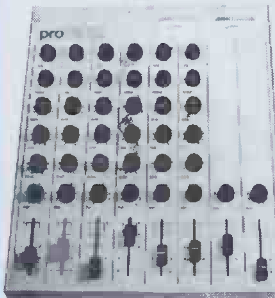

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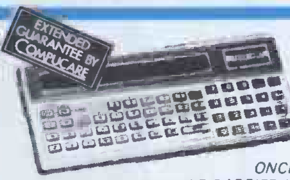

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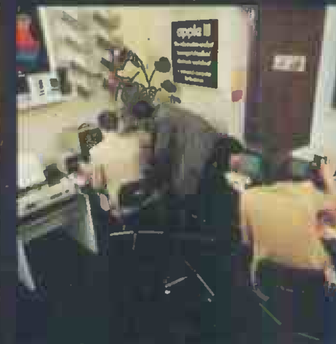

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