Practical Computing

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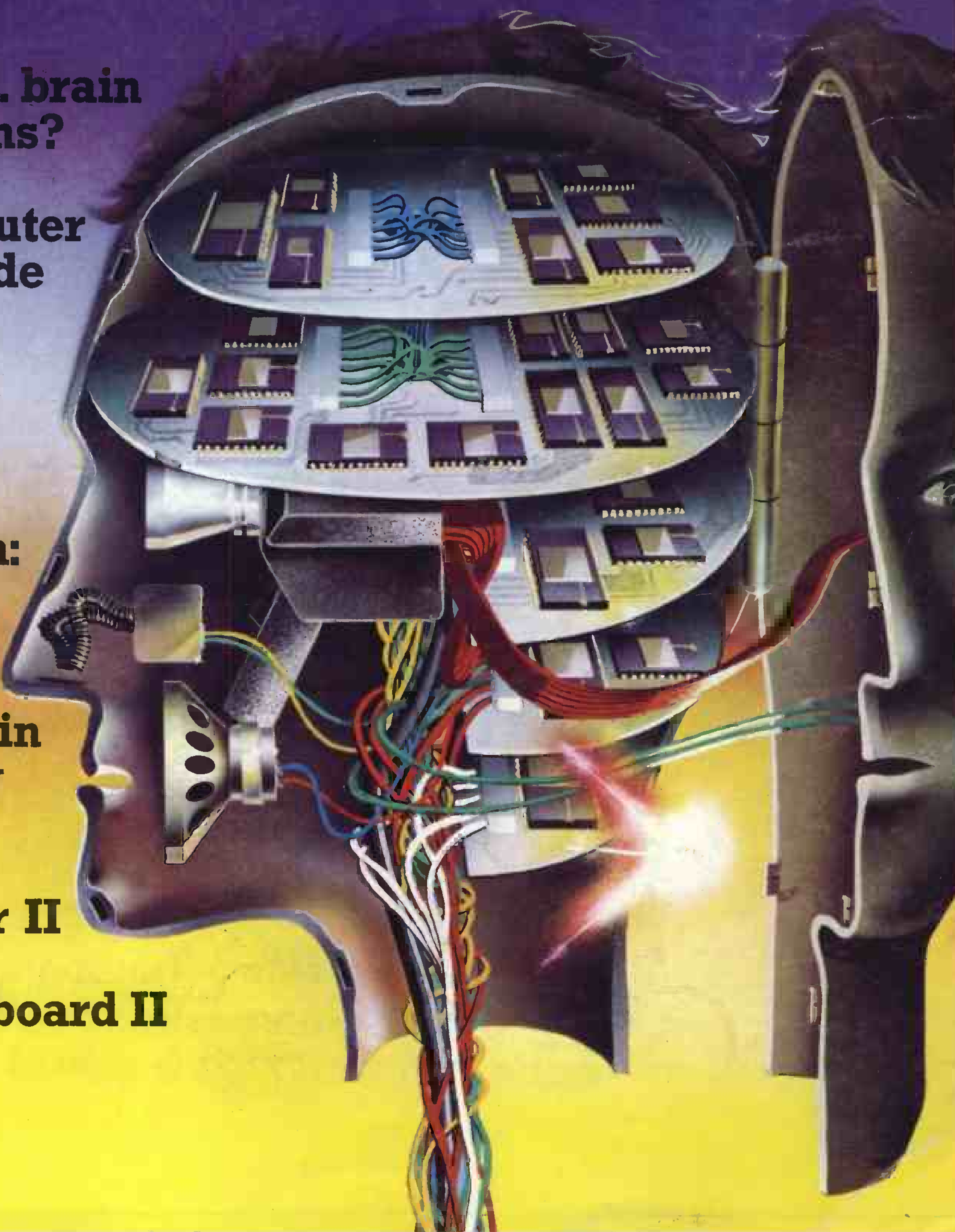

Computer v. brain —which wins?

Microcomputer Buyers Guide

Low-cost word processing

Competition: Program of the Year

Computing in a pharmacy

We review: Compucolor II plus Ohio Superboard II

Keen Computers take off !

Software

A full range of Software is available for the Apple II, on disk or cassette.

- Incomplete Record Accounting
- Addressing and Mailing
- Word Processor
- Chequebook
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- Order Entry Invoicing
- Purchase Ledger
- Management Information
- Stock Control
- Information Retrieval

Games from:

- Speakeasy
- Personal Software

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- Shape Create
- Matrix Inversion
- Microade Assembler
- Variance
- Regression
- Data testing
- Standard deviation
- Correlation
- Distribution

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● Circle No. 101

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ISSN 0141-5433.

CONTENTS

BUMPER JULY MICROCOMPUTER SHOW ISSUE ON SALE JUNE 13

apple II AT MICRODIGITAL

JOIN THE MICROCOMPUTER REVOLUTION BY BUYING THE BEST APPLE PLUGS INTO A DOMESTIC TELEVISION AND CASSETTE RECORDER TO MAKE A POWERFUL, EASY TO USE COMPUTER SYSTEM

Apple II

Features

- A fast powerful integer BASIC is built into Apple II. The built-in assembler, disassembler and monitor will be appreciated by advance programmers in search of more speed or flexibility than BASIC can provide.
- Fifteen colour standard graphics in a 1,880 Point array for spectacular visual effects.
- High resolution graphics in a 54,000 point array for finely detailed display.
- Loudspeaker and sound capabilities that bring programs to life.
- Four hand control inputs for games and other human input applications.
- Internal memory capacity of 48K Bytes of RAM, 12K Bytes of ROM for big system performance in a small package.
- Eight expansion slots to plug in cards that give your Apple even more power.
- Superb, easy to follow documentation, so even a total beginner can use the machine.
- Fast (1500 baud) cassette interface.
- Proper typewriter style keyboard.

Apple II prices

Nett.	Vat.	Total
With 16K of RAM		
985.00	78.80	1063.80
With 32K Bytes of RAM		
1185.00	94.80	1279.80
With 48K Bytes of RAM		
1305.00	104.40	1409.40

Applesoft II Floating Point BASIC

An expanded version of Microsoft's popular floating point BASIC. Its 9 digit arithmetic and large library make it ideal for business and scientific programs. Applesoft II is supplied either with a cassette tape or a plug in ROM card. The tape version is supplied free with every Apple.

Apple II ROM card		
110.00	8.80	118.80

Floppy Disk Subsystem

Gives your system immediate access to large quantities of data. The subsystem consists of an intelligent interface card, a powerful Disk Operating System and one or two mini-floppy drives.

Features

- Storage capacity of 116 Kilobytes/diskette.
- Data transfer rate 156K Bits/second.
- Individual file write protection.
- Powered directly from Apple II.
- Full disk capability with systems as little as 16K bytes of RAM.
- Fast access time — 600 m sec (max) across 35 tracks.
- Powerful disk operating software.
- Load and store files ;by name.
- BASIC program chaining.
- Random or sequential file access.

Floppy disk subsystem		
425.00	34.00	459.00
Second disk drive and connecting cable		
375.00	30.00	405.00

Parallel Printer Interface Card

Allows you to connect almost any popular printer to your Apple. A BASIC program can produce hard-copy output as easily as it prints to the TV monitor screen. Command interpretation and printer control details are handled by the firmware built into the card, to eliminate user programming requirements.

Parallel Printer Interface Card

Nett	Vat	Total
110.00	8.80	118.80

Communications Interface Card

Allows your Apple to "talk" (though a modem) with other computers and terminals over ordinary telephone lines. Now you can load programs over the phone, send messages to remote terminals or access your office computer from the comfort of your home.

Communication Interface Card

Nett	Vat	Total
110.00	8.80	118.80

High Speed Serial Interface Card

Allows Apple to exchange data with printers, plotters and computers in serial format at up to 19.2 K Baud

High Speed Serial Interface Card

Nett	Vat	Total
110.00	8.80	118.80

Speechlab Voice Recognition Card

Allows the Apple to recognise a spoken vocabulary of up to 32 user-selected words. The computer can be programmed to perform any task desired upon recognition of a key word.

Voice Recognition Card

Nett	Vat	Total
165.00	13.20	178.20

Prototyping Card

Provides the User with a means of building up experimental circuitry for the Apple computer. The 2¾" x 7" double-sided board includes a hole pattern that accepts all conventional integrated circuits and passive components. Documentation includes a complete system bus description to aid the interface designer.

Prototyping Card

Nett	Vat	Total
18.00	1.44	19.44

Carrying Case

The Apple is truly portable and this padded vinyl, leather look case protects your Apple in transit and makes it easier to carry.

Carrying Case

Nett	Vat	Total
25.00	2.00	27.00

BARCLAYCARD VISA

accepted

Other Products

Apple maintains a 6 to 12 months technology lead over the competition. There is not sufficient space to give full details of all that is available, but the following is a sample to whet your appetite.

Light pen
Real time clock
Co-resident assembler on disk or tape
Programming aid ROM
Joysticks
PROM Burner

Apple Hire

The Apple is one of many machines from Microdigital (Hire) Ltd. For details ring Mike Maughan on 051-227 2535.

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Trade Counter Program (integer basic, needs 32K of RAM and a single disk)

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	Nett	Vat	Total
With 4K Bytes of RAM..........	827.00	66.16	893.16
With 16K Bytes of RAM..........	950.00	76.00	1026.00
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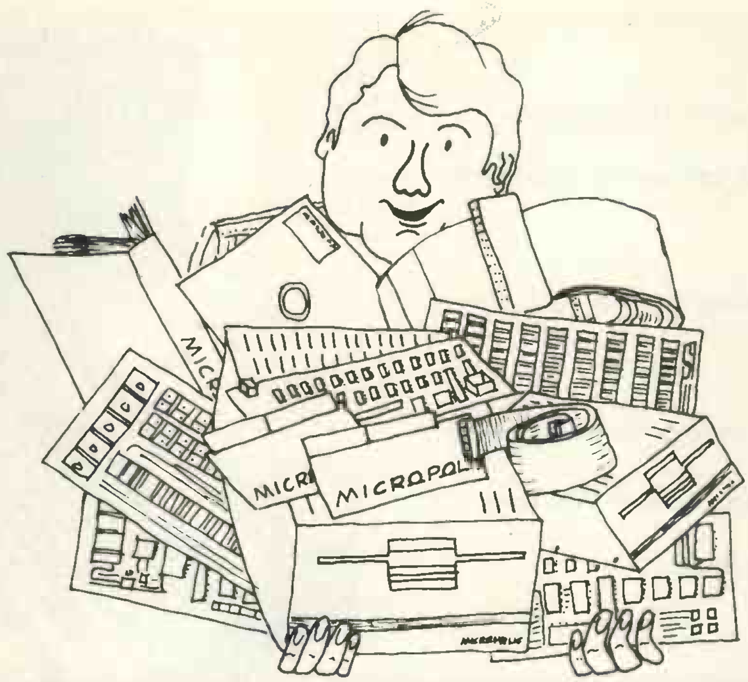
● Circle No. 102

O.K. so you've got a computer.



So we've got all the add-ons!

Floppy Disks

Micropolis drives are available in 143K and 315K (formatted) versions expandable from one to four drives in various packaging options. Prices quoted below are for single 143K units including 240V power supply and case.

For S100 computers: Cromemco, Vector, Horizon, SOL, Sourcerer with S100 expansion.

1042-1 Master unit; includes controller card and Micropolis system software	**£499**	1022-1 Add-on unit	**£339**
CP/M	**£100**	COBOL	**£400**

For NASCOM and other small Z80 configurations:

143BZ Master unit; includes controller card and Raindos system firmware	**£499**	1022-1 Add-on unit	**£339**

For Motorola D1/D2, SWTPC MP-68 and other small 6800 configurations:

143BM Master unit; includes controller card and RPDOS system firmware	**£499**	1022-1 Add-on unit	**£339**

For TANDY TRS 80 with expansion interface:

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Memories

For S100 computers:

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Microspeech

For SS50 (SWTPC, MSI) computers:

Microspeech analogue speech synthesiser converts text strings in phonetic spelling to audio output. Complete with special BASIC interpreter **£295**

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- Processor Technology SOL
- Exidy Sorcerer

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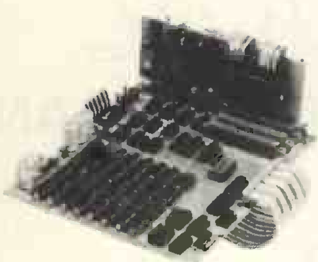

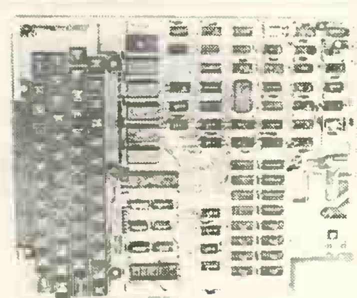

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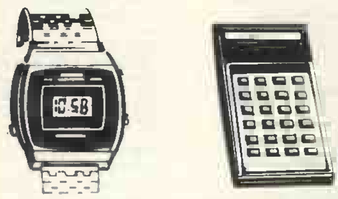

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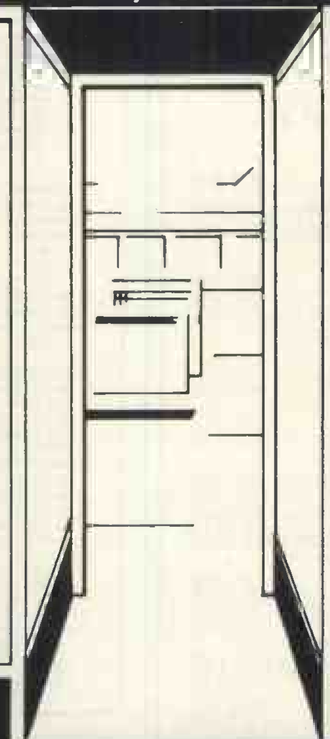
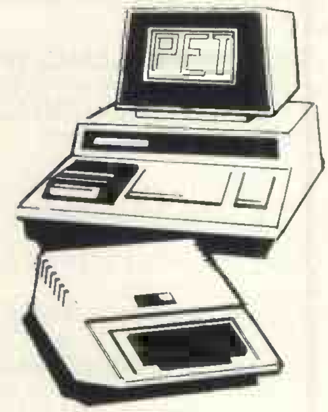


We stock a complete range of



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Horizon Z80A computer with 2 double-density disc drives and 24K RAM £1,823 (exclusive of VAT and carriage).

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Tel: 01-739 2387/9.
01-729 4460.

For North Star Horizon systems and software contact the people with experience:

LONDON
Equinox Computer Systems Ltd., 16 Anning Street, New Inn Yard, London. EC2A 3HB. (Tel: 01-739 2387/9–01-729 4460)

SCOTLAND
Scotia Software Services, 95 Woodfield Avenue, Edinburgh. (Tel: 031-441 603).

DEVON
J.A.D. Integrated Services (Plymouth) Ltd. 21 Market Avenue, City Centre, Plymouth, Devon. (Tel: 0752-62616).

HUNTS
Micropower, 26 High Street, Great Paxton, Huntingdon, Cambs. PE19 4RF. (Tel: 0480-213785).

SURREY
Radix 2 Technology Ltd., 92 Wimbledon Hill Road, Wimbledon, S.W.19. (Tel: 01-946-8887).

MIDDX
Jacobs Computer Systems Ltd., 36 Bengeworth Road, Harrow, Middx. HA1 3SE. (Tel: 01-908-1134).

HANTS
Claisse-Allen Computing, 5 Upper High Street, Winchester. (Tel: 0962-69368).

DORSET
Micro Systems Specialists, Market Place, Sturminster, Newton, Dorset. DT10 1BB. (Tel: 0258-72946).

SOUTH WALES
Micro Media Systems, 12 Clarence Place, Newport, Gwent. (Tel: 0633-50528).

LANCS & NORTH WALES
Cortex Computer Centre, 25/35 Edge Lane, Liverpool. (Tel: 051-263 5783).

CAMBS
Wisbech Computer Services Ltd., 10 Market Street, Wisbech, Cambs. (Tel: 0945-64146).

LINCS
Loveden Computer Services, 167 Bartowby High Road, Grantham, Lincs. (Tel: 0476-72000).

KENT
Microtek Computer Services, 50 Chislehurst Road, Orpington, Kent. (Tel: 66-26803).
Tor Business Systems, 83 Timberbank, Vigo Village, Meopham, Kent. (Tel: 0732-822956).

ESSEX
Micro Software Systems Ltd., Stanhope House, High Street, Stanford-le-Hope. (Tel: 03756-41991/2).

EQUINOX
COMPUTER SYSTEMS LTD.
"Kleeman House" 16 Anning Street,
New Inn Yard, London EC2A 3HB.
Tel: 01-739 2387/9. 01-729 4460.

● **Circle No. 121**

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Sigma Systems Ltd
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Allen Computers
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24K Memory Expansion Boards (disk-compatible) only £320 + VAT

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Circle No. 141

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	1N4005	600v	1A	.08
	1N4007	1000v	1A	.15
	1N4148	75v	10mA	.05
	1N4733	5.1v	1 W Zener	.25
	1N753A	6.2v	500 mW Zener	.25
	1N758A	10v	"	.25
	1N759A	12v	"	.25
	1N5243	13v	"	.25
	1N5244B	14v	"	.25
	1N5245B	15v	"	.25

SOCKETS/BRIDGES

QTY.					
	8-pin	pcb	.20	ww	.35
	14-pin	pcb	.20	ww	.40
	16-pin	pcb	.20	ww	.40
	18-pin	pcb	.25	ww	.95
	20-pin	pcb	.35	ww	.95
	22-pin	pcb	.35	ww	.95
	24-pin	pcb	.35	ww	.95
	28-pin	pcb	.45	ww	1.25
	40-pin	pcb	.50	ww	1.25
	Molex pins	.01	To-3 Sockets		.25
	2 Amp Bridge		100-prv		.95
	25 Amp Bridge		200-prv		1.50

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QTY.			
	2N2222	(2N2222 Plastic .10)	.15
	2N2222A		.19
	2N2907A	PNP	.19
	2N3906	PNP (Plastic Unmarked)	.10
	2N3904	NPN (Plastic Unmarked)	.10
	2N3054	NPN	.45
	2N3055	NPN 15A 60v	.60
	T1P125	PNP Darlington	1.95
	LED Green,	Red, Clear, Yellow	.15
	D.L.747	7 seg 5/8" High com-anode	1.95
	MAN72	7 seg com-anode (Red)	1.25
	MAN3610	7 seg com-anode (Orange)	1.25
	MAN82A	7 seg com-anode (Yellow)	1.25
	MAN74	7 seg com-cathode (Red)	1.50
	FND359	7 seg com-cathode (Red)	1.25

9000 SERIES

QTY.			QTY.		
	9301	.85		9322	.65
	9309	.35		9601	.20
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	4015	.75
	4016	.35
	4017	.75
	4018	.75
	4019	.35
	4020	.85
	4021	.75
	4022	.75
	4023	.20
	4024	.75
	4025	.20
	4026	1.95
	4027	.35
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	4029	1.15
	4030	.30
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	4034	2.45
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	4037	1.80
	4040	.75
	4041	.69
	4042	.65
	4043	.50
	4044	.65
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	4050	.45
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	7401	.15		7483	.75		74367	.95		74LS04	.30
	7402	.15		7485	.55		75108A	.35		74LS05	.35
	7403	.15		7486	.25		75491	.50		74LS08	.35
	7404	.10		7489	1.05		75492	.50		74LS09	.35
	7405	.25		7490	.45		74H00	.15		74LS10	.35
	7406	.25		7491	.70		74H01	.20		74LS11	.35
	7407	.55		7492	.45		74H04	.20		74LS20	.30
	7408	.15		7493	.35		74H05	.20		74LS21	.35
	7409	.15		7494	.75		74H08	.35		74LS22	.35
	7410	.15		7495	.60		74H10	.35		74LS32	.35
	7411	.25		7496	.80		74H11	.25		74LS37	.35
	7412	.25		74100	1.15		74H15	.45		74LS38	.45
	7413	.25		74107	.25		74H20	.25		74LS40	.40
	7414	.75		74121	.35		74H21	.25		74LS42	.75
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	7417	.40		74123	.35		74H30	.20		74LS74	.45
	7420	.15		74125	.45		74H40	.25		74LS76	.50
	7426	.25		74126	.35		74H50	.25		74LS86	.45
	7427	.25		74132	.75		74H51	.25		74LS90	.65
	7430	.15		74141	.90		74H52	.15		74LS93	.65
	7432	.20		74150	.85		74H53	.25		74LS107	.50
	7437	.20		74151	.65		74H55	.20		74LS123	1.20
	7438	.20		74153	.75		74H72	.35		74LS151	.85
	7440	.20		74154	.95		74H74	.35		74LS153	.85
	7441	1.15		74156	.70		74H101	.75		74LS157	.85
	7442	.45		74157	.65		74H103	.55		74LS160	.95
	7443	.45		74161	.55		74H106	.95		74LS164	1.20
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	7446	.70		74165	1.10		74L03	.25		74LS244	1.70
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	7450	.25		74176	.85		74L20	.35		74S00	.35
	7451	.25		74180	.55		74L30	.45		74S02	.35
	7453	.20		74181	2.25		74L47	1.95		74S03	.25
	7454	.25		74182	.75		74L51	.45		74S04	.25
	7460	.40		74190	1.25		74L55	.65		74S05	.35
	7470	.45		74191	1.25		74L72	.45		74S08	.35
	7472	.40		74192	.75		74L73	.40		74S10	.35
	7473	.25		74193	.85		74L74	.45		74S11	.35
	7474	.30		74194	.95		74L75	.85		74S20	.25
	7475	.35		74195	.95		74L93	.55		74S40	.20
	7476	.40		74196	.95		74L123	.85		74S50	.20
	7480	.55		74197	.95		74LS00	.30		74S51	.25
	7481	.75		74198	1.45		74LS01	.30		74S64	.15
										74S74	.35
										74S112	.60
										74S114	.65
										74S133	.40
										74S140	.55
										74S151	.30
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Publisher's Letter

EXHIBITIONS at which *Practical Computing* exhibits in Britain and overseas, are improving significantly and attracting more and more visitors, They provide a fine opportunity to inspect and compare the latest products and to meet our many friends in the computer industry.

The most important aspect to us is meeting our readers and receiving your brickbats—and sometimes even compliments. The suggestions from you at the shows, added to the many constructive letters we receive, are invaluable in helping us to develop the magazine.

A recurring comment concerns newsagents from whom *Practical Computing* can, or more pertinently cannot be obtained. There are some 35,000 newsagents in Britain. Not all are as yet fully aware of the tremendous growth, not only in terms of size and quality, but also in popularity, of *Practical Computing*. Many of them in any event carry only a small selection of monthly magazines.

The larger ones, and the more enterprising among the others, usually receive *Practical Computing* at publication date but even they still frequently under-estimate the increasing demand and sell their supplies very quickly.

If you have problems obtaining the magazine from a sizeable newsagent near you, please write to us with the name and address of that newsagent, or give us the name and address at our stand at the Microcomputer Show from July 5-7, so that we may attempt to remedy the situation.

Meanwhile, you can make sure of your regular copy by giving the coupon below to your newsagent.

The Publisher

Dear Newsagent,

Please deliver/keep a copy of *Practical Computing* for me every month, starting with the bumper July Microcomputer Show issue available June 13.

Name ....

Address ....

....

....

....

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

Selling system

I AM a reader of your magazine, though a computer novice. My job is selling supplies of inks and papers for duplicators and photocopiers over a wide area.

Regular repeat business is a very important factor and contacting users when they are about to re-order increases our chances of retaining the customer and keeping-out competition. Maintaining records of 100 or 200 customers is difficult, and I have been thinking of the advantages of a microcomputer as a sophisticated filing system. Is it possible for an average-sized microcomputer to be used? Ideally, when a customer placed an order I would key-in a projected date for the next order. It might also be possible to check the dates of previous orders as a guide in making the estimate.

With the system running, I would be able to key-in a date and receive a list of calls to be made that day. It could also be used as a diary—for appointments, errands and deadlines.

Would the use of codings enable the main body of customer information to be broken down in different ways? For example, to be able to obtain a list of all copier owners in a certain area, or of the top 20 percent of customers, or of all of the owners of a certain type of machine, would be invaluable.

I would be very interested to know how much of the above could be done with the popular micros like the Pet, Apple II and TRS-80, or how much bigger the machine would need to be.

Would I have to get deeply involved in DIY programming, or buy expensive software to do the job? How much would it cost to rent a suitable machine?

Phil Symons
Cheltenham

● **This sounds an interesting application for a microcomputer, and it is by no means one which is out of the question. Using a computer system as an automated filing cabinet with over-tones of the appointments diary is a well-accepted application.**

There are two obvious constraints which will dictate the type of system you should consider buying. One is speed of access to records; using a cassette-based system you probably would not be able to get at individual records fast enough. "Quick" in this case means in fractions of a second rather than several seconds.

Secondly, there is the question of storage capacity. Using a sequentially-ordered system like cassette, where records are stored one after the other, it is possible to build a long list of records overflowing from one cassette to another. It is not so easy to do with a floppy disc system, though, and it sounds as if you will need a floppy disc system to obtain the speed of access to records—cassettes can be slow on applications such as the one you are suggesting.

It sounds as though the programming involved would not be over-taxing; you could probably manage it yourself with a little hands-on practice.

You asked about specific computers which you should consider. We would not recommend any cassette system. A floppy disc system with printer will cost at least £1,500 and it could run to £1,000 more than that. As a first step, it might be worth inviting one or two of the smaller systems suppliers and software houses to quote for the job if you have that kind of money available.

For starters

I WOULD like to know about any books which will instruct a non-electronics person on how to build a personal computer system. I have done some programming in basic and Plan and after buying your magazine am eager to build my own computer. Could you tell me of any computer in my area I could visit?

W. S. Crawford
Norden
Rochdale

● **The best way to learn how to build a personal computer system is to do it yourself and the cheapest way to start is to invest in a Science of Cambridge Mk 14 or Acorn Computers kit. With a little more to spend, and with a little more resulting from the project, you might try the Nascom-1.**

If you want to read your way into the subject we recommend Ronday Zaks' Sybex books and Adam Osborne's microprocessor series.

Is Atari normal?

I OWN an Atari video computer system which I understand contains a microprocessor. Could you tell me if it is possible to use this as a 'normal' computer. Do you know of any company which could supply a Basic cartridge for the Atari?

I have just started taking *Practical*

(continued on page 33)

(continued from page 31)

Computing and I must congratulate you on an excellent magazine.

M. Fryer
Gloucester

● **The Atari games system does contain a microprocessor though we are not sure how accessible it is to the user. Like any micro it can be programmed and re-programmed. In practice that is all that happens when you select another game—the games are pre-prepared programs.**

To get at the micro to enter your own programs you will need a keyboard and, in practice, a programming language as well. Both are available on Atari systems in the States, and Atari headquarters there might be your best bet. You will be lucky to find either a compatible keyboard or a compatible Basic in this country.

Technology interface

THERE IS an increasing recognition that the conventional wisdom relating to economic growth, the application of technology and expectations of progress being automatically forthcoming is an insufficient basis on which to build the sustainable society which could last throughout the twenty-first century.

The conventional philosophy of interface with technology has been questioned most seriously in relation to the application of the microprocessor, whose indiscriminate application has been seen to be likely to cause unemployment extending to the professional classes.

It has therefore been found necessary to consider alternative cultures and the strategies necessary to achieve them.

The role of the microprocessor is two-fold in this process; it can provide a means of distributing information throughout the alternative movement and its constituent elements—such as Friends of the Earth, the Conservation Society, the Future Studies Centre and Ecological Life Styles Ltd—via the suggested organisation of these into 'resource units'. They could cover the ecology of an Alternative Culture, Politics of an Alternative Culture, Energy for an Alternative Culture—and so forth; the overall organisation would be strategies for an Alternative Culture.

The Microprocessors for an Alternative Culture resource unit could also consider applications in the running of small-scale enterprises such as co-operatives and service facilities.

Anyone interested in this type of enterprise can contact me.

Gordon Foy
22 West Preston Street
Edinburgh E8H. 9PZ

Invitation

IN OUR Department of Computer Science we have cross-assemblers for three microprocessors—Motorola M6800, 6502 (Kim) and SC/MP (Cambridge Mk 14). If any other educational establishment would like to use this software, they should contact me for details and possibly to arrange access.

Michael Farmer
Birbeck College
University of London
Malet Street
London WC1E 7HX

Advice

My advice to any TRS-80 or Pet owner is to buy themselves a better computer. May I suggest a Mk 14?

A. C. Dove
Eaglescliffe
Cleveland

Taking the plunge

MANY THANKS for an interesting and instructive magazine—parts of which at least I can understand. I have not yet taken the plunge and bought a micro but I am very interested, although very much a novice as far as detailed knowledge is concerned. I have a list of points which would seem to me to be necessary in a micro:

- a decent keyboard (QWERTY) since I can type well enough to be annoyed by that of the Pet.
- a Basic interpreter, as I am confident of writing working programs—and have done for some time—but as yet I know little of machine language.
- a reasonable amount of RAM and the ability to expand it.
- the ability to connect a TV screen, since I already have one I see little point in buying another unnecessarily.
- the ability to connect one or two cassette recorders—for the same reason.

Naturally, my points will not apply to everyone. I have been looking at systems and prices and the Ohio Superboard II seems to be good value. Have you any experience of this? I realise you cannot review every micro on the market but have you any plans for this one?

I am a student with the Open University and am doing two computer courses, one hardware and one software. I spend time using the local terminal; two games available are Adventure which is addictive, and Star Trek, which unfortunately has no instructions. Playing it was very much a matter of luck—so I was very pleased to see your explanation of the game.

C. J. Green
New Malden
Surrey

● **Thanks for the kind words about the magazine. *Adventure* is addictive even for those of us who do not have enough memory to run it.**

We have reviewed the Superboard II. Apart from any technical impressions we have, you should be aware that supplies of this micro are constricted.

Your list of desirable attributes for a personal computer is much too rigid, incidentally. A good keyboard is vital, to be sure, and so is a high-level language. Basic is prevalent but you should also keep your eye for Pascal and APL.

We are not sold on the idea of a TV screen as an output medium. In principle, you're right, of course; it seems to make good sense to use a CRT device you already have, but it is not a particularly ergonomic design for I/O, especially for program development. At the very least, a separate video monitor should be considered; you can buy one for less than £100.

You should also keep your options open on external storage; it is important to go for the multi-user interfaces—like RS232, also called CCITT V24—which can attach a variety of external devices as your needs and your budget expand.

Nascom fan

A WORD of warning to builders of the Nascom expansion board—check the plated-through holes.

Having recently added a 16K board to my Nascom-1, much midnight oil was expended when both the RAM and ROM on the expansion board refused to respond to a modify command. The problem eventually revealed itself as four plated-through holes which were not.

The fault-finding would have been speeded by the inclusion of a circuit diagram, incidentally. Despite this, I can only say that I am very pleased with the Nascom; the basic board ran first time and it is excellent value.

David G. Thorley
Cairneyhill
Fife

Grampian Society

I AM writing to advise you of the formation of the Grampian Amateur Computer Society and I should be grateful if you could help us increase our membership, which now stands at a small but select 16.

Usually we have meetings on the second Monday of each month but the location varies depending on the type of meeting. At present, we are using the meetings to demonstrate the members' various systems.

Anyone interested should get in touch with me.

Michael Brown
Grampian Amateur Computer Society
282 Queen's Road
Aberdeen AB1 8DR

● **We are glad to give space to computer clubs. Let us know what your society is doing, and we will publicise it.**

We have been trying to compile a

(continued on page 35)

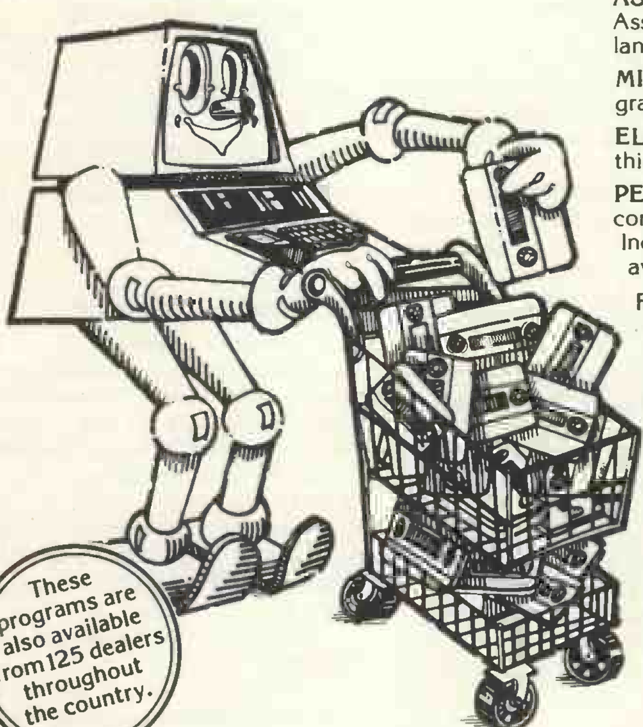
Pet program supermarket

At last a whole menu of programs to feed your PET at prices which knock the bottom out of traditional software costs.
Our 16 page catalogue lists nearly 130 programs from £3 to £50 (including VAT).
These cover Business Routines, Programming Aids to help you make the most of your PET and some super games to play with it. Here are just a few examples.

MAILING LIST—£15. Stores and prints names and addresses; carries out labelling etc.

INVOICING—£20. Stores pricing information and prints numbered invoices. Handles differing VAT rates, and at least 50 items on 8k PETS; more with additional memory.

WORD PROCESSOR—£25. Composes, edits and prints letters, articles, leaflets etc. Script directives include line length, left margin, centering and skip. Edit commands allow user to insert, delete and move lines, change strings, save and load from cassette, move up and down, print and type. Addresses any RS-232 printer through special adaptor, available separately.



V.A.T. PACK—£17.50. Two programs, one for output VAT and one for input VAT. Allows data to be entered, processed and stored on tape. Information, including VAT return, can be displayed at any time. 'VAT SCHEME D' is also available for retailers, price £15.00.

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MY PET NEEDS FEEDING Please rush me a copy of your free 16 page catalogue of PET programs without obligation.

My name is

My PET lives at:

● Circle No. 152

(*continued from page* 33)

register of all computer clubs and societies in the U.K. and a few weeks ago we mailed three dozen letters requesting more information from clubs whose names have appeared on our files.

If you think your club did not receive one, call us, and if you received one but have not yet responded, please do so.

Astronomy

I HAVE bought two of your magazines and have found them very interesting. The articles, however, have shown how little I understand computers, my use of a calculating machine being limited to a Texas TI59. I have learned about flowcharts and the like but no doubt you will dismiss the TI59 as being not worthy of 'computer' status.

Could you answer some nagging questions I have? As an amateur astronomer, I have always wanted to be able to show theory in 3D—a comet in orbit around the sun, for instance. Is this at all possible on these home computers? I have contacted some manufacturers but they seem reluctant to say yes or no.

This kind of reply has led me to suspect that such computers are fine for games, accounts and limited maths but for anything else they are not so good.

I hope I am wrong and that you can give me some information on my problem.

Paul Benham
Warlingham
Surrey

● **We have nothing against programmable calculators, and we intend to start a Calculator Corner soon, to which you may wish to contribute.**

On your specific question about astronomy problems, there are two considerations—the fact that programming may be difficult and, much more pressing, the likelihood that a personal computer would run out of steam. In this case 'steam' means memory to hold all the calculation variables and arithmetic functions to simplify and speed the computation.

If it can almost be done on a TI59 it can certainly be done on a personal computer. But these machines were never designed for heavy scientific computations; they are very deliberately general-purpose systems, biased towards I/O functions and facilities —like graphics and floppy discs—rather than esoteric calculations, for which you might want Fourier functions and high-speed floating point.

Why not wait until TI produces a home computer? That might make an interesting contrast with the TI59.

Cutting solution

WITH the aid of a sharp pair of wire cutters, a ruler and a white pencil, you can double the capacity of a floppy disc.

Draw lines across from the square cut-out to the opposite edge from the top and bottom of the small circle—on each side of the disc—to the opposite side of the large central hole.

Then snip away the cut-outs—that near the central hole does not have to be circular—and you can then use both sides after backup or formatting.

Norman A. Law
Urmston
Manchester

● **This works—we've tried it. What is more it also works for single-sided floppies which have been damaged on the normal read/write surface, for instance by a head crash. So don't throw away your duff discs—seek your scissors.**

Beginner's ideas

AS a newcomer to the world of computers, I would like to say how much I am enjoying this new interest. I look forward to each issue of your magazine, although some items in it are still too specialised for me.

My reason for writing is to give you an idea of the articles which a beginner like me would like to see. After discussion with friends who are also new to the field, it seems that we are in general agreement about the difficulty of understanding certain of the basic techniques.

Some of your beginner-level articles are very good; they tend to be compact and limited, very suitable for the beginner. Then there is a gap, before you cover much more complex programs or hardware ideas in much more detail. To give you an idea of the kind of problems which have puzzled me, here's a list of topics:

- **Programs steps**—a brief resume of what each program step is doing where this is not obvious—this would certainly not be needed on a 100 percent basis.
- **Monitors**—a series explaining how monitor software works. I have Nasbug listings for my Nascom but I cannot make full use of the subroutines available as I am unable to see the wood for the trees.
- **Games**—I am trying to write simple games for my Nascom but have not yet found how to interact with a running program—for instance, to wipe-out targets on screen. A series on methods of changing displays and other games techniques would probably be of considerable interest.
- **Languages**—where programs in high-level languages use uncommon routines, commands or functions, could the authors give alternatives so that the program may be translated to a less powerful version of the language?
- **Commands**—general articles on Basic are usually limited in their treatment of the more specialised commands. It would be helpful to see a series where a particular command is given a more extensive treatment. I have in mind arrays, matrices, the PRINT statements, use of strings, complex loops, when to use INPUT, DATA statements, and so on.
- **Hardware**—this is generally well done but perhaps a few articles on logic design, memories, registers, multiplexers and PIOs would help overcome some of the associated comprehension problems.

I hope the foregoing will be taken in the spirit in which it is offered. I wish your magazine success in the future.

C. Bowden
Tregwyn
Stithians
Truro, Cornwall

● **We welcome constructive criticism of this kind. It is rare to hear from anyone so positive, so let us have more ideas.**

- *Program steps*—**this makes sense.**
- **We will try for more explanation and comment in future.**
- *Monitors*—**functions vary greatly from one machine to another but we will look into the question of a general series.**
- *Games*—**a series on games techniques has been commissioned.**
- *Languages*—**most people do not know more than one or two versions of Basic, so it is usually difficult for the program author to decide what is unusual and what is not. There is no widely-agreed standard Basic to act as a reference point, though we are looking at two alternatives—one of the U.S. hobby magazines has tried. Meanwhile, try** *The BASIC Handbook*, **which we reviewed in May.**
- *Commands*—**a series on the more complex areas of Basic is due later this year.**
- *Hardware*—**we are a little unwilling to delve too deeply into the nuts and bolts of hardware but we will consider this if there is enough demand.**

Pet plea

DO YOU know where I could obtain a Pet 2001 microcomputer fairly cheaply? I decided to choose a Pet because they are complete, they are a popular make of microcomputer, and there is a wide range of games available to them.

I have to choose a cheap one because my pocket money, plus extras, isn't enough for a new one. I don't care about its condition, so long as it works.

G. Clements
Canterbury, Kent

● **We have no idea where you can obtain a cheap Pet. There is no second-hand market for them; Commodore is selling all it can make.**

Two alternatives suggest themselves. You could wait until prices fall even further —though we think the Pet won't get much cheaper. Or you could band together with some like-minded people, start a club, and buy one co-operatively.

THE EXPANDABLE GENERAL-PURPOSE MICROCOMPUTER

THE RESEARCH MACHINES 380Z

A UNIQUE TOOL FOR RESEARCH AND EDUCATION

Microcomputers are extremely good value. The outright purchase price of a 380Z installation with dual mini floppy disk drives, digital I/O and a real-time clock, is about the same as the annual maintenance cost of a typical laboratory minicomputer. It is worth thinking about!

The RESEARCH MACHINES 380Z is an excellent microcomputer for on-line data logging and control. In university departments in general, it is also a very attractive alternative to a central mainframe. Having your own 380Z means an end to fighting the central operating system, immediate feedback of program bugs, no more queueing and a virtually unlimited computing budget. You can program in interactive BASIC or run very large programs using our unique Text Editor with a 380Z FORTRAN Compiler. If you already have a minicomputer, you can use your 380Z with a floppy disk system for data capture.

What about Schools and Colleges? You can purchase a 380Z for your Computer Science or Computer Studies department at about the same cost as a terminal. A 380Z has a performance equal to many minicomputers and is ideal for teaching BASIC and Cesil. For A Level machine language instruction, the 380Z has the best software front panel of any computer. This enables a teacher to single-step through programs and observe the effects on registers and memory, using a single keystroke.

WHAT OTHER FEATURES SET THE 380Z APART?

The 380Z with its professional keyboard is robust, hardwearing equipment that will endure continual handling for years. It has an integral VDU interface—just plug a black and white television into the system in order to provide a display unit—you do not need to buy a separate terminal. The integral VDU interface gives you upper *and* lower case characters and low resolution graphics. Text and graphics can be mixed *anywhere* on the screen. The 380Z also has an integral cassette interface, software and hardware, which uses *named* cassette files for both program and data storage. This means that it is easy to store more than one program per cassette.

Owners of a 380Z microcomputer can upgrade their system to include floppy (standard or mini) disk storage and take full advantage of a unique occurrence in the history of computing—the CP/MTM* industry standard disk operating system. The 380Z uses an 8080 family microprocessor—the Z80—and this has enabled us to use CP/M. This means that the 380Z user has access to a growing body of CP/M base-software, supplied from many independent sources.

380Z mini floppy disk systems are available with the drives mounted in the computer case itself, presenting a compact and tidy installation. The FDS-2 standard floppy disk system uses double-sided disk drives, providing 1 Megabyte of on-line storage.

Versions of BASIC are available with the 380Z which automatically provide controlled cassette data files, allow programs to be loaded from paper tape, mark sense card readers or from a mainframe. A disk BASIC is also available with serial and random access to disk files. Most BASICs are available in erasable ROM which will allow for periodic updating.

If you already have a teletype, the 380Z can use this for hard copy or for paper tape input. Alternatively, you can purchase a low cost 380Z compatible printer for under £300, or choose from a range of higher performance printers.

*CP/MTM Registered trademark Digital Research.

380Z/16K System with Keyboard **£965.00**
380Z/56K complete with **DUAL FULL FLOPPY DISK SYSTEM FDS-2 £3,266.00**

380Z Computer Systems are distributed by RESEARCH MACHINES, P.O. Box 75, Chapel Street, Oxford. Telephone: OXFORD (0865) 49792. Please send for the 380Z information Leaflet. Prices do not include VAT @ 8% or Carriage

● Circle No. 153

Cossor in MAP link

COSSOR ELECTRONICS has been accepted by the Department of Industry to help implement the Microprocessor Appreciation Programme.

Cossor will be running a series of five-day courses for the engineer and technician. They are designed to "lead students through the new technology and give a clear understanding of the architecture, procedures and applications of micro-technology", Cossor says.

The Government makes a £2,000 grant for any course thus chosen and the cost to the student will be £200 plus VAT. The course is called the Cossor Microprocessor Appreciation Course, and the first, held in May, was fully-booked in advance.

Other starting dates are June 18, July 16, September 10, and then in alternate months, the precise dates of which have to be decided.

The venue is the Cossor Service Division Training School, Harlow, Essex. Further information from Henry Lassman on (0279) 26862.

British retailers making international study

ALLTECK (Technology Initiatives) has embarked on the first international study of the problems and opportunities of retailing microcomputers by non-specialist electrical retailers.

The study incorporates Japan, ECC countries and the U.S. It has already established that the U.S. government has a grant system whereby it pays for up to six microcomputers to any class in schools at any level of education, as part of a Basic Computer Literacy programme.

The study is expected to be complete by September and so far six major British retailers are involved. Peter Matthews of Allteck is "always looking for new people to take part in the study" and can be contacted on (01) 839–3143.

The programme is in two parts. The first is a market research project to define distribution chains, sales patterns of electrical goods and the market possibilities for the home computer.

The second part of the study will be a practical examination of the problems the retailer encounters in the shop or department. Allteck is planning a pilot scheme to establish several micros in retail outlets.

The scheme will study the level of skill and knowledge needed by sales staff, as well as the sort of back-up necessary for programming and servicing the installation of a computer.

The third sector of the project is to examine the home market, which represents less than one-fifth of all computers sold in the U.S. Allteck says that there is an opportunity for the U.K. retailer to improve the market because of Prestel and other Teletext services.

It says that the boundary between the microcomputer and the telephone-linked computer terminal is being blurred and will soon lead to a situation where we will see a machine with 64K RAM and a telephone-linked connection for people to access the information which will be held on their computers.

Spelling aid

A NEW DEVICE to make spelling fun for children has been introduced by Texas Instruments. The Spelling B uses proven word and picture association techniques to help children with spelling and word recognition.

It uses an alphabetical keyboard laid-out like a calculator and one-line display, combined with a picture book full of everyday objects.

It selects and displays a picture number and the child has to find the picture in the book and spell the name of the object. When the letters have formed a word, the display indicates whether it is right or wrong. If wrong, then you have another attempt, and if it is still wrong the unit will give the correct spelling. At the end of each set of five words the score is displayed.

Three levels of play are available and there is a variety of pre-spelling games for younger children on the unit. They are designed to improve reading skills and are simple, games like a derivation of Hangman and filling-in the mystery letter of a word.

The Spelling B costs £19·95.

Spelling B learning aid.

Equipment reward

SEVERAL items of computer equipment were stolen in January from Hinxton Hall, Cambridgeshire, and the Cambridgeshire police are still trying to recover it.

The equipment was stolen on January 19 from TI Research Laboratories. Missing are: Model 231 Intellec Series II microcomputer development system with detachable keyboard (serial no. DG.1247); microcomputer development system floppy disc drive for use with it (serial no. CS.954); microcomputer development system universal PROM programmer, dark/light blue (serial no. DN.1206); in-circuit emulator, ICE 80, 8080. Blue metal box, multi-coloured cable (serial no. AY.3930); diskettes storage file (licence no. 3401 590–01); and Intellec 8 microcomputer development system, light blue.

The value of the stolen property is £20,000 to £23,000 and it was all supplied by Intel. If you know of any of these items being offered or have purchased anything like it second-hand, please check the serial number. There is a £2,000 reward for information leading to the recovery of the property and conviction of the persons responsible.

All information should be passed to Sgt. D. S. Miller of the Cambridge Constabulary on 0223 58966.

Teletext and Prestel available in three-way package

WITH TECS, it is possible to buy equipment which enables you to read Teletext/Prestel and buy a cheap computer all in one.

The Technalogics Expandable Computer System was designed to bring to the professional, business and domestic user cheap decoding and computing. Prices begin at £360 for the basic model and rise to £1,200.

You plug TECS into a television aerial socket and it translates information from Ceefax or Oracle, which is already transmitted in coded form at the top of the TV picture.

Screen-size page

When the signals are decoded it produces a coloured screen-size page of the information you select. The simple graphs, maps (for weather) and diagrams are in six colours, as well as black and white.

Sub-titles and news flashes can also appear on the screen during normal TV programmes if required. There are hundreds of pages of this type of information available, which means that you can be one of the best-informed people.

The self-contained, ready-to-use unit has output to feed users' standard 625-line colour or black and white television sets. Based on the Motorola 6800, it uses fully-buffered TECS bus structure and allows for standard microprocessor expansion—floppy discs, cassette I/O and the like.

It offers program access to Teletext information, such as share prices, which can be stored or processed locally; all colour display facilities, such as graphs, are available, providing you with a powerful colour VDU.

The machine has ROM, resident TECS mini-Basic and machine code monitor program. Hardware and software will be updated constantly and increased to cater for most users' needs. Technalogics regards the main applications areas for TECS as being education and training, business and domestic markets.

Off-line editing

When used with Prestel, the system becomes more than just an information retrieval service. It offers the user an intelligent terminal capable of off-line editing, data storage and local processing, thus increasing the cost-effectiveness of the viewdata service.

In addition to its Teletext facilities, TECS has a specially-developed Basic interpreter and a powerful Monitor program. The user has access to Teletext information in the 1K display RAM which forms part of the addressable memory space.

With suitable software, analysis of broadcast information is possible. An analysis of the share price trend is one such example. Similarly, writing to the display RAM provides a colour VDU complete with graphics.

Many options

The mini-Basic is a powerful ROM-resident interpreter which offers simple high-level programming, even for the minimal system. It is an Integer Basic supplied within the 4K ROM space and is very easy to use.

Also available is the TECBUG Monitor, which allows for machine code programming. With it, you can load, edit, assemble and debug machine code programs using the TV screen as a VDU.

The minimal TECS system consists of a Teletext input processor sub-equipped card display, direct connection TV interface, power supply, case and keyboard. The many options include aerial input adaptor unit, extra RAM processor, full facility keyboard, simple cassette interface and PROM and RAM boards. The Motorola 6800 has a built-in clock generator, 6875, with 3·68MHz crystal.

The display functions supply combined text and graphics in PAL colour and 'blast-thru' alphanumerics at any location of a graphics plot. It has read/write access to 1K display RAM.

The text is 40 characters per line by 24 lines and it is all software-controlled. The graphics are full Teletext specification and can be in colour or black and white. Any graphics cell can be replaced by an alphanumeric character for close mixing of graphs with text. This, too is all under software control.

The Teletext card allows continual address cycling, which covers whole memory sequentially. This makes I/O software very easy. The fully-buffered busses enable easy expansion up to 64K addressable memory/peripherals.

The configuration for the minimal system is a 5U card frame, three edge connectors, display, Teletext, microprocessor, TV interface and keypad. The software is Teletext in ROM and the hardware has 1K display RAM. The kit form price is £360 and ready-built costs £420.

Variants

System A is the same as the minimal system but has TECS mini-Basic in ROM and 4K user RAM. This costs £465 in kit form and £525 ready-built.

System B is as System A, less TV interface card, plus an edge connector and a PAL encoder/tuner unit. In kit form it will cost £570 and ready-built £640.

System C has a 5U card frame, a 5U case, five edge connectors, a display card, Teletext card, microprocessor card, PAL encoder/tuner, ASCII keyboard, modem interface and PSU. The software is Prestel, Teletext and Monitor. Hardware is 1K display RAM, 4K user RAM. Options are as for System A where applicable.

The price for the system has been decided only recently and the built version will cost around £1,200.

More information from Technalogics, 8 Egerton Street, Liverpool, L8 7LV. Telephone: 051-724 2695.

TECS system.

Low-cost keyboard

A LOW-COST keyboard and monitor is available from Video Terminals for £113·50, inclusive of VAT and post and packing.

The keyboard can generate all ASCII upper- and lower-case codes and features all TTL encoding, dual polarity strobe, two-key rollover and a power requirement of only plus 5V at 120mA. Long key-stroke keys are used and all the keytops have removable transparent caps. Overall size is 290mm by 140mm by 25mm. The cost is £28·50.

The monitor is a VT9 9 in. display which has been designed to satisfy the needs of a data and graphics terminal It can display more than 80 characters on a line and prices start at £85 for one off, with discounts available for quantity.

More information from Video Terminals, 197 Hornbeams, Harlow, Essex.

Microspeech system

A SINGLE-BOARD speech synthesiser for the SWPTC and MSI 6800 microcomputers has been developed by Costronics Electronics.

Microspeech costs £295 plus VAT. The board plugs into the SS50 bus on the two models and the software translator program (MSP2) converts phonetic code into sets of data which control the speech synthesiser.

It uses 4K of memory and every extra 1K of buffer space can store 90 seconds of speech. When decoded, the data produces nine control parameters which determine pitch, amplitude and resonant frequencies in the speech model. Phonetically-spelt phrases are entered and synthetic male speech is output.

A digital noise source and a voltage-controlled oscillator produce the signals to drive the unit. An external signal can be fed-in to form speaking musical sounds.

Typical applications include speech research, education and system design. As well as the standard translator package, a disc-based Basic interpreter with speech output is available as a software option. The package features computer games and a hardware and software manual, The software is available on disc and cassette.

Software Sciences is now dealer for BSO

SOFTWARE SCIENCES has secured a dealership for microprocessor development systems supplied by Boston Systems Office (BSO) of Massachusetts. It will supply the product to the U.K. and Benelux countries, making it the largest dealer in Europe.

The development system is designed to run with either a PDP/11 or Data General Nova as the host computer and can be used with any microcomputer in volume production.

It can be configured for up to 20 on-line users and Software Sciences will provide the necessary software alone if you have one of the two machines. If you want to add the software to new or different microcomputers, it can be done cheaply.

The software is written in Assembler for greater efficiency and its main advantage is improved cost. It is a faster way of implementing a development system than doing it on a manufacturer's prototype and is capable of handling multi-users with a number of terminals all doing software development. Several software development systems can be operated on the same machine at the same time.

Prices start at £1,230 and increase according to your needs. The first U.K. order to Software Sciences has already been placed and the development system has "generated a lot of interest", especially in the manufacturing and education areas.

New phase

A NEW PHASE in the Department of Industry Microprocessors Awareness Programme has been launched.

Latest developments include a workshop programme for top decision makers. It takes the form of a non-technical course for managers of the top 1,000 firms in the U.K. and the DoI expects 3,000 people to take part in the course in the three months to July.

Byte's chain link

THE BYTE SHOP is opening a chain of stores around the country. One year after its start in Gants Hill, Ilford, it has stores in London's Tottenham Court Road, Nottingham, Manchester and Birmingham. Another in Glasgow will be opening shortly.

Brainchild of Bill Cannings, who first saw the idea in the States, the Byte Shop sells computers ranging in price from £160 to £20,000, including models such as Pet, Nascom, Cromemco System 3, Compucolor, Exidy Sorceror, North Star Horizon and ITT 2020.

The rapid expansion involves employing two new staff per month, and the Byte Shop now offers a back-up service of around 35 highly-trained staff to deal with any problem on any machine purchased from a branch.

Byte Shop Tottenham Court Road manager Glenn Dacre (left) with customer John Andrews, of the College of Data Processing.

Hand-held games

GAMES SPECIALIST Spectrum Marketing has launched a range of hand-held microprocessor games for children, as well as a variety of computer board home entertainment products.

Spectrum was responsible for the introduction to the U.K. of the Chess Challenger which has been enormously successful, reaching sales of £1·5 million per annum.

The new games are designed specifically for young children from the age of five. Some, on sale for two months, have already been reduced in price.

Amaze-a-Tron, a maze game, now retails at £17·95; Zap!, a missile game is £10·95; Digits, similar to Mastermind but with numerals instead of pegs, £13·95; Lil' Genius, a learning calculator to teach the rudiments of arithmetic, is £6·45 and UFO Master Blaster, a space game, is £21·95.

The games are manufactured by several companies, including Coleco Industries of the U.S., Bambino of Japan and Fidelity, makers of the Chess Challenger and Checker Challenger.

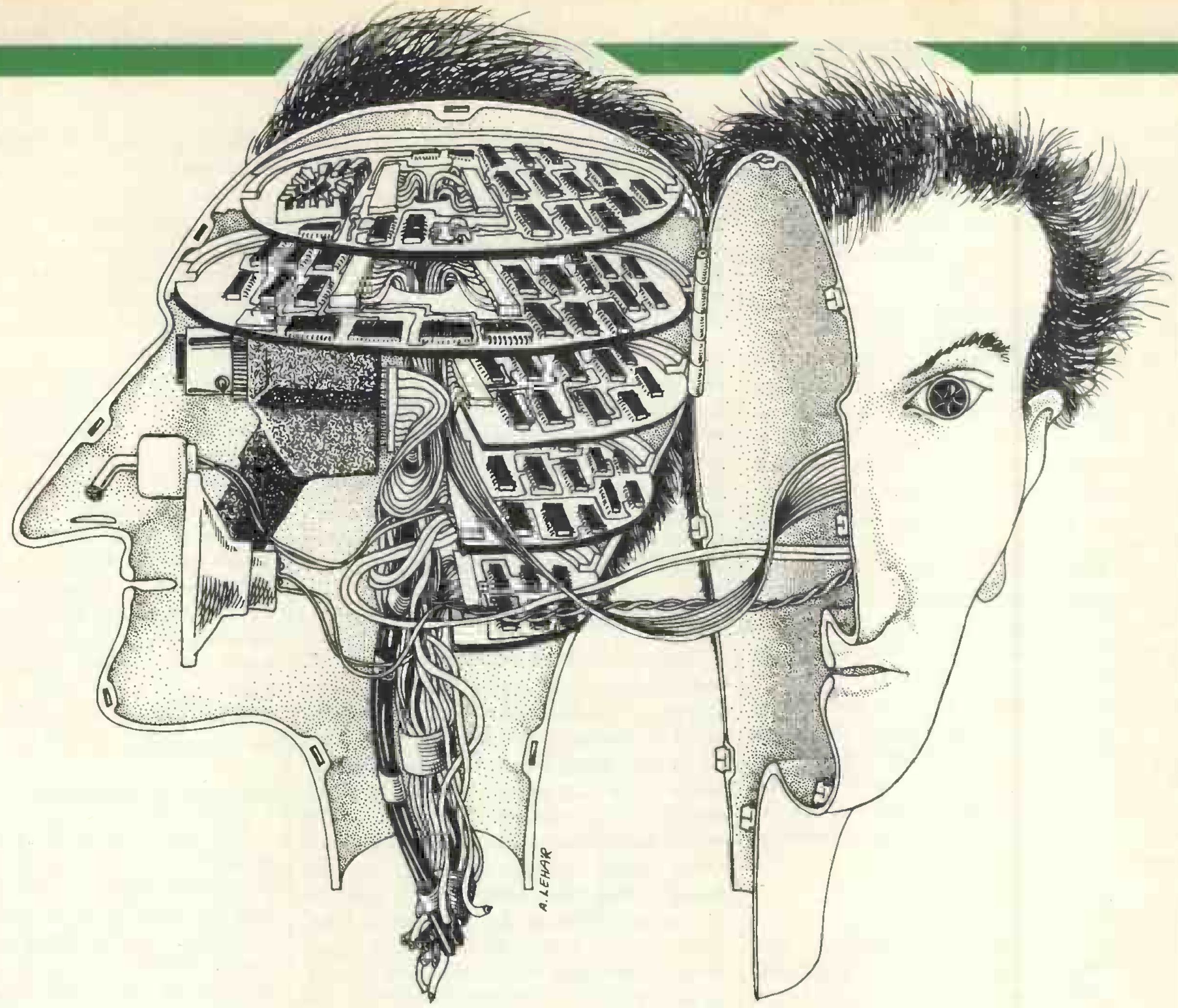
New high-powered versions of Chess Challenger are on the way. Voice Chess Challenger is a fourth-generation technology model, where there is no need to use keys—just speak to your board. It has seven levels of play and will cost £95 when it reaches the U.K.

Another Voice Chess Challenger is expected to follow soon; it uses fifth-generation technology. It has an infinite level of play and will cost £250.

Bridge Challenger will provide you with one, two or three partners. No price is available yet.

Z-80 group

WE RECEIVED a letter from a Mr. R. Sinden, whom we had been told was the contact for a Z-80 users' group. He points out that the group is open only to ACC members, and that in any case he has decided to relinquish control of it.



Computer versus brain

IF PRESENT developments in semiconductors continue, in 20-30 years semiconductor memory will be as dense as are neurons in the body. We need, however, to understand the way in which the brain processes information to be able to use this power properly.

More and more, as the brain yields its secrets to research, it is possible to see its inner workings without mystery and to realise that it performs as a machine, albeit a very complicated one. The activity of areas of the brain can be viewed directly as it performs the processing of different tasks, such as reading or manipulating objects.

A complete 'wiring diagram' of the simpler structures of the brain can be drawn; for example, the cerebellum cortex looks delightfully reminiscent of a computer bus structure, with arrays of complex planar networks linked by orthogonal connections. Enormously complicated and dimly understood, the brain is the successful survivor of untold trillions of alternatives from 500 million years of animal evolution.

On the other hand, the computer, with a real history of less than 40 years, is growing rapidly more and more complicated. The largest machines are already so complex that it is impossible for an individual to comprehend all the details of them. They represent a planar silicon 'intelligence' which, in some ways, compares remarkably well already to the three-dimensional carbon technology of the brain.

What are the similarities and differences between the two structures? Obviously,

by Dr. R. J. Stevens

as a general-purpose machine for living, the brain is orders of magnitude better than any computer. As has often been said, there is no computer so intelligent that it will prevent you putting an axe through it. When it can, that is the day to start worrying.

The main differences between the two structures are the organisation, the memory size and memory speed—the only factor where the machine wins.

Consider the following test between brain and machine. Imagine you have made the whole of the Oxford English Dictionary available to the man and the machine.

The question master asks the vital question: "Name a group of marine animals which sound like a Celtic part of the country."

The computer stands dumb-struck—assuming it even understood the question—while, in a flash of a billion flickering neurons, the human being answers in less than two seconds.

First round to the carbon-oxygen processor. The computer cannot compete with the human brain—or can it?

Ready for the next one?

"What is the only word in the English language with three successive pairs of letters in it?"

The computer answers in two seconds this time—solution at the end of this article*—while the human is left flat-footed. It is no use cheating and looking through the dictionary. The information simply is not stored in any way you are able to extract. Sequential searching through the whole of memory, though very inefficient, is better than having no algorithm at all.

Those problems really serve to demonstrate that the brain organises its memory normally so that it can trace the location

(continued on next page)

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of information from a small piece of that information, i.e. it 'tags' the data with the address location. For remembering information 'tagged' in this fashion, the brain is fantastically efficient.

In computer terms the address of the data is pointed to by the data itself. The first primitive memories of this kind—called 'contents-addressable stores'—are now available for S-100 bus computers. The brain is organised somewhat like a disc system, with a directory of files indicating where those files are stored.

This obviates the need for the brain or computer to search sequentially through untold billions of memory cells. After all, if you found the answer to the first problem in about one second, you did not have time to perform more than 100 or so sequential operations to search tens of thousands of words for a match. Even allowing for data reduction and the massive parallelism of operations in the brain, it has performed a remarkably efficient search. The problems begin when it hasn't put a tag on the data, as in problem two.

Building blocks

Apart from the organisation of the processing, another significant difference is the sheer amount of memory the brain possesses—about 10-(11) elements. One of the ways computer manufacturers have been foiled consistently is the lack of direct addressing space they have made available. This lesson has not been learned even now; the new Intel 8086 16-bit micro can address directly only one megabyte of memory—probably eight chips maximum by 1983.

No-one even knows how and where the brain stores information. The brain is built from neurons, wildly different physically from one another, but often with great structural similarities—i.e., the brain has been built from building blocks, which may have different shapes but have the same basis.

The 'CPU', 'memory' and, most critical of all, the organisation between the two are all constructed from the same kind of unit. A neuron can be regarded as a microprocessor, connected in parallel to many others like itself. It has digital inputs—usually between 50 and 100,000—analogue inputs, can be triggered into action by outside events and the threshold of that trigger can be altered.

Complex network

The brain is thus a complex network of fairly independent units, which act as the memory, the processor and the organisation of the tasks of the other two. This contrasts strongly with the rigid organisation of a computer, where the data usually flows through the CPU. The brain has about 10 (11) such neurons. Once again, nobody is sure; it was thought that there were 10 (10) until 10 (11) were found in the cerebellum lobe. This is many orders of magnitude more direct addressing than computers usually have (10–7 to 10–9) but really it is the organisation of the brain which sets it apart.

To see how impressively the organisation uses the rather slow hardware, consider how the body performs a task which stretches its physical and scene analysis abilities to the full, like catching a cricket ball moving at 100 mph. The neurons respond to stimulii in a few milliseconds, yet the body is able to perform complex actions in about 50 milliseconds—about 5–10 'instruction cycle' times.

If we imagine a computer, with a TV camera atttached and a pair of controllable mechanical hands, the catching of a ball could not be done in real-time with software. It would have to be simulated and would take millions of instruction cycles.

The superior organisation of the brain has bettered the machine performance by a factor of a million or so, with slower hardware. No wonder it is sensible to analyse this organisation to find ways to improve computers.

Even a block diagram of the process would take more than 5-10 blocks. The only way such a process could succeed is on a hierarchical basis, i.e., the 'goal' of catching the cricket ball is set and monitored by a master—probably the cerebellum cortex—and then a vast parallel organisation is set up and pre-programmed as much as possible.

More primitive

This pre-programming becomes more primitive as it descends the hierarchy towards the sensors or the active elements, like the muscles. For example, the eye, which is scanning about one million elements 10 times a second, has to reduce that amount of data (10 megabytes/sec) to manageable proportions. This is done by 'hardware' close to the eye, which finds edges in the scene, compares it to the previous scene, and works only on the differences.

As the problem moves nearer to the top of the hierarchy, software becomes more predominant. Although the software is slower, the data has been reduced sufficiently to analysable proportions. Meanwhile, the 'master' is controlling the position of the hands and body with a similar hierarchical structure.

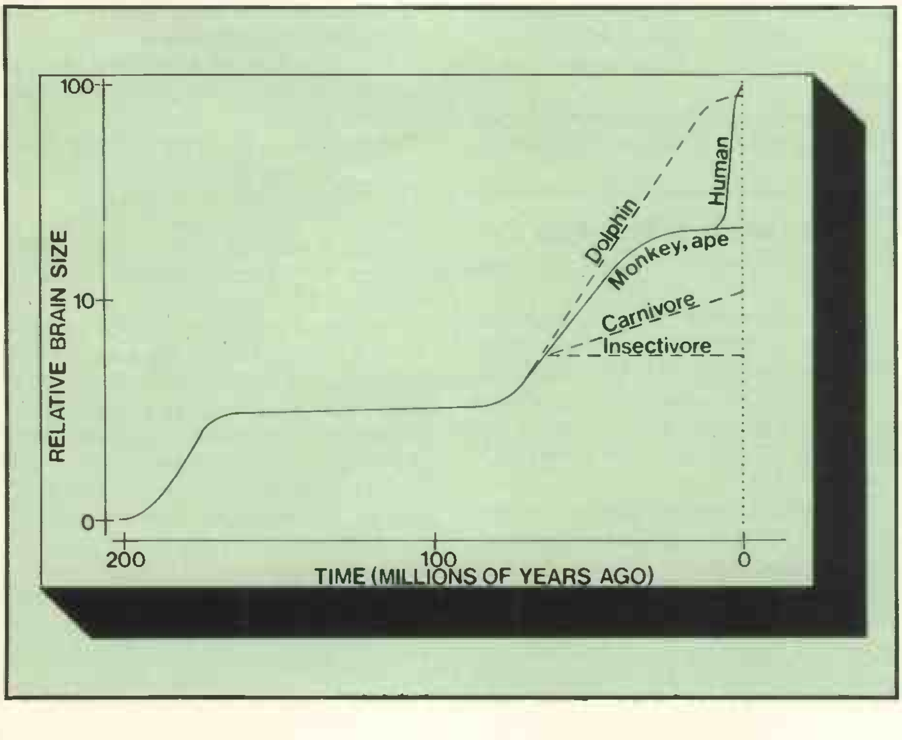
Brain size, of course, cannot be equated strictly with intelligence nor indeed can 'intelligence' be blamed for the position in which man finds himself in the world.

Which is the most intelligent animal might be a fit subject for philosophical dispute; the identity of the most violent and aggressive is certain. After all, the sperm whale has a 15lb brain, far larger than any land creature, but that does not prevent man murdering the animal to make transmission oil.

Great increase

If, however, we compensate for body weight there seems to be a reasonable correlation of brain size and apparent 'intelligence' between animal species. Man's rise to 'domination'—and potential annihilation—in the last two million years has been accompanied by a very great increase in brain size. Figure 1 shows how the brain size of animals has varied through evolutionary times. It plots encephalisation quotient, a measure

Figure 1



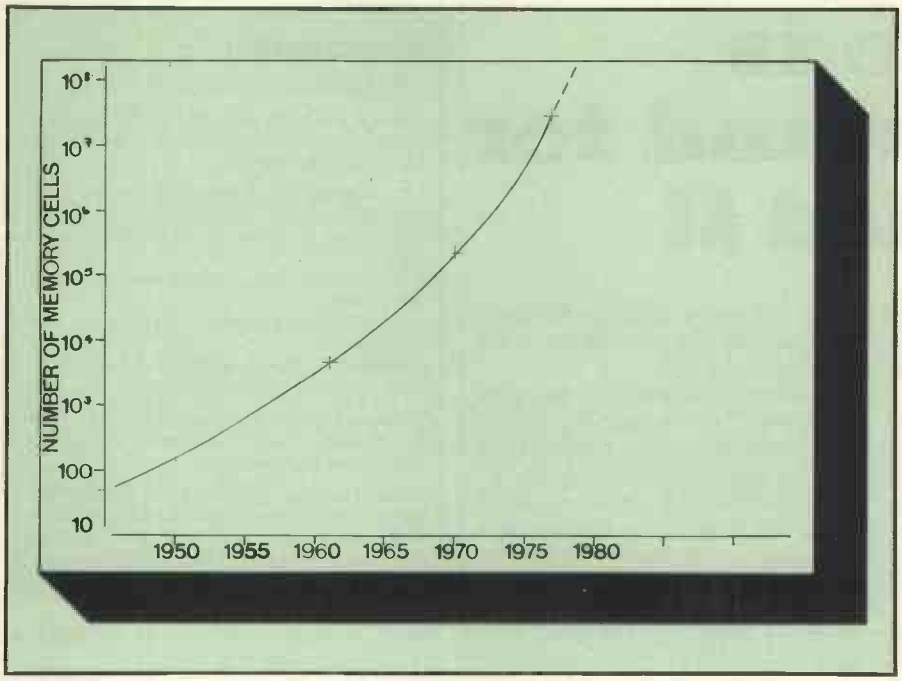


Figure 2

of brain power which compensates for different body size.

As you might expect, the most intelligent animals have become steadily more intelligent, taking niches from the less clever, who still retain their place where intelligence is not required—such as in some nationalised industries?

Significant changes

Two particularly significant changes can be seen on the graph. One is where mammals were bequeathed control of the world by the annihilation of all of the large dinosaurs. The other is the rapid increase in brain size of the ancestors of man within the last few million years. This shows that during that period, there has been the most intense selective pressure for more intelligence, probably at the expense of other attributes.

Nevertheless, it is interesting to note that man rates no higher than the dolphin in brain-size rating and lagged behind such creatures for millions of years. Presumably the oceans have not proved to be as easy an environment to dominate as the land.

Compared even to this increase in brain weight, an equivalent graph for computer memories is even more spectacular—figure 2, note the logarithmic scale. This graph plots the number of memory cells we have been able to pack into one body weight. Of course, memory is not a measure of intelligence in a computer but it is a good indication of the intelligence potential of such a machine.

The graph is rising at an amazing rate. It reflects the fact that, at the moment, semiconductor memory density is doubling each year—and has done since 1964—while the power-supply requirements are falling rapidly.

In fact, the slope is even steeper than is shown, because there has been a further improvement of memory access time as well. If one memory cell were equated to one neuron, and development continues at the present rate, the machine and man would have an equal encephalisation quotient within 20 years—a machine weighing 168lb would have 10 (11) memory cells.

In fact, a typical neuron is more like a small microprocessor, with say 1,000–3,000 transistors. It seems almost unreal to contemplate that a factor this large would be swallowed by a further 5–10 more years development at the present rate.

A number of factors are likely to slow this advance. Firstly, there are fundamental limits to silicon technology, in many ways. The maximum circuit density which can be imagined without a technological breakthrough is perhaps 100x that of today. That may be overcome by changes in the direction of technology, of course.

Antique languages

Neither do we understand, except perhaps very crudely, how the brain analyses some tasks, such as recognition of faces or voices. Software, in the form of operating systems and computer languages, is such a slowly-developing subject that we are using antique languages like Cobol and Fortran on our machines.

There is little general understanding of the theory of parallel processing, except in one or two specialised areas. That presumably will remain true until the serial processor reaches some blockage, which prevents further progress and requires the kind of efficiency only a parallel processor can provide. Unless there is theoretical and experimental work in this area, we shall not be able to use our machines efficiently when they arrive.

It is interesting to note that Britain is playing a leading role in developing efficient parallel processors. Let us hope that it does not suffer, from lack of support, the fate of other British pioneering efforts.

There is no real requirement to build a processor with human capabilities but that will not prevent man trying to do it. Mankind's combination of aggression and lack of self-restraint will ensure that it is attempted, regardless of the consequences.

Long before Frankenstein or Pinnochio, man has been attracted by the idea of creating his own intelligent being. There was a Jewish myth of the 'golem' or humanoid servant created by the Chief Rabbi of Prague in the 15th century. Strangely, three great computer geniuses, John von Neumann, Norbert Wirner and Marvin Minsky, are reputedly direct descendants of the rabbi.

The possession of such an intelligent machine, and others more intelligent which will follow it, is certain to increase man's capabilities, even if only for self-destruction.

Unbroken line

Evolution has provided man with an amazingly powerful general-purpose processor, successful over millions of years; each one of us is descended in an unbroken line from the tiny shrew-like mammals which survived the Armageddon of the dinosaurs 70 million years ago.

Nature, however, has had to work within constraints which have hindered development as well. Brains have to be made and operated at body temperature—it may be more efficient to make them at 1,200 degrees C and operate at absolute zero. Furthermore, the brain has had to be successful, at every time during its evolution, to cope with difficulties which are no longer relevant. This is like a computer which has to be designed, for good reasons, to be hardware- and software-compatible with its predecessors; it is bound to be a less efficient machine than an unconstrained design.

A considerable fraction of the brain must be concerned with self-programming and growth and replacement of the brain. All of these factors are bound to reduce the efficiency of an evolved system compared to a created intelligence, though we should never under-estimate the subtleties of organic processors.

Although we are only on the foothills of human intelligence, it is no contempt of the human brain to regard it as essentially an analysable machine. One day, an artificial intellect, silicon or not, will rival it for those aspects of 'intellect', such as creativity, which we now hold to be entirely human.

**Answer to problem 2—book-keeper or, if you allow sub-book-keeper, four pairs.*

Why there is great demand for Superboard II

SUPERBOARD II is described by its manufacturer as "the world's first complete personal computer system contained entirely on only one board". Ohio Scientific apparently designed it "specifically with low price and the first-time user in mind . . . it has more features and higher performance than some home or personal computers selling for up to $2,000".

I suppose it could be considered as a major achievement to get one's hands on the elusive Superboard II from Ohio Scientific. Certainly from advertisements it looks a most attractive item.

It has been suggested that it is one of the fastest-selling single-board computers in the U.K., at least as far as order books are concerned, but very few have been imported. Production delays have been compounded because Ohio is reportedly directing its efforts to produce enough Challenger IPs—the boxed-up version of the Superboard—to meet the heavy U.S. demand.

Our review model arrived in the office because one enterprising distributor with advance orders heard of some stocks in Switzerland and flew there to buy a couple of dozen. So is all the ballyhoo worthwhile?

Facilities

By comparison with other single-board computers, the Superboard shows its more recent design distinctly. Modern high-density memory components give it a high specification for such a relatively low advertised price.

The Superboard II is a single-board computer with a 53-key alphanumeric keyboard in the normal QWERTY layout. For output it has a composite video output—it needs a modulator for TV aerial input—displaying 24 lines of 16 to 24 characters (selectable).

The CPU is the 6502 running at 1MHz; there is a 2K monitor/bootstrap ROM, an 8K Basic in ROM, and 4KB of user RAM. That is expandable to 8K on the board; there is also a 1K RAM memory map dedicated to the video screen refreshing. The audio cassette interface is Kansas City standard.

Setting-up

The Superboard arrives fully-assembled on a full-size PCB. The makers claim it to have been tested. Connecting the power supply was easy, as the test sample already had leads and it needed only a single 5V supply. We were not the first people to get our hands on it and we found a dry joint on the ground lead.

Connection to a domestic TV was more of a problem. The Superboard display output is composite video, suitable for a monitor but not for a television set. To have it compatible for the aerial socket of a domestic TV, it needs the addition of a UHF modulator like those supplied for TV games.

Here is the awkward part—the modulator needed a supply greater than 6·5V—I used 7V—which obviously meant that the advantage of a single 5V supply disappeared.

by Vincent Tseng

The audio cassette connects by two standard 3·5mm minijack plugs for earplug playback and microphone input record.

In use

The first thing noticed was the stability of the modulated TV display—or rather the lack of it. It displayed reasonably well on a 22in. colour TV, though the display 'swam' a little and occasionally the frame juddered.

On our 12in. portable monochrome set the picture was very unstable; the image had very bad interlacing problems and it was very difficult to read the screen. We checked the modulator and it displayed a very stable picture on both TV sets with a video game—and when tried on a Nascom-1.

The likely cause of our poor picture is that the video output on the test kit was compatible for 60Hz U.S. standards and was not converted for U.K. 50Hz.

If you buy a Superboard, check this with the vendor—some we know will be supplying a 50Hz modification for use in this country.

There is a very large character set available (256 codes). This includes full alphanumerics in both upper- and lower-case, and many graphics characters. They are displayed in an 8 × 8 matrix; the upper-case alphabetics use a 4 × 7 matrix.

The 53-key keyboard has a roll-over function by virtue of a shift lock key to obtain lower-case characters from the keyboard. The keys have a good feel but the board probably needs to be inclined a little to facilitate fast typing. The space bar proved a trifle stiff, however, and needed a firm push for positive contact.

Specification

CPU: 6502 (Synertek) at 1MHz.

Memory: 10K ROM, 4K RAM (expandable on-board to 8K via i.c. sockets), 1K screen memory.

I/O interfaces: Composite video output to U.S. NTSC (60Hz) standards displaying 24 lines of 16 to 24 characters.
Kansas City standard audio cassette interface.
Full alphanumeric keyboard is standard.
QWERTY layout with shift lock rollover for lower-case characters.

Software: 8K interpretative Basic in ROM; 2K machine code monitor, bootstrap and utilities.

Character set: 256 characters including upper- and lower-case alphanumerics and numerous graphics and games symbols in 8 × 8-dot matrix.

Basic

The interpretative Basic of the Superboard has a good pedigree—it was developed by Microsoft. It is in 8K of ROM and it is a comprehensive one, certainly for programming facilities. It is a decimal Basic with a claimed range of 10^{-32} to 10^{32} but I think they must mean 2^{-22} to 2^{22} (or 6½ digits).

Ohio claims that this Basic is one of the fastest available on a microcomputer. Running the standard benchmarks published last year in the U.S. magazine *Kilobaud*, our timings certainly were fast.

The Basic functions and statements available are very useful, including very good string functions. Having good programming functions is not really enough for serious programming. There are no debugging and trace facilities, so the user has to be ingenious in testing—inserting STOP statements or using CONTROL C a great deal. Neither are there editing facilities, so long statements with single-character errors need the whole line to be re-entered.

The shift lock has to be engaged to obtain the upper-case characters which are the only ones recognised by the bootstrap, Basic, and monitor programs.

Machine monitor

The so-called 'machine code monitor' looks an attractive addition to Basic but it is some 255 bytes only and so is fairly minimal; it gives merely the capability to address a memory location display and alter it.

The monitor also allows a 'jump to start' command and load from cassette. There is no jump/save from cassette and no writing to tape. The display in machine monitor shows only one line of four address hex digits and two data hex digits. All in all, we found this fairly useless.

Cassette

The audio cassette worked first time with no fuss. Our cassette recorder was a cheap £19 job (with counter) and it had automatic record level control. The volume control range for acceptable data both on sample program cassette and ones recorded in the test was enormous—from just above minimum volume up to maximum. This interface probably will have few problems working with any cheap recorders.

The counter on the cassette recorder is an essential item, as there is no file management; the computer will load the first program or even the first valid statement it meets.

Now the bad news. Remember the screen width can be specified—any number of characters above 16 to a maximum of 24. Well, if any number below 24 characters across the screen was selected and a program was dumped on to cassette, playing it back produced syntax errors on any statements longer than one line, regardless of the screen width selected for the playback.

Graphics

The characters have to be written to the screen refresh memory direct. So the user has to do this via the machine code monitor or the POKE statement in Basic. POKE uses decimal, the monitor uses hex. The graphics characters look very useful and include several games symbols, such as houses, aeroplanes, cars and arrows.

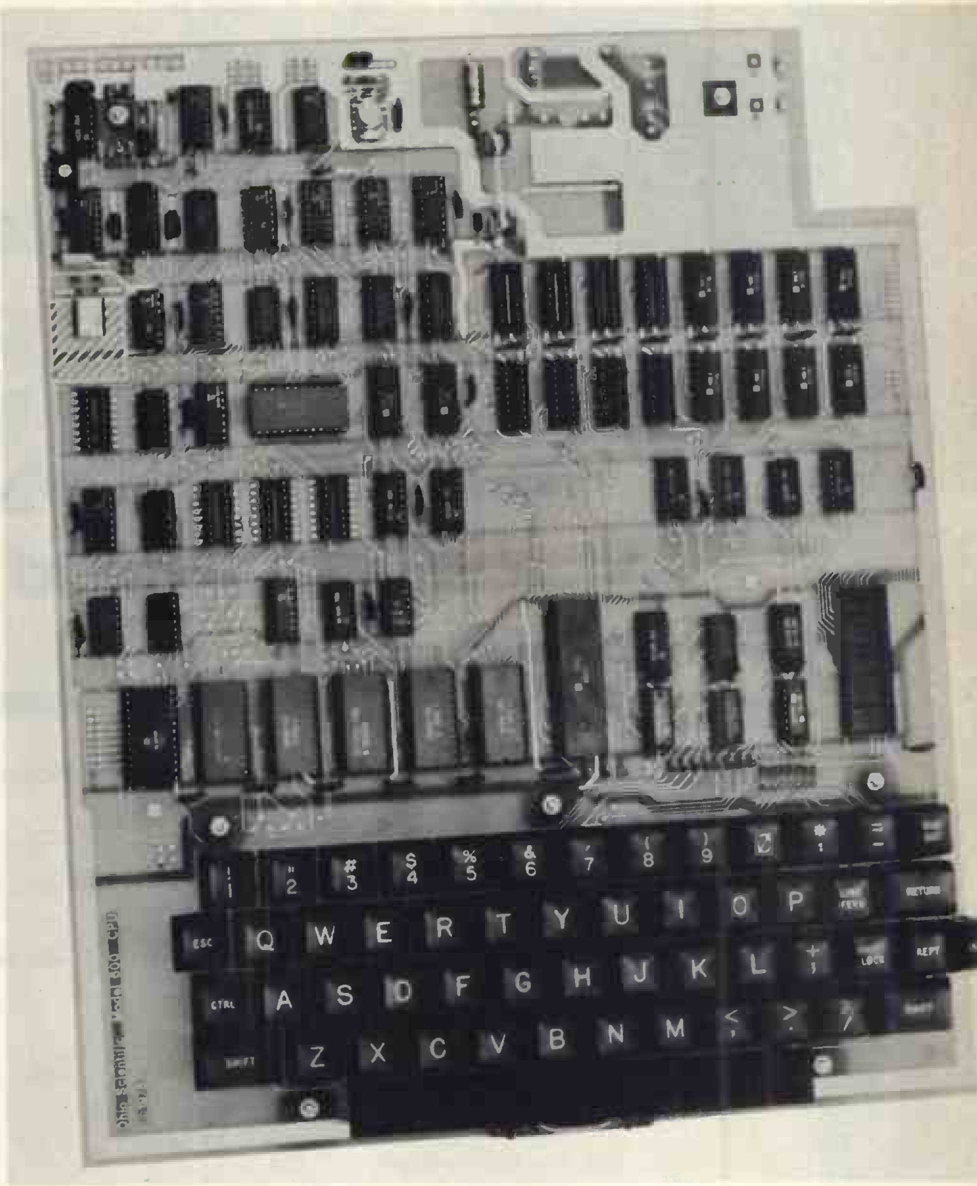
Documentation

Our Superboard had four booklets—*User's Reference Manual*, *Basic*, *Graphics* and a *Technical Discussion*. We also had two sheets of paper giving minimal instructions on how to use the sample program tape.

The *User's Manual* was adequate but not particularly well laid-out. For example, we would have expected a note of the fact that the keyboard needs to have shift lock depressed in the section on program start-up procedures.

There is scarcely any reference to hardware—not even a summary specification; there are a few paragraphs of introduction and a bus specification. Circuit diagrams are split into 13 parts with little or no labelling. On the plus side, the *Manual* gives some sensible programming examples in both Basic and machine code.

The *Basic* manual is distinctly minimal with inadequate explanation of some functions and statements. On the other hand, the *Graphics* reference manual looks good with several Basic program examples for useful graphics. *Technical Discussion* is no more than an advertising booklet but it gives some insight into the concept behind the design.



Memory notes

The RAMs used are Z114s and sockets are already provided on the 4K versions to insert to a total of 8K. Our reviewer put on another 3K. Power consumption is quoted at 3 amps but with 7K of RAM and dumping to cassette—screen is used here—the monitored power consumption was 1·8 amps.

The ROMs used are compatible with 2716 single 5V UV EPROMs. So there is a very powerful potential to replace them with up to 10K of your own EPROMs holding self-developed functions—if you can get at a PROM burner.

One really pleasant feature of the Superboard packaging was the inclusion of a C30 cassette of six sample Basic programs. Programs 1 to 5 worked well with only 7K of user RAM; the sixth loaded but did not have free space to run.

Our thanks to Lotus Sound for the loan of the review system.

Conclusions

- **For less than £300 the Superboard represents good value with plenty of potential. The 6502 chip is a good thing, of course. In this incarnation it is on a ready-to-go board containing a good deal of memory in both ROM and RAM.**
- **The correct interfaces are provided and they are genuinely useful but the video output was for U.S. 60Hz standards, and the cassette interfaces can dump without syntax errors only when used in conjunction with a screen width of 24 characters.**
- **The user can be up and running in Basic very quickly and the Basic is rich in facilities. They do not include any debugging, program testing or easy-to-use editing functions, though. The machine code monitor is almost useless; you might as well use PEEK and POKE statements.**

Keen Computers, Spread Their Wings

Hardware

Keen Computers are the Midlands distributors of the Apple II and Attache microcomputers.

The attaché : the new 8080 based business system from America. The system is sold complete with monitor, printer dual 8" floppy disk drives and has a full range of commercial software available.

The **AppleII** : The best all purpose micro available with sophisticated graphics, voice recognition, it has applications in business and education.

Attache system	£6250
Apple II 16K	£950
16K Additional Memory	£100
Disk drive with Controller	£425
Disk drive without Controller	£375
Applesoft Rom Card	£110
RS232 Communication Card	£110
R232H Hi Speed Card	£110
Speech Lab	£165
Apple Clock	£165
AC Line Controller and Slave	£400
Anadex DP 8000	£850
Centronics 779	£850
Lier Siegler 200	£1850
Diablo 1610	£1950

Memory upgrade kits also available for ITT 2020 and Tandy.

Keen Computers Ltd,
5 The Poultry, (off Market Sq)
Nottingham
Tele: Nottm 583254/5/6

● Circle No. 157

Compucolor II makes strong appeal

THE COMPUCOLOR II is described as "the Renaissance Machine" on the company literature. We could not figure what Compucolor Corp means by that but perhaps it refers to the polymathic capabilities of this machine.

The Compucolor II looks like a TV set with a separate cable-connected keyboard, a very neat piece of packaging. The keyboard was not the most basic QWERTY-style layout Compucolor can supply, nor was it the bells-and-whistles de luxe option with 16 extra function keys.

The so-called 'extended' keyboard is probably the one Abacus will be supplying as standard. As well as the usual alphanumerics we had a numeric keypad, some edit functions, and a block of colour controls.

The screen displays eight colours and that is its most immediately obvious attribute, once you are accustomed to the use of colour on special keys. To the right of the screen is a mini-floppy drive.

by Martin Collins

The system we had for review had 8K bytes of RAM; there is also a 16K version. Both can be extended by 16K, giving a maximum of 24 or 32K bytes.

The main case houses the CRT, disc drive, and electronics. As standard it has an RS32 interface and a 50-pin bus connector. The back of the cabinet is commendably clear, even if Compucolor did not miss the opportunity to add a little advertising material about the quality of the casing—imitation woodgrain, but you don't have to look at it.

The microprocessor is an Intel 8080A; the mini-diskette drives are from Wangco.

Up and running

We unpacked the system and had it up and working very quickly and without problems. A well-produced 16-page instruction manual is supplied. It proved to be an excellent reference manual, covering the needs of the absolute novice—'What is a program?'—as well as the more experienced.

We loaded the demonstration disc, pressed the AUTO key and watched a menu of the programs on the disc appear quickly on the screen. This is a very neat feature; pressing AUTO causes the system to load and run a program called MENUBAS from the disc. The manuals inform you how to write menu programs and they make the system very easy to operate.

The demo disc provided a very impressive performance for those of us used to monochrome. The display was stable when we were using it at home, but it had a considerable wobble at *Practical Computing*. This we assume is because there is a variety of electrical equipment running from the same circuit at the office —electric typewriters, a Pet, a TRS-80, copier, and so on.

Display

Compucolor has 128 displayable characters—numerics, upper-case alphabetics but no lower-case, the usual typewriter key-top symbols, and 69 graphics symbols.

It is difficult to do justice to the colour capabilities of the system in a short article. The colours are black, blue, red, magenta, green, cyan, yellow and white.

They can be chosen from a program by using the PLOT statement. Alternatively, you can use the keyboard. The 'standard' and 'extended' keyboards provide the same functions but the extended version is easier to use.

As well as its separate numeric pad and edit controls, it has keys to select the colours. On the standard keyboard they are selected by using the CONTROL and an alphabetic key—for example CONTROL S for yellow.

The de luxe keyboard, incidentally, includes a set of function keys for the

(*continued on next page*)

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different graphics mode, as well as all the keys on the extended keyboard. The idea of 'single keystroke entry' is provided on the de luxe and extended keyboards to allow a COMMAND mode—with that key held down, hitting other keys will produce a complete Basic command on the screen. In square brackets are the often-used commands which can be accessed.

The characters can be displayed large or small, again selected by key or the PLOT statement.

Basic and filing

The Basic is in ROM. It is a good extended Basic, including string handling, interfaces to machine language, and support for data files.

Numeric data is restricted to six significant digits. It is held as 32-bit floating point and this could cause problems for some business applications.

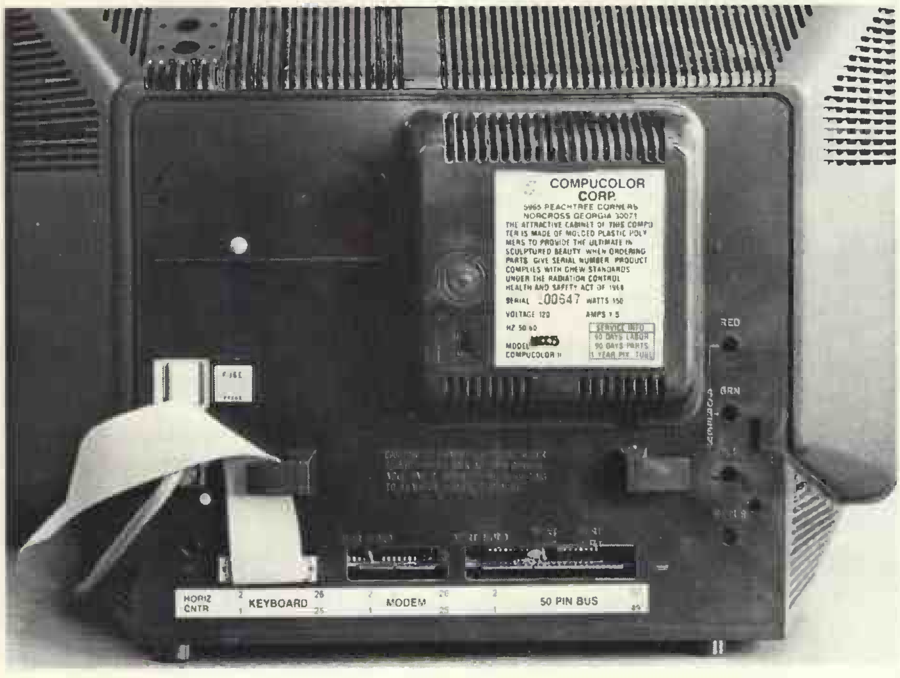
The LIST command does not allow single lines or a specified group of lines to be listed; this seems to be a common fault in many of the micro Basics.

One neat feature is the way in which corrections can be made while entering programs. The ← key deletes the next character to the left and as usual allows the cursor to be positioned to correct an error. The → key can be struck after the error has been corrected and this will restore the characters removed by the ←.

The file handling on the system is unusual and I think considerably more powerful than that supplied on most small micro systems. Three file types are supported:

- **Array**—these contain a numeric array as defined in a program, so an array can be saved to or loaded from a disc file.
- **Data**—contain data dumped from a specified location in memory.
- **Random**—these are random access record files. As the user can specify the block size and number of buffers to be used, and as the system uses the buffers to reduce the number of disc transfers, this is a very efficient file access system.

The filing system is entered by pressing ESCAPE, D. The prompt FCS> is displayed and a set of commands can then be used to list the contents of a disc, copy files, and so on.



Colour graphics

The display is controlled from a Basic program using the PLOT statement. This allows the following functions to be performed from a program:

- colour selection—foreground/background.
- character size selection.
- blink on and off.
- create and reference special characters.
- cursor visible or invisible.
- vector graphics (resolution 128 × 128).
- bar graphs.

We did not have time to try all of them but the demonstration programs provided a good idea of what can be achieved. The resolution is, in fact, rather better than 128 × 128; this is the number of plot blocks which can be addressed and each is made up of eight dots (four high and two wide). They can be assembled into special characters.

Documentation

The documentation supplied with the system consisted of the instruction manual, a good but very brief description of the system with some notes on available software and possible problems.

The instruction manual included a list of recommended books on Basic, one of which was the *Compucolor Basic Manual*. It costs an additional £19 and is very professional, well worth the investment. The only part we found less than ideal was the discussion on graphics; you probably need to experiment on the system as you read this section.

There is also a *Maintenance Manual* costing £37·50, which we have not seen. Abacus does not offer a maintenance contract on the system, although it will deal with hardware problems on a 'time and materials' basis.

In addition, U.S. buyers—and U.K. users, too, we hope—receive a very fine newsletter called *Colorcue*.

Personal note

As with most systems for review, we had the Compucolor II only for a few

Prices

The system can be extended to 32K bytes of memory and a second disc drive can be added. The costs are:

Compucolor II	8K RAM	£1,390
	16K RAM	£1,485
	32K RAM	£1,750
extended keyboard		£120 extra
deluxe keyboard		£175 extra
second disc drive		£350
Programming Manual		£19
Maintenance Manual		£37·50

Other software available includes a number of games programs (Star Trek in colour is good), an editor and assembler, and a 'personal database system'. They cost £16 per diskette.

days. Our reviewer collected it from Abacus on a Thursday evening and returned it to *Practical Computing* on the following Tuesday.

That is usually long enough to assess the hardware and software. Most systems, after all, offer the same facilities—display, cassette interface, simple filing systems, programming in Basic. Assessing them is straightforward.

If I have a system at home for a weekend, my children (aged 8 and 5) try any games. They are becoming blasé about having computers around and usually lose interest once they have tried any demonstration games.

The Compucolor II proved to be very different. It was the first computer I had used which offered interactive colour graphics, and they frankly are stunning. As it is complete with colour display, minifloppy disc drive, Basic and filing system in ROM, it offers considerably more than most micro systems.

I did not have time to try all its capabilities, so this is more of an overview. In any case, it must be the kind of system whose full capabilities emerge only over a period of active use.

My time on the system was further restricted by my children. They were so enthusiastic about the Compucolor that they almost forgot to watch Worzel Gummidge on Sunday afternoon as they were trying to break the bank on the one-arm bandit—praise indeed.

Our thanks to Abacus Computers, main importers of the Compucolor II, who loaned us one of the earliest models to arrive in this country.

Conclusions

- **The Compucolor II is one of the best small systems we have reviewed.**
- **The colour and graphics capabilities are excellent. The display could be affected, however, by poor mains or other equipment.**
- **The expansion capability is rather restricted, as only minifloppies are available and the system can support only two of them. Further, the disc capacity is 51·2K bytes, considerably less than the 80K to 160K available on other minifloppy systems.**
- **Documentation is good.**
- **All systems have an RS-232 port and this simplifies attaching printers or using them as terminals.**
- **It is not expensive. The crunch will come when you compare it to the obvious competitor, the Apple II. Apple can start cheaper, as a cassette system, but for an equivalent floppy disc set-up we reckon Compucolor receives the vote on price.**
- **Its packaging is also simplified; you get a monitor with integral floppy disc, and though it is a matter of taste, there is much to be said for putting the electronics into the CRT case.**
- **Apple has a head start, though. It is more expandable, has more dealers, and is supported by much more off-the-shelf software.**
- **We would like a Compucolor. It is an upmarket home computer or very small business system but it has no pretensions to being anything else.**

Practical Computing evaluation

	Yes/No NA	1	2	3	4	5
Ease of construction (where applicable)	NA					
Quality of documentation					●	
Dealer support/maintenance					●	
Can handle 32K of memory	Y					
Quality of video monitor (consider resolution and screen size)						●
SS-50 Bus	N					
S-100 Bus	Y					
Sockets for chips	N					
Numeric, calculator-type pad on keyboard	Y					
Large amount of removable memory, randomly accessible	Y					
Cassette tape recorder capability: Own	N					
Built-in recorder	N					
Floppy disc capability	Y					
Communications capability (can talk to other computers)	N					
Speed of instruction cycle	4MHz					
Ease of expansion				●		
Low power consumption					●	

	Yes/No N/A	1	2	3	4	5
Assembly language	Y					
Basic language					●	
Other languages	N					
Compatibility with other systems		●				
Reputation of manufacturer					●	
Appearance						●
Portability				●		
No. of software applications packages available		●				
Hobby use						●
Business use					●	
Educational use						●
Suitability for: Commercial applications					●	
Home applications						●
Educational applications						●
Ability to add printer(s)	Y					
Ability to add discs			●			
Ability to add other manufacturers' plug-in memory		●				

Ratings
1 = poor; 2 = fair; 3 = average; 4 = good; 5 = excellent.
N/A = not applicable.

WORD PROCESSING has become one of the emotive phrases of the microprocessor business. Everybody writes things which need correction and it is very attractive to think of a machine automating the business of altering what you've written without you having to re-write it.

Such a function is also a very good use for a small computer. The amount of effort required from the processor is not great, so a microcomputer can handle it, and the programming involved for the editing functions is an absolutely classic set of test-and-branch instructions.

You will probably buy your microcomputer for other reasons, but we look at what word processing can offer and will follow this with details of off-the-shelf software which is obtainable.

Some people seem to think it covers everything

WHAT is word processing? It makes sense to start with some fundamentals. It is usually described, somewhat ponderously, as "the automatic manipulation of natural-language text" or "the sum of activities involved in the production and handing of text communications". Some people use the term to cover everything from office dictation machines to photo-setting equipment.

We don't. We use the term 'word processing' to cover computer-aided editing and printing of stored text. This is how it usually works:

- You have a computer with somewhere to store the text—like a cassette or floppy disc. You also have some means of inputting it in the first instance—a keyboard; some ways of getting it out again—a printer, perhaps, or a screen; and some method of producing the final version—a printer.
- You can type-in words at top speed without stopping to check for errors. There is no need to gauge the end of a line for the carriage return because the system moves on automatically to the next line; the same applies to page ends, which are also automatic.
- Proof-reading and corrections are done later. Before anything goes on paper, you can call-up the document from memory on to your screen or printer and check it; change spelling mistakes, add or delete words, and move sentences or paragraphs or other blocks of text around within the document; all of that can be done with just a few key-strokes.
- The document is stored on cassette or diskette, and can be called-up subsequently to make further changes. Or you might want to produce a nearly-similar document; so call-up the original, make a copy of it inside the system, and alter the copy so that you have two different originals.
- Some word processors allow you to browse through several documents on your cassette or disc, selecting and copying a paragraph from one, a sentence or two from another. They can be assembled to create an entirely new document.
- Apart from editing and amendment of text, there is a second basic operation in word processing—the print formatting. It defines what the printed version will look like on the paper—how long are the lines, what is the spacing between lines, whether some text perhaps could be indented or highlighted by use of bold print, and so on.
- Some word processors have two separate programs, one for the editing and one for outputting, which have to be run independently. You create a text file and edit it with one and set-up the print layout on the other and run it against the same text file.
- Most word processors can number the pages automatically for you and repeat a heading on each new page if required.
- You will have to set up the output format before printing the final draft version of your draft, but once the format is ready, you can print identical copies any number of times, or you could alter the format to see how it would look printed in a different layout.

Improvements

Word processing can be said to have started with the invention of the typewriter more than 100 years ago. Over the years, a number of improvements have been made to the operation of typewriters but they still retain some of their important original characteristics, notably the QWERTY keyboard layout.

That is effectively the standard arrangement of keys on all U.K. and American keyboards; in Europe an AZERTY layout is preferred but both arrangements derive from Dr Christopher Scholes.

He was an American and a typewriter pioneer who patented the first such practical machine in 1886. He opted for the QWERTY layout specifically to slow down the typist to prevent the locking of the type-hammers.

It may seem ridiculous to persist with this layout when the general concern is to speed the typing process and many keyboards are no longer connected to type-hammers.

The investment in typists trained to use QWERTY, however, precludes a change to a more effective layout. The typewriter and keyboard manufacturers will not change until there is a demand from users and there will be no demand from users because they cannot conceive a better layout.

There are more effective keyboard layouts. If you are interested in pursuing this, try looking for the magic names Malt and Dvorak. Lilian Malt's Maltron keyboard layouts are used fairly widely by type-setters, the people who convert typescript to the printed type you are reading now.

Dvorak, though, languishes in obscurity. An inveterate designer and enthusiast, he chose the less-than-receptive United States of the '20s and '30s to demonstrate that a barely-trained child could type faster with a Dvorak layout than a professional typist using the Scholes QWERTY.

Musical start

The first automatic typewriters were produced by a Chicago-based firm called Schultz, which made punched parchment rolls to drive pianolas. Driving a typewriter by the same method presented far fewer problems, because of the very much smaller number of keying possibilities; so the Automatic Typewriter Co was set-up in the early 1930s. Those automatic typewriters were capable only of duplicating text.

During the second world war, the U.S. Army decided it needed a machine to produce personalised letters automatically. The recipients were to be the next-of-kin of war casualties. Personalisation implied the ability to insert into or omit sections from a previously-prepared text, which was a new technical departure.

The standard text was prepared on paper tape. The contract was won by a company called International Business Machines Corporation.

After the war, IBM vested the manufacturing and marketing rights of the product in a company which subsequently

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became Friden. Friden enhanced the product with the facility to produce paper tape for subsequent input to a computer and also added arithmetic capabilities; that machine was used widely and today is known as the Flexowriter.

More type styles

A further advance was the introduction by IBM in 1961 of the Selectric golf-ball typewriter; the change to a single print-element—the golf-ball—the ability to have several type styles available on one machine, the quality of print achieved and the relative robustness of the sophisticated printing operation were all significant.

Then, in 1964, IBM announced the Magnetic Tape Selectric Typewriter Mark I, the first automatic typewriter to include a magnetic memory. The MTST was soon enhanced to include a second memory, so considerable flexibility could be achieved by reading a previously-prepared text from one memory, editing from a keyboard and producing a final text on the second memory.

Around that time IBM also produced Ulrich Steinhilper, a man who worked for IBM Germany and who is credited with coining the term *textverbeitung*—text processing. From there to word processing is but a short step.

Limitations

IBM subsequently added some extra items to the MTST in terms of the editing functions available from the keyboard and a new form of storage—magnetic cards, with information encoded on them just as it might be on magnetic tape. The success of that line of equipment inevitably attracted competitive suppliers.

The automatic typewriter, though, has several inherent limitations. In particular, you cannot see the final text as it is produced and therefore you cannot be sure amendmends are being made correctly.

That problem increases with the complexity of the editing. When the final text is printed-out, some time will have elapsed since those amendments were made, and it may not be easy to recall the precise actions which resulted in mistakes.

The effect is a rather long learning curve; it can take anything up to a year to train a typist fully on this kind of word processor.

That limitation has been overcome by the introduction of a visual display unit. The effect of the keying operations is apparent immediately from what is shown on the display. Although word processing systems incorporating a display unit are more expensive than the automatic typewriter system, the fact that they are economically viable at all is due to the rapidly-falling costs of technology developed primarily for computer systems.

Obvious factors

There are dozens of purpose-built word processors available today. Last year our sister publication WHICH COMPUTER? ran a survey of all word processing systems it could find; there were 99 of them.

A few were basically standard data processing computers with word processing software of some kind available, computers which would be bought principally to do the accounts or for some other standard computer application; word processing is a bonus extra available on these systems.

The bulk of the 99 were dedicated word processors, though designed from the start to do nothing but process words.

So what exactly goes into a purpose-built word processor? Any WP system needs a text entry method, storage, a means of output, and an internal microprocessor or minicomputer for control. Put like that, a word processing system sounds like any general-purpose microcomputer.

To a point, it is, but in addition it will probably be engineered specially for its purpose. Let us look at some of the more obvious factors:

- **Keyboard:** Apart from the usual alphanumeric character set, the WP keyboard will have a number of special control keys allowing specific editing functions to be carried-out with a single keystroke. In addition, it will probably have a separate numeric keypad to speed data entry of numbers.
- **Screen:** Of the list of 99 to which we refer, 69 word processors had a decent-sized screen and most of the others had a limited display capability. Some WP screens have the long edge vertical rather than horizontal, so that the display resembles an A4 page. Many have on-screen status information missing from a simple general-purpose computer, and most have an impressive array of display and format functions

Questions to ask

We did not think it worth analysing in detail all the WP packages available for personal computers. Requirements vary greatly. Some will not require an elaborate word processor; some will not have much choice for a particular computer. These are some of the points you might bear in mind if comparing one word processor to another:

Text entry

Are numerals available in both upper- and lower-case? If you are keying-in capital letters, it can be irritating and a source of error to have to disengage shift lock for numerals.

Do you have control and function keys for editing? Some of the better thought-out WP packages use single keys to activate specific functions and even provide sticky labels to put on the key-tops.

Screen

What is the maximum number of text characters on the screen? A display theoretically may show 24 lines of 80 characters but the word processor may be limited to 16 lines of 64 and that may mean it cannot print-out longer lines—which might be needed, for instance, in tabular work.

Are true risers and descenders displayed? Text can be uncomfortably illegible if not.

What on-screen status information is there? Are format commands displayed so that you know what format you are using? Is there any record of tab and margin settings visible?

Can the cursor be moved to all possible character positions on the screen? Can you 'home' the cursor in a single operation to the top of the current page? To the start of the previous or the next page? To the beginning or the end of the document?

Text storage

What is the maximum text storage capacity? Is it on cassette or disc?

If it is floppy disc, must a 'system' disc be permanently resident?

What is the transfer speed between memory and storage? What is the average access time to find and display a stored page?

What are the minimum and maximum file sizes? How many documents can be stored on one cassette or disc?

Does it set-up a directory of document names? Does it prevent you from duplicating names for documents accidentally?

Searching

What are the rules for searching a document for specified words, or phrases? How particular can you be? Will the system find underlined versions of the search string? Can it search for numerics?

Does it have a 'global search and replace' capability? That locates every occurrence and replaces it with a specified patch of text. How long can the replacement be?

Editing

What is the maximum number of characters per line? Per page? Per document?

Are pages numbered automatically? Is renumbering automatic after changes?

Is right-hand justification available? Is centring provided? How are indentations handled? Is word wrap-around provided, so that a word which would over-run the right-hand margin is put whole on to the next line automatically?

Can a document be formed by merging, in whole or part, two separate documents on the storage media? If so, are the original documents retained in store? Can this facility be used to generate letters from standard paragraphs automatically? Can files be used for automatic processing and selection—selections from name and address lists for standard letters, for example?

Can text be re-formatted automatically by changing length? By changing line length?

Are "widow lines" detected automatically?

like emboldening, flashing, half-intensity and reverse video.

- **Software:** The crucial difference, of course, is in the software which drives the machine. WP systems are optimised for WP, which means that their basic operating systems do not allow for all the other functions and facilities for which a general-purpose operating system has to cater.

The cheapest word processors in the survey cost slightly less than £3,000, and that buys a fairly limited system—no discs and no screen. For floppy discs and a decent display you will be paying more than £7,000.

All of the systems we shall look at cost less than £5,000. They are popular micro-computers for which you can buy word processing software, and that special software will add only a few pounds to the cost of a system which can look very desirable for totally different uses.

Points to watch

If you want to add word processing to the capabilities of your computer, you will have to bear in mind a number of things the supplier might have omitted to mention.

Because it is possible to load a cassette or disc, marked impressively Word Processor System Version XO14.99, does not necessarily mean it will operate easily and/or effectively for you. If it proves to be quicker, and perhaps cheaper, to write your novel by hand there is no good reason why you should stick blindly with the technological solution.

- **Screen:** Do you have one? if not, forget it. If you have, is it clear enough to fill with text? Indistinct letters, waving screens, no lower-case characters, a lack of true below-the-line descenders if you have lower-case—all can be irritating.

- **Keyboard:** You will be doing plenty of keying. You might be prepared to tolerate a less than ideal keyboard if you are inputting lines of Basic, but how does it feel for masses of text? Is the SHIFT key easy to reach? You will be using it a great deal. How about a numeric pad? That is very handy, especially if you are a business user.

- **Memory:** Word processing software tends to be large; in an eight-bit micro-computer the minimum amount of memory required to run an effective word processing system is about 16K. For a really complete system, however, twice that amount is needed. Many of the available word processing programs are written in Basic and the Basic plus the word processing program must be in memory at the same time.

The text is typed last. The memory must be large enough to support the several levels required to use all the programs. A text program which runs in machine language is much more efficient and needs less memory; at least one personal computer has gone further and offers a text editor in read-only memory. Make sure your system has enough memory to do all you want it to do.

- **Storage:** Most word processing requirements are sequential in their nature; you input one line, then the next; you edit one line, then the next; you store documents one after the other. So cassette tape, a sequential storage medium, can often be used. Beware the speed factor; passing information from memory to cassette and vice versa can be very slow. The speed is determined by the particular cassette interface on your system, but typical data rates are 300, 600 and 1,200 baud. Divide by 10 and you will have an approximate idea of the number of characters per second which can be transferred.

At 300 baud a well-filled page of 25 lines each holding about 64 characters can be stored in about three minutes; at 1,200 baud it will take 50 seconds. The faster the baud rate, the more information your cassette can store since the tape is always moving at the same rate. A C30 cassette can take about 10 of those pages at 300 baud, around 36 at 1,200 baud. It makes a big difference. Be warned, though—the higher data rates are more prone to error.

- **Disc:** Floppy discs are the really attractive alternative and if you can afford them your word processor should have them. Discs lend themselves to clever ways of reaching stored information and some word processing software packages make use of that; more important, though, their data transfer rates are much faster than cassette.

At the very least you can expect 960 cps Since the smallest single-sided, single-density mini-floppy stores about 55,000 characters, you can put more than 30 pages of those 1,600-character pages on to one diskette.

Mini-floppies more usually store 70,000 characters; a full-size diskette holds between 230,000 and 310,000, depending on make. The more expensive double-sided diskette systems obviously double those figures; so does double-density storage.

A full-size, double-density, double-sided floppy can hold more than one million characters, something like 620 pages.

- **Printers:** It is all very well editing and amending your documents but until floppies and cassettes can be used as a substitute for paper you will need to print-out your edited version at some time. The best kind of printer is probably a daisy-wheel unit, which gives good typewriter-quality output at a respectable 40 characters per second, or 50—and you will pay about £2,500 for the privilege.

You can pay less for faster output—down to around £1,100 for about 100 cps but there you are looking at a dot matrix printer which builds up a character by a dot pattern. They are legible but they are nowhere near as neat as a typewriter-style impact printer—you might not get below-the-line descenders and £1,000 is still a sizeable sum.

The cheapest printers, the little electro-sensitive or thermal units at £500 or less, don't print on particularly wide or particularly lovely paper.

The other alternative is to buy a converted IBM golf-ball typewriter—to do the conversion yourself see *Practical Computing* for January, February and March 1979. That would give the best quality print but the units are not designed to be hammered, so don't try to print-out that novel all at once.

WP packages

Three packages dominate the personal computer scene as far as word processing is concerned—the Electric Pencil, Word-Master and the CMC Word Processor—the latter because it is widely regarded as the fullest WP package yet to be made available for the Pet, the other two because they are offered on a wide variety of computers.

We also found a number of word processors which have received less exposure, ranging from the letter writer produced for the Nascom-1 by ICL Dataskil to the impressive specification of the Processor Technology systems.

To produce the list we shall be publishing we telephoned as many potential suppliers as we could find, more than 100 companies. Many offer the same WP packages, of course.

Those without a package include ITT, which says a word processor for the Apple-based ITT 2020 is "imminent". Monocland, the U.K. distributor for the Pertec Attache, apparently has commissioned a U.K. author to write a word processor for it.

Commodore says a number of British Pet owners have submitted word processor programs to its users' library but so far none looked good enough. Research Machines is about to announce one.

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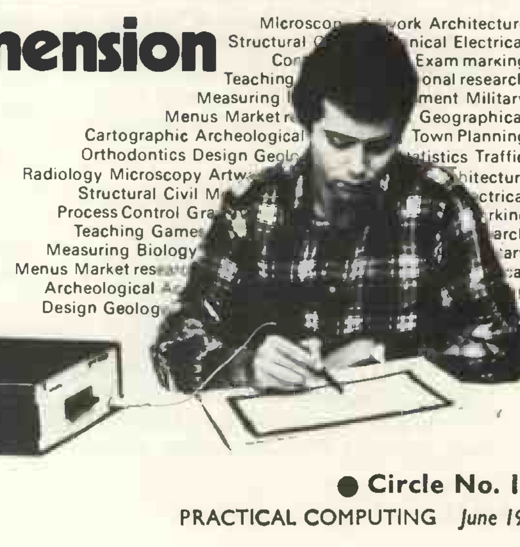

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● **Circle No. 162**

Taking the Pet route to Utopia for dispensing

by Richard Pawson

IF, like me, you have ever had difficulty in reading the hand-written directions on a prescription dispensed by a chemist, you will be pleased to learn that there is a solution to the problem.

Venture into a small pharmacy in Hertfordshire and you may have a pleasant surprise. Affixed to the prescribed bottle of cough mixture, or whatever, will be a neatly-printed label containing all the requisite information, including your name, the drug dosage, directions, and even the date and time of dispensing.

Enquire further and you will be told that the whole rubric was produced on a computer and in half the time it could have been hand-written.

With around 10,000 High Street pharmacies in this country, dealing with a monthly average of 2,700 prescriptions each, dispensing is big business. Add to this the enormous problems of buying and controlling upwards of 2,000 stock lines on a tight budget and retail pharmacy becomes a widespread application which entreats computerisation.

Captive market

Although it is generally acknowledged that Britain has one of the finest and most advanced pharmaceutical services in the world, the associated authorities have been slow to design or recommend a suitable system. They are not unaware that attenuating the terrific burden of administration placed on the average pharmacist's shoulders would leave him with more time for his trained function, helping the general public by matching drugs to their ailments.

Thus, for some years, there has been a captive market, waiting for someone to combine a working experience of the dispensary problems with a good knowledge of computer capabilities.

Enter Idris Hughes. Owner of two pharmacies, with four close relatives in the same business, Hughes is known as being something of an entrepreneur. Previous enterprises include the successful establishment of a local drug-buying co-operative.

Little more than a year ago he decided to teach himself the fundamentals of computing. Having only a limited technical background, he had to learn Basic from scratch with the aid of books and tutorial tapes. To gain programming experience he purchased a Pet, self-containment and low-cost being the chief deciding factors.

It was not long before Hughes realised the possibility of using the Pet in his dispensary.

A small number of independent pharmacists employ full-time typists to produce the labels. While that is undoubtedly fast, and results in a high standard of presentation, labour costs are prohibitive to all but the larger operations. There is also an ergonomic factor—in many dispensaries space is at a premium and any personnel not involved directly in making-up a prescription are hard to justify.

His pharmacy being no exception, Hughes concluded that this solution was not feasible. Instead, he obtained a small printer and set about developing a program to print labels from abbreviated information typed-in on the Pet keyboard.

Feedback from his customers was promising. Most preferred the new, large-format labels to the previous hand-written ones, though Hughes recalls that a handful of his clientele, not being versed in such esoteric concepts as ASCII characters, mistook the zero (printed θ) in the pharmacy telephone number for an eight. Though there was never any danger from this—all quantities specified in the directions are written in words—ironically a routine had to be altered to replace the zero with a letter 'O'.

It occurred to Hughes that disappearing out of the door with every customer was a labelful of valuable information, generated on his own computer. Why not, then, write a routine to capture this data—specifically the drug name, quantity and date—and store it on cassette tape by means of the inbuilt Pet cassette deck?

More professional

This could be retrieved at any time, processed to identify trends in prescriptions and, more advantageous, to form the basis of a stock control and re-order scheme. Such a data capture routine was implemented successfully, within a relatively short time.

With a system which was growing rapidly into a powerful and adaptable package, it was possible that other pharmacists would be interested. Even at that stage Hughes was receiving telephone calls and visits from colleagues who had heard of his ideas. Could the package be marketed on a commercial basis? More commitment was necessary.

The first move was to contact the manufacturers of the equipment in use—Commodore for the Pet and Computer Workshop for the PR-40 microprinter used to print the labels.

After outlining his proposals, Hughes negotiated dealer purchase arrangements so that he could provide himself with several systems for development and evaluation work. Having done all the programming himself, the point had then been reached where the software needed to be made foolproof and more efficient in terms of speed and size.

Outside programmers were consulted

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from time to time and gradually the program began to look more professional, both in its listing, and more important, in its operation.

Meanwhile, Hughes had been indulging in some market research. A questionnaire mailed to several friends in retail pharmacy was returning some interesting answers.

It became apparent that what was needed was not one system, but several, with a range of options to suit different businesses—both their requirements and their budgets.

Working within those constraints, a ladder of systems was envisaged, starting with the original idea of label generation for prescriptions. Optional additions to this would include simple data recovery to give a monthly list of all the items dispensed.

General approval

More advanced systems would offer full stock control with re-order reminders and analysis of prescription trends. A number of ancillary functions would also be possible, such as a small payroll program and ledger accounting.

A few careful calculations, based on the amount of information which had to be available instantly to the pharmacist, indicated that the more advanced options necessitate a floppy disc to be incorporated into the system. Hughes prefers to wait for the Commodore 2040 disc to arrive rather than use a compatible disc from another manufacturer.

For that and other reasons, a fixed-price structure has not yet been announced. Hughes estimates, though, that prices will vary from around £1,000 to £3,000 for a system "fully installed and working", depending on the chosen configuration.

That seems to have met with general approval among those pharmacists who are interested. Bespoke programming will be available for people wanting custom-made or adapted systems.

So what next? Obviously the system must be stringently and exhaustively tried and tested, as must every innovation in the pharmaceutical world, but since Hughes has produced nearly 5,000 labels on his first set of equipment, it appears he is rapidly approaching the point where it can be marketed viably.

Time limitation

The main limitation is time. Since Hughes has financed the enterprise himself, all development work on the system has been in addition to his full-time job as a pharmacist, one which cannot by law be delegated to an unqualified employee.

If he is to be able to devote the necessary time and effort into finalising the software, setting-up a marketing operation in his company and providing the required back-up services, he will need more staff, both to replace his existing functions and assist in the new ones.

All that requires capital and Hughes has been probing the relevant channels to find an outsider willing to invest the amount required. Fortunately, he is in a better position than many entrepreneurs, having already demonstrated the feasibility of his design and the size of the possible market.

Turning to the details of system, it has changed considerably over the last few months. The Pet, though chosen originally for personal use, fulfills the role of the central processor in the system ideally. The calculator-type keyboard—sometimes regarded as a shortcoming on the 8K machines—has proved to be adequate and robust enough for the somewhat hazardous environment.

The only fault concerns wearing of the keytops, a problem which Commodore apparently has now cured. While 8K of internal memory is sufficient for the labelling and data recovery program, the more complex options which incorporate twin floppy discs will be based on a 32K Pet.

The internal cassette deck is used for storage of the prescription data and while the transfer rate is somewhat slow, the amount of information recorded after each label—the drug name and quantity—is only a few bytes long, hence the delay amounts to no more than two seconds.

On the disc-based systems, this form of sequential transaction record will be abandoned. Instead, the information entered via the keyboard to produce labels will be used to adjust directly the quantity in stock of the particular drug.

Each product will have a field of 130 bytes on the disc and this will contain the description and strength of the drug, a price code, supplier code, re-order level, re-order quantity and the volume dispensed in each of the preceding 12 months.

Easy to install

This arrangement has been modelled very closely on a number of existing stock record card systems—another field in which Hughes has been particularly active—to make the computer system easy to install. Thus the pharmacist has instant access to the stock position of any one of his drugs.

At the end of the week or month, another program is used to interpret the figures. The first task is to find all the products which need re-ordering and to list them, along with the appropriate re-order quantities, on the printer—categorised under supplier name.

A more ambitious routine would analyse the quantities dispensed over the last 12 months and adjust the re-order quantity, after approval by the pharmacist, according to the trend in prescriptions.

Another very important application of the figures has been impossible previously. Every pharmacy is re-imbursed by the Department of Health and Social Security for the drugs dispensed against NHS prescriptions. The amount of remuneration—is based on fixed rates and is calculated by the DHSS from the used prescription forms.

Replacement costs

Many pharmacists have been concerned, faced as they are with stock replacement costs which can increase by 20 percent per annum, that there is no practicable way of checking on the accuracy of this calculated figure. A system such as Hughes' which can give an indication of the expected value of payment, with no extra effort, must surely be welcome.

So much for tape and disc; the other peripheral vital to the operation of the system is the printer. Knowing that the maximum print width needed for the labels would be 4in., Hughes bought a Computer Workshops 40-column PR-40 microprinter after a visit to the Commodore showroom, where one had been linked to a Pet.

Not being compatible with the IEEE peripheral bus, the PR-40 was driven from the Pet 8-bit user port, on which the individual lines can be PEEKed and POKEd according to any desired pattern.

Printer problems

The subroutine to do this was written originally in Basic, an adaptation of the routine listed in the Commodore Pet Users' Club newsletter. Although it worked successfully, it was translated later into 6500 machine code which speeded the operation and left more RAM space for the main program. In the finished marketable system, printers will be driven from custom-designed interfaces.

The printer, however, has been the weak link in the chain. After having produced nearly 50,000 labels over the last seven months, the mechanism is showing signs of wear. Credit where credit is due, though—Hughes' PR-40 has printed an estimated seven million characters with a negligibly small number of errors.

The other main problem is peculiar to using self-adhesive labels. After printing the relevant information, the medium must be advanced clear of the print mechanism to allow the label to be peeled-off from the backing paper. The number of line feeds must be arranged so that the print-head lines-up simultaneously with the top of the next label.

There lies the problem. Although the stationery can be manufactured so that the label height corresponds to an exact number of line feeds, all friction feed printers are prone to a small amount of "creep". It means that after dealing with a few dozen prescriptions, the printing will not be in perfect alignment with the labels and eventually information will be lost from the top or bottom of each label.

While re-alignment is not a particularly difficult operation, Hughes says that it contravenes his original specification of ultra-simple operation, aimed at non-trained personnel. The search for an alternative printer was thus essential.

So far, Hughes has located two possible solutions and both are under serious consideration. The first option, and perhaps the more obvious one, is to use a sprocket or tractor feed mechanism with appropriate stationery, thus guaranteeing consistent alignment. Four-inch width sprocket mechanisms are somewhat scarce and larger ones are generally unadjustable; this leaves tractor feeds.

New design

Hughes thinks he has found one suitable mechanism and is modifying the paper-advancing arrangement. In his new design, the tractor mechanism is mounted underneath the printer and so pushes the paper directly up on to the platen. This may prove to be the answer, though, as might be expected, an increase in cost is inevitable.

The second alternative is the cheaper one but has appeared on the market only recently. Whymark Instruments of Reigate, Surrey has an ingenious extension to its Model 201 printer which, incidentally, can be attached directly to the IEEE bus, specifically to facilitate label printing.

The problem is thus purely a mechanical one and Hughes does not anticipate long delays before a workable solution is reached.

Software for the system is at different stages of readiness. The simple labelling and data capture program, having been used for so long in Hughes' dispensary, has undergone a number of re-writes. Consequently, it is virtually saleable already.

Labelling

The disc-based programs have reached the detailed specification stage, with several routines perfected, though a large proportion of the coding cannot be performed without the disc.

It is worth looking in more detail at the operation of that program; it entails one or two interesting features. When a prescription is dispensed, the first entry made on the computer is the customer's name. All inputs have been made fail-safe to avoid wrong entries from hitting 'Return' by mistake. Following that comes the question: "How many labels for this name?" which obviates the need to re-enter the same name should the prescription contain more than one drug or item.

The next piece of information required is the name and strength of the drug. A subroutine has been written to allow the names of 30 common medicaments to be abbreviated, thus saving a considerable amount of time. For example, entering "MO" at this point results in "MOGADON 5MG" being printed on the label. The quantity prescribed also has to be entered.

The subsequent stage is the one which saves the most time and concerns the directions to the patient, which may take three lines of printing. Although special directions may be entered in full, most are in standard forms, such as;

"*Take one three times a day*" or
"*The medicine—shake well before use—*"
"*Take one 5ML spoonful as directed*"

In those cases, all the operator has to do is enter a number from 1 to 250 according to the message required. A card is mounted above the Pet giving the details of which code corresponds to which directions. Hughes found, however, that after a short period, his staff could remember most of the codes without using the card. The label is displayed on the screen and checked, any way, before it is printed.

Each of the directions was stored originally as an individual string in a DATA statement. That occupied so much RAM space that the system was re-designed so that they could be stored in condensed form, with characters corresponding to commonly-used words and phrases.

Computer links

This code would then be interpreted and made up into its full string form before printing. An example is the sentence:

"*Take one, three times a day and two at night*" which is stored in the form:

"T1, 3D&2N"

The saving in space with this system is enormous.

After checking, the whole of the information is transferred to the printer along with the time and date—keyed-in only at the start of each day—the name, address and telephone number of the pharmacy and an optional reference number.

The process may appear long-winded but it is true that an untrained operator can produce an entire label in 10–15 seconds using this equipment. That is not only considerably faster than handwriting but produces a far better-presented result.

What of the future? Hughes, as much an innovator as an entrepreneur, has a number of proposals for improving the world of medicine. Computer links in health centres between the doctor's surgery and in-house pharmacy, patient-held prescription record-cards and computer checks for drug incompatibilities are all ideas he mentions with relish.

Who is to say that they are impracticable? In seven months, Hughes has already gone a long way towards achieving his pharmaceutical Utopia.

These pages represent an independent collection of news and views for owners of the Commodore Pet. If you wish to contact Pet Corner, send articles or ideas directly to us. We are not connected with Commodore or with the official Commodore-run Pet Users' Club, though we wish it well. We give space to Mike Lake, of the Independent Pet Users' Group (IPUG).

TV interface

MANY people have written to Mike Lake about how he made his TV interface. The answer lies in the official *Pet Newsletter*. Nos. 1 and 2 contain a circuit for interfacing the Pet to a UHF modulator (easily available at £2·54). This interface works well on a black and white TV so long as there is plenty of vertical and horizontal hold adjustment; it does not work with a colour TV.

There is some problem with the horizontal and vertical synchronisation signals from the Pet, which tends to cause the top of the screen to lean over. It is believed that the signals apparently cause problems with 50-cycle equipment. Commercial interfaces are down to about £25 and IPUG is examining the possibility of producing one even more cheaply. Any ideas from members would be appreciated.

Sound boxes

PETSOFT is now selling a sound box—which means a small amplifier—for £13·99 inc VAT. It has demo software and is driven from the second cassette port, so that the device can be driven from the Pet power supply.

It is a pity that different conventions are emerging for music programs. *Pet Gazette* in the U.S. has for some time been trying to standardise on the use of the user port—as shown in the Pet page previously. It can be linked directly to a hi-fi, or you can buy an intercom system, like the Eagle at around £6, which includes an amplifier and a speaker.

IPUG has a program which allows you to write music for the Pet, turns your keyboard into an organ, and translates key-strokes into morse; it uses the *Pet Gazette* method and the user port.

Light pen

MIKE LAKE received a light pen recently from 3G in the States and has been trying it. It plugs into the user port and is complete with a demonstration program, which did not work properly. The pen responds to light and changes the status of a bit of the user port, depending on whether it sees light or not.

To use it, a program must generate a flashing cursor at which the pen can be pointed; a small subroutine then checks if the pen is pointing at the cursor; if it is, the program can branch to take appropriate action.

Mike found the pen useful for games, especially space games. If there are a number of options, that number of cursors can be generated and the pen pointed at the appropriate one. This makes games extremely fast and the keyboard need not be used.

Other possible uses are in education—the pupil is asked to select an answer from a choice displayed on the screen. No knowledge of the keyboard is needed—only the ability to point the pen in the right direction.

The pen does not allow you to draw on the screen. Mike tried various methods to scan the screen quickly with a flashing cursor and then pick-up where the pen is pointing; the response time of the pen is not fast enough to allow this to work quickly, so the best use of the pen appears to be when a number of choices are offered in a program.

One or two changes would improve it considerably. A pressure switch at the tip would make it less likely to pick-up the wrong cursor. Adjustable sensitivity would allow the pen to respond to reverse characters but not to ordinary characters, thus making selection of options even easier.

Mike's overall conclusion is that the pen is a useful tool where choice is involved but is not suitable for "drawing" on the screen. The pen is available from 3G, Rt 3, Box 28A, Gaston, Oregon 97119, U.S., at $24.96 plus $6 post and package. Spectrum Software, of 44 Berners Street, London WIP 3AB, says it hopes to import the pen and sell it complete with some of its programs for about £25.

Microdiary

Julian Allason of Petsoft sent this interesting piece of PET programming lore.

AMONG the daily mountain of post from Pet users there are always requests for programs not in the Petsoft catalogue. The enquiries are logged and if there seems to be a genuine demand, we set about writing a program to match.

One regularly-requested title was an Appointments Diary routine. In fact, there are several versions published in the States. None seemed suitable, so I set about preparing a specification. Clearly it should use the excellent Pet graphics and reverse-field facility to display a full week on the screen. Looking at a number of desk diaries, we decided that the format adopted by *The Economist* was the most useful.

The program should ask today's date and from that calculate the correct date for each weekday in the present week and print that on the screen, too. That would be relatively easy, I thought, but it was vital that the program stored layouts, not just for the present week but for several weeks ahead, so that they could be recalled and amended easily.

That was the nub of the problem. The program might be used by secretaries with no Pet experience; I could not, therefore, use data tapes or any method which required more effort than writing an ordinary diary. It would have to be done by menu selection—pressing a single key from a choice offered to select the particular option required.

Experimental

I started by experimenting with a subroutine which would print a line number, a question mark—shorthand for PRINT—and quotation mark down the left-hand side of the screen, using the following method:

```
100: B=200  :REM SETS NEW LINE NUMBER
     STARTING POINT
110  FOR A=1 TO 11 :REM 22 LINES OF SCREEN
     DISPLAY TO BE STORED (EXCLUDING
     MENU ON BOTTOM THREE LINE)
120  POKE 245, Y:PRINT "[UP]?"; B; CHR$(34):
     REM THE POKE COMMAND ISSUED AS A
     VERTICAL TAB.CHR$ (34) IS THE QUOTE
     MARK
130  B=B+10 REM: INCREMENTS LINE NUMBER
140  NEXT A
```

We are following the convention of using square brackets to denote unprintable functions—this time it's cursor UP, the 'up' arrow. This routine printed the line number, one position in from the left—position TAB(1) on account of the Pet habit of printing a blank before positive numbers. A cursor left would solve this difficulty in all positions except HOME; there is no position to the left of HOME! A little POKEing took care of this.

The disadvantages of the method were two-fold. Firstly, it sacrificed seven precious print positions from the layout of the week—five for the line number to be printed and two at the end. Secondly, it required human intervention; to hit RETURN 11 times to include the new lines in the program and once more to execute a GOTO, which would re-start it.

There was a solution to the second

(*continued on page* 61)

(*continued from page 59*)

problem. Although it is not possible to POKE Return directly on the Pet, it can be done using the keyboard buffer. Memory location 525 stores the number of keystrokes hit since last checked by a GET or INPUT. Poking a ∅ into it will clear the counter.

The buffer can count up to 10 keystrokes, so if we POKE locations 527 to 536 with a 13—the POKE number for Return—the Pet will execute 10 Returns. If line numbers have been printed on the screen, the information will be committed to memory in the form of new line numbers.

Unfortunately, the addition of new lines has an unsettling effect on the variables; it re-sets them to zero. My solution was to display their values on the screen and hit them with one of the auto-Returns, to get them back into memory.

A further side-effect was that the subroutine pointers were lost, although this could be avoided by dispensing with Gosubs altogether.

Another difficulty arose. Once the new lines were included in the program, they could be called and displayed selectively, but they were printed from the left-most positions (TAB (∅)), leaving no room for line numbers to be printed again if further modification was required.

Two solutions

Two solutions offered themselves—treating each line as a subroutine to be called consecutively, interspersed with a Cursor right, right, right, right command, or merely listing the relevant lines.

That approach was beginning to look a little inelegant, so I abandoned it. There was another method and it is so useful I would like to share it with you.

PEEKing and POKEing scare many first-time users. They need not. Each part of the memory is called a location and has a number. By PEEKing that number, you can see what is in that particular location. The numbers for Pet screen locations are 32768 to 33767, the former being top left-hand corner or HOME, and the latter bottom right.

The routine I have developed looks at each location in turn by PEEKing it. This gives the PEEK/POKE number for that character—in the case of A the code is 1. So we use CHR$ to turn the POLE number back into a character? Wrong. The numbers used by Pet differ from standard ASCII codes. So a conversion is necessary. PEEKing returns the Pet PEEK code. CHR$ requires the ASCII print number, which may be the same, 64 or 128 more or less than Pet print codes; lines 5020 to 5028 implement the conversion.

```
5000 REM***PAGE PEEK ROUTINE******
5006 FOR SCRN=32768 TO 33727
5010 PK=PEEK(SCRN)
5020 IF PK<32 THEN PK=PK+64:GOTO 5030
5022 IF PK>64 AND PK<96 THEN PK=PK+128:
     GOTO 5030
5023 IF PK>95 AND PK<127 THEN PK=PK+64:
     GOTO 5030
5025 IF PK>127 AND PK<160 THEN PK=PK-64:
     GOTO 5030
5027 IF PK>159 AND PK<192 THEN PK+PK-128:
     GOTO 5030
5028 IF PK>223 AND PK<256 THEN PK=PK+64
5030 CR$=CHR$(PK)
5040 F=LEN (Y$)
5042 IF F=240 THEN X=X+1
5050 S$ (X)=S$(X)+CR$
5060 Y$=S$(X)
5070 NEXT SCRN
5080 PRINT S$(0);S$(1);S$(2);S$(3)
```

Once converted safely to the string CR$, the character can be added to the string S$(X). Note, however, that a string cannot exceed 255 characters. When string length reached 240, I started a new string. Four such strings will hold a screenful of information, including the graphics.

The strings can be recalled easily for amendment and manipulated if necessary. Since string variables are not stored by SAVEing on to tape, it will be necessary to convert them to line numbers or DATA statements by poking the buffer as suggested above.

And what of the Appointments Diary program? It is selling well.

Teletype 33 interface

ALLEN COMPUTERS of Grimsby has a £106 interface package, a combination of hardware and software which provides two-way communication between a Pet and a Model 33 Teletype. If it is an ASR 33, that not only provides the Pet with a printer but also gives paper tape input and output. And, of course, you will have a full-size keyboard.

The standard package is designed for a 20mA current loop but compatibility with 60mZ or RS232 can be provided "by special order". Connectors are provided to the Pet user port and the second cassette port. It can also be adapted to operate via the IEEE port and it is possible to arrange for a second cassette unit to be operated simultaneously with the Teletypewriter (£65 from Allen).

Two machine-coded programs are included in the package. One resides in the second cassette buffer; the other reserves RAM at the top of 8K and the coding resides there, so that the second cassette unit can be used.

A Basic program is included as a handy extra, giving a routine to list an entire program on the printer without operator intervention.

Allen Computers is at 16 Hainton Avenue, Grimsby, South Humberside DN32 9AS; telephone 0472-40568.

Key-top wear

P. MEEHAN of High Wycombe apparently went through "one or two unsuccessful experiments" before finding a solution to the problem of key-top wear. It involves the use of a hard-wearing and non-tacky 3M product obtainable from W. H. Smith and elsewhere in small rolls, costing less than 40p.

A strip of it is stuck to the keys, one row at a time, and the shape of each key-top is outlined carefully with the point of a hobby knife; surplus tape can be removed.

It seems the job takes a little patience, but Meehan's covered keys have been in use "for some 300 hours without any sign of deterioration".

Pet organ

FOR THOSE who have invested the money needed to make the circuit shown in the February edition—about 6p, I think, for the two resistors—we list a program which will turn your Pet into an organ. If you want notes to be an octave or two higher, modify line 110 to include POKE 59466,51 or POKE 59466,85 instead of POKE 59566,15. If you play about with the numbers in the DATA statements you will have some strange notes indeed.

Organ program

"Q" means cursor down
"S" means clear screen
"R" means reverse character on.

```
 10 PRINT"SQQQQ           COMPUTER ORGAN
QQ"
 20 PRINT"TO PLAY JUST USE THE ROW OF KE
YS FROM"
 30 PRINT"QA TO :.  SHARPS AND FLATS ARE
IN THE"
 40 PRINT"QROW ABOVE OR BELOW.  PRESS SP
ACE TO"
 50 PRINT"QEND YOUR PLAY."
 55 PRINT"      -------------------------
-"
 60 PRINT"       KEY  A S D F G H J K L :
"
 70 PRINT"       NOTE B C D E F G A B C D
"
 75 PRINT"      -------------------------
-"
 80 END
 100 DIMN%(100):FORI=1TO100:READN%(I):NE
XT

 110 POKE59467,16:POKE59466,15
 120 J%=PEEK(515)
 124 IFJ%=255THENPOKE59464,0:GOTO120
 126 IFJ%=6THENPRINT"QQRTHANK YOU FOR PL
AYING.":POKE59467,0:POKE525,0:END
 130 POKE59464,N%(J%)
 140 GOTO120
 150 DATA0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
,0,0,0,54,64,82,98,117,0,0,0,57,73,87
 160 DATA110,132,0,0,0,51,61,77,92,117,0
,0,0,57,68,87,104,124,0,0
 170 DATA0,48,61,73,92,110,0,0,0,54,64,8
2,98,124,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0

 180 DATA0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
,0,0,0,0
```

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TANDY FORUM is devoted to the Tandy TRS-80. We will be using it to pass on news about the TRS-80 and its supplier and product announcements from Tandy and other vendors of compatible equipment. Above all, these are pages for users, and would-be users, of this personal computer. We want you to send tips, queries, moans and comments, and we want this page to become a market-place for TRS-80 information.

Harding's Hints

A. J. Harding is a specialist supplier of cassette software for the TRS-80, which gives him an unusually good perspective on the Tandy baby. This is the first of what may become a regular offering exploring the idiosyncrasies of the TRS-80—and a mass-produced machine must be more susceptible than most to small peculiarities.

This month we consider cassette loading, which seems to give rise to more problems than any other section of the computer.

MOST OWNERS will have been supplied with the CTR-41 recorder with their computers. This is awkward to use. It is necessary to disconnect it from the computer or to enter CLOAD if you want to re-wind or fast-forward the tape. Current 80s have the CTR-80 with which this procedure is no longer required. Whichever model you have, however, loading can be somewhat difficult, so let us look at what goes on inside the system, as this may well help you to more successful loads.

The object is to record on tape a series of 0s and 1s and play them back with as little distortion as possible. The 80 does not use the Kansas City standard, by which a 1 is allocated one frequency of sound and a 0 another; instead, a series of pulses to the recorder spaced at one milli-second is sent, so that the presence or absence of this intervening pulse indicates a 0 or a 1.

The problem is that this pulse stream rides atop the 50Hz mains hum. This is removed by an operational amplifier filter in the computer but it is essential for the proper working of this circuit that the ratio of signal-to-hum be within certain limits.

Three rules

The recording level is automatic and cannot be altered, so the prime responsibility for passing the correct mixture of signal and hum to the computer rests on the setting of the volume control on playback.

If the hum can be reduced in the recorder, clearly the mix will be better. How best to achieve this reduction depends on whether or not you are willing to use a soldering iron.

If you are not, you should observe three rules. Always have the tone control in the high position; on particularly critical recordings and playbacks remove the mains lead and run the recorder on batteries; and tend always towards lower playback volume settings. In fact, there is a method of determining the best setting at which we will look next month.

If you are prepared to carry-out a small modification, you can reduce the hum by half, giving an appreciable increase in performance. Remove the back of the recorder and position it upside down with the battery compartment away from you. Half-way up the right-hand side of the printed circuit board, between the Mic and Aux sockets, is a thick copper trace; cut it. Solder a short length of wire from the top section of the cut strip to the ground connection of the earphone jack—about one inch away. The modification is completed and half the hum has disappeared.

Cassette loading

THIS TIP comes from William Jupp, of Reading, who says "it really works". Purchase a VU meter from your local hi-fi shop—Tandy does one for about £4.95. Connect the meter to a jackplug to fit the cassette recorder output socket. Play tape known to load at a given volume setting; note the meter deflection.

Then play a tape which is difficult to load and adjust the volume control to obtain the same deflection on VU meter. The tape will then load at that setting.

Circles

WE HAVE had many interesting attempts on the circle-drawing front in response to Freddie Nicholls' *cri de coeur* in March. Here's one from Nigel Dibben:

```
5 CLS
10 INPUT"ORIGIN IS TOP LEFT CORNER:
   ENTER COORDS OF CENTRE, RADIUS AND
   ECCENTRICITY (1 FOR CIRCLE)";XC,YC,E
20 A=2/3/R : AT=A : E=E*2.3 : REM CORRECTS
   FOR SHAPE OR GRAPHIC BLOCKS
30 X=XC+R*E*SIN(AT) : Y=YC+R*COS(AT)
40 IF X 128 AND X=0 AND Y 48 AND Y=0
   SET (X,Y)
50 AT=AT+A : IF AT 6.3 THEN 30
55 REM 6.3 IS ABOUT 2 × PI
60 IF A 0 THEN X=XC : Y=YC : A=0: GOTO 40
70 IF INKEY$=CHR$(31) RUN ELSE 70
```

After the centre has been set, press CLEAR to re-run.

This is also from Dibben—not so neat but a little faster:

```
5 CLS
10 INPUT "XC,YC,R,E"; XC,YC,R,E
20 FOR XC0 TO 127
30 Z = R*R —(X–XC) * (X –XC) : IF Z<0 THEN 70
40 D = E* SQR(Z) /2.3
50 GOSUB 200
60 D= —D : GOSUB 200
70 NEXT
80 X=XC : D=0 : GOSUB 200
90 IF INKEY$ = CHR$(31) RUN ELSE 90
200 Y=YC+D : IF Y>= 0 AND Y<48 SET (X,Y)
210 ETURN
```

You input centre co-ordinates which can be off-screen, radius and eccentricity; setting E=1 produces a perfect circle, E=2 produces an upright ovoid, E=.5 an elegant fit oval.

This is from Bob Williams and it, too, seems to work:

```
5 CLS
10 PI=3.142 : FY=2.42
20 PRINT, "CIRCLE DRAWING PROGRAM"
30 INPUT "HOW MANY CIRCLES—UP TO 10";N
50 PRINT "THE SCREEN IS 128 UNITS WIDE
   AND 116 UNITS HIGH"
60 PRINT "MAXIMUM RADIUS FOR A
   COMPLETE CIRCLE IS 57"
70 PRINT "BUT YOU CAN SELECT ANY
   RADIUS YOU LIKE"
80 PRINT "AND ANY CENTRE YOU LIKE ON
   OR OFF THE SCREEN (TOP LEFT CORNER =
   ORIGIN; +Y IS DOWN)"
90 FOR I = 1 TO N
100 INPUT "KEY RADIUS, X,Y"; R(I), X(I)X Y(I)
110 NEXT I
120 CLS
130 FOR I = 1 TO N
140 FOR A = 0 TO 2 *PI STEP PI/(3*R(I))
150 SX = INT (X(I)+SIN(A)*R(I)): IF
   ABS(SX—63.5) >63.5 GOTO 180
160 SY=INT(Y(I)/FY—R(I)*COS(A)/FY):IF
   ABS (SY—23.5) >23.5 GOTO 180
170 SET (SX,SY)
180 NEXT A
190 NEXT I
200 GOTO 200
```

FY is the scale factor; the screen is 58 'x' units by 24 'y' units, so FY = 58 ÷ 24 = 2.42.

Bob suggests designing a clock with moving hands, based on a subroutine containing this. Do that successfully and we will print it.

He also has s tweak for the Nicholls' square-drawing program from the March Tandy page, again based on the 58/24/2.42 axis correction factor. If you change variables C and D in lines 8, 20 and 50 of Nicholls' program to INT(C/2.42) and INT(D/2.42) respectively, you should be able to get a scale drawing. For example, try INPUT A and C as 10 and B and D as 50.

John Whitehouse, of Norwich, read with interest about Dibben's problems. "I can only say I have been using a TRS-80 (Level II 4K) for four months and have no problems and can give the machine only the highest praise. In fact it has recently

(continued on page 67)

(*continued from page 65*)

withstood a DIY upgrade to 16K and still works".

Our 'Square Cut' piece prompted some thinking from him on drawing circles. There are several ways of solving the problem but he settled for good old Pythagoras—"what would he have achieved if he had access to a TRS-80".

Solution

The solution is to set values of X and to calculate the position of Y by considering the right-angled triangle formed by the radius of the circle and the line normal to the diameter in the X plane joining the diameter to the point on the circumference of the circle cut by the radius.

That has the effect—by stepping along the diameter—of 'rotating' the radius about the centre of the circle and plotting the loci of the points traced; it's heavy, but try reading it slowly. At point X(1) the length of side Y(1) is given by

$$Y(1) = \sqrt{R^2 - X(1)^2}$$

where X(n) is the distance to the point X(n) from the origin 0 and R is the radius of the circle. Since R is constant and we can choose values of X(n), we can compute any number of Ys. In the computer it is necessary only to compute the first quadrant points; the rest are only projections from there.

So much for the theory—now for the implementation. First we must choose the origin (centre) of the circle on the TRS-80 screen. Here we encounter our first problem. As the TRS-80 has an even number of video addresses (blocks) in each axis, you cannot define a point exactly at display centre.

John chose the point 65,24 for the centre. If we define the centre co-ordinates in the main body of the program, all we have to do is INPUT the radius and let the TRS-80 go. Here is John's opening attempt:

```
10 CLS
20 INPUT "RADIUS (MAX:59)";R
30 FOR X = 65 — R TO 65 + R
40 T = ABS (X—65)
50 Y = FIX (0.4 * SQR ((R * R) — (T * T)))
80 SET (X. 24—Y): SET (X, 24+Y)
90 NEXT
100 GOTO 100
```

Try running it, and you will get an ugly circle. Here we encounter problems 2 and 3. Problem 2 we cannot do much about; the TRS-80 graphics resolution is low, so you have a somewhat lumpy circle. Problem 2 is that FIX returns the integer part of Y only—i.e., if Y = 3.99 then FIX (Y) = 3 or if Y = 3.10 then FIX (Y) is also 3: so where the circle clips the corner of a graphics block, that whole block is SET.

Now, what is that '0.4' doing in the SQR expression? That is the inevitable fiddle factor—the link between theory and the real world. The TRS-80 graphics blocks have a 2:1 ratio between height and width. Since line 50 gives the value of Y in terms of X, and since the blocks are twice as high (Y) than they are wide (X) the height of the Y co-ordinate has to be scaled by a factor of 0.5—and reducing it to 0.4 tends to smooth-out some of the errors arising from the FIX problem.

Listing MKII checks first to see if the value of Y to be FIXed is more than half-way to the next value of Y upwards (i.e., it rounds Y).

```
10 CLS
20 INPUT "RADIUS (MAX:58)":R
30 FOR X = 65 — R TO 65 + R
40 T = ABS (X — 65)
50 A = 0.4 * SQR ((R * R) — (T * T))
60 IF A — FIX (A) 0.5 THEN Y = FIX (A) ELSE
   Y = FIX(A) + 1
80 SET (X,24 — Y): SET (X, 24 +Y)
90 NEXT
100 GOTO 100
```

Experiments

There is not much decrease in the irregularity of the outline. Now is the time to start experimenting. Try running the two routines together—male line 100 in the second listing read GOTO 200 and put in MKI at line 200 on, omitting lines 10 and 20. Now RUN. The first plot gives the circle generated by MKII; the MKI plot follows inside it. So the circumference of our real circle lies exactly between the two plots, thus demonstrating the lack of resolution in the TRS-80 graphics.

Another experiment uses one of the programs and starts with R = 10. After plotting the circle, use R=R+1 to increase the radius and plot the next concentric circle, and so on, up to the maximum permitted radius—don't forget an IF-THEN to test for the maximum radius allowed. Then try again with R=R+2, and so on. All kinds of interesting patterns will start to emerge.

A final thought—as the 0.4 fiddle factor scales the X:Y ratio, altering it enables the program to plot ellipses as well. So you arrange for an INPUT statement to call for the major and minor diameters of the ellipse, find the ratio of one to the other, multiply by 0.4, and generate ellipses.

John ends with a plea of his own: "Now perhaps someone can help me and explain why the TRS-80 is blessed with three instructions—FIX(X); INT(X) and CINT(X)—which all appear to do the same thing?" We have no idea, John. Any input?

Tips

WE RECEIVED a letter from Les Aston, of Ealing, containing two tips and a comment about cassettes.

This is his contribution to the square/rectangular drawing debate, which he describes modestly as "the simplest way to do it":

```
10 R=0: L=127: U=0: D=47
20 FOR X = R TO L: SET (X,R):SET (X,D):NEXT
   X: FOR Y = U TO D: SET (R,Y): SET (L,Y):
   NEXT Y
```

The letters R,L,U,D mean right, left, up and down as reminders of which way the figure will be drawn. If line 20 is made a subroutine, it can be used again and again to produce the required boxes in a program, for example:

```
10 R = 0: L=127: U=0: D=47
11 GOSUB 20
15 R=5: L=45: U=5: D=34
16 GOSUB 20
20 FOR X = R TO L: SET(X,R):SET(X,D): NEXT
   X: FOR Y = U TO D:SET(R,Y): SET (L,Y):
   NEXT Y
```

This produces a large rectangle with a smaller display panel inside it.

Now a short routine to display a moving message:

```
FOR I = 900 TO 1 STEP —.2:A$ = "YOUR
MESSAGE" : PRINT AT I, A$;: NEXT I
```

This message—up to 255 characters in Level 2—runs across the screen from right to left, line by line until it reaches the top and stops. At 32 characters per line, Aston says, this is most effective. The same procedure can be used, of course, with other messages, making the screen fill with advertisements, rude comments or whatever you like.

Aston has had problems with cassettes —haven't we all? He also had one batch of blank tapes which worked on one side but not the other. A small modification to the recorder—75 ohm resistor from earpiece socket to one side of the loudspeaker —makes it possible to hear a CLOAD in progress.

He found that the suspect cassettes were wowing and a close check on the mechanisms showed distorted tape guides. The best cassettes he has found are those supplied by Microdigital; the tape is made by Pyral and seems to be one of the audio-type tapes capable of working reliably at 500 baud.

Terminal

LANCE MICKLAUS has a reputation in the States as the author of top-quality software and we have heard pleasant remarks about ST80, which turns a TRS-80 into an RS232-compatible terminal.

Tandy provides a TERM program with its RS232 board—has anyone seen one of these in this country?—but that is to whet your appetite. ST80 adds a CONTROL key, ESCape, REPEAT and RUN keys and a functioning BREAK keys.

The full upper- and lower-case ASCII character set can be used—unmodified TRS-80s will display only the upper-case, but ST80 also has instructions for the hardware modifications.

Many cursor controls are also provided. They include left and right, up and down, clear screen and clear to end of line, and home.

You need a 16K Level II, some way of transmitting $49·95, plus freighting, to the U.S. for the tape; the address to contact is TSE TRS-80 Software Exchange, 17 Briar Cliff Drive, Milford, NH 03055. We believe TSE takes Visa and Masterchange, which correspond to Barclaycard and Access respectively, so try sending a signed order quoting your card number and expiry date.

That, incidentally, is by far the easiest way to buy anything from the other side of the Atlantic.

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● Circle No. 170

WHEN is an Apple II not an Apple? When it's an ITT 2020. Bryan Spielman visited ITT in Basildon to ask some questions, such as what is the difference? And are there any advantages in having an ITT 2020 rather than an Apple II?

Graham Pybus, marketing director, said categorically that the European purchaser of a 2020 would benefit in two main ways. First, it is ITT policy that the machine should be handled only by distributors who can provide a full software and service back-up—by implication, Apple would appear less choosy.

Second, once home production is properly under way, supplies relating to the machine will be more reliable than having to depend on imports from the States. Since production of 2020 items at ITT has scarcely begun, it looks as if the second claim has still to be proved.

New features

There are some other features peculiar to the ITT machine, however, which are worth noting. The Applesoft interpreter on the 2020 has high-resolution graphics with a plot grid of 360 × 192, compared to 280 × 192 on the standard Apple II.

The latest version, called Palsoft, is now reported to have ironed-out some irritating trouble with the colours. Earlier forms of Applesoft tried to cater in one interpreter for both the SECAM and the PAL TV systems, and the colour of the output depended not only on the parameter you specified but also its whereabouts on the screen.

A single-colour diagram would have a way of being, say, partly green and partly red and some of it would not be there at all—the missing parts were there really but the 'colour' was black.

The old Applesoft had four high-resolution colours, including black and white; the new edition has eight colours, or rather eight specifying parameters—two of the colours being black and another two being white. At low resolution there are 16 colours and if some of them look very similar to others it would probably be mean to complain about it.

The Palsoft is shortly to be provided in the machine in ROM. The old Integer Basic will be dispensed with eventually. For a time it will be possible to continue buying the machine with Integer Basic if you insist but the plug-in card with the little switch which turns into one sort or the other is due to be discontinued.

Own modulator

ITT has produced its own UHF modulator for the machine. The first version of it is not wildly successful but the improved one, which should be into new machines shortly, is modestly described (by ITT) as "excellent". ITT is also producing its own power supply unit.

There is a team of seven at Basildon on R&D for the 2020. The prototype of a plug-in character generator card will en-

hance the Apple with lower-case (at the sacrifice of flashing text), but you can easily program it back in. Trevor Gale, who designed it, is confident it should be perfected and available before the end of the year.

There is also a real-time clock card in the pipeline; it has its own rechargeable battery so that it can keep the time even when the computer is switched off.

Shape table

At present, there seems to be no plan for colour in the display of text—a pity. It is also a shame that you cannot mix text with graphics other than in the form of a four-line caption under the picture. With some patience it is possible to overcome this by designing your own character set and coding it into what is called a shape table. You then use the command:

```
DRAW S AT X,Y
```

S is the number of the shape in the table and this persuades it to appear instantly at the given position. This is common to both the 2020 and the Apple, of course.

ITT is also working on its own documentation. Together with a User Club and Update Service, it hopes it will increase the usefulness of the machine in England. Like other personal computer vendors, ITT is particularly keen to develop its appeal in areas beyond the recreation field, which is where the Apple's chief success has been so far.

ITT operations are not properly under way yet and it has had production problems and setbacks in deliveries from the States. The worst of the difficulties seem over now but I think ITT will probably have to speed its procedures for proceeding from prototype to production if it is to succeed in this game.

Certainly in the R&D department some exciting creative thinking is going on. If they can continue to progress it is possible that the ITT 3030 could be much, different from the Apple III.

Application idea

THIS IS from R Wellings of Shrewsbury, who reached the highly-commended stage of the *Practical Computing* Apple II competition. We think it makes good use of a system like the Apple.

"As company representative for an international company I have to keep records of calls I make to about 1,200 customers. Each may be interested in any or all of 14 products I sell, and customers are scattered over an area of 20,000 square miles of Wales and the border counties.

"Some customers may be seen without appointment, others can be visited only at specific times or on specific days, The time between making the appointment and seeing the customers varies from one day to approximately 18 months, The company expects a four-month cycle for visiting customers.

"So there are two uses I would have for an Apple II in the general administration of my job. The first is, of course, in the general recording of calls. This would require Basic and a large backing store, since a minimum of 200 characters of information would be needed for each customer.

"Customers could be split into geographical groups, however, and stored separately. Finding the correct tape from a dozen cassettes would be simpler than the continual shuffling of record cards I have to do at present.

"Searching for particular customers with particular interests, or those on whom I have failed to call, would obviously be easier.

"The second use would be a computerised diary. I could be reminded that I should make appointments in a particular town three weeks before going there. When offered an appointment I could be reminded that I already have a date nearby. Even this simple diary would optimise the use of my time and resources.

Territory model

"So far it could be argued that I need only a better manual system, or that another non-computerised solution would do. I have two further uses, however, for the Apple II. Both depend on high-definition colour graphics and these certainly mean that Apple II is the computer for my job.

"I would like a computer model of my territory, featuring a map of the area with major towns and roads. On this would be super-imposed customers' locations and each facet of each customer's profile could be given a different colour. It would be computerised version of the coloured map pins used normally for this. Each pin could be in any of 16 colours and each could be inserted, removed or re-coloured at a keystroke.

"In addition, the Apple II can be used in marketing—interacting with the customer and displaying answers to specific queries, or going through a specific sales detail on a particular product.

"This would be particularly helpful at trade shows and exhibitions, where the company often needs several representatives to be on hand to cope with the occasional rush of customers."

Torpedo Run

Cassette for Commodore Pet only. Available from Games Workshop, 1 Dalling Road, Hammersmith, London W6 0DJ. Tel: 01-741 3445. Price, £8.

IF YOU are an employer who believes in good worker relations and do not mind a 50 percent drop in productivity, leave this program on your Pet. I made the mistake of not erasing the program from memory, only to return half an hour later to find three programmers crowded round the Pet with accompanying cries of "Watch that tie fighter" or "Missed. How could I have missed?".

Torpedo Run is another game based on Star Wars. It is a real-time simulation of the attack on the Death Star. A cross-section of the trench is shown along which you are moving at a given velocity. You have to position yourself directly above the vent shaft and release your torpedo at exactly the right moment, while trying to avoid the dreaded tie fighters.

The direction of your fighter is controlled by the numeric keypad, which can be treated as a compass—pressing "8" moves you North—in a vertical direction —pressing 1 moves you South-east. The movement in one direction continues until another key is depressed.

Six shots

You have limited weaponry which consists of a short-range gun, i.e. the tie fighter has to be next to you, with a limit of six shots. A shot is fired by pressing the "return" key.

Once your distance has reached zero, the vent shaft appears and you can release your torpedo by pressing the "space" key.

This game impressed me tremendously. It has the right balance of skill without becoming too technical. The graphics used are clear and concise, although the movement is slightly jerky.

The game is short enough to let you build a certain amount of experience within a short time, yet still has enough variation to prevent you becoming bored with it. Congratulations to Games Workshop on producing a program of very good quality.

One programming error I found was that the subroutine call to display the instructions has been omitted. A simple amendment is to insert:

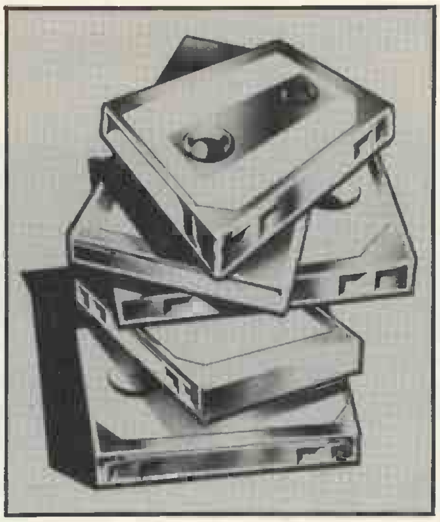
```
15 GOSUB 520
```

This will display the instructions the first time the game is started.—K.F.

Yam 1 and Yam 4

Cassette for Commodore Pet only. Available from Games Workshop, 1 Dalling Road, Hammersmith, London W6 0DJ. Tel- 01-741 3445. Price, £6.

TWO GAMES on one cassette for impulsive gamblers. For the beginners there is Yam 1, and if you consider Ladbrokes as your



second home, Yam 4 should keep you happy for hours.

Both games are based on the schoolboy pastime of Poker-dice. The computer rolls five dice and allows you to change as many or as few dice as you wish. The score is entered on a chart which consists of aces to sixes, a plus score, a minus score, a full house, a straight and a yam (five of one kind).

Each time you take a turn a score must be entered on the chart and a position may be filled only once; for example a throw of three twos, a six and a five would allow you to enter six points in the twos row.

If all the positions are filled the score must be entered somewhere else, either in plus or minus where it will register as the totals shown on the dice or in any other position, where the score will be entered as zero. As many as six people may play and the winner is the person with the highest score after 11 turns.

High quality

Yam 4 differs from Yam 1 in that it has four columns. The first column is the same as in Yam 1; the second column may be filled only from the top downward; the third from the bottom upward and the fourth may be filled only on the first throw.

Both games are of high quality with good use of the graphics and layout. After a few games of Yam 1, I was a trifle bored but this could have been because our secretary beat me each time. Yam 4 was much more interesting but, with four playing, a game can take three hours. The documentation supplied was passable but not brilliant.—K.F.

Mail III

Cassette to disc for Tandy TRS-80. Manufactured by and available from Micro Architects, 96 Dothan Street, Arlington, MA 02174. Price: $35.

MAIL III is not distributed in the U.K. as far as we know but if you see it in a secluded corner of your local shop, our advice is to leave well alone. There are much better programs which do a better job for less money.

As the name suggests, it is a mailing list system and is run under TRS-80 DOS. For it to work you will need the complete Tandy system, including diskette drive and printer. It is divided into two programs, Mail and Label.

Mail allows you to initialise the database, add, display, update, search and delete name and address information—no provision for telephone numbers. It opens-up 157 files, sequentially, which takes around three minutes. At the end of the initialisation, the system prints "done" on the screen.

Rather than clearing the whole screen, it then gives a prompt to let you know that you can start to input your data.

It presents a menu of six choices, badly-designed so that they are cramped in two lines of the screen instead of one choice per line. The options are add, inquiry, change number run, general information, search and end.

Layout problem

To make up a file you input the name first. If it is an individual's name, the surname comes first and it is printed thus. The address command then appears but does not indicate if it is address line one or whether there is more to come.

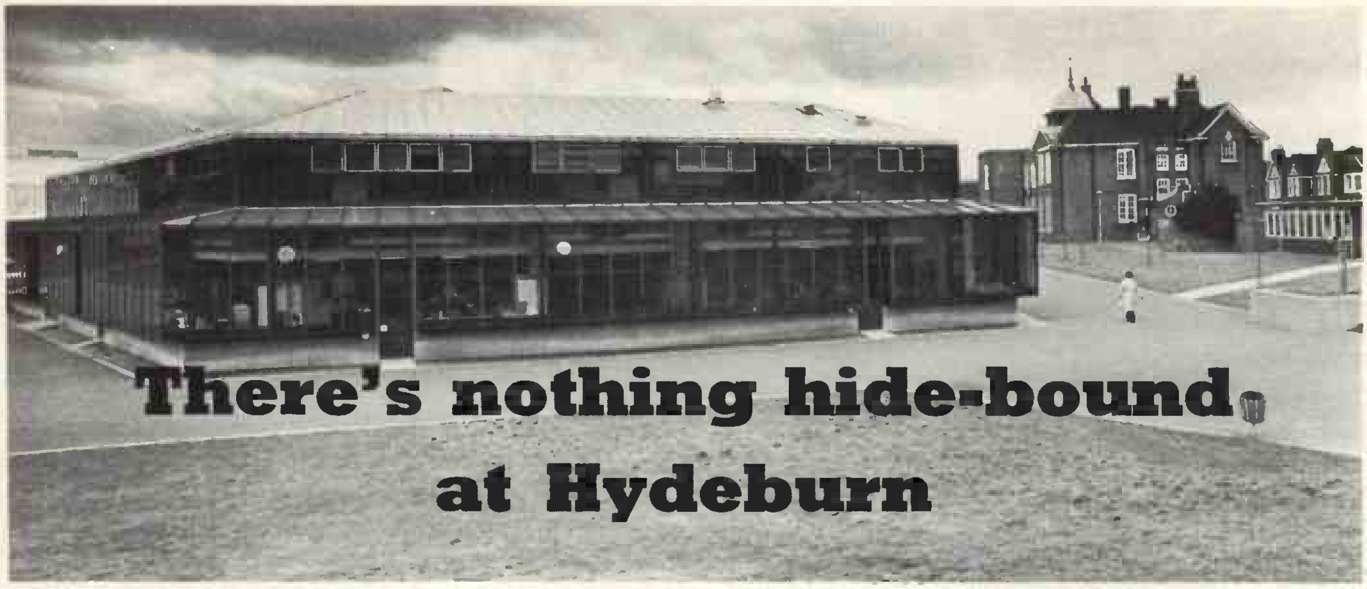
The last two contain room for only five characters and we often found ourselves over the limit. The full address which you type on to the screen will appear in the labels but when you make a list, it is thrown out of sequence, with half a word missing here and there, and you finish with something totally nonsensical.

The layout of the labels leaves something to be desired. It puts the town, country and postcode all on one line, which would not please the Post Office.

The program takes a maximum of 470 names and addresses, which can be sorted into numerical and alphabetical order of name, street number, postcode, county or city. It does not enable you to check a person's name and address by calling them up. You have to search through a whole printout before you find what you are looking for, as each file is under a code number.

Another thing we found annoying was that 'number' was always represented by a hash mark, when there was plenty of room to write it in full. There is little to recommend the design of this program. It is very slow and the commands become obscure with many things abbreviated unnecessarily.

On the whole we found that the program was purely a mailing list, which by the time you had it sorted out, you could have done faster on a typewriter. It is unsuitable for the U.K. unless you are prepared to do extensive re-programming. —K.F.



There's nothing hide-bound at Hydeburn

THE GLEAMING plate-glass premises of Hydeburn School, in south London, contrast vividly with the grim, forbidding streets around Balham. The new building looks like an enormous greenhouse; inside it is light and airy, carpets muffle the clatter of teenage feet, reggae music pours from an open door into the corridor.

The school computer, however, is not housed in this shining palace of educational architecture. It is in the solid Victorian pile 50 yards from the main building.

The maths teacher, Ian White, was responsible for Hydeburn acquiring its computer. He is one of the people instrumental in deciding that the Research Machines 380-Z would be the best micro for schools. He was a member of the advisory panel which made the recommendation to the Inner London Education Authority.

Hydeburn had its computer before the scheme for financing school purchases of computers came into existence in June, 1978. Hydeburn paid for its system through what is called AUR—Alternative Use of Resources.

Social priority

That is a variable sum dependent on the number of pupils and the social priority of a school, among other factors; it is allocated to a school for 'extras'. Most of it is spent on extra staff but White persuaded his colleagues a computer would be "a useful aid to a growing school" and the purchase was approved. No money was received from external sources.

The school system comprises the 380-Z with 32KB memory, serial output, a Trend 800 printer (20 characters per second), an acoustic coupler and an SWTP CT64 VDU. The school has television monitors which can be used in conjunction with the system. The VDU was acquired before White's arrival at the school and he plans to use it for teaching in the class-room adjoining the computer room.

A floppy disc system is on order, and White estimates that the installation of the discs "will speed software development by a factor of ten". He has already done a good deal of the preparatory work on a borrowed unit. He has no complaints, however, about cassettes—"they've been very reliable".

He would also like to add a high-resolution colour graphics unit which could be a very attractive feature, since ILEA is installing colour television in all its schools. Moreover, as he says, "the colour output unit also provides you with an extra 16KB of core when you're not using the graphics".

Although Hydeburn School has almost 1,000 pupils, only a handful do any computing. That unfortunate situation has arisen because of the lack of trained staff, the bugbear of computing anywhere. Hydeburn has two teachers who know anything about computing and both have other subjects to teach.

As a result, use of the computer has not yet touched any other discipline. Putting it to work for the teaching of topics other than computer science is a long-term aim —"We are working towards a true set-up by 1980", says White.

He has a few ideas on educational computing, especially for the kind of school in which he is teaching. For example: "You should re-write the Basic to suit the level at which you are teaching, and include more keywords as the students become more advanced".

That, he declares, is "especially important where you are dealing with inexperienced or young children who can be frightened and discouraged if they cannot understand or control what is happening.

"What's the use of having 'syntax error' flash across the screen when most of the kids have never met the word 'syntax'?" he asks.

Hydeburn pupils are from a racially-mixed background and live in a socially-deprived area. There are difficulties of communication with immigrant children and even the other children are sometimes short on comprehension. Comments White: "Most educational programs are programmed in too high-level a language for the kids I teach".

To remedy that, he is working on new software; he has already written a program for multiple-choice testing which can be used in any subject.

In addition to his own work, he is planning to run the standard packages developed by London University at Chelsea College under the umbrella title *Computers in the Curriculum.* The range includes science and geography applications and is undergoing modification by Research Machines.

Conversion

White also intends to convert the programs acquired as a result of the school's terminal link to the large Systime machine operated by ILEA and he will be moving to multi-user working when the modification is available next year.

We were surprised to hear White talk disparagingly of playing games on the computer. In any school where many pupils must have very little motivation to learn anything at all, it might seem that computer games could provide a powerful stimulus.

He explains that he cannot see the value of playing games of the Star Trek variety, though he favours games which teach the pupil a certain principle or technique. Games, however trivial, though, seem to be as good a way as any of familiarising children—and adults—with a computer, and children seem much keener to write their own games programs than to devise programs to calculate VAT.

We also approve of the idea of using simulations—in history or geography as well as maths and sciences—and game-playing in that role is not too far removed from Star Trek.

Staff shortage remains the biggest stumbling-block to an increase in computing in schools, at Hydeburn or elsewhere. Pre-service training is virtually non-existent and in-service training is scarce.

White, who lectures at in-service courses in computing, is pessimistic about any substantial increase in the number of teachers trained in the use of computers.

Computer science, he reckons, is still a minority subject. It is perhaps inevitable that subjects such as maths and English take priority in the allocation of resources.

There are 20 students as Hydeburn taking O level and CSE courses in computer science. There are two taking it at A level and they are obliged to work on their own for half the week, because of insufficient staff.

The numbers taking computing as a subject, however, should increase. The school is in the process of becoming comprehensive. Comprehensive intake began three years ago; the first three years' classes are thus composed of girls and boys of all abilities, whereas the upper school remains the all-male secondary modern school.

Low profile

A converted storeroom serves as the computer room. There is nothing on the door to indicate its identity; it is thought wiser to keep a low profile, so that people do not realise what it is. Vandalism is rampant in the area, and the school is very open, with people milling around all day and most evenings, too.

A good deal of work under way is for A level. We questioned this in a school with a diminishing sixth form—as sixth-form colleges are increasing their intake. White replies that it is at A level that the system can be used more effectively.

"With class sizes in the lower school, only batch processing would be feasible". Experience with the terminal link has shown how frustrating that type of work can be.

It will be easier to give the younger children some computing when the system has its disc upgrade. White likes to quote a favourite computer maxim: "You shouldn't be a slave to the computer—it ought to be your servant". By which he means that it should not be necessary to spend very long setting-up the system and getting it to a usable state.

In common with the Government and *Practical Computing*. White is concerned with imparting a "basic awareness' of computers to his pupils. He says: "Its something they are going to encounter in everyday life . . . I don't want them to grow up in the ignorance my generation did".

ILEA decided on the Research Machines system at a time when there were fewer micros from which to choose. Nevertheless, White thinks it was the correct decision. "It was chosen as the most flexible machine . . . the operating system is reliable, and you are not too constrained by the software. Also, Research Machines Basic seems to be very compatible with the Digital Equipment Basic which runs on the ILEA Systime system.

Glancing at the blue box which houses the 380-Z, White remarks: There's plenty of room in there for more. Research Machines has proved to be very helpful, even asking us for suggestions".

It will be interesting to see how computing develops at Hydeburn, a school with perhaps more than its fair share of problems. White's ambitious plans are delayed because of insufficient suitable teaching personnel but perhaps as the recent comprehensive intake reaches computing age, it will produce a supply of programmers and technicians who will speed the development of the system and its integration into the life of the school.

Program exchange

As soon as White has the disc system running, he intends to organise a Software Exchange—a library of educational programs. Someone who has developed a program widely applicable can contribute it to the exchange, where White will copy it and return it to the originator.

It will, of course, be necessary to establish that the person who requests a particular program is a bonafide teacher or has a genuine interest in using it for educational purposes.

With the dearth of educational application software, the Hydeburn exchange sounds a good idea. Anyone interested can contact White at Hydeburn School, Chestnut Grove, London, SW12.

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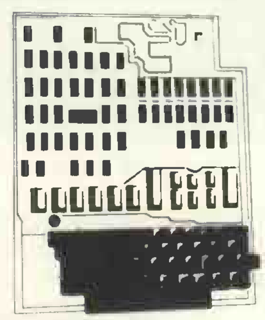

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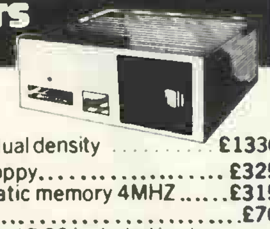

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● Circle No. 171

ZOMBIE

A game in Basic

by Trevor Lusty

PARACHUTED on to a remote island, you find yourself surrounded by Zombies. The appalling creatures cannot see but their acute sense of hearing enables them to move in your direction from the sound of your heartbeat.

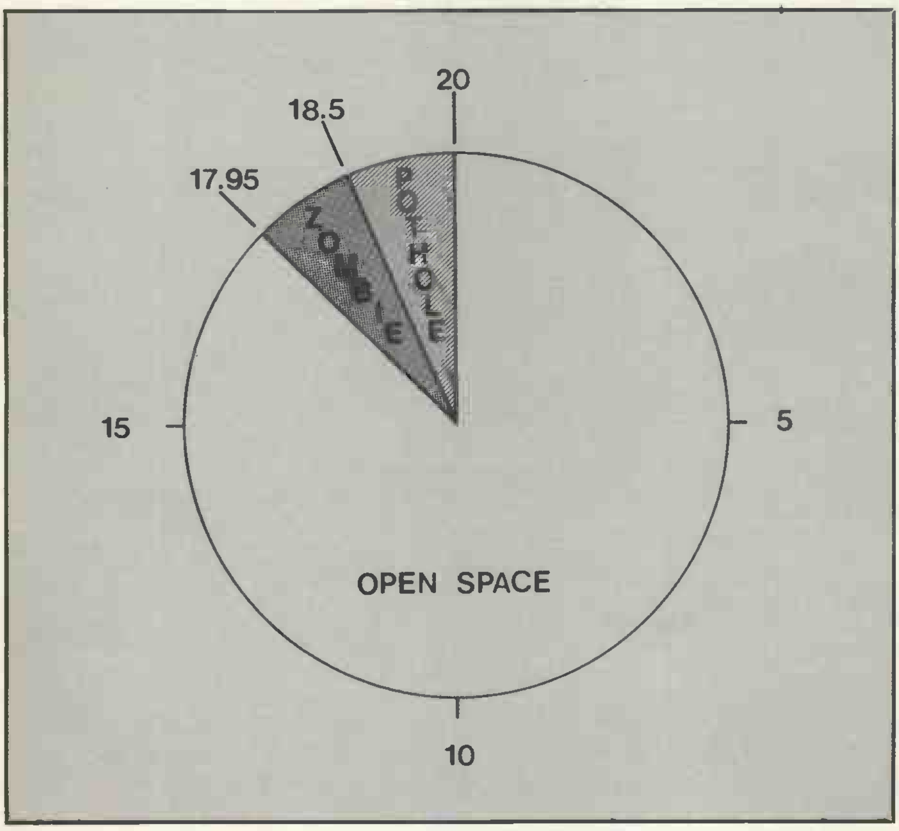
The island has a number of deep pot-holes, however, which the Zombies cannot see. If you position yourself so that there is a pot-hole between you and the Zombie, the Zombie invariably falls into it and is lost forever in the murky depths.

The island is divided into squares. When it is your turn, you may move to any square adjacent to your present position. The Zombies are able to move in the same way and at the same speed. You cannot out-run them—you have to out-wit them.

The island

The island is represented in the computer as a 12 by 22 array B, which allows a 10 by 20 land area surrounded on all sides by a row of pot-holes to simulate cliffs. It is easy to vary the size of the island for computers with more or less storage, but 10 by 10 would be a minimum area.

The island is set up in three parts. Initially, the whole area is covered with potholes by assigning the value 4 to all elements of the array. Then, for every square on the island, a random number between 0 and 20 is generated. That random number dictates whether the position should remain a pot-hole, change into a Zombie, or become open ground. The decision on which course of action is to be followed is illustrated by the pie-chart, which shows the relative probabilities for each event.



A number between 0 and 17·95 creates a space, between 17·95 and 18·5 creates a Zombie and between 18·5 and 20 leaves a pot-hole.

The values 17·95 and 18·5 were found by experiment; they are not the only values which may be used and they may be varied (lines 410 and 420) to make the game easier or harder if required.

With the numbers given the probability of getting a Zombie is (18·5 — 17·95)/20 = 0·0275 for any square. As there are 200 squares, the total number of Zombies should be 200 × 0·0275 = 5·5 and we can therefore expect five or six Zombies in every game.

The final step is to select the landing area. That is also achieved by generating random numbers but they are modified suitably so that the landing area is never too near the edge of the island. The area in the immediate vicinity of the landing spot is cleared of pot-holes and Zombies, thus removing the possibility of being swallowed alive before the game starts.

The chase

At first sight the problem of moving the Zombies towards their target might seem to pose some difficulties, as they must move exactly one square in the best direction. Elementary vector algebra and the use of the SGN function provide an elegant solution.

Subtracting the co-ordinates of the Zombie from the corresponding co-ordinates of the target gives the distance and direction in which the Zombie must move to reach the target. The SGN function returns a value of +1 if the argument (the bit in the brackets) is positive, zero if the argument is zero, and −1 if the argument is negative. This ensures that the Zombie moves exactly the right amount in the correct direction. For example:

Zombie at (2,6) · · · Target at (5,6)
SGN (5—2) = +1 · · · SGN (6—6) = 0
Therefore the new position of the Zombie is (2+1), 6+0) = (3,6)

As the Zombies move, it is useful to know exactly where they are at any given moment. The co-ordinates of their positions are stored in the 25 by 2 array Z. The dimensions of this array were chosen to be much larger than the expected number of Zombies, so that there was little or no possibility of the subscripts going out of bounds. If you reduce the size of the array to save space, you should also insert a check that the dimensions are not exceeded.

Moving the target

To move the target requires only a single numeric value giving the direction in which you wish the target to move.

7	8	1
6	×	2
5	4	3

This number is used as the index for two 8 by 1 arrays P and Q, and their stored values are added to the co-ordinates of the target to obtain its new position. It helps to think of the two-dimensional array B as being stored within the computer as follows:

B(1,1)	B(1,2)	B(1,3)	B(1,4)	B(1,5)	·····
B(2,1)	B(2,2)	B(2,3)	B(2,4)	B(2,5)	·····
B(3,1)	B(3,2)	B(3,3)	B(3,4)	B(3,5)	·····
B(4,1)	B(4,2)	(B4,3)	B(4,4)	B(4,5)	·····
·····	·····	·····	·····	·····	·····
·····	·····	·····	·····	·····	·····

Note that the subscripts of the array do not correspond to normal co-ordinates. The horizontal direction is associated with the second subscript, and the first subscript increases in the downward direction. This means that to move in direction 1 we must add one to the second subscript (P(1)= +1) and subtract one from the

(continued on next page)

(continued from previous page)

first subscript (Q(1) = −1). The complete 'move' table is:

Direction	Value of P	Value of Q
1	+1	−1
2	+1	0
3	+1	+1
4	0	+1
5	−1	+1
6	−1	0
7	−1	−1
8	0	−1

Running

The program uses a standard set of Basic statements. As no string functions are required, few problems should be encountered but the following comments may be useful for anyone trying to run the program on a very small system.

Only integer variables are required. The only part of the program which uses real variables (in lines 400–420) may be altered easily by multiplying the random number and the associated tests by 100. Most systems would also allow the random number less than 20 to be generated by RND(20); and although 20*RND(0) would still work, the former is to be preferred as it saves space. Space may also be saved in other ways:

- Remove all remark statements.
- Reduce the number of words in the print statements. Perhaps a ubiquitous 'You're Dead' or 'Yum Yum' would be sufficient.
- Remove the checks on data entry and try not to make mistakes.
- Reduce the size of array Z to 10 by 10 and insert a new check at line 425 IF Z1 >= 10 THEN 480.
- Make your moves by inputting the required values of P and Q rather than storing them:

```
1110 INPUT P, Q
1160 LET B(Y,X) = 1
1170 LET Y = Y+Q
1180 LET X = X+P
```

- Remove all spaces within statements.

The only other statements which might cause difficulty are the multi-branch GOTO statements. Each element of the board array B is assigned a value between one and four, as follows:

1. Square vacant.
2. Zombie present.
3. Position of target.
4. A pot-hole.

This enables decisions to be made using one ON/GOTO statement. Some versions of Basic may require this to be changed to a GOTO...OF...statement, while others may require separate IF... THEN... statements.

```
00100  REM    ******************************************************
00110  REM    *****  'ZOMBIE'  ---  BY TREVOR L LUSTY.         *****
00120  REM    *****                                            *****
00130  REM    *****  PROGRAMMED IN BASIC --- 4 MARCH 1979      *****
00140  REM    ******************************************************
00150  REM
00160  DIM B(12,22), Z(25,2), P(8), Q(8)
00170  REM
00180  REM    *****  INITIALIZE MOVE AND ZOMBIE ARRAYS  *****
00190  REM
00200  FOR  N1 = 1 TO 8
00210  READ P(N1), Q(N1)
00220  NEXT N1
00230  DATA 1,-1,1,0,1,1,0,1,-1,1,-1,0,-1,-1,0,-1
00240  FOR  N1 = 1 TO 25
00250  FOR  N2 = 1 TO 2
00260  LET  Z(N1,N2) = 0
00270  NEXT N2
00280  NEXT N1
00290  LET  Z1 = 0
00300  REM
00310  REM    *****  SET UP POTHOLES AND ZOMBIE POSITIONS  *****
00320  REM
00330  FOR  N1 = 1 TO 12
00340  FOR  N2 = 1 TO 22
00350  LET  B(N1,N2) = 4
00360  NEXT N2
00370  NEXT N1
00380  FOR  N1 = 2 TO 11
00390  FOR  N2 = 2 TO 21
00400  LET  R = 20*RND(0)
00410  IF   R > 18.5  THEN 00490
00420  IF   R < 17.95  THEN 00480
00430  LET  Z1 = Z1+1
00440  LET  Z(Z1,1) = N1
00450  LET  Z(Z1,2) = N2
00460  LET  B(N1,N2) = 2
00470  GOTO 00490
00480  LET  B(N1,N2) = 1
00490  NEXT N2
00500  NEXT N1
00510  REM
00520  REM    *****  COMPUTE LANDING POSITION  *****
00530  REM
00540  LET  X = 5+INT(10*RND(0))
00550  LET  Y = 3+INT(5*RND(0))
00560  LET  B(Y,X) = 3
00570  FOR  N1 = Y-1 TO Y+1
00580  FOR  N2 = Y-1 TO X+1
00590  IF   ABS(Y-N1)+ABS(X-N2) = 0  THEN 00610
00600  LET  B(N1,N2) = 1
00610  NEXT N2
00620  NEXT N1
00630  REM
00640  REM    *****  PRINT HEADING  *****
00650  REM
00660  PRINT
00670  PRINT  "YOU HAVE JUST LANDED ON ZOMBIE ISLAND"
00680  PRINT
00690  PRINT  "YOUR ONLY HOPE OF SURVIVAL IS TO LURE ALL THE ZOMBIES"
00700  PRINT  "INTO POTHOLES.  YOU MAY INDICATE THE DIRECTION OF YOUR"
00710  PRINT  "MOVES AS FOLLOWS :-"
00720  PRINT
00730  PRINT  "7 8 1"
00740  PRINT  "6 X 2"
00750  PRINT  "5 4 3"
00760  PRINT
00770  REM
00780  REM    *****  REMOVE ZOMBIES FROM LANDING POSITION  *****
00790  REM
00800  FOR  N1 = 1 TO Z1
00810  IF   B(Z(N1,1), Z(N1,2)) = 2  THEN 00880
00820  FOR  N2 = N1 TO Z1
00830  LET  Z(N2,1) = Z(N2+1,1)
00840  LET  Z(N2,2) = Z(N2+1,2)
00850  NEXT N2
00860  LET  Z1 = Z1-1
00870  GOTO 00800
00880  NEXT N1
00890  PRINT
00900  REM
00910  REM    *****  PRINT THE STATE OF PLAY  *****
00920  REM
00930  FOR  N1 = 1 TO 12
00940  FOR  N2 = 1 TO 22
00950  ON   B(N1,N2)  GOTO  00960, 00980, 01000, 01020
00960  PRINT  "  ";
00970  GOTO 01030
00980  PRINT  " Z";
00990  GOTO 01030
01000  PRINT  " X";
01010  GOTO 01030
01020  PRINT  " O";
01030  NEXT N2
01040  PRINT
01050  NEXT N1
01060  PRINT
01070  REM
01080  REM    *****  INPUT MOVE AND CHECK POSITION  *****
01090  REM
01100  PRINT  "YOUR MOVE ";
01110  INPUT A
01120  IF   A > 8  THEN 01140
01130  IF   A >= 1  THEN 01160
01140  PRINT  "PLEASE USE A NUMBER BETWEEN 1 AND 8 --- ";
01150  GOTO 01100
01160  LET  B(Y,X) = 1
01170  LET  Y = Y+Q(A)
01180  LET  X = X+P(A)
01190  ON   B(Y,X)  GOTO  01200, 01220, 01200, 01240
01200  LET  B(Y,X) = 3
01210  GOTO 01290
01220  PRINT  "STRAIGHT INTO THE ZOMBIE'S MOUTH --- ";
01230  GOTO 01600
01240  PRINT  "HEAD FIRST INTO THE PIT --- ";
01250  GOTO 01600
01260  REM
01270  REM    *****  MOVE ALL ZOMBIES TOWARDS TARGET  *****
01280  REM
01290  LET  Z2 = 1
01300  LET  Z8 = Z(Z2,1)
01310  LET  Z9 = Z(Z2,2)
01320  LET  B(Z8,Z9) = 1
01330  LET  Z8 = Z8+SGN(Y-Z8)
01340  LET  Z9 = Z9+SGN(X-Z9)
01350  ON   B(Z8,Z9)  GOTO  01480, 01450, 01430, 01360
01360  PRINT  "SPLASH GOES A ZOMBIE"
01370  FOR  Z3 = Z2 TO Z1
01380  LET  Z(Z3,1) = Z(Z3+1,1)
01390  LET  Z(Z3,2) = Z(Z3+1,2)
01400  NEXT Z3
01410  LET  Z1 = Z1-1
01420  GOTO 01520
01430  PRINT  "YOU'RE ZAPPED BY A ZOMBIE --- ";
01440  GOTO 01600
01450  PRINT  "ZOINK --- HERE COME THE ZOMBIES"
01460  LET  B(Z(Z2,1), Z(Z2,2)) = 2
01470  GOTO 01510
01480  LET  B(Z8,Z9) = 2
01490  LET  Z(Z2,1) = Z8
01500  LET  Z(Z2,2) = Z9
01510  LET  Z2 = Z2+1
01520  IF   Z2 <= Z1  THEN 01300
01530  REM
01540  REM    *****  ARE THERE ANY MORE ZOMBIES ?  *****
01550  REM
01560  IF   Z1 >= 1  THEN 00890
01570  PRINT
01580  PRINT  "WELL DONE --- THE ZOMBIES ARE EXTINCT"
01590  PRINT  "YOU ESCAPED --- ";
01600  PRINT  "ANOTHER GAME ";
01610  INPUT A$
01620  IF   A$ = "YES"  THEN 00290
01630  IF   A$ = "NO"  THEN 01660
01640  PRINT  "PLEASE ANSWER 'YES' OR 'NO' --- ";
01650  GOTO 01600
01660  END
 YOU HAVE JUST LANDED ON ZOMBIE ISLAND
 YOUR ONLY HOPE OF SURVIVAL IS TO LURE ALL THE ZOMBIES
 INTO POTHOLES.  YOU MAY INDICATE THE DIRECTION OF YOUR
 MOVES AS FOLLOWS :-
 7 8 1
 6 X 2
 5 4 3
```

```
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                   Z     0
0 0                                       0
0       0 0           0               Z   0
0   0                       0             0
0         0     X       0     0 Z         0
0         Z                               0
0                     0                   0
0             0           Z               0
0         0     Z               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

YOUR MOVE ? 2
SPLASH GOES A ZOMBIE
```

```
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                                Z      0
0       0 0           0                   0
0   0                       0       Z     0
0         0 Z     X     0     0           0
0                                         0
0                     0 Z                 0
0             0   Z                       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

YOUR MOVE ? 2
```

```
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         Z         0
0   0                       0             0
0         0   Z     X   0     0   Z       0
0                     Z                   0
0                   Z 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

YOUR MOVE ? 8
```

```
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           Z   X       0 Z Z         0
0         0         Z   0     0           0
0                   Z                     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

YOUR MOVE ? 8
```

```
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       Z X 0     Z Z           0
0   0               Z       0             0
0         0         Z   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

YOUR MOVE ? 1
SPLASH GOES A ZOMBIE
```

```
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                 Z X   Z Z             0
0       0 0           0                   0
0   0                 Z     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

YOUR MOVE ? 1
YOU'RE ZAPPED BY A ZOMBIE --- ANOTHER GAME  ? NO
```

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CONTENTS

INVERSION

FIRST A BRIEF INTRODUCTION TO THE MEANING OF "INVERSE".

FOR AN ORDINARY ALGEBRAIC EQUATION:

$$4.5\ X = 37$$

THE SOLUTION IS:

$$X = (4.5)^{-1} \times 37 = 0.2222 \times 37 = 8.222$$

THE PROCEDURE IS TO "INVERT" THE COEFFICIENT OF X AND MULTIPLY BY THE RIGHT-HAND SIDE (*RHS*). NOTICE THAT THE ORIGINAL COEFFICIENT, 4·5, MULTIPLIED BY ITS "INVERSE", 0.2222, IS 0·9999.... (IDEALLY EXACTLY 1).

IN *MATRIX* ALGEBRA THERE IS AN ANALOGOUS APPROACH TO *SIMULTANEOUS* EQUATIONS. CONSIDER THESE THREE:

$$\begin{aligned} 15X + 10Y + 5Z &= 3.1 \\ 12X + 24Y + 8Z &= 4.5 \\ 6X \qquad\quad + 36Z &= 6.3 \end{aligned}$$

THEY MAY BE WRITTEN IN MATRIX FORM LIKE THIS:

$$\begin{bmatrix} 15 & 10 & 5 \\ 12 & 24 & 8 \\ 6 & 0 & 36 \end{bmatrix} * \begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 3.1 \\ 4.5 \\ 6.3 \end{bmatrix}$$

(IF YOU FORM THE INNER PRODUCT OF ROW 1 OF THE FIRST MATRIX AND COLUMN 1 OF THE SECOND YOU GET 15×X + 10×Y + 5×Z *etc.* JUST AS THE INNER PRODUCTS ARE SET OUT ON PAGE 88.)

THE SOLUTION OF THE EQUATIONS IS:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 15 & 10 & 5 \\ 12 & 24 & 8 \\ 6 & 0 & 36 \end{bmatrix}^{-1} * \begin{bmatrix} 3.1 \\ 4.5 \\ 6.3 \end{bmatrix}$$

WHERE THE "−1" AS A SUPERSCRIPT TO THE MATRIX DENOTES THE "INVERSE" OF THAT MATRIX, WHICH (AS WILL BE SHOWN) WORKS OUT LIKE THIS:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} .1029 & -.0429 & -.00476 \\ -.0457 & .0607 & -.00714 \\ -.0171 & .00714 & .0286 \end{bmatrix} * \begin{bmatrix} 3.1 \\ 4.5 \\ 6.3 \end{bmatrix}$$

FROM WHICH YOU CAN GET ANSWERS FOR *ANY* RIGHT-HAND SIDE BY MATRIX MULTIPLICATION. FOR EXAMPLE, TO GET Y (ROW 2, COLUMN 1):

$$Y = -0.0457 \times 3.1 + 0.0607 \times 4.5 - 0.00714 \times 6.3 = 0.4598$$

TO COMPLETE THE ANALOGY WITH ORDINARY ALGEBRA, MULTIPLY THE ORIGINAL MATRIX OF COEFFICIENTS BY ITS INVERSE:

$$\begin{bmatrix} 15 & 10 & 5 \\ 12 & 24 & 8 \\ 6 & 0 & 36 \end{bmatrix} * \begin{bmatrix} \cdot1029 & -\cdot0429 & -\cdot00476 \\ -\cdot0457 & \cdot0607 & -\cdot00714 \\ -\cdot0171 & \cdot00714 & \cdot0286 \end{bmatrix} = \begin{bmatrix} 1.001 & -\cdot0008 & -\cdot0088 \\ \cdot0012 & \cdot9991 & \cdot00032 \\ \cdot0018 & -\cdot00036 & 1.001 \end{bmatrix}$$

GIVING A MATRIX VERY NEAR TO THE *IDENTITY* MATRIX — A SORT OF "MATRIX UNITY". (IDEALLY THE ANSWER SHOULD BE PRECISELY THIS BUT WE WORKED TO ONLY 4 SIGNIFICANT FIGURES.)

SO YOU CAN GET THE INVERSE SHOWN ABOVE BY SOLVING 3 SIMULTANEOUS EQUATIONS USING THE COLUMNS OF THE IDENTITY MATRIX AS RIGHT-HAND SIDES — EFFECTIVELY "DIVIDING" *MATRIX UNITY* BY THE COEFFICIENTS — OR "INVERTING" THE MATRIX OF COEFFICIENTS.

15×X	+	10×Y + 5×Z =	1	THEN	0	THEN	0
12×X	+	24×Y + 8×Z =	0		1		0
6×X	+	0×Y + 36×Z =	0		0		1

WE DO THIS AS WE DID AT SCHOOL BUT PERHAPS IN A MORE RIGIDLY-ORDERED SEQUENCE. FIRST ELIMINATE COEFFICIENTS OF X IN EQUATIONS 2 AND 3. MULTIPLY EQ.2 BY 15, DIVIDE THROUGH BY 12, AND SUBTRACT THIS SCALED EQUATION FROM EQ.1 THUS GIVING A NEW EQ.2. SIMILARLY FORM A NEW EQ.3 BY MULTIPLYING EQ.3 BY 15, DIVIDING THROUGH BY 6, AND SUBTRACTING FROM EQ.1.

	15×X	+	10×Y + 5×Z =	1	0	0
EQ2 = EQ1 − (15/12)×EQ2 ...	0×X	−	20×Y − 5×Z =	1	−1·25	0
EQ3 = EQ1 − (15/6)×EQ3 ...	0×X	+	10×Y − 85×Z =	1	0	−2·5

NOW ELIMINATE THE COEFFICIENT OF Y IN NEW EQUATION 3. MULTIPLY EQ.3 BY −20, DIVIDE THROUGH BY 10, AND SUBTRACT FROM EQ.2.

	15×X	+	10×Y + 5×Z =	1	0	0
	0×X	−	20×Y − 5×Z =	1	−1·25	0
EQ3 = EQ2 − (−20/10)×EQ3 ...	0×X	+	0×Y − 175×Z =	3	−1·25	−5

THE ORIGINAL MATRIX OF COEFFICIENTS NOW HAS ALL ELEMENTS BELOW THE DIAGONAL EQUAL TO ZERO. SO NOW "BACK SUBSTITUTE" STARTING AT EQUATION 3 AND WORKING BACK TO EQUATION 1.

THE ONLY UNKNOWN IN EQ.3 IS Z, SO DIVIDE *RH*-SIDES BY −175:

Z = −·0171   ·00714   ·0286

NOW FROM EACH *RHS* OF EQ.2 SUBTRACT (−5) TIMES THE CORRESPONDING VALUE OF Z, AND DIVIDE BY THE COEFFICIENT OF Y WHICH IS (−20) (*e.g.* THE FIRST IS [1−(−5)×(−·0171)]÷(−20) = −·0457).

Y = −·0457   ·0607   −·00714

FINALLY, FROM EACH *RHS* OF EQ.1 SUBTRACT 5 TIMES THE CORRESPONDING VALUE OF Z, 10 TIMES THE CORRESPONDING VALUE OF Y, AND DIVIDE BY 15 (*e.g.* THE FIRST IS [1−5*(−·0171)−10×(−·0457)]÷15 = ·1029).

X = ·1029   −·0429   −·00476

THESE ARE THE 3 ROWS OF THE INVERSE — PRODUCED IN REVERSE ORDER.

MAT A = INV(B)

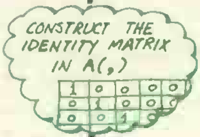
```
10   DIM   A(3,3),  B(3,3),  I(3,3)
```

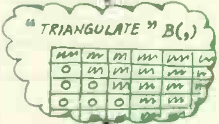
	1)	2)	3)
A(1,			
A(2,			
A(3,			

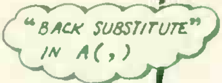
	1)	2)	3)
B(1,	15	10	5
B(2,	12	24	8
B(3,	6	0	36

HERE IS A ROUTINE TO INVERT A MATRIX OF DIMENSIONS N BY N STORED AS AN ARRAY B(,): THE INVERSE IS BUILT UP IN A(,). THE METHOD USED IS EXPLAINED BY THE EXAMPLE ON THE PREVIOUS DOUBLE PAGE.

```
200   REM    A(,) = INVERSE B(,);  N BY N.

210   FOR    I = 1 TO N
220   FOR    J = 1 TO N
230   LET    A(I,J) = 1 - ABS(SGN(I-J))
240   NEXT   J
250   NEXT   I

260   FOR    I = 1 TO N-1
270   IF     ABS(B(I,I)) > 0.00001 THEN 300
280   PRINT  "CAN'T COPE WITH"; B(I,I)
290   STOP
300   FOR    J = I+1 TO N
310   LET    X = B(J,I)/B(I,I)
320   FOR    K = 1 TO N
330   LET    B(J,K) = B(J,K) - X* B(I,K)
340   LET    A(J,K) = A(J,K) - X* A(I,K)
350   NEXT   K
360   NEXT   J
370   NEXT   I

380   FOR    I = N TO 1 STEP -1
390   FOR    K = 1 TO N
400   FOR    J = I+1 TO N
410   LET    A(I,K) = A(I,K) - B(I,J)*A(J,K)
420   NEXT   J
430   LET    A(I,K) = A(I,K) / B(I,I)
440   NEXT   K
450   NEXT   I
```







BUT YOU MAY DO THIS MUCH BETTER WITH A SINGLE "MAT" INSTRUCTION:

```
100   MAT   A = INV(B)
```

IF THE MATRIX HAS NO INVERSE (IF IT IS "SINGULAR") THEN SOME *BASICS* REPORT AN ERROR AND STOP EXECUTION; OTHERS DON'T REPORT AN ERROR BUT PROVIDE THE MEANS OF PICKING UP THE *DETERMINANT* OF THE MATRIX AS SHOWN BELOW. A ZERO DETERMINANT IMPLIES A SINGULAR MATRIX. (A DETERMINANT IS *ILLUSTRATED* ON PAGE 43.)

```
110   LET   D = DET
120   IF   D > ·001   THEN   150
130   PRINT "SINGULAR MATRIX"
140   STOP
```

CARRY ON

THE VALUE PROVIDED BY "DET" IS THE VALUE OF THE DETERMINANT OF THE MATRIX LAST INVERTED (OR LAST ATTEMPTED) BY YOUR PROGRAM. NOT ALL *BASICS*, HOWEVER, PROVIDE THE "DET" FUNCTION.

A *NON*-SQUARE MATRIX CAN HAVE NO INVERSE; ATTEMPTS TO COMPUTE ONE ARE TREATED AS MISTAKES. AND MOST *BASICS* REFUSE TO REPLACE A MATRIX BY ITS OWN INVERSE.

```
150   MAT   A = CON(2,3)
160   MAT   B = INV(A)
170   MAT   B = INV(B)
```

NOT SQUARE

SAME NAME BOTH SIDES

YOU CAN JUDGE THE ACCURACY OF INVERSION BY PRINTING THE PRODUCT OF THE ORIGINAL MATRIX AND ITS INVERSE. BY DEFINITION THIS SHOULD BE THE IDENTITY MATRIX EXACTLY BUT USUALLY DIFFERS BECAUSE OF "ROUNDING" ERRORS AS PREVIOUSLY ILLUSTRATED USING FOUR SIGNIFICANT FIGURES.

```
180   MAT   A = INV(B)
190   MAT   I = B * A
195   MAT   PRINT I
```

"MAT PRINT" IS DESCRIBED ON PAGE 98

THE DIMENSIONS OF A(,) IN ITS "DIM" STATEMENT MUST BE AT LEAST AS BIG AS THE *CURRENT* DIMENSIONS OF B(,) AT LINE 180 ABOVE. IMPLICATIONS OF RE-DIMENSIONING ARE DISCUSSED ON PAGE 79.

THE ROUTINE FROM LINE 200 OPPOSITE DIFFERS IN ITS EFFECT FROM "MAT A=INV(B)". FIRST OF ALL IT MAKES A MESS OF ARRAY B(,): THE "MAT" INSTRUCTION SHOULD *NOT* DO THIS. (IF YOUR VERSION *DOES* MANGLE B(,) IT WILL BE EVIDENT WHEN YOU RUN THE TEST AT LINE 180 ABOVE.) SECONDLY THE ROUTINE OPPOSITE ONLY WORKS WELL IF NUMBERS ON THE DIAGONAL OF B(,) ARE MUCH THE SAME SIZE AS ONE ANOTHER AND BIGGER THAN TERMS *OFF* THE DIAGONAL. (IT WILL NOT WORK AT ALL IF B(1,1) IS ZERO.) THE "MAT" INSTRUCTION SHOULD SELECT BEST DIVISORS; NOT SIMPLY USE DIAGONAL ELEMENTS AS DONE AT LINE 310 OPPOSITE FOR THE SAKE OF A SIMPLE ILLUSTRATION.

MAT READ

THIS INSTRUCTION READS FROM THE SAME "DATA" STATEMENTS AS THE ORDINARY "READ".

```
10  DIM   A(2,3),  B(3,1),  C(1,3)
20  DATA  1.5, 2.3, 3.2, 4.6, 5.7, 6.5, 7.1
30  DATA  8.9, 9.0, 11.7, 12.6, 13, 14, 15
```

	1)	2)	3)
A(1,	1.5	2.3	3.2
A(2,	4.6	5.7	6.5

	1)
B(1,	7.1
B(2,	8.9
B(3,	9.0

	1)	2)	3)
C(1,	11.7	12.6	13

SUPPOSE YOU WANT TO FILL ARRAY A(,) BY ROWS FROM THE QUEUE OF DATA STARTING ON LINE 20. YOU COULD DO IT LIKE THIS:

```
200  FOR   R = 1 TO 2
210  FOR   C = 1 TO 3
220  READ  A(R,C)
230  NEXT  C
240  NEXT  R
```

BUT YOU COULD DO THE WHOLE THING WITH A SINGLE "MAT" STATEMENT LIKE THIS:

```
100  MAT  READ  A
```

A(,) IS READ BY ROWS

IN FACT YOU MAY FILL ANY NUMBER OF ARRAYS (BY ROWS) USING A SINGLE "MAT" INSTRUCTION:

```
100  MAT  READ  A, B, C
```

ALWAYS COMMAS IN THIS LIST

THE ARRAYS A(,), B(,) & C(,) WOULD THEN BE AS SHOWN AT THE TOP OF THIS PAGE. NOTICE THE LETTERS A, B & C HAVE NOTHING TO DO WITH SIMPLE VARIABLES A, B & C.

ON THE OTHER HAND YOU MAY *PARTIALLY* FILL ARRAYS BY SPECIFYING NEW DIMENSIONS IN THE "MAT" INSTRUCTION — AS LONG AS THEY ARE NO BIGGER THAN THOSE IN THE "DIM" STATEMENTS.

```
100  MAT  READ  A(2,2), B, C(1,1)
```

	1)	2)
A(1,	1.5	2.3
A(2,	3.2	4.6

	1)
B(1,	5.7
B(2,	6.5
B(3,	7.1

	1)
C(1,	8.9

IF YOU OMIT DIMENSIONS FROM "MAT READ" THEN *BASIC* USES THE *CURRENT* DIMENSIONS OF THAT ARRAY — THESE MAY BE SMALLER THAN THOSE IN ITS "DIM" STATEMENT.

```
100  MAT  A = ZER(1,1)
110  MAT  READ  A
```

THUS THE INSTRUCTIONS ABOVE WOULD CAUSE JUST ONE NUMBER TO BE READ INTO THE 1 BY 1 ARRAY A(,). IMPLICATIONS OF SUCH RE-DIMENSIONING ARE DISCUSSED ON PAGE 79.

YOU MAY HAVE VARIABLES OR EXPRESSIONS AS DIMENSIONS IN THE "MAT" STATEMENT:

```
10  DIM   E(10,10)
20  DATA  2, 3                           <- DIMENSIONS AS DATA
30  DATA  1.1, 2.2, 3.3, 4.4, 5.5, 6.6
40  READ  R, C
50  MAT   READ  E(R,C)                   <- EXPRESSIONS ALLOWED HERE
```

BUT ALWAYS ENSURE (PERHAPS BY USING "INT") THAT THE EXPRESSIONS YIELD INTEGRAL RESULTS BECAUSE SOME *BASICS* USE THE *NEAREST* INTEGER TO THE RESULT AND OTHERS USE THE *INTEGRAL PART*.

THERE IS ONLY ONE QUEUE OF DATA IN THE "DATA" STATEMENTS AND EACH "READ" OR "MAT READ" TAKES WHAT IT NEEDS WHEN OBEYED. THE INSTRUCTION "RESTORE" TAKES THE PROGRAM BACK TO THE BEGINNING OF THE QUEUE AS EXPLAINED ON PAGE 17.

THE "MAT READ" INSTRUCTION IS USEFUL FOR SETTING UP "STATE TABLES" IN PROGRAMS THAT USE SUCH DEVICES: A FULL EXAMPLE IS INCLUDED ON PAGE 102.

CHAPTER 5

MAT INPUT

THIS INSTRUCTION DEMANDS COMPLETE ARRAYS AS INPUT DATA.

```
10   DIM   A(3,3)
```

	1)	2)	
A(1,	1.5	2.6	
A(2,	3.7	4.8	

HERE IS ONE WAY TO FILL A SPECIFIC PART OF AN ARRAY WITH NUMBERS DEMANDED FROM THE KEYBOARD.

```
200   PRINT "TYPE THE DIMENSIONS"
210   INPUT R,C
220   FOR  I = 1 TO R
230   PRINT "TYPE ROW"; I;"ONE NUMBER PER LINE"
240   FOR  J = 1 TO C
250   INPUT A(I,J)
260   NEXT  J
270   NEXT  I
280   END
RUN
TYPE THE DIMENSIONS
? 2,2
TYPE ROW 1 ONE NUMBER PER LINE
? 1.5
? 2.6
TYPE ROW 2 ONE NUMBER PER LINE
? 3.7
? 4.8
```

THIS COULD BE ACHIEVED IN A DIFFERENT WAY USING THE "MAT INPUT" INSTRUCTION LIKE THIS:

```
100   PRINT "TYPE THE DIMENSIONS"
110   INPUT R,C
120   PRINT "TYPE"; R ;"ROWS OF"; C;"NUMBERS"
130   MAT INPUT  A(R,C)
140   END
RUN
TYPE THE DIMENSIONS
? 2,2
TYPE 2 ROWS OF 2 NUMBERS
? 1.5, 2.6
? 3.7, 4.8
```

WHENEVER YOU WANT TO DEMAND DATA FROM THE KEYBOARD IT IS BETTER TO WRITE A SPECIAL INPUT ROUTINE (SUCH AS THAT STARTING AT LINE 200) THAN TO USE THE "MAT INPUT" INSTRUCTION. THREE REASONS ARE:

YOU CAN PRINT HELPFUL INTERMEDIATE MESSAGES SUCH AS THAT ON LINE 230 ⇔ IMPOSSIBLE USING "MAT INPUT".

YOU MAY TEST THE RANGE OF EACH NUMBER AS TYPED AND TAKE ACTION BEFORE THE WHOLE ARRAY HAS BEEN TYPED. FOR EXAMPLE, IF YOU KNOW THAT ALL NUMBERS SHOULD BE *SMALLER* THAN ±10:

```
252    IF  ABS(A(I,J)) < 10  THEN  260
254    PRINT "OUT OF RANGE; RETYPE COL."; J
256    GO TO  250
```

THEN YOU COULD INSERT THIS ROUTINE IN THE ROUTINE OPPOSITE.

TYPING ONLY ONE NUMBER PER LINE AVOIDS AN EMBARRASSING PROBLEM: WHAT IF YOU CAN'T GET THE WHOLE ROW ON ONE LINE? SOME *BASICS* ALLOW AN AMPERSAND ⇔ & ⇔ AT THE END OF THE LINE TO SAY "I HAVEN'T FINISHED THE ROW YET": OTHER *BASICS* OFFER DIFFERENT SOLUTIONS.

SO FOR THE SAKE OF PORTABILITY, IF NOTHING ELSE, *DON'T* USE "MAT INPUT" FOR DEMANDING DATA FROM THE KEYBOARD. THIS INSTRUCTION IS USEFUL FOR OTHER PURPOSES AS WILL BE SHOWN.

THE LIST FOLLOWING "MAT INPUT" MAY CONTAIN NAMES OF ANY NUMBER OF ARRAYS; ANY OF THESE NAMES MAY HAVE DIMENSIONS AFTER THEM. AS IN THE CASE OF "MAT READ" THE DIMENSIONS MAY BE INTEGERS, VARIABLES OR EXPRESSIONS AS LONG AS THE VALUES EXPRESSED DO NOT EXCEED THOSE IN THE "DIM" STATEMENTS. IF YOU USE EXPRESSIONS FOR DIMENSIONS MAKE SURE THEY WILL ALWAYS YIELD INTEGRAL RESULTS BECAUSE SOME *BASICS* USE THE *NEAREST* INTEGER TO THE RESULT AND OTHERS THE *INTEGRAL PART*. SOME OTHER IMPLICATIONS OF RE-DIMENSIONING ARE DISCUSSED ON PAGE 79.

```
150    MAT INPUT  A, B(2,1), C(2*X, Y)
```

ALWAYS COMMAS

CHAPTER 5

MAT PRINT

THIS INSTRUCTION CAUSES COMPLETE ARRAYS TO BE PRINTED.

```
10   DIM   A(3,3),   B(2,3),   C(2,3)
20   MAT   A = IDN(2,2)
30   MAT   B = CON
40   MAT   C = (-1.5)*B
```

	1)	2)	
A(1,	1	0	
A(2,	0	1	

	1)	2)	3)
B(1,	1	1	1
B(2,	1	1	1

	1)	2)	3)
C(1,	-1.5	-1.5	-1.5
C(2,	-1.5	-1.5	-1.5

HERE IS A ROUTINE TO PRINT THE 2 BY 2 MATRIX STORED IN ARRAY A(,) AND TO PRINT IT BY ROWS.

```
200   PRINT                 <= START A NEW LINE
210   FOR   R = 1 TO 2
220   FOR   C = 1 TO 2
230   PRINT  A(R,C);        <= ; ENSURES RESULTS ARE CLOSE TOGETHER IN EACH ROW
240   NEXT  C
250   PRINT                 <= START A NEW LINE
260   PRINT                 <= ONE BLANK LINE BETWEEN ROWS
270   NEXT   R
```

YOU CAN DO THIS WITH A SINGLE "MAT" INSTRUCTION:

```
100   MAT   PRINT   A;      <= PRINT RESULTS CLOSE TOGETHER
```

AND YOU MAY PRINT ANY NUMBER OF ARRAYS WITH A SINGLE "MAT" INSTRUCTION. THE PUNCTUATION IS EXPLAINED IN MORE DETAIL OPPOSITE.

```
110   MAT   PRINT   A; C,   <= PRINT C(,) IN ZONES
```

THESE ARRAYS GET PRINTED BY ROWS. (IF YOU WANT *COLUMNS* OF AN ARRAY PRINTED AS ROWS ON THE PAGE USE "MAT B=TRN(A)" FIRST.) THESE ARRAYS ARE PRINTED ACCORDING TO THEIR *CURRENT* DIMENSIONS. THUS ARRAY A(,) WHEN PRINTED WOULD HAVE 2 ROWS WITH 2 NUMBERS IN EACH ROW: IT WAS GIVEN THESE DIMENSIONS ON LINE 20 ABOVE. ARRAY C(,) WOULD HAVE 2 ROWS, EACH OF 3 NUMBERS.

DON'T WRITE DIMENSIONS IN THIS INSTRUCTION. *BASIC KNOWS* THE CURRENT DIMENSIONS OF ALL ARRAYS AND OBJECTS TO BEING REMINDED.

```
120   MAT   PRINT   A(2,2) ; C   <= COMMA IMPLIED BY OMISSION
```

ILLUSTRATING BASIC PAGE 98

LAYOUT OF THE OUTPUT PAGE FOLLOWS THE RULES GIVEN BELOW ⇐ THOUGH THERE MAY BE MINOR DIFFERENCES IN SOME *BASICS*.

EVERY ROW OF THE ARRAY STARTS A NEW LINE ON THE OUTPUT PAGE.

THERE IS A BLANK LINE ON THE OUTPUT PAGE AFTER EVERY PRINTED ROW OF THE ARRAY.

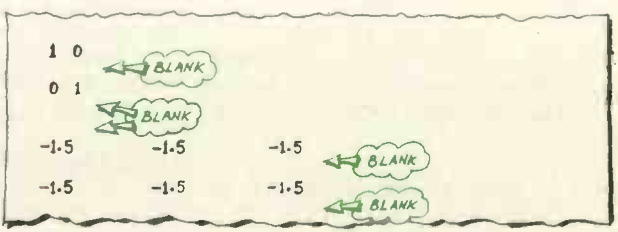
IF A ROW OF THE ARRAY DEMANDS MORE THAN THE WIDTH OF THE OUTPUT PAGE (TYPICALLY 72 CHARACTERS) THEN THE ROW IS CONTINUED ON THE NEXT LINE OF THE OUTPUT PAGE.

IF A SEMICOLON FOLLOWS THE NAME OF AN ARRAY IN THE LIST AFTER "MAT PRINT" THEN THE NUMBERS IN EACH ROW ARE PRINTED CLOSE TOGETHER; IF A COMMA FOLLOWS THE NAME THEN THE NUMBERS ARE PRINTED IN ZONES (TYPICALLY 15 CHARACTERS WIDE). THE PRECISE EFFECTS OF SEMICOLONS AND COMMAS IN THIS CONTEXT ARE EXPLAINED ON PAGE 29.

IF THERE IS NO PUNCTUATION AFTER THE FINAL NAME LISTED IN THE "MAT PRINT" INSTRUCTION THEN A COMMA IS IMPLIED BY OMISSION. (PUNCTUATION IS ESSENTIAL *BETWEEN* ITEMS IN THIS LIST.)

YOU MAY FIND THE RIGID FORMAT IMPOSED BY THIS INSTRUCTION GIVES LITTLE SCOPE FOR DESIGNING ATTRACTIVE PAGE LAYOUTS ⇐ BUT THE INSTRUCTION IS VERY USEFUL WHEN DEVELOPING NEW PROGRAMS.

WITH THE ARRAYS AT THE TOP OF THE OPPOSITE PAGE THE OUTPUT GENERATED BY LINE 110 WOULD LOOK LIKE THIS:



BASIC Computing

by Robert P. Hammond (Published Deerfield Academy, 1978; 43 pages; price $1·75).

DEERFIELD ACADEMY is a college in Massachusetts and this book was produced by its maths department; a committee of three staff and six students was responsible for the first real edition, in 1976.

Here's the rationale: "We felt that we needed some sort of step-by-step back-up written encouragement in the learning process. In our opinion, none of the existing Basic introductions answered the purpose; each moved too quickly and didn't provide the right amount of empathy for the nervous high school beginner."

If you don't like the existing texts, it makes sense to write your own. The text is also intended to be generally suitable for anyone using a PDP-RSTS/E system—RSTS being the acronym for the Resource Sharing Time Sharing operating system on the PDP-11.

The book is certainly pitched at a level appropriate for school and college students requiring the knowledge of a computer language to carry-out assignments, bearing in mind the restriction that it is aimed solely at systems with RSTS/E and its Basic.

The language statements covered are explained in a competent and generally sympathetic fashion, with the examples used to illustrate the text being mostly of a non-technical nature. The book does, however, show its mathematical origins by including examples and exercises on quadratic equations and the Fibonacci Series.

As is common with texts of this type, each section is summarised by a set of exercises. No answers are provided and the reader is expected to have access to a computer terminal to try the exercises for himself.

The major point in favour of the book is the style of writing. Every effort is made to alleviate the fears that a beginner may feel towards the computer, starting in the introduction with the remark that "as far as we know there hasn't been a single computer fatality".

Other points we liked include the much-needed comment that very few programs work first time and that it is important to use single test data, with known expected results, to make sure that a program performs exactly in the fashion required.

As frequently is the case, though, the book is deficient in some explanations. In particular, it omits some of the more commonly-used facilities of the language, like character string manipulation and file handling. These two functions differ from one version of Basic to another, so the author of a generalised handbook at least has some excuse. Deerfield is writing specifically for one dialect of the language, and could have covered all of its functions.

Conclusion

- **This book is designed specifically for second-level beginners using a PDP-11 with RSTS Basic. As such it is likely to be in appropriate for the general reader, and in any case we resented its omissions. It is cheap, albeit typed and available only by post from Deerfield Academy, Deerfield, MA 01342, U.S.**

Using the 6800 Microprocessor

by Elmer Poe (published by Howard Sams Inc; paperback, 175 pages; £5·05).

WHAT would you expect from a book with the word 'using' in its title? Applications examples? Guidance on systems design? Something on interfacing techniques?

Well, if they are your expectations you will be disappointed with *Using the 6800*. In the final analysis it is another none-too-inspiring 'introduction' book.

To be fair, it's a well-produced book, abounding in flowcharts and diagrams with clear and spacious text setting, but it proves that you can have too many flowcharts. The profusion of them in covering such a straightforward topic as moving a byte of data contributes to the overwhelming sense of obfuscation with which the reader is left.

More important, where diagrams would really have been of genuine benefit—explaining the 6800 interrupts structure,

for instance—there is next to none and the reader is left hopelessly confused over such unimportant topics as the use of the stack pointer and the saving of the MPU status.

To his credit, Poe includes chapters on interfacing, A/D conversion and systems design. They are woefully short, though, and of little practical use.

The final chapter, on systems design, claims optimistically that the reader will be able to "determine the hardware/software distribution in a system and "design software efficiently after reading its two bare pages of text.

Conclusion

- **Fine as an introduction text, but at £5·05 for about 175 pages you could probably find something far better. This book flogs to death the basics and glosses over more advanced topics, leaving the reader not much better off than when he started.**

Beginning Basic

by Paul M Chirlain (Dilithium Press, 1978; limp covers, A5, 224 pages, £7·12).

WITH the departure of Dymax, Dilithium Press is challenged only by Sybex as a fount of general books for the small computer enthusiast. Dilithium bought Dymex, so some of the well-liked titles from that imprint—including James White's *Your Home Computer*, one of the introductions we can recommend—are still available.

Dilithium's reputation tends to be for fact-filled books with no frills and dull covers. *Beginning Basic* is a meaty little tome. Although written as a students' text book, its approach provides a structured and generally concise introduction to programming in Basic.

It covers not only the structure of the language but it also explains how a programmer and a Basic program interact with the computer, in that there is a simple but very neat explanation of compilation and interpretation.

The author shows commendable concern for the problems likely to be met by the beginner and takes pains to illustrate how faulty programs can be debugged. You are shown how to approach the writing of Basic programs in a manner which will undoubtedly alleviate much of the frustration inherent in learning a programming language.

Chirlain explains major examples with flowcharts, which we liked; he also stresses the need for and uses of documentation—this is often overlooked. Each chapter has a number of worked examples, most having a mathematical bias, and is terminated by a set of problems for the reader to try.

That brings us to a major criticism. The author has provided no answers within the text. A separate Instructors' Manual must be bought to find the correct solutions. We do not like this approach; there is a sneaking suspicion that it is a way to sell a second book. At £7 for the first one, we felt we deserved the answers as well.

The pitfalls associated with each statement type are well explained, with good examples of what a general language implementation will and will not allow. Differences in the implementation of Basic are noted, which is good; curiously the author makes an exception for the chapter covering file handling.

Conclusion

- **This book was designed by an electrical engineering academic for students. It can still serve, however, as a useful introduction to programming in Basic for the general reader.**
- **Coverage is thorough and the style palatable. The fact that the book is more expensive than most of its competitors may detract from its appeal, however, and so might the absence of those test answers.**

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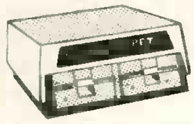

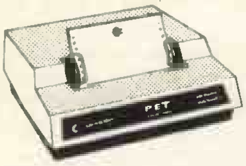

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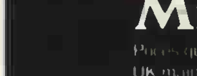

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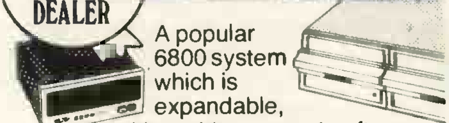

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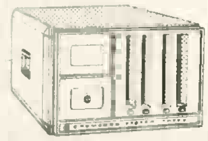

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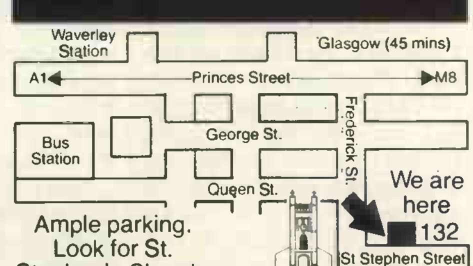

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Insight to computing tasks

THE AIM OF this series is to present the basic concepts and principles in computing. Its purpose is to help clear many misconceptions, to give a better understanding of and some insight into the tasks involved in computing.

While the title of the series is Practical Concepts, the emphasis will be on the application and use of the concepts and principles in practical work. The terminology used will be non-technical as far as is possible, so that newcomers to computing can grasp the significance of the ideas.

They may also stimulate the more experienced towards re-examining some of those aspects which are so often taken for granted. An explanation of principles in practical terms should also help those who become involved with computer applications, as a recipient or as a manager.

As far as I am concerned, there are no laws of computing, no hard and fast rules. There are concepts, ideas, principles, ways of doing things, 'practices'—which, are merely someone's opinions formulated at sometime or other.

Restrictions

True, certain ways of doing things have proved better than others, and there are also rules, for example, in various computer languages. But they are merely restrictions to enforce a certain agreed method and there may well be other ways of achieving the same results. Those are methodologies, as opposed to laws, based on opinions formulated from experience.

This is one of the basic principles of this series. The concepts presented are all opinions, albeit considered opinions.

Because of that, there is a standing and open invitation for readers to write and express their opinions and/or concepts on any topic relevant to computing, whether or not they have been discussed in the series.

One of the prime aims is that the series should be a two-way conversation and a genuine forum for the propagation of practical concepts in computing.

Is this a computer ?

The movement of computers into small businesses, the automation of more and more equipment, the emergence of home computing, and even the existence of this magazine can all be attributed to one thing—the new technology of microcomputers.

Readers probably will be familiar with the names of the Intel 8080, Motorola 6800, Zilog Z-80, MOS 6502, and so on. There have been articles written, conferences, and even TV programmes about them. The media have coined the term "the computer on a chip", a convenient and even effective terminology which has

Vincent Tseng has been a featured speaker at several conferences and seminars. He is an authority on developing microprocessor applications. He is principal consultant for microcomputers at ICL Dataskil, where he was responsible for setting-up the central consultancy and microdevelopment workshop. He is a regular reviewer for *Practical Computing*.

been accepted by many people, but what exactly are we talking about?

Those well-known names are not microprocessors. They are merely dual-in-line packaged integrated circuits or, to put it another way, a microprocessor is just a component. While it is a very clever component, based on the technology which packs a very large number of logic ele-

by Vincent Tseng

ments into a single integrated circuit, it can do very little on its own. It is not a computer but a component which can be used to make up a computer.

To utilise a microprocessor as the processor unit of a computer, it needs to receive a logical sequence of instruction and data patterns. The most convenient way to supply that information in an orderly manner is by memory elements, which normally are of two types, Read-Only Memory (ROM) and Read-and-write memory (or Random Access Memory, RAM).

Having equipment talking to itself is not much use: to be useful, it needs to communicate with the outside world. This is done by input/output signals (I/O).

The components communicate with each other via a system called a bus. For the moment this can be considered as sets of parallel wires carrying signals which are either ON or OFF, therefore being able to carry patterns of address, data and control. So the components can be connected by this method. Only when a microprocessor has been configured with some memory and I/O can one call it a computer.

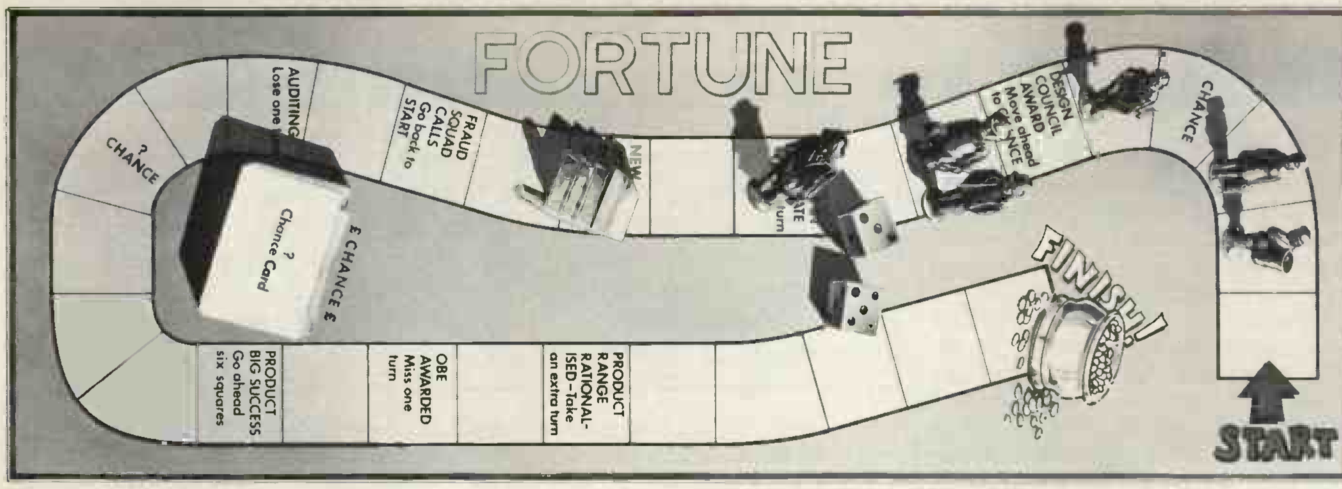
When the microprocessor label can be replaced with CPU (central processor unit), it becomes no more and no less than the configuration of a conventional computer. There is nothing new in the concept of microcomputers.

Some people may contend that microcomputers are supposed to be the very latest technology. This may be so in the fabrication and manufacturing technology; it is not so in the concepts of computer architecture. Most of the well-established microprocessors have fairly primitive internal structures when compared to conventional present-day computers.

Versatile

All we can say is that we are working with the latest technology in electronic manufacturing and the only real pioneering is being done on the application of computer power in areas not considered previously.

Microprocessors may be versatile, powerful and even influential, but they are not yet computers—they are merely components. They are only 'state-of-the-art' in the fabrication technology; the conceptual use of micros as computers is well-established and now conventional. Any application making claims to be the latest technology can be justified only if the application is sufficiently original.



Initial development

by Mike Collier

THE REVOLUTION in the computer world which has resulted in huge reductions in the price of computer hardware has also created many problems for users of such equipment. When a typical computer installation cost £100,000 or more, it was sensible to invest another £20,000 to have the best possible programs written.

Now we can obtain a small business system for more in the region of £3,000 to £10,000, the prospect of heavy costs for software seems out of proportion. So many small businesses faced with the problem are deciding to write their own systems or to use a friendly amateur computer programmer.

It appears logical at first sight to visit the local computer shop, pay the necessary cash for a smart new Apple, TRS-80, Sorcerer or whatever, together with a couple of floppy discs and a printer—not forgetting the Basic programming manual—and expect to have a system up and running within a day or two. But there are snags.

Stepping forward

The intention is to take you several steps further into the world of system analysis and to show how to design and develop a computer system which will really be effective for your own particular circumstances.

Systems analysis can be described as the building of a bridge between the user, or potential user, and the programmer. In many cases the user and the programmer may be one and the same individual but, even so, it is unlikely that he will be an expert on both the application in question and the hardware and software available.

In the progessional world of computing the analyst has to understand the requirements of the user and also to know the capabilities and limitations of the computer.

The design of a satisfactory business system is much more involved than writing a programme to play Hangman or Mastermind, since it will be in constant use—possibly by several people, some of whom may have little or no knowledge of computers.

It may be used for many years, perhaps even after you have departed for pastures new, so it is worth the effort of doing the job properly from the outset.

The decisions, such as methods of file organisation, must be made correctly from the beginning or the system is doomed. Any system which is not a success will invite criticism and affect the further advance of business computing, which will be detrimental to all of us.

When starting to design a new computer application you should not expect to be able to write the programs at once. There is a great deal of work to be done before this can be started.

First, the existing system has to be investigated thoroughly. Once that is completed, it will be possible to give some thought to the question of file contents and file organisation, based on the information collected. They are the critical decisions for any system.

Even if you intend to make use of a standard system obtained from a magazine or bought from a software supplier, the system analysis work will still be necessary to check that the programs are suitable for the particular application, and to decide what amendments may be necessary.

Professional computer departments make surprisingly little use of standard packages, because most applications tend to lack standard requirements and the cost of understanding the packages and then carrying-out the changes to make them suitable is likely to be greater than the cost of writing the system from scratch exactly as required.

The same applies to microprocessors. General accounting packages for £25 or stock recording systems for £20 are on offer. Anyone buying them, however, can be faced with several problems.

Disadvantage

They may be written in a version of Basic incompatible with the computer to be used; the files may not have room for the extra information necessary; the package may not cope with the particular parts coding system in use.

Consultants, of course, will often make use of their own standard program, because they already have a deep understanding of how they work and what they can and cannot do; as a newcomer to a package you would not have this advantage.

Let that not discourage you, however, from studying programs published in magazines to discover the assumptions made by the writer and the techniques used in his programs; but when it comes to obtaining your own system, you will fare much better in the long run if you write your own system, or have some professional assistance to select and modify a standard package.

Now I will assume that the reader is intending to design and write his system. It may be a relatively simple mailing-list

MIKE COLLIER designs computerised business systems, not in terms of putting together the boxes for the businessman's office but by assessing and organising how the software of a small computer can fit the needs of the application.

That is what systems analysis and design is about and in this three-part series he provides an introduction for the businessman to the basic principles, and to the practicalities, of thinking about what you want your computer to do.

application or an integrated system covering stock control, invoicing and accounting—with a mailing list included for good measure—but the approach should always be the same.

Today's system may be only to maintain a mailing list but you may want to expand later to include other facilities, and unless the files have been designed with that in mind, you could find you may have to change everything. So let us examine the detail of how to do it.

If a computer system is being considered normally it will be to replace an existing manual system. So the first step is to understand fully how the manual system works. If something is missed at that stage, it may be very difficult to introduce later.

Formal approach

The best way to ensure a complete understanding is to formalise the procedures by producing a flowchart of the various stages and decisions required. As an example, figure 1 shows a flowchart of a simple invoicing application using the standard flowchart symbols.

Together with the flowchart, it is essential to obtain certain other pieces of information—the likely volumes of each type of transaction must be measured or estimated; if a product file is envisaged, then the number of products and the frequency of new product creations and old product deletions must be known; similarly for customer files it is important to know if there are 200 customers each ordering every month, or whether each order is from a customer who may never order again.

Another important point requiring investigation is to discover the coding systems being used, or if none is being used, then a suitable one may have to be invented.

Most coding systems tend to be most unhelpful to the computer programmer, since they seem to be constructed of a random collection of alphabetic and numeric characters, probably with punctuation marks included for good measure. It would be pleasant to change this complex coding system for a straightforward numerical one but that is not usually possible without destroying the usefulness of the entire system.

If a particular product is known as MCU47-29A, then calling it something different will cause only the additional chore of having to seek the computer code each time the part number has to be entered into the computer, thus causing confusion to the user, who will then have to deal with two coding systems.

Very often the code used is that by which the part is ordered from the supplier, so it is an important piece of information. Therefore we shall have to stay with whatever weird and wonderful coding system may have evolved over the years and make our computer system sufficiently clever to cope with it. With all the power of the modern microprocessor at our disposal, this should not be too difficult and requires only a little thought and application.

In other cases, there may not be a coding system in use, Many businesses, even large ones, refer to their customers by name and not by any account number. Although that is acceptable in a manual system, using a name is much too imprecise for a computer system.

File methods

There are all the problems of spelling as well as doubt in some instances over the precise title of the customer. In manual systems, the human memory is very good at handling such imprecise data and allowing the account of J G Jones (London) to be found when someone asks for the Jones account.

For the computer system, we would like customers ideally to be given a neat, numeric code which would allow a simple file organisation to be used—but again we must pay attention to what the user is accustomed. We may not be able to handle the full alphabetic customer name conveniently but we should try to devise a code which follows similar lines, thus giving the user the nearest thing possible to his present methods.

He expects to find the Jones account in the J section, so we should base the code on the key word of the customer's title. With the size of file found normally in small business systems—say about 250 to 1,000 customers—there is no need to use the whole of the key word; the first two or three characters normally will be enough to identify the great majority of customers and to cover those few instances where it does not, we can add a couple of numerics on the end to make the codes.

Code system

In that manner we can obtain a meaningful customer code which takes only four characters. We shall, of course, have to suffer this convenience to the user by making the programs a little more complex than we would have to do for a simple numeric code, but this is a small detail in a system to which the user will be able to relate with ease. Using this approach, the following codes could be created:

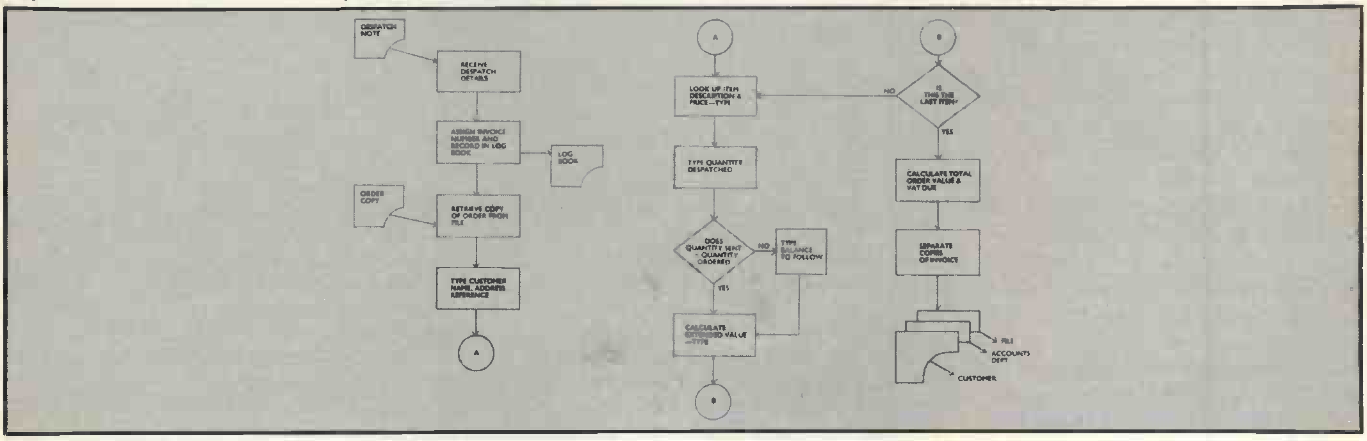
J. Wilson Ltd	WI01
Carter Associates	CA01
Basic Computing	BA01
Wickstead Garages (London) Ltd	WI02
Baltic Freight Company Ltd	BA02

If the user cannot remember the code for Baltic Freight he will try BA01, to which the computer will reply that it is the code for Basic Computing. He will then try BA02 and discover that he has the required account, all without the need for any referring to code lists, and without the need for the computer to do much in the way of file-searching.

One essential point about codes is that whenever a code is assigned to a product, customer, or whatever, that code must never be altered unless the system user wishes it to be changed. That is, of course, because the user will become familiar with codes over a period and any changes on the grounds of simpler programming methods will be condemming the user to a lifetime of look-up tables. Most businessmen can use their time more efficiently.

Having ascertained the volumes of transactions, understood the workings of the existing system and decided on coding methods, we will then be in a position to think about file organisation.

Figure 1. Flowchart of simple invoicing application.



Menu approach minicab operati

MONITOR, the idea which won our competition for MIKE STANLEY

A TAXI OFFICE is not such an unlikely location for a microcomputer as you might think. If you were to visit a taxi office during a busy period, you would see that the situation cries out for re-organisation of some kind. But what exactly does it need? Here's MONITOR, the Multi ONgoing Information Technique for Online Retrieval.

UNTIL RECENTLY, there was no easy answer to the problems of the hire car firm. Various systems have been tried with varying degrees of success; ultimately they have all fallen short of requirements.

To gain an understanding of MONITOR, let us look at the existing manual system, and especially the role of the receptionist. It should be pointed out at this stage that MONITOR is designed to aid the receptionist and not to replacc that job function—it is too important to trust to a machine.

A private hire firm can consist of one driver or a few hundred. The firm for which I work has 30 or so drivers, which seems to be fairly typical. At the centre of the operation is the receptionist. She is usually the first contact with the customer. She also has to deal with personal callers to the office, handling two telephones and the two-way radio, as well as making endless cups of tea for the drivers.

When someone books a taxi, the information is written on a chit and placed on a board in chronological sequence with the other bookings. When a driver is eventually sent on that call, the chit is transferred to another board, where it is placed alongside the driver's number.

At the end of the day the information on the board has to be transferred again, this time for permanent records. One of the more important files used here is the contracts file.

❛ As the evening progresses, it becomes busier and busier, until chaos reigns.❜

Contracts are arrangements made with local firms, hotels, schools and other organisations whereby they use the taxis freely and are invoiced monthly as in normal business transactions. The drivers, however, receive their contract money weekly from the taxi firm, which then has to recover it from the various invoices. As this forms a major part of the business, it needs to be controlled very strictly.

So why introduce a computer? The problem is that the workload is not spread evenly, nor can it ever be. The level of activity varies from zero to a point where sometimes we are unable to cope and have to unload work to other taxi firms. On a Saturday evening, there is a quiet period when the drivers have relatively little to do, and usually sit in the office watching television. As the evening progresses, it becomes busier and busier, until at about 11 p.m., after closing time, chaos reigns. Drivers wonder why they do the job—next day they look at their wallets and remember. The bedlam continues until about 3 a.m. until the last stragglers reel out of the clubs.

At the office, meanwhile, the receptionist is having a rough time. All the drivers are out on jobs and the place is full of customers, many of them drunk and all demanding taxis. Both telephones ring non-stop, with more people wanting to be somewhere else. There are also bookings to be met.

The receptionist memorises a detailed map of the town and outlying districts. She also has to visualise where all the cars are at any given moment, bearing in mind, of course, that the cars are moving continually.

If a taxi is ordered from one phone box, it is no use sending one car there from the other side of town if in two minutes another car will be in that area anyway dropping passengers.

This process of tieing-up the calls is crucial to the movement of as many people as possible as quickly as possible. It also optimises the firm's income, a not unimportant consideration.

The re-scheduling of calls and re-routeing of vehicles must take place every few seconds within the receptionist's head; she always has to know if an order can be accepted and, if so, how long it will be before a car can get there.

She also needs to know the prices of all the fares—not only to give a quotation to a customer but also for the drivers. There are always new drivers still learning; and even experienced ones find new places to go.

For the same reason drivers often radio to ask for directions. She takes it all in her stride, directing the driver and often adding useful details like "go to the back door and knock very hard" or "watch for the dog".

Remember that all this takes place in a busy office with people talking, two telephones ringing, and drivers radioing. While she is trying to log the runs, it is not surprising that mistakes can occur. It is a miracle that they do not happen more frequently.

❛ Drivers wonder why they do the job; next day they look at their wallets and remember.❜

A good receptionist is difficult to find and is worth a great deal to a taxi firm. Inevitably, when one leaves us or is sick, the customers, the business and the

Figure 1. Menu screen.

DATE DD/MM/YYY

MENU

DL—DRIVER LIGHT	PM—PRINT MENU
ND—SEND OUT NEXT DRIVER	MS—MAIN SCREEN
RD—REMOVE DRIVER FROM LIST	QT—OBTAIN QUOTE
PN—PRINT NEXT DRIVER LIST	LD—LOCATE DRIVERS
LR—LAST RUN INFORMATION	CC—CANCEL LAST COMMAND
ER—ENTER RUN INFORMATION	FN—FIND NEAREST DRIVER
RT—ENTER RETURN INFORMATION	NB—ENTER MISCELLANEOUS NOTES
EB—ENTER BOOKING	BN—PRINT MISCELLANEOUS NOTES
CB—CANCEL BOOKING	BL—PRINT BANNED PERSONS LIST
PB—PRINT BOOKINGS LIST	CL—PRINT CONTRACTS LIST
RW—PRINT ALL RUNS AWAITING	DE—DIRECTORY ENQUIRIES
PR—PRINT ALL RETURNS	PP—PRINT PHONE DIRECTORY
BR—DRIVER SENT ON BUM RUN	PI—PRINT PLACE INFORMATION
PD—PRINT DRIVER DETAILS	SE—SUNDRY ENTRIES
FI—FINISH	

. to solving ng problems

drivers all suffer. New receptionists are often frightened away when they realise exactly what is expected of them. Those who stay take a long time to reach the standard of their predecessor.

So what can be done? Enter the computer. The all-singing, all-dancing MONITOR system will alleviate all these difficulties.

The system

MONITOR is based on the menu approach. When the program is first loaded it will ask for the date and display the menu in figure 1.

The menu is a set of easily-remembered program commands, with each command calling a different subroutine or program module. The advantage of this method is that a simple skeleton system can be set up

> **‘The process of tieing-up the calls is crucial to the movement of as many people as possible as quickly as possible.’**

and later, as time and other resources allow, the trimmings can be added to give a more sophisticated system.

The menu can be displayed at any time by typing PM (Print Menu) or by typing an invalid command.

The main screen (type in MS) is the one displayed throughout most of the day. Shown in figure 2, it is divided into three parts which, with a colour graphics system, could be in different colours.

Calls list

This shows the next six scheduled calls. It contains a run number which is used later, the departure point and destination of the call, the time the call is due, the price quoted (if any), an indicator to differentiate between bookings and returns, and a driver's number if someone has been assigned specifically to a particular run. The difference between a booking and a return, incidentally, is that on a return the driver who carried the passengers originally will usually collect them later.

Runs waiting

This is simliar to the bookings and returns, except that the calls have not been booked. They result from a telephone call or from a caller to the office and are required immediately.

Next driver

If there are drivers in the office, this list shows the order of the next seven drivers to be despatched. To send a driver on a call the receptionist types ND and the run number. The computer will print-out the number of the next driver available. The receptionist has the option of accepting this or over-writing it with another number. The screen is then updated by the ‘calls list’ moving up one place and the next-driver list moving down one place. The information is also written away to a file on disc.

To enter a booking, type EB. The computer will respond by asking a series of questions such as ‘Where from?”, “Where to?”, “What time?”. The system will supply its own run number and write the details to a file.

The bookings have to be sorted into order. As it would be impracticable to sort them physically each time a new booking is entered, they would have to be sorted logically using record pointers.

‘Runs waiting’ are entered similarly by typing ER. They, however, are stored on a separate file in the order in which they are entered. The ‘next driver’ list is added to by typing the driver's number when he walks into the office.

If someone wants a quotation, the entry is QT. The computer will ask the necessary questions and display the price.

The question-and-answer technique is employed throughout, so that by constant prompting from the computer the receptionist has very little to remember about operating the system. All the information she requires is literally at her fingertips.

From the point of view of the business it means that the loss of a receptionist will not be detrimental to everyone concerned; the special know-

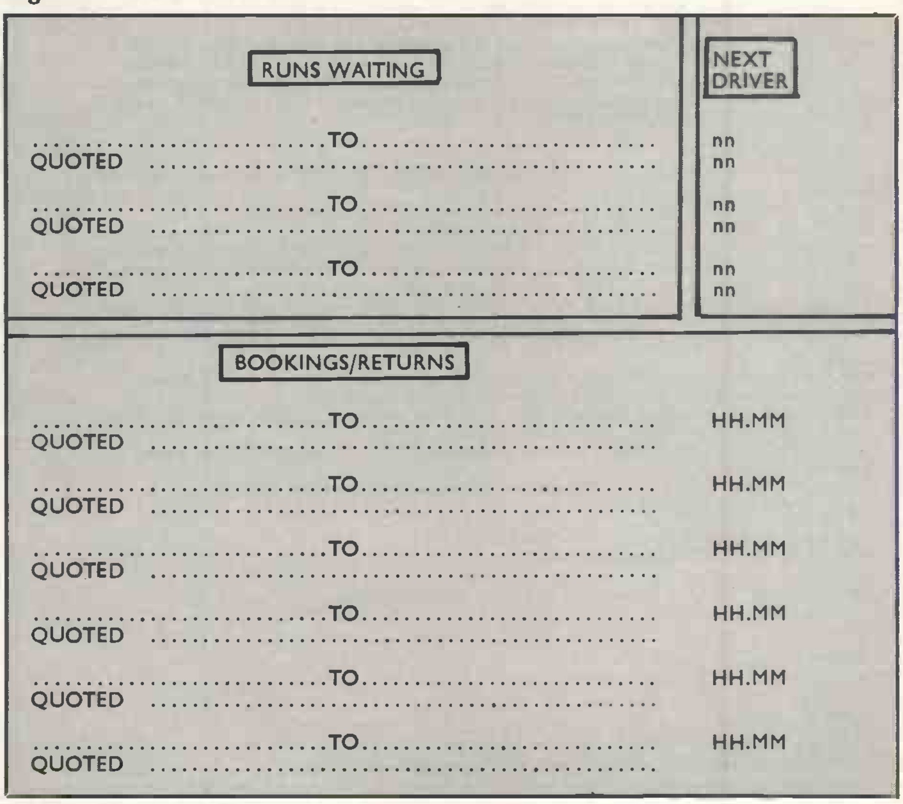
> **‘The all-singing, all-dancing MONITOR will alleviate all the difficulties.’**

ledge and skills required are not confined to selected individuals but are available freely to anyone who can push a button.

The system does not end with this program. The file which has been output during the week is input to a batch run during a quiet period, such as Sunday morning. This consists of a suite of programs which will go through the work

(continued on next page)

Figure 2. Main screen.



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done during the week to produce the following reports:

Driver's report

Each driver will receive one. It shows him what work he has done, how much he should have earned (excluding tips) and how much contract money he has due, less the amount he owes for the settlement fee, radio rental, sign rental and tea money.

Manager's report

This is a condensed version of the drivers' reports. It shows how many runs each driver has made, the amount they owe or are owed, and the contracts for each driver.

> **'It would be impracticable to sort bookings physically each time a new one is entered.'**

Invoices

This is the automatic invoicing of contracts. A summary report is also produced for the files. The invoice print would be optional as it would not be required every week. The contract details are carried forward until invoices are produced.

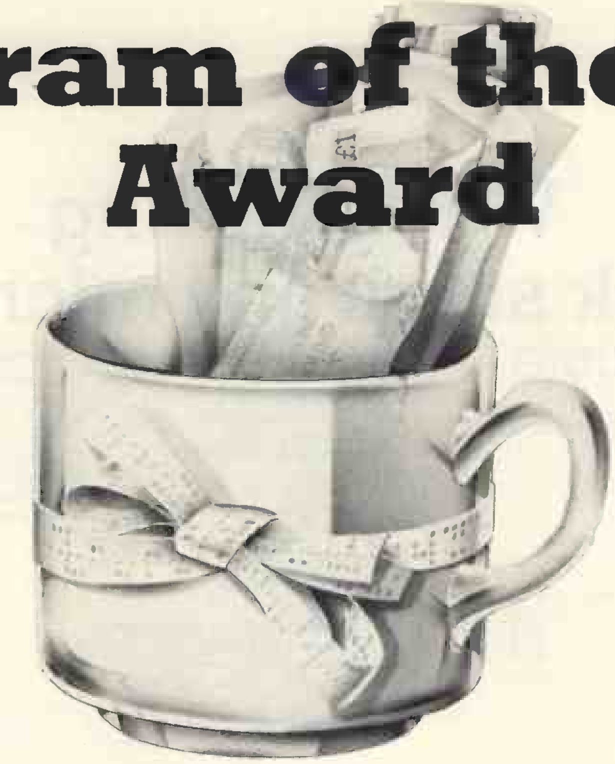
> **'By constant prompting from the computer, the receptionist has very little to remember about operating the system.'**

In addition, a history file would be produced. It would be used as and when the need arises—for instance in producing graphs or bar charts to show how the business is faring. Or it could be used to show distribution analyses, useful for planning fare increases.

Finally, there would be a general accounts program for handling the settlements, rent, rates, gas, electricity, wages, advertising and so on.

The only thing this truly remarkable system could not do is make the tea.

Program of the Year Award



Practical Computing welcomes you to its first Program of the Year Award, in which you have a chance to write a program and make some money in the process.

Awards

Two classes of awards will be given:

- A Grand Prize—to the best overall entry.
- A first prize in each of the five categories listed below, plus on extra prize awarded to the best entrant under 18 on June 15, 1979.

The *Grand Prize* winner will receive *The Practical Computing Program of the Year Challenge Cup* and a cheque for £100.

First Prize winners will receive the *Category Winners' Cup* and a cheque for £50.

First Prizes will be awarded for the following categories:

1. Business and administration
2. Sciences and mathematics
3. Computer Art
4. Games and simulations
5. Education projects

In all there will be seven winners—the Grand Prize and the Best Under-18 Entry plus the five First Prizes.

What you have to do

The judges are looking for good programming projects. By this we mean a program (or groups of programs) characterised by:

- an imaginative and/or useful *application*—we do not want elegantly-coded programs which do nothing
- full *documentation*—we need some evidence of a thoroughly thought-out approach.

How to enter

A project may be submitted by an individual or a team and any number of entries may be submitted, provided each conforms to the rules and provided each includes the following:

- a completed *entry coupon*.
- A complete *description* of the program, which must conform to the *Guidelines for Documentation. You must keep one copy for yourself, as no entries can be returned.*
- The program must have been tested thoroughly and run successfully on a computer, and entries should be accompanied by a listing of the program and samples of the output produced.

Guidelines for Documentation

The documentation must be good enough to allow someone else to use the program easily; as well as being complete and comprehensive, it must also be readable, preferably typed.

The program description must be organised as follows:

Cover page

Program title, entrant's name and address.

Single-page summary

Program title, category, the computer and programming language used, the configuration needed to run the program (how much memory is necessary, types of input/output needed, auxiliary storage requirements), and an outline of the purpose or objectives of the program, the problem it solves, and its restrictions or limitations. Include any features which distinguish this program from others of the same type.

Statement of the problem

This section states what the problem is, though not HOW you solve it, which follows on your next page.

Program description

This is a statement of how the problem was solved, what methods you used, the number of instructions involved, and the time required to run the program on your computer. You should include a flowchart using standard flowcharting symbols and techniques.

Input/Output

Sample input formats and fully-documented output samples for the reports produced should be included.

Operation

This section covers the operation of your program. If it requires any user intervention during the run, or any special preparation before it, this should be noted here; your file formats, if you use them, should also be included.

Appendices

We must have a listing of the source program, sample input/output forms, and the results of several runs which show the features of your program. Please do *not* send punched cards, floppy discs, or paper tape.

All documentation and supporting data of your project should be bound—for example in a cardboard folder or ring binder. Please remember that we consider the documentation of projects to be as important as the development and debugging of the program.

All entries become the property of *Practical Computing* and cannot be returned. World rights transfer to *Practical Computing*. Royalties will, of course, be paid if the programs are marketed subsequently, subject to agreement with the authors.

All projects will remain confidential until the end of the competition. The winners will be published in the September issue of *Practical Computing*. The judges' decision is final and no correspondence will be entered into.

All entries must be received by Friday, June 15, 1979.

Competition entry coupon

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Address ....

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Project category(ies) ....

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Multiprocessor systems

by Nick Hampshire

MORE manufacturers of microprocessor-based computers are offering systems with 10MB discs and multi-user capability but the logic of this is doubtful.

One could justify a rigid-disc system with up to 100MB controlled by a micro if the application to which it is being put is data retrieval and storage, but to add expensive mass storage to cater for extra users is not necessarily justified.

The reason for such systems lies in mainframe and minicomputers, where the processor was the most expensive item in a system. Now you can buy a 6502 or 8080 for less than £10, so why use only one processor in a system?

Microprocessor chips are not very fast or efficient compared even to minicomputers, so why reduce the speed to an almost unacceptable level by making one micro perform the processing for up to eight users?

It is the peripherals which are the most expensive part of a system. With a low-priced system like the Pet, a printer will cost more than the computer and a rigid disc subsystem more than 10 times as much. Surely it is more efficient to have a number of cheap processors sharing a few expensive peripherals than a conventional multi-user system running off just one processor?

This approach is known as distributed processing. Each user has a small low-cost computer. Each of the small machines could run programs in a high-level language like Basic. They could incorporate dual mini-floppies for user data and program storage; perhaps they could have a printer.

Data transfer between users could be as simple as the manual transfer of discs from one machine to another. At the other extreme, each user's system could be connected to a central controlling machine with a large common data store.

This set-up might even be cheaper than a multi-user system with a single processor, since a low-cost machine like the Pet with dual floppy discs is only twice the price of a VDU.

This is not the only kind of use for a multi-processor system. Considerable advantages can be obtained by incorporating more than one processor into a computer system, principally in terms of processing speed and power.

Speeding access

In the standard micro-plus-disc system, the processor controls disc access and data transfer with the disc software occupying 4K or 5K of memory. By using a separate micro exclusively to control the disc, access can be speeded, new options added, and the memory space occupied formerly by the disc controller released for the user's software.

This is the approach which has been taken by Commodore is the design of its new Pet disc system and also in the other Pet peripherals.

A true multiprocessor system is not created by connecting a group of computers or by placing microprocessors in

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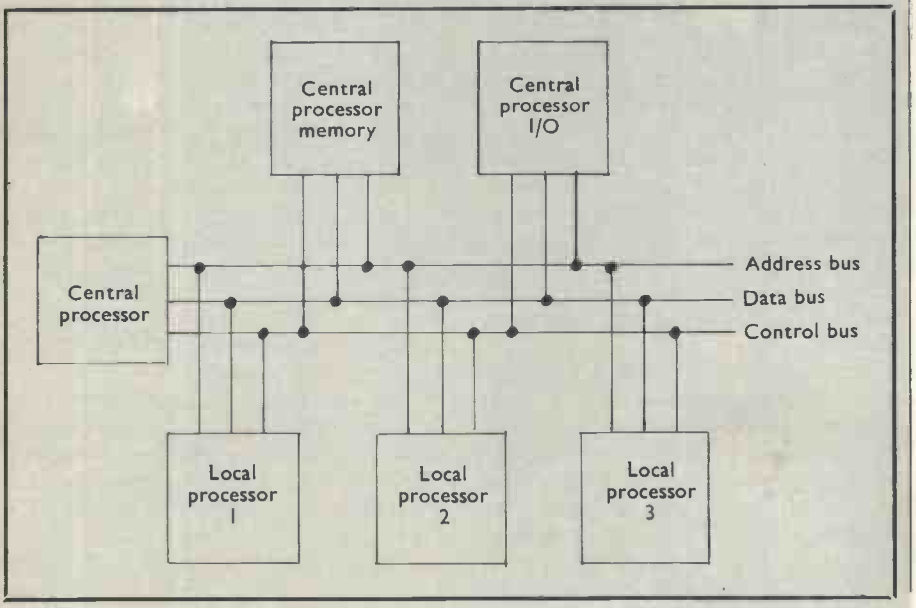
Figure 1. Multiprocessor System Design.



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all the peripherals. Communication between processors in both these methods is via an I/O channel. The problem with communication via an I/O channel is that it is considerably slower and far less flexible than communication between two blocks of memory in the same system.

So in a multiprocessor system it is desirable to have all the processors sharing common address, data and control buses. Each processor thus becomes a memory block with processing capability.

Such a system would be hierarchical in structure with a control processor and a set of local processors, each sharing a common block of memory with the control processor. Figure 1 is a block diagram of such a system.

Three-way split

Of the three forms of multiprocessor systems mentioned, it is the last which is the most interesting and potentially the most powerful. The virtue of such a system lies in the fact that the sub-processors can relieve the main control processor of much time-consuming work and thereby increase the processing speed of the computer.

The sub-processors could, for example, calculate the arithmetic functions which normally consume a good deal of processor time. A calculation like $A^2 + B^2 + C^2$ could be split between three processors —one processor doing A^2, another doing B^2 and the third doing C^2. All the main processor does is add the three results; processing time is thereby reduced to one-third of that for a single processor.

By storing the subroutines in the sub-processor memory blocks, we can give the central processor program the facility of self-executing subroutines, a feature which would be very useful in any real-time simulation program where several complex variables must be calculated at the same time.

Powerful

Although only 4K of memory may be shared by the local processor and the central processor, there is no reason why the local processor cannot have up to 64K of memory and I/O. By giving each local processor I/O circuitry to its own terminal, a very powerful multi-user system can be created where each user has his own processor, and the role of the central processor is one of system control and data access from a mass storage device.

If instead of a terminal a local processor was interfaced to, say, a multi-channel analogue-to-digital converter, the sub-processor could be devoted solely to inputting and processing data from that device, with the processed data being stored in the common memory block.

This kind of application can often take most of a processor's time, especially if sampling frequencies are high and there are several multiplexed inputs; using a sub-processor to do this frees the central processor for more essential tasks.

Another example would be the use of a local processor to control a high-density graphics display, so that the control processor could plot points and lines by giving their co-ordinates to the sub-processor.

Perhaps the most interesting property of local processors is that they can change their function under control of the central processor. The programs in each local processor, whether in shared or unshared memory, can all be loaded from the central processor and can thus be changed at any time under control from the central processor.

In my own experimentation in this field, I have used the 6502 microprocessor for both the control and local processors. The 6800 could be used equally well. The reason these two microprocessors are preferred over, say, the 8080 lies in the method used to allow two processors to share a common block of memory.

The 6502 is especially well-suited, since addresses are transmitted on the address bus during the 01 clock/pulse and data is transmitted on the data bus during the 02 clock pulse; bus conflicts between two processors can be eliminated by having the two processors run opposite-phase clocks. When the control processor is in phase 1, the local processor is in phase 2.

Buffers

The only requirement with this system is that the memory shared between the two processors must have a very fast access time if the two processors are to run at full speed. In this way the operation of each processor is transparent to the other, and to the central processor each local processor looks just like an ordinary block of memory.

To ensure the complete separation of the two address buses, the address lines from both processors are fed into an address demultiplexer. This device consists of two sets of tri-state buffers, the outputs of each corresponding pair of chips being tied together to give the address bus for the local processor memory.

The buffers are arranged so that if the control pulse is high, the central processor has control. The control input to the tri-state buffers comes from an address decoder on the central processor address bus, which also functions as a memory block select line.

This line, together with the R/W line, is used additionally to control a bi-directional data bus buffer which isolates the data buses of the two processors, except when the central processor is accessing the local processor memory block.

The remaining two inputs to the local processor are the 01 and 02 clock lines which are generated by the central processor. Before entering the local processor, those two lines are inverted so that the 01 line becomes the 02 line and vice versa, thus ensuring that the two processors run on opposite phase clocks.

To guarantee further correct timing, the 02 clock line is used to enable the address decoding logic of the local processor, so that the memory is selected only for access by the local processor during the time it is not being accessed by the central processor.

As you can see, the hardware required to implement each local processor is not very complex and it would not be too difficult to add extra processors to an existing computer—a Kim, a Pet, or a super S100 system.

Biggest obstacle

The software required by such a system is, however far from simple. The problem of creating viable software which can utilise a multi-processor system to its maximum potential has posed the biggest obstacle to the widespread use of these systems.

Two requirements must first be satisfied. The central processor must be able to write not only to the local processor memory space but it must also be able to control the local processor by generating signals on the Re-set and Interrupt lines. An I/O port on the central processor can be used for this purpose with separate outputs going to local processor Re-set and Interrupt inputs.

By generating a pulse on one of these output lines, the central processor can re-set or interrupt one of its local processors. This feature is very important during power-up and initialisation and also allows the central processor to synchronise its own processing with that of one or more local processors.

The second requirement is the creation of a protocol for communication between central processor software and local processor software. To achieve this the area of shared memory must be divided to give fixed locations for input and output variables, status register, program and control software.

Obviously the way the division is made is the prerogative of the system designer but Figure 2 is a suggested memory map for a 4K block of shared memory stored at local processor address 1000 to 1FFF hexadecimal; 1K bytes are allocated to the input and output buffers with 256 bytes each, a single byte status register and 512 bytes of control software.

Figure 2. Memory Map of Shared Memory Block.

1FFF	1400—1FFF Local processor shared Program area
	1300—13FF Output buffer
	1200—12FF Input buffer
	11FF—Status register
	1100—11FE Interrupt handling routine
	1080—10FF Reset routine
1000	1000—107F Program relocator

The input buffer is used to store data required by the local processor in its calculations and supplied by the central processor, and could be organised as a first-in first-out (FIFO) buffer. The output buffer is the same as the input buffer, except that it is used to store the results of the local processor calculations for use by the central processor.

The control software consists of a set of three routines, the first of which is used to service interrupts. Its starting address is stored in the interrupt vector at address FFFE and FFFF. Next is the re-set servicing routine, located at an address pointed to by the contents of the re-set vector in location FFFC and FFFD.

The third is a re-locator and is used to shift programs or data loaded into the shared memory block by the central processor to an area of memory in the local processor not accessible to the central processor.

Figure 3. Contents of Status Register.

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Status		Reset status	Input status	Output status	Busy flag	IRQ request	Reset request	Relocate request
Byte	Set if local processor is in interrupt sequence	Set if local processor is in reset sequence	Set if local processor ready for input	Set if local processor has output ready	Set if local processor is busy	Central processor interrupt request if set	Central processor reset request if set	If set then shared memory relocated

Control routines

These control routines are located in the shared memory block because they will probably vary slightly, depending on the current application of the local processor.

The functioning of input, output and control software is controlled by the contents of the status register, the contents of which are shown in Figure 3. The individual bits in this register can be set or read by either processor; they are used to show either the current status of the local processor or to signal to the local processor that a particular control function must be performed.

Thus, since a local processor can be

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interrupted by an external device as well as by the central processor, the setting of the interrupt flag in the status register by the central processor indicates that the interrupt was from the central processor.

Similarly, the setting of the output status flag to 1 indicates to the central processor that data is ready for it in the output buffer.

The remaining 3K of the shared memory block is available for use as a program area. It is there that subroutines directly under the control of the central processor but run by the local processor are stored.

Obviously a limited number of local processors can be attached to the central processor; a practical limit would probably be 16 processors each with a 2K shared memory block. The memory map for a proposed central processor with six local processors is shown in Figure 4.

Figure 4.
Central Processor Memory Map.

FFFA—FFFF IRQ and RESET VECTORS
A000—FFFA Central processor operating Software in ROM
9000—9FFF Control register I/O
8000—8FFF General purpose I/O
7000—7FFF Local processor 6
6000—6FFF Local processor 5
5000—5FFF Local processor 4
4000—4FFF Local processor 3
3000—3FFF Local processor 2
2000—2FFF Local processor 1
1000—1FFF Program memory area
0200—0FFF Variables and input buPers
0100—01FF Stack
0000—00FF Page zero variables

Figure 5.
Local Processor Memory Map.

FFFA—FFFF IRQ and Reset vectors
A000—FFFA Local processor operating system in ROM
8000—9FFF General purpose I/O
2000—7FFF Local processor program area
1000—1FFF Shared memory block with central processor
0200—0FFF Variables—buffers and program memory area
0100—01FF Stack
0000—00FF Page zero variables

As I have already mentioned, the memory area of the local processor is not restricted to the memory shared with the central processor and it could be the full addressable space of 64K. In a system with six local processors there could be a maximum of 448K bytes of memory. Figure 5 shows the memory map of a proposed 64K local processor.

Thus multiprocessor architecture can be expanded by adding a third level to the hierarchy, so that each local processor has its own local processors. Adding extra levels to the hierarchy, though, would probably make the system very difficult to control.

Multiprocessor systems are not new and many of the world's largest computers are, in fact, multiprocessors, including the ultra-fast parallel processors used in weather forecasting and image analysis—though they would not use microprocessors but a special dedicated circuit for each processing element.

As yet, only one product has reached the low-cost micro systems market on either side of the Atlantic—an intelligent memory board produced by Semionics, described as a content-addressable parallel-processing 4K bytes memory board with its own instruction set.

There are many people interested in this subject, though, and I am sure that within the next 12 months we will see some very interesting product developments. In my opinion, the multiprocessor is the next step forward in the microprocessor revolution.

Reducing errors

IN DATA PROCESSING the fact that a file has been verified is no guarantee that the file is error-free. If the source data is incorrect, verification will not show any errors, apart from mistakes made in encoding from the source to the media.

The most common cause of source errors is handwriting, where sometimes it is difficult to differentiate between letters and numerals. Most computer installations require data collection documents to be completed in capital letters and a standard is used to reduce the mis-reading of data.

For example, the letter I must be 'top and tailed' to avoid being taken for numeric 1; zero is crossed to differentiate from the letter O; Z is crossed so that is is not mistaken for a 2; and 7 may also be

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```
10       INPUT "START NUMBER";S
20       INPUT "END NUMBER";E
30       PRINT
40       PRINT "NUMBER     CHECK DIGIT"
50       FOR L=S TO E
60               LET C=L
70               LET T=0
80               LET W=2
90               LET D=INT(C/10)
100              LET T=T+(C-(D*10))*W
110              IF D=0 THEN 150
120              LET C=D
130              LET W=W+1
140              GO TO 90
150              LET M=T-(INT(T/11)*11)
160              LET M=11-M
165              IF M=10 THEN LET M=0
170              IF M=11 THEN PRINT L," X" ELSE PRINT L,M
180      NEXT L
190      END

READY

RUN

START NUMBER? 2000
END NUMBER? 2020

NUMBER     CHECK DIGIT
 2000          1
 2001          0
 2002          8
 2003          6
 2004          4
 2005          2
 2006          X
 2007          9
 2008          7
 2009          5
 2010          9
 2011          7
 2012          5
 2013          3
 2014          1
 2015          0
 2016          8
 2017          6
 2018          4
 2019          2
 2020          6

READY
```

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crossed so that it cannot be misread as a 1.

The errors which can occur in data processing may be classified as any one of or combination of the following types:

- **Insertion** . . . an extra character is added.
- **Omission** . . . character is omitted.
- **Transcription** . . . this is mis-reading data, a common cause being handwriting.
- **Transposition** . . . characters change position.

Consider an extreme case where all four types of error corrupted a part number in turn. The original part number is 121146. A transcription error may change the first 1 so that it becomes 721146. As omission error may then occur, changing it to 72146. A transposition error might change it to 71246; and finally an insertion error may add an extra 6, changing it to 712466.

The result is not only a corruption of data but, in practice, could mean a customer receiving the wrong goods or being billed incorrectly. That might result in the loss of a customer or loss of profit.

To obviate such errors one must try to ensure that data is read, written and stored accurately. One way of detecting errors in important numeric data items is the use of a check digit. A check digit is produced by performing some calculation on a data item which is then appended to the data.

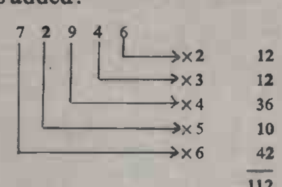
Whenever the data is input to a computer system the check digit is re-calculated to ensure it is accurate and if it has been corrupted, then the data must be rejected and checked.

Weighting technique

There are many ways of calculating check digits and normally they involve some weighting technique. The success of the error detection depends on the method of calculation used but it is possible to have a 100 percent detection rate.

The following method is often used in various forms where a data item has each of its digits weighted, starting with the least significant digit and incrementing the weight used by 1.

For example take a part number 72946. First, each digit is weighted and the results added:



The total is then divided by 11 and the remainder noted:

$$\frac{112}{11} = 10 \text{ remainder } 2$$

The remainder is subtracted from 11,

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giving the check digit 9; the part number then becomes 729469.

This method produces check digits in the range 1–11 and as part numbers are normally of a fixed length, something must be done with 10 and 11. Some people choose not to use numbers which result in the check digits 10 and 11. If they are to be used, then the 10 can be replaced by a 0 but some representation of 11 is needed.

The obvious solution might be to use the letter B, which is 11 in hexadecimal but this is not suitable, as B could be misread as 8. A symbol must be used which cannot be confused with any of the numerals 0–9. such as X.

The program on the previous page may be used to calculate check digits for a range of numbers using the technique discussed.

When reading-in data which has a check digit it is not necessary to calculate the digit and compare it to the one entered. The number is weighted in the normal way and the entered check digit is added to the total.

If the total is then divided by 11 and no remainder is produced, the check digit is correct, otherwise if a remainder is produced, the data must be rejected and checked.

Designing VDUs

THIS ARTICLE describes the basic elements of an intelligent data terminal based on the cathode ray tube and featuring a single-chip CRT controller, use of which reduces the component count substantially.

Ben Mullett works for National Semiconductor and it will be no surprise that he lauds the Nat Semi D08350 CRT controller. He offers a specific application, using this controller and an 8080 microprocessor.

The views expressed are those of the author and not necessarily those of the company he represents.

DESPITE recent developments in display technology, the trusty cathode ray tube remains the only practical device for displaying large amounts of information, but more and more VDUs are being required. So developments in data processing and display logic are most likely to reduce the cost and increase the sophistication of current-technology VDUs.

The comparatively recent appearance of LSI CRT controllers has allowed the design of simple, flexible, low-cost CRT terminals with a minimum number of ICs. There is now a wide range of CRT controller ICs available, some of which can introduce more complications than they remove. A few do not even replace the minimum CRT control circuitry required in a terminal and several require software overheads not needed in previous designs.

This article examines microprocessor-based terminals. Once an intelligent terminal comprised at least 60 components; the new CRT controllers have cut that by at least 50 percent.

Most of the controllers are NMOS ICs. Some offer software flexibility in the display format but frequency limitations do not allow the inclusion of a dot rate oscillator, dot counter, and the associated logic on the chip. The DP 8350 from National Semiconductor instances an alternative approach using bipolar circuitry. It allows the inclusion of all the required logic on the chip, while display program flexibility is provided by internal mask-programmable ROMs.

Figure 1 is a block diagram of a 'typical' intelligent terminal. It can be considered as six separate sections—CRT monitor, I/O interfaces, microprocessor, the system and CRT memory (RAM), character generator, and the CRT controller.

CRT terminal

Any CRT terminal contains a monitor in which an electron beam is used to form a character or video pattern on a phosphor screen. Usually the beam scans horizontally, left to right, as it scans vertically top to bottom. Simultaneously, the intensity of the beam can be modulated to form light and dark areas on the screen. The horizontal scan frequency (typically 15·7 KHz) is much greater than the vertical scan frequency (typically 50 Hz); and so a series of zig-zag lines are generated on the screen (figure 6).

The CRT internal sweep circuits usually require external synchronisation by a CRT controller to provide a meaningful display. The horizontal sync pulse locks the horizontal scan frequency to a particular value; the position and width of the pulse determines horizontal video centring.

Similarly, the vertical sync pulse locks the vertical scan frequency and determines the vertical position of the video

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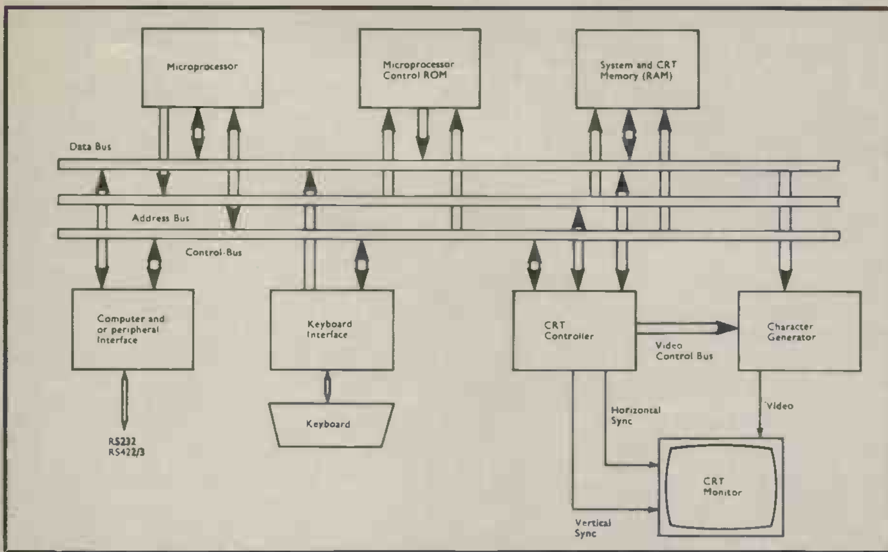

Figure 1. Basic CRT terminal organisation.

(continued from previous page)

data. The intensity of the beam is controlled by a third video input.

The intelligence of the terminal depends on the capabilities and speed of the microprocessor, plus the amount of control ROM provided. Functions will include updating of the CRT display memory; control of communications with peripherals, the CRT controller and keyboard; and serial communications with a computer.

The keyboard interface looks for key depressions and communicates the appropriate ASCII code to the microprocessor.

Generally, additional circuitry provides a serial communications interface with a computer and/or peripherals not located within the terminal. This interface is designed usually to the RS232 (or sometimes RS422) specification.

The system and CRT memory provide terminal edit and control functions. A block of RAM is allocated as the display memory, since a CRT cannot maintain video data on the screen indefinitely; this is typically 2K bytes, enough to store one video page of 24 rows with 80 characters per row. Edit features, like cursor control and scrolling, are implemented with the aid of a RAM scratchpad memory store.

Character generator

The character generator creates the data—graphics, alphamunerics, or both—displayed on the CRT monitor. ASCII code from the keyboard or the serial communications interface is placed in the CRT memory by the micro; the character generator then converts it to serial video data for the CRT.

The CRT controller co-ordinates the other elements of the terminal. It provides memory addresses to the CRT page store, develops control pulses for the character generator, and has programmable horizontal and vertical sync outputs for the CRT monitor.

It must also provide easy access to the microprocessor through the control bus; this allows the microprocessor to perform its function simply and without disturbing the video display.

The main function of a CRT controller is to synchronise and control the elements of the 'video loop' (figure 2). It has to generate an address to the display-memory, provide all control pulses to the character generator, and control the monitor.

The controller presents the display RAM with an address defined by the position, at that time, of the electron beam on the screen. The RAM presents the ASCII code, for instance, located at that address to the character generator, which then converts the code into serial video data for the CRT monitor.

Beam modulation

This data modulates the intensity of the electron beam, generating dots as it scans horizontally. A group of dots associated with one ASCII input represents the width of one cell; for alphanumeric displays, a character is formed by a matrix of dots, usually 5×7 or 7×9. The cell width on a scan line determines the character width, while the character height is determined by the number of horizontal scan lines used to form the cell.

Horizontal and vertical spacing between lines of characters and between characters must be allowed for within the cell. Each cell has its own RAM address and each address stores an ASCII code for the content of that cell.

The dot matrix associated with a particular character is stored in a character ROM. This ROM requires two sets of addresses—the address of the character and the cell scan line numbers of the character row being displayed. There are, typically, 10 scan lines to a row of characters. The data outputs of the ROM are loaded into a parallel-to-serial shift

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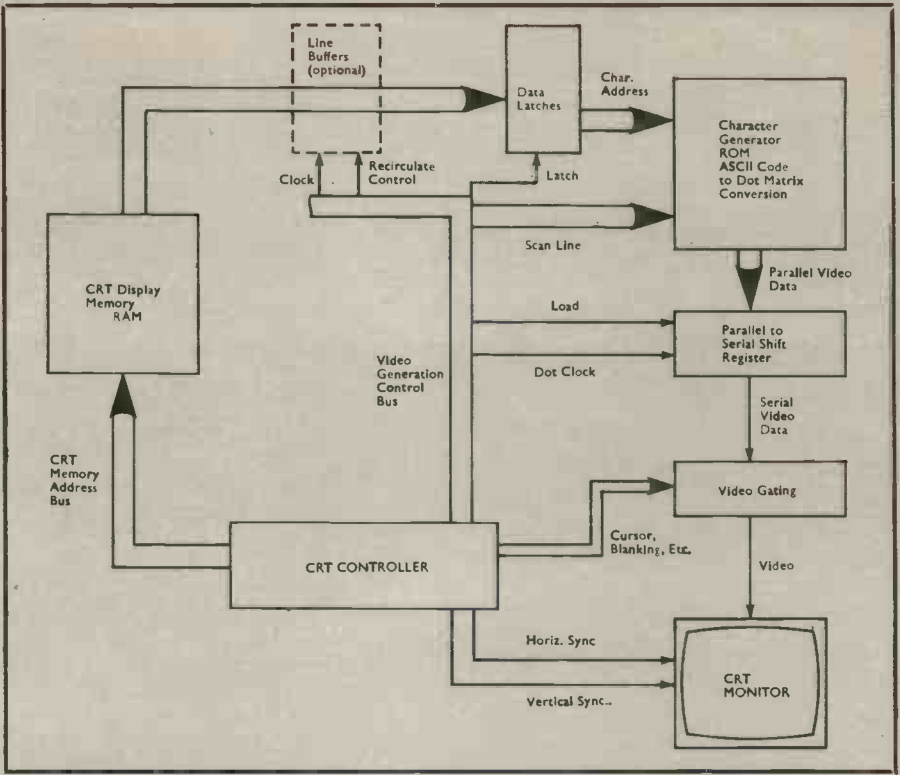

Figure 2. The Video loop.

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register, which then clocks the data serially to the CRT monitor at the dot frequency.

In a 'direct addressing' system the CRT controller presents a cell address, giving the cell position on the screen to the display RAM on every scan line. So the microprocessor access to the display RAM is limited to the horizontal blanking (line flyback) and vertical blanking (field flyback) intervals.

Line buffers also can be included in the video loop between the data outputs of the display RAM and the video generator (figure 2). A character row typically will comprise 10 scan lines. The first scan line of ASCII cell data for a character row is loaded into a re-circulating shift register and then presented to the video generator; the data is then re-circulated within the line buffer during the remaining scan lines of the row. The micro, therefore, has direct access to the RAM address bus for 90 percent of the scan lines.

Another method of improving access is to use a fast microprocessor and memory block. Although the CRT still uses direct addressing, the address lines are multiplexed during each character time so that the controller and the microprocessor can both access the display RAM.

Both methods require that the CRT controller provides adequate control pulses to synchronise the presentation and latching of data. Also, since the delays through the display RAM and the character generator ROM usually exceed one character time, the video data must be 'pipe-lined' for correct screen synchronisation.

Generally, one full character time of screen display is allowed for display RAM access and another character time for access through the video generator. The CRT controller must also generate the correct latch and clock pulses to phase this pipe-line properly.

Controller features

A CRT controller must contain dot logic circuitry, character cell and line counters, character row counters, memory address counters, and the logic for such added features as cursor and display scrolling. Figure 3 shows a block diagram for a basic controller.

The dot logic circuitry usually includes a crystal-controlled oscillator which operates at the dot frequency—this may vary from 3 to 25Mhz depending on the format of the video display. The clock output is fed into a dot counter which keeps track of the number of the dot increments in the character cell width. Decode logic circuits driven by this counter generate the control pulses required by the character generator.

The 'carry' output of the dot counter is fed to the character cell counter. This records the total number of character cells per scan line, both displayed and blank. Decode logic in this section generates the necessary horizontal sync for the CRT monitor and horizontal blanking signals.

The line counter records the number of scan lines per character row and is driven by the carry output of the character cell

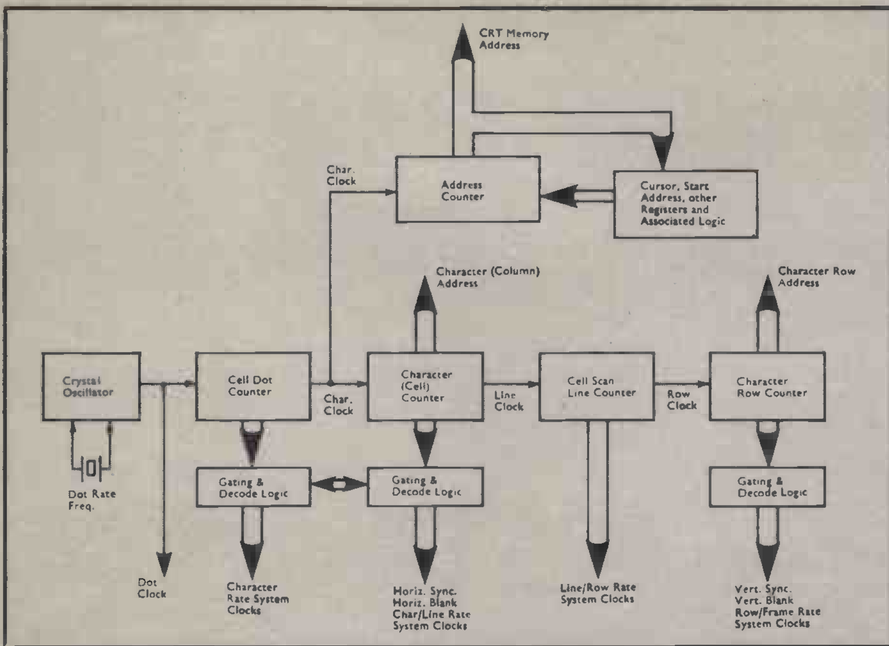

Figure 3. Basic CRT controller block diagram.

counter. Its outputs feed directly to the row address lines of the character generator.

The character row counter is driven from the carry output of the character line counter and records the number of character rows, both displayed and blank. Decode logic circuits generate the vertical sync for the CRT monitor and video blanking signals.

Additional features in a terminal, such as cursor control and scrolling, are implemented together with the RAM address outputs of the CRT controller by the addition of latches, comparators and adders.

The complete CRT controller as described would require approximately 35 MSI and SSI components. An MOS controller reduces the chip count to about 10. Components still required include the crystal oscillator, dot counter, and dot decode logic—all of which are necessary to control the video loop.

LSI CRT controllers

You also need to interface the CRT controller to other parts of the terminal, such as the character memory address multiplexers, address latches, and logic for the monitor sync pulse shaping.

On the other hand, a bipolar CRT controller like the National Semiconductor DP 8350 has a minimum chip count of one for the provision of a fully-functional CRT controller; that is in figure 4. The DP 8350 is a single-chip, bipolar (I^2L),

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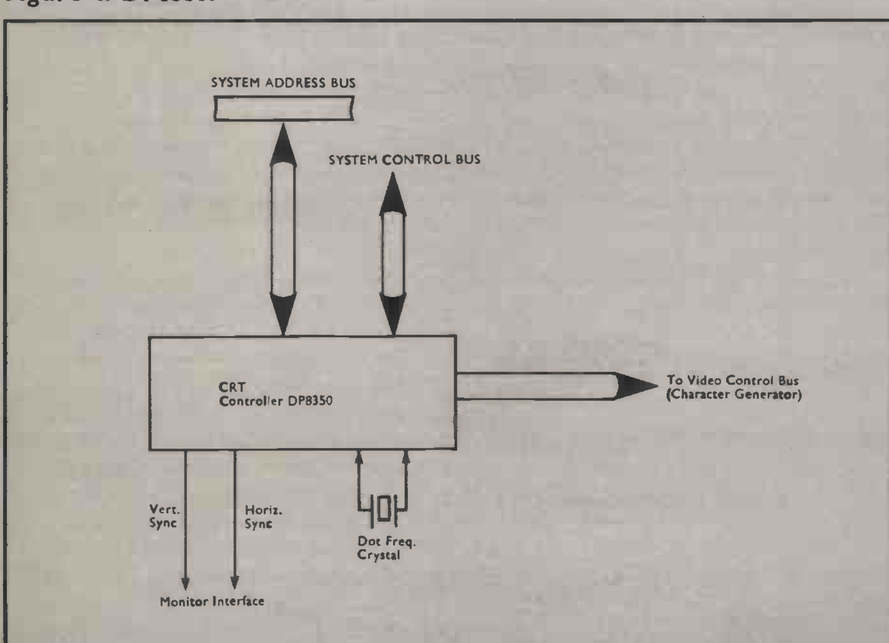
Figure 4. DP8350.



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programmable LSI chip in a 40-pin package.

There are generally two types of display memory addressing in terminal designs. The display RAM outputs may be generated by using character and row counter outputs; or by a separate counter block driven by the dot counter carry output. If the same area of RAM is to be used both for CRT display storage and microprocessor scratch pad, the first method is suitable only if the number of displayed characters per row is a binary multiple like 16, 32, 64; otherwise separate blocks of RAM are recommended.

If a separate linear address counter is used, however, the addressing is sequential from one row to the next and this problem is eliminated.

The DP 8350 can modify sequential memory addressing on a row-by-row basis. Within a character row the address counter outputs are sequential from the start address. The start address of the next row may not be sequential from the last address of the previous row, so by keeping track of the row start addresses, non-sequential screen addressing can easily be implemented.

CRT terminal example

The advantages are particularly applicable to the more sophisticated terminals; they include faster and easier scrolling with the cursor on the screen and fast row swapping—the video RAM does not require re-writing.

Figure 5 is the block diagram for a video terminal using the DP 8350 CRT controller and an 8080 microprocessor. The DP 8350 generates all the required control and timing signals for displaying video information on the video monitor. It provides dot clock, control and counter outputs for the character generator and it has a bi-directional RAM address refresh counter for refreshing the video memory. Direct-drive horizontal and vertical sync signal outputs, as well as a direct cursor address location output, are provided. The cursor is delayed internally or 'pipelined', which allows for the access time of the video RAM and the character generator ROM.

The 8080 provides CRT controller, operator, and external machine control for the system. When the CRT controller is not refreshing the video RAM actively—during vertical re-trace or blank scan lines, for instance—the micro is enabled for system housekeeping (figure 6); this multiplexing estimates the need for line buffers.

The character generator consists of three elements—an address latch to hold the input address to the character ROM, allowing for the access time of the ROM; the character ROM which stores the ASCII in a form suitable for parallel-to-serial conversion by the shift register; and the shift register, which converts parallel output of the character ROM to serial form. The serial output from the shift registers is the true video output, modulating the electron beam of the monitor, which writes characters on the screen.

All these elements are combined in another Nat Semi component, the DM

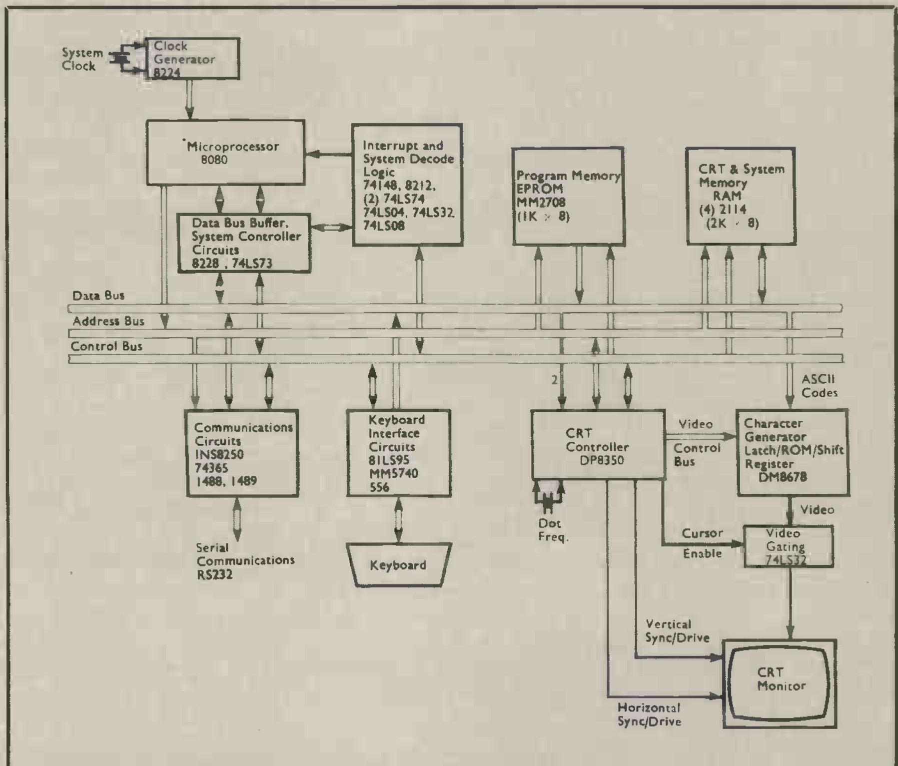


Figure 5. CRT terminal system using DP8350.

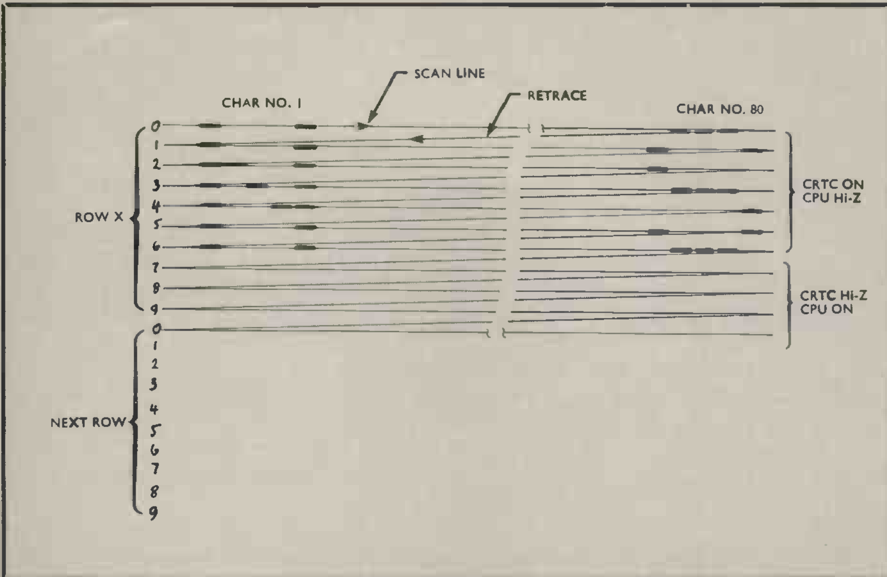


Figure 6. Multiplexing INS 8080 with DP8350.

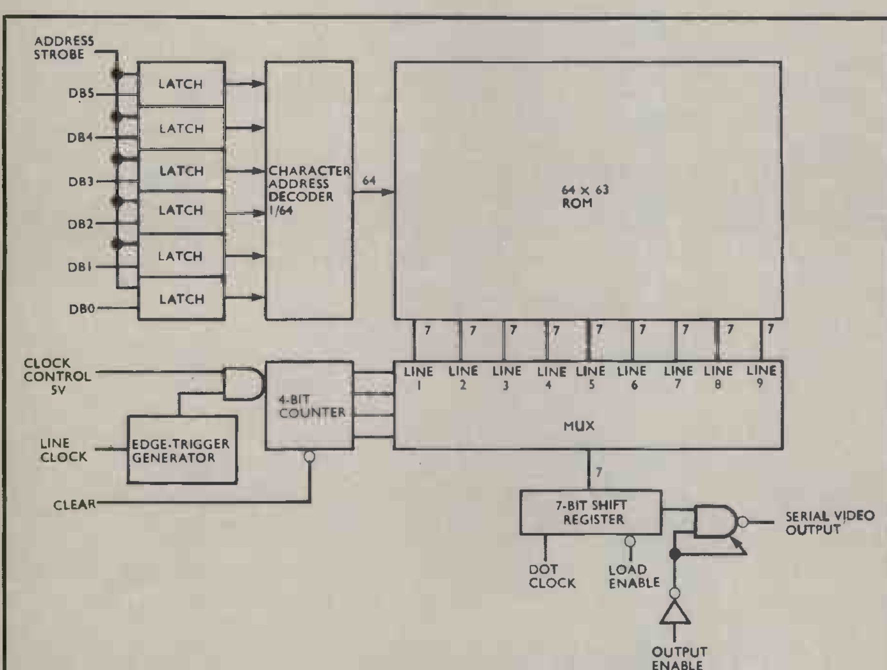
8678. All control signals required by the 8678 are provided by the 8350.

The INS 8250 is the asynchronous communication element (ACE) for the data terminal. It allows the micro to communicate with peripherals or host computers at the correct rate up to 4,800 baud; the ACE also provides full RS232C synchronous communication if higher buad rates are required.

System communication speed must always be considered to ensure that the baud rate does not exceed the time required for the microprocessor to process a data byte. A synchronous communication of baud rates higher than 4,800 are possible by adding a line buffer. This design provides:

- 64 ASCII upper-case characters
- cursor up, down, left, right, home and return
- block or underline cursor
- clear line and clear screen
- scroll up and down
- row edit (non-sequential addressing)

Figure 7. DM 8678 character generator block diagram.



CP/M review

by Roland Perry

NOW that few major advances in hardware design have been made for about two years, more emphasis is being placed on the design and ease of use of software.

The disc operating system is a software product designed to allow the user to interface physically with a floppy disc storage unit; load, save and run programs; and generally emulate the familiar time-sharing services available on mini or mainframe computers.

Traditionally, disc operating systems have been supplied by hardware vendors to sell their equipment, with the price being bundled into that of the disc system. Previously available only to OEMs, where for three years it has existed within various manufacturers' products undergoing extensive field testing, CP/M is a disc operating system designed for use with IBM-compatible diskette-based computer systems which employ the Intel 8080. Z80 hardware is therefore also compatible. No specific diskette drive or computer configuration is implied and an important feature is the ability to adapt, as painlessly as possible, to the host hardware.

Under licence

CP/M is serial-numbered and supplied under licence for use on a single computer system by the licensed customer. Each copy of the program costs between £75 and £100 depending on the level of customisation to hardware. Although designed primarily for 8in. floppy discs, the version reviewed was for a $5\frac{1}{4}$ in. Micropolis minifloppy and it is anticipated that most future deliveries of CP/M will be for the more cost-effective mini disc drive.

Comparisons will be drawn between CP/M and two well-known bundled disc operating systems. CP/M configured for 315K Micropolis drives is a direct replacement possibility for the Micropolis MDOS as supplied with S100 bus 8080 systems while FLEX is the TSC-written software supplied as part of the Southwest Technical 6800-based minifloppy product.

The CP/M manual has a very clear and concise summary of the main operating system functions and supports it with detailed manuals for the utility programs, such as Editor and Assembler, supplied on the diskette. If the reader has a working CP/M system in front of him, there should be little difficulty in performing the example commands as described in the summary, although the document in its own right is a little heavy going.

The *System Alteration Guide* and the *Interface Guide* provide a detailed insight into the internal workings of the operating system and are definitely not for the novice. Sample program listings with handwritten comments accompany the *Debug manual*, an essential aid to comprehending what would otherwise be pages of hex.

Basic-E, supplied with CP/M, is described by a very dry manual written in BNF. That is satisfactory if you already understand Basic and require the detailed structure of statements legal in this implementation, but is no real help as a way of learning the language from scratch.

Very simple

The Micropolis manual presents more information, in a more easily-readable form, and FLEX has the most readable but least informative manual.

CP/M, like FLEX. operates as a series of overlays and utilities loaded into High-RAM. This must be the top of a block of contiguous RAM located at addresses zero upwards, whose size has been set previously into the operating system.

It is very simple, using one of the utilities provided, to re-configure the program for an increased memory size. A minimum of 16K is required to implement CP/M but the user is likely to find that 32 or 48K is required to run some of the more complex language programs available.

Built-in commands within the Console Command Processor component of the operating system are used to perform such tasks as memory save to disc, program load and go, file re-name and delete and directory listing. Two levels of directory are provided, with the more detailed sorted into alphanumeric order.

As with FLEX, but not MDOS, it is possible to select by specifying an afn (note 2) particular groups of entries from the directory. This selection is legal for listing, deletion and copying of files, in fact wherever an operation might possibly be applied to more than one file.

Powerful tool

Thus a very powerful tool is available to the systems programmer when performing disc-juggling operations. Further built-in commands will produce an ASCII dump of a file on to the console, a HEX dump of a file on to the console and load-and-go a selected utility program.

The CP/M PIP utility treats the disc as a peripheral, and all peripherals as file-producing or consuming devices. Four channels are available for physical communication; the console, a printer or

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listing device, a paper tape reader or cassette input and a paper tape punch or cassette output.

A degree of flexibility is allowed in channelling information streams between these physical devices and the logical names associated with them. Files, or part of files, may be transferred between any peripherals and may be added together.

All combinations are allowed which are physically possible; thus disc files may be listed or a paper tape plus console input sent to the line printer. Although all-powerful, the utility requires careful driving and it is a pity some of the more common combinations except file list to console which is implemented as a built-in command—are not available to the user as separate easy-to-use utilities.

Text editor

The text editor, ED, which merges a source file with console input to give an output file has more than 20 commands and the ability to form macros of combinations of commands. With statements, however, such as:

```
MFGAMMA↑Z-5DIDELTA↑Z0TT<cr>
```

to replace all occurences of GAMMA to DELTA within the text, it is much harder to drive than either the almost identical FLEX Text editor C/GAMMA/DELTA/! or the line rather than character-orientated DOS Line edit:

```
CHANGEALL
search mask GAMMA
change to DELTA
```

Possibly the greatest disadvantage of the CP/M system as a whole is the need for a high degree of skill in operating the editor. The editor must be used to produce the files containing source statements in Basic, Cobol or other high-level language, and this, particularly in Basic where it is more common to incorporate the editor into the interpreter/compiler, requires a high degree of skill from the operator.

All three operating systems contain adequate assemblers for their respective machine codes. All assemble a text source file of about the same level of syntactical complexity, producing a machine code file and, if required, a listing.

Similarly, all three Basics allow roughly the same level of string handling and disc data handling, with Micropolis MDOS having a few more system subroutines available, plus a number of other features.

Conclusions

- **A very large number of application programs and system software packages are available to run with CP/M. If they are required in a fundamentally end-user application, the operating system works and as a vehicle for the add-on software provides facilities for all the housekeeping functions of a microcomputer.**
- **The degree of skill required to operate the utility packages must make the Micropolis MDOS a better proposition for the user who requires to write either applications programs or system software in Basic or assembler language.**
- **Many more facilities are provided also for access to disc and peripheral subroutines from user programs.**
- **CP/M is very powerful in certain areas but the power is very seldom required and difficult to control. Paradoxically, therefore, CP/M is at its best when not used directly but interfaced to and invisible behind an application package.**

Notes

BNF – The language in which serious computer language specifications are written.
e.g. a definition of the REMARK statement:
[<line number>] REM [<remark>]

afn – Ambiguous file reference. A way of defining a group of files which have certain common features about their names.
e.g. STOCK?.* is the afn for:
STOCK1 . CBL
STOCK2 . INT
and STOCK . REC
where the ? stands for any character (including null) and the * stands for any character string.

Kit problems

As this issue of *Practical Computing* went to Press, Nascom, among other kit manufacturers, was having trouble with the world-wide shortage of certain low-power Schottky ICs. For a time it was forced to send kits to retailers without the missing chip. Retailers were told to warn customers that the kits were incomplete and that customers should contact Nascom to obtain the parts direct. We hope that by this time the problem will have been solved but to avoid disappointment, readers who buy kits are advised to make sure of the situation before they take delivery.

June

●6 **Computing for Beginners Inside Micros.** Venue: Newport Civic Centre. Run by Gwent Amateur Computer Club, which meets on alternative Wednesdays, at 7 pm. Anyone with an interest in computers can attend one meeting free. Normal charge is £1 per annum subscription, plus 15p per meeting. More Information from Alan Beale, (0633) 50207.

●6-7 **An Introduction to Microprocessors.** Venue: Albany Hotel, Birmingham. Organised by Microcomputer Training Programmes, this one-day course is adapted from an American idea and was introduced to Britain last December. Aimed mainly at engineers, it offers hands-on experience of microcomputers and breadboarding techniques. More information from MTP Ltd., Monks Hill, Tilford, Farnham, Surrey. Tel: (025 18) 2066.

●20-22 **Introduction to Microprocessors.** Venue: Cafe Royal, London. This three-day non-residential seminar aims to provide an overview of microcomputing, as well as familiarity with commercially-available systems and a discussion of user experience. Speakers from Software Architects, which is organising the seminar. Cost £200, excluding VAT. Contact: Julia Symonds, Software Architects, 34, Dean Street, London, W1. Tel: (01) 734 9402.

●21 **The use of small computers in business.** Venue: Kinver, near Stourbridge. One-day seminar at a hotel, run by local software house, Video Software. Cost £50.

●27 **How to avoid wasting money on computers—data processing for the small user.** Venue: London. Organised by BIM. Non-technical one-day summary "designed to assist the user or intending user to reap the benefits while avoiding the pitfalls". Speakers from Deloitte Haskins & Sells. Cost: £59·40.

●28 **Microprocessors for your company:** Venue: London. One of several introductory courses for management which have appeared recently. This promises a basic understanding, an appreciation of capabilities and limitations, and an overview of applications. It takes the form of four substantial papers, including a potentially interesting one from the Glynwed Group Central Resources Unit. The fee is £75, and it is organised by Allteck.

July

●9 **An introduction to logic.** Venue: Cossor Electronics, The Pinnacles, Harlow, Essex. This five-day course is aimed at engineers and technicians whose work is involved increasingly with microprocessors. Backed by the DoI, it will be held every eight weeks and costs £150, plus VAT. More information from Henry Lassman, Cossor Electronics, Sales Department, Service Division, The Pinnacles, Harlow, Essex. Tel: (0279) 26862.

●16-20 **Electronic applications for teachers.** Venue: Salford University. This one-week course sounds good value for £34·50, plus £26·73 for accommodation. It is aimed at teachers who have some knowledge of semiconductor technology and who want to study it in greater depth. The material covered will be adequate for the electronics option of the A level physics syllabus. It will be devoted primarily to the study of operational amplifier and integrated logic circuit applications, and around half the time will be spent on experimental work. More information from the Administrative Assistant (Short Courses), 061-736 5843, extension 449.

November

●1-3 **Microprocessor Chess Tournament.** Venue: West Centre Hotel, Lillie Road, London. The second London chess tournament is the first European Open Microprocessor championship. The highest-placed participants will qualify for the world championship in London next year. More information from David Levy, 62a Westbourne Grove, London, W2.

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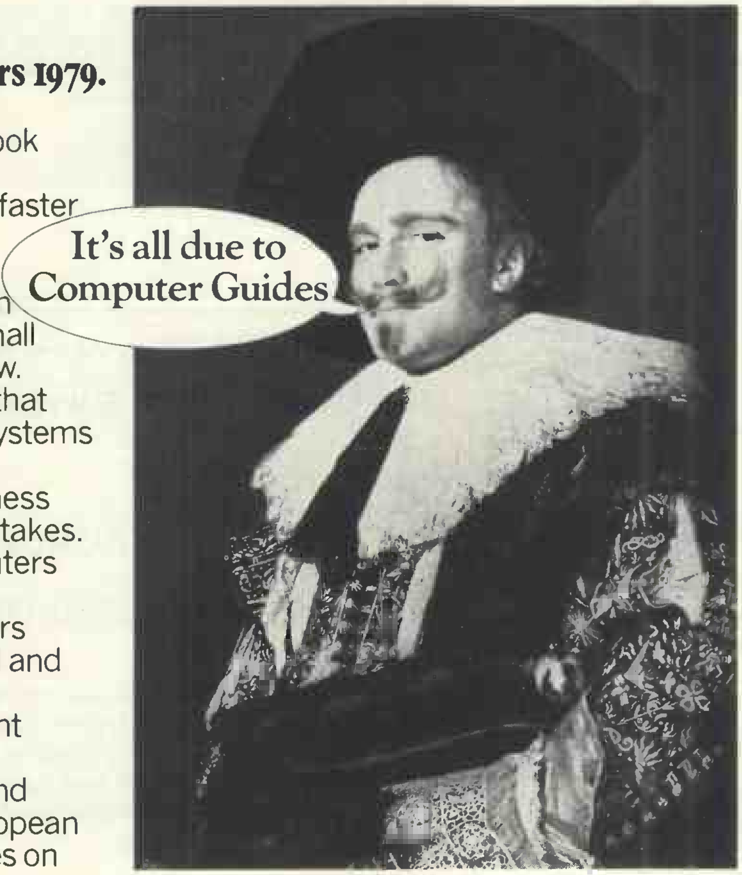

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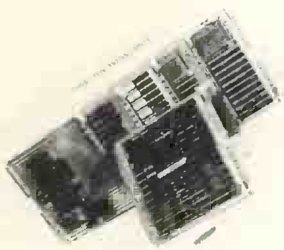

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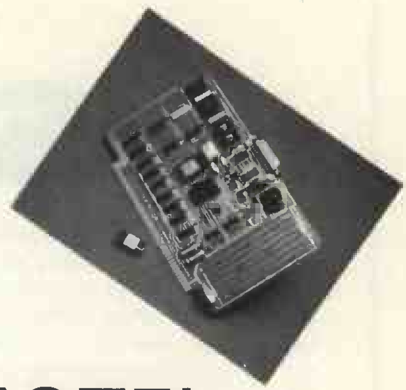


MOUNT ROYAL HOTEL, LONDON, W.1. JULY 6, 1979

Today it is possible to buy a microcomputer and a range of general accounting software for a price which, when converted to a lease payment, is about the cost of one clerk. In addition, the ease of operating a microcomputer is such that a semi-skilled office worker may be trained to operate one of these machines. So for the first time computer power is really available to very small businesses and to divisions or departments within larger firms.

This does not mean that no skills are required in buying or using microcomputers. From the point of view of buying a microcomputer, there are so many machines available with so many differing facilities that the would-be purchaser often has great difficulty in deciding what he requires. This applies both to hardware and software, and once the would-be purchaser has decided to acquire a microcomputer, he is faced with the difficult task of knowing which aspects of his business he could computerise and what benefits he should expect to obtain from computerising.

This is a one-day practical conference which will explain to managers, accountants entrepreneurs and other professionals what a microcomputer is and how to decide which type of microcomputer would suit their business needs. The benefits which may be obtained by owning one's own computer will be explained and the pitfalls which a first-time user could encounter will be demonstrated.

The conference will give participants an opportunity to discuss the needs in their business.

For further information please circle the number below on the Reader Enquiry Card.

● Circle No. 222

THE BUYERS' GUIDE is a summary of low-cost computers available in this country. It appears each month; we add new computers and amend existing information as required to keep up-to-date. The cut-off point is taken as £5,000, because we feel that computer systems costing more than that for a minimum configuration cannot be summarised adequately in a brief table. Systems are listed by manufacturer.

This month another five manufacturers are added to the Buyers' Guide. They include Sord, with a very sophisticated range based on three models; Hewart, with two models starting at £127·50; Netronics, Digital Microsystems and National Multiplex, with one model each.

This brings the list to 40 manufacturers and we are still finding new ones.

We also list two new models from Cromemco—new configurations of existing models featuring diskette drives. The Tandy TRS-80 entry is also updated.

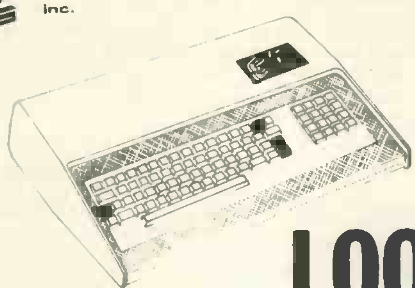
Please continue to inform us about new models and updates, so that our Buyers' Guide can remain comprehensive and up-to-date.

MANUFACTURER	HARDWARE/SOFTWARE & APPLICATIONS/AVAILABILITY	PRICE
ACORN COMPUTERS	**Acorn.** Single Eurocard-sized microcomputer with 6502 processor, 1KB RAM, 16-way I/O. Max size: a second Eurocard adds hex keypad and CUTS cassette interface. Monitor and machine-code programming now, Basic and disc operating system in the future. "Highly cost-effective basis for a computer or an industrial development system". Sold by post or from Microdigital (051-236 0707).	£70·20 inc VAT and postage for kit. £81 complete for assembled Acorn.
APPLE COMPUTERS	**Apple II.** Min size: 16K memory; 8K ROM; keyboard; monitors; mini assembler; colour graphics; Pal card; RF modulator; games; paddles and speakers; 4 demo cassettes. Max size: Expandable to 48K memory; floppy discs and printers are now available. Two versions of Basic, PASCAL; Assembler; games; business packages. An American system regarded as suitable for any kind of applications. Maintenance contracts offered. Personal Computers Ltd (01-283 3391) is the sole U.K. agent but has a distributor network of 20 dealers.	Around £1,000
ATTACHE	**Attache.** Min size: system with 10 slots, S100 bus, 8080 processor and 16KB housed in desk-top case with built-in keyboard. Max size: 64KB, parallel printer interface, two single- or double-density 8in. floppies, video screen. Disc Basic; business applications produced by Moncoland, the sole U.K. agent. Distributors include Keen, GBH, Alba, and Lion.	From £1,737 without video or external storage. Full business system with screen, discs and printer about £5,000
BRUTECH ELECTRONICS	**BEM-CPU1:** single-board processor with 6502 and no RAM. No applications software. Available from Data Precision Equipment (04862 67420)	From £116
COMART	**Microbox.** Chassis with three to six PCB sockets for S100 boards, plus fan. Several S100 boards available. Aimed mainly at OEM industrial users and perhaps the serious hobbyist. It will take Cromemco, North Star and other processors. Available from Comart (0480 215005).	£255 for full package plus case.
COMMODORE SYSTEMS DIVISION	**Pet.** Single unit containing screen, tape cassette and keyboard. Floppy disc, printer and full-size keyboard are options, as are external cassettes. Basic; games; business packages. The British subsidiary of Commodore Systems of the U.S. sells Pet for home, educational and small business applications. About 80 distributors.	£460–£795 exc VAT
	Kim 1, processor (6502 chip); small calculator-type keyboard; LED six-digit display; built-in interfaces for audio-cassette and Teletype; 1K RAM; 2K ROM (can add up to 64K). No software available. but it has three good manuals. An American import which gives Pet-type capabilities with a maximum configuration. For the hobbyist but used mainly as an evaluation board for the 6502 chip. Twelve to 15 dealers.	£99·95
COMPELEC ELECTRONICS	**Series 1.** Z-80 processor 512MB floppy, 32KB, Centronics printer, VDU. Up to 4MB disc and 64KB. CP/M, Basic, Cobol, PASCAL, Fortran IV, Assembler. Business and word processing packages available. From Compelec (01-580 6296), which is also sole supplier of Altair systems.	Less than £5,000 for basic system.
COMPUCOLOR	**Compucolor II.** Packaged system including 13in. eight-colour display with alphanumerics and graphics, 72-key detachable keyboard, 8KB, and built-in mini-floppy. Max size: 32KB. Extended disc Basic in ROM, graphics programs and games. The system now ranks fourth behind Pet, TRS-80 and Apple in personal computer sales. Abacus (01-580 8841) is sole U.K. agent and is arranging distributors, including the Byte Shop and Transam.	From £1,390
COMPUCORP	**610:** desk-top unit using Z-80 and incorporating screen, 150KB floppy, 48KB. Up to 60KB memory, four floppies, printers. Basic, Assembler, DOS, text editor, file manager; business packages. Nine dealers.	From £3,890
COMPUTER CENTRE	**Mini kit:** Z-80 CPU, CTC, USART, serial and parallel I/O. 16 bytes memory, Western Digital disc controller, SA400 5in. drive plus CP/M, cables and connectors.	Mini kit: £786.
	Maxi kit: As above but with DRI 7100 8in. drive instead of 5in. drive. All (33) volumes of CP/M user group library available for cost of media. Library includes utilities, games, Basic compilers/interpreters and Algol compiler. Microsoft Basic, Cobol, Fortran also available. Computer Centre (02514 29607).	Maxi kit: £886.
COMPUTER WORKSHOP	**System 1.** Typical size: 40K memory; dual 8in. floppy discs, total storage capacity 1·2MB; Ricoh daisywheel printer. **System 2.** Typical size: 24K memory; dual minifloppy discs of 80K bytes each; Centronics 779 dot matrix printer; VDU.	System 1, £5,000 plus. System 2, around £3,000.
	System 3. 12K memory, cassette interface; 40-column dot matrix printer. Editors, Assemblers, Basic, games, information retrieval package. The systems were designed and built in Peterborough and are suitable for educational and small business users and perhaps the more serious hobbyist. Twenty-five dealers.	System 3, from £1,350.
CROMEMCO	**Single-card computer.** 4MHz Z-80 CPU, S100 bus, 1KB RAM, sockets for 8K ROM. 20mA/RS232 serial interface and parallel bi-directional interface. Basic in ROM and Z-80 monitor. For OEM and industrial users; used with backplane for "full computer capability". Comart is the sole agent and has 12 distributors.	£247–£281.

(continued on page 115)

Introducing the personal computer you've waited for.

The Exidy Sorcerer.



16K £760
32K £859
add 8% VAT

LOOK *AT THESE FEATURES*

- WORD PROCESSING, COBAL, FORTRAN etc
- PLUG IN ROM CARTRIDGES
- WORKS WITH NORMAL TV
- S100 EXPANSION UNIT
- CASSETTE INTERFACE
- Z80 CPU
- 32K RAM ON BOARD
- A REAL BUSINESS MACHINE

The Sorcerer Computer is a completely assembled and tested computer system ready to plug in and use. The standard configuration includes 63 key typewriter-style keyboard and 16 key numeric pad dual cassette I/O, with remote computer control at 300 and 1200 baud data rates, RS232 serial I/O for communication, parallel port for direct Centronics printer attachment, Z80 processor, 4K ROM operating system, 8K Microsoft BASIC in separate plug-in Rom Pac™ cartridge, composite video of 64 chars · 30 lines, 128 upper/lower case ASCII character set and a 128 user-defined graphic symbols, up to 32K on-board RAM memory, operators manual, BASIC programming manual and cassette/video cables, connection for S100 bus expansion unit giving access to the spectrum of exciting and useful peripheral devices, such as Floppy disk drives, voice recognition/synthesis battery back-up board in case of power failure, additional memory boards, E-PROM cards give you the facility to program and re-program your own ROM memories etc. etc. This is the most useable and flexible system that's now available to the home and business user at such a low price.

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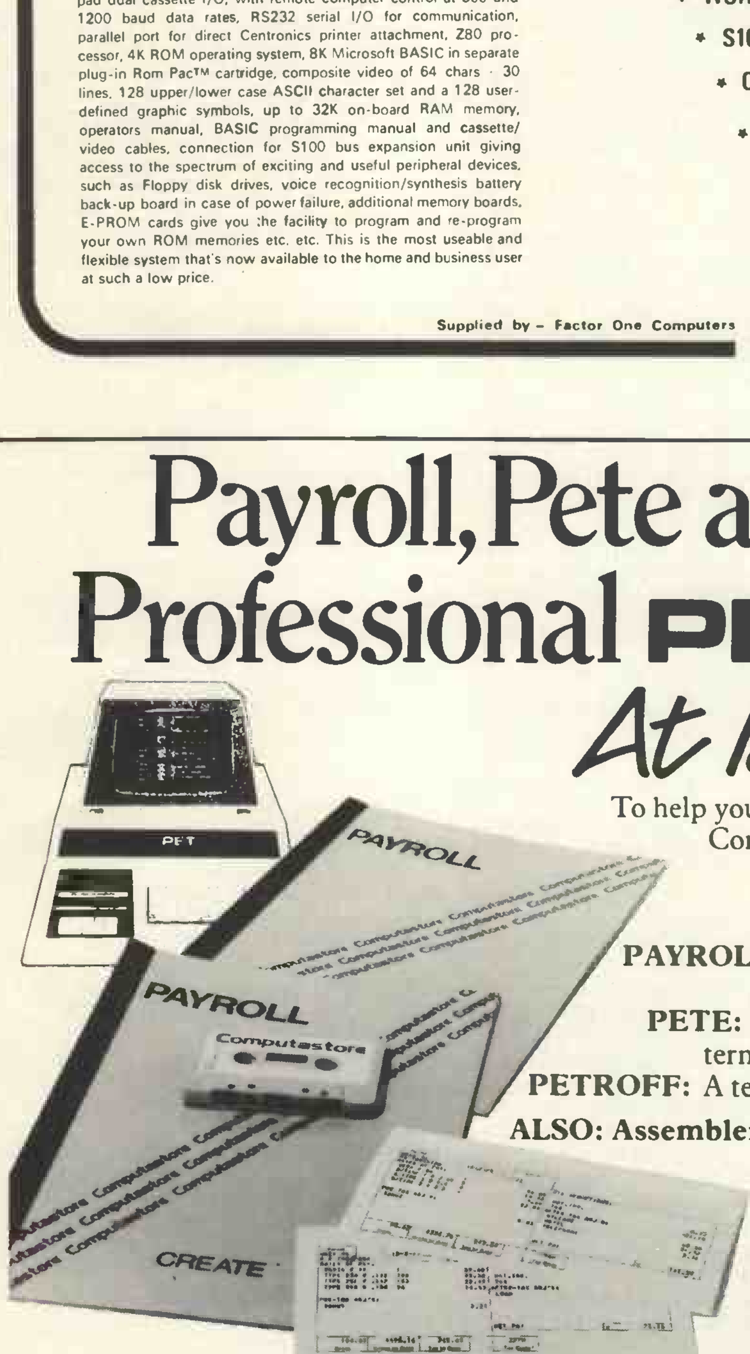

To help you get the most out of your Commodore PET, Computastore has developed a range of software packages to cope with the demands of both Industry and Education.

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● Circle No. 224

(continued from page 113)

MANUFACTURER	HARDWARE/SOFTWARE & APPLICATIONS/AVAILABILITY	PRICE
CROMEMCO (continued)	**Z-2.** Min size: chassis, 30A power supply, motherboard, Z-80 processor, 16KB memory. Max size: 512KB, 21 sockets, three minifloppies or four 8in. floppies. Basic, Fortran, Cobol, assemblers. For serious hobbyists, OEMs, educational applications, and industrial/scientific users.	£372 (in kit form) to more than £4,000.
	System Two. Min size: factory-assembled system with 32KB, dual 90K minifloppies, dual printer interface, serial interface. Max size: two additional floppies, 512KB, up to seven terminals. CP/M-compatible operating system (CDOS), Fortran, Cobol, Basic, assemblers, word processing, database manager. Multi-user system for software development, or scientific/industrial/business users.	£2,294 upwards.
	System Two/64. New configuration featuring mini-diskette drives and 64K bytes memory. Software and application as System Two.	£3,050.
	System Three. Min size: 32KB, dual 256KB floppies, dual printer interface, 20mA/RS232 serial interface, Z-80 processor. Max size: two additional discs, 12KB, seven terminals, multi-channel A/D and D/A interface, PROM programmer. Software as for System Two. Described as appropriate for small to medium business, scientific and industrial users—"rivals minicomputers at more than twice the price".	£3,444 to more than £10,000.
	System Three/64. New configuration featuring dual 8in. diskette drives; Z-80A processor; 64K of 4MHz memory; console and printer interfaces. Macro Assembler, Fortran IV, Extended Basic, Cobol, Multi-user Basic.	£4,385.
EQUINOX	**Equinox 300.** Min size: 48K memory; dual floppy discs giving 600K bytes of storage; 16-bit Western Digital m.p.u. Max size: up to 256K memory; up to four 10MB hard discs. Basic, Lisp, PASCAL, Macro Assembler, Text Processor. All software bundled. The system is a multi-user, multi-tasking, time-sharing system for two to 12 users. Application software available for general commercial users. Sole distributor Equinox Computers Ltd (01-739 2387).	£5,000–£40,000 plus.
EXIDY	**Sorcerer:** based on Z-80. 16K and 32K; cartridge and cassette interfaces; 79-key keyboard; 256-character set (128 graphics symbols); 12in. video monitor; expandable with Micropolis floppy discs. Basic, Assembler and Editor; games, word processor. Other pre-packaged programs plus EPROM pack for your own programs on cartridges. There is no sole importer for U.K.; sold through various importers and dealers.	£760 for 16K, £859 for 32K (excludes video monitor); £1,200 with floppy discs.
HEWART MICROELECTRONICS	**Mini 6800 Mk II.** 1K monitor; 1K user RAM, 1K VDU RAM; CUTS. Upper and lower-case VDU with graphics option. 128-byte scratchpad; decoder/ buffer; power supply; Basic In ROM; monitor command summary. SWTPC programs; Newbear 6800; Scelbi 6800 Cookbook. Markets are small business, education and home user. Cash with order to Hewart. (0625) 22030.	From £127·50 plus VAT
	6800S. 16K dynamic RAM; 1K Mikbug-compatible monitor; room for 8K Basic in ROM; upper and lower-case graphics; single floppy disc drive; printer and high-speed tape interfaces. "Mountains of software available". Test tape with CUTS test tones, test message and games with kit.	From £275 plus VAT.
DIGITAL MICROSYSTEMS	**DSC-2.** Min size: 32KB, but 64K standard; Z-80; over 1MB floppy disc on two single-sided 8in. drives; four programmable RS232 and one parallel interface. CP/M and Basic included in price. Extended Basic, Fortran, Cobol, text processing, Macro Assembler, Link Loader, business packages and CAP-CPP business software. Add-on rigid disc system (14 and 28MB) available soon. Modata (0892 39591) is sole U.K. distributor; dealers being appointed.	From £4,465.
IMSAI	**VDP 40:** 32K or 64K RAM memory 9in. display screen, standard keyboard. Two 5¼in. floppy disc drives; serial I/O. No software support, but packages for the larger VDP-80 could be converted for smaller system. This would be from about £700 per package. Computer Mart, Norwich (0603 615089), is the main U.K. supplier but there are other distributors.	£4,507 for 32K model.
ITT	**2020.** Identical to Apple II. Min size: 4K memory; 8K ROM; keyboard, monitor, colour graphics, mini assembler; Powell card; RF modulator, games, paddles and speaker; Max size: 48K with floppy discs and printers. Basic, Assembler, games, business packages. Generally suited to any type of application. Fifteen wholesalers, including Fairhurst Instruments.	From £965 for 4K and cassette, to £2,014 for 32K plus floppy and printer. £3,003 for 48K version, two floppies and serial printer.
MICRONICS	**Micros.** Typical size: 1K monitor; 47-key solid state keyboard; interfaces for video, cassette, printer and UHF TV; serial I/O, dual parallel I/O ports; 2K RAM; power supply. 2K Basic; British-designed and manufactured system. Claimed to be the cheapest data terminal—a system with an acoustic coupler and VDU for £1,020. Prospective applications for small businesses, process controllers and hobbyists. Manufacturer is sole distributor (01-892 7044).	From £400, assembled.
MICRO V	**Microstar.** Single box with twin 8in. floppy discs, 64K RAM, three RS232 serial inputs, STARDOS operating system enables system to have three VDUs, plus a fourth job running simultaneously. Word processing software available. Packages being developed include invoicing system, payroll, accountancy type system. Price includes a reporter generator language. Imported by a Data Efficiency subsidiary, Microsense Computers. Microsolve is London agent; other distributors being arranged.	£4,950 or machine and software.
MIDWEST SCIENTIFIC INSTRUMENTS	**MSI 6800.** Min size: 16K memory, Act I terminal; cassette interface. Max size: three disc systems—minifloppy system with triple drives of 80 bytes each and 32K memory, large floppy system with up to four 312K-byte discs and 56K of memory mounted in a pedestal desk, or hard disc system with 10MB and 56K. Basic interpreter and compiler; editor; assembler; text processor on small disc system. American-designed system being manufactured increasingly in the U.K. Sole U.K. agent is Strumech (SEED) (05433 4321) but a distributor network is being established.	Basic system: £1,100 (£815 as kit); Minidisc, £2,500; Large floppy disc £3,200, plus £1,400 for quad system; hard disc, £8,000–£12,000.
NASCOM MICROCOMPUTERS	**Nascom 1.** Min size: CPU; 2K memory; parallel I/O; serial data interface; 1K monitor in EPROM. Max size: CPU; 64K memory; up to 16 parallel I/O ports. Mostly games, but also a dedicated text editor system written by ICL Dataskil. Nascom is working on large versions of Basic, and 8K Microsoft Basic should be available soon. Eleven distributors in U.K. Nascom is negotiating to increase the number.	£165 exc. VAT.

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MANUFACTURER	HARDWARE/SOFTWARE & APPLICATIONS/AVAILABILITY	PRICE
NATIONAL MULTIPLEX	**Pegasus.** Min size: 48K; Z-80; double-density floppies (320KB); S100 bus; 12in. CRT; 58-key keyboard; two serial and one parallel intefaces; bi-directional printer. Options: 8in. drives; 1·2MB additional drives; digital recorder 9,600 baud. Assembler, Cobol, Fortran,Extended Basic. General business package available as well as text editing and mailing list. All run under CP/M. Suitable for education, business and home users. London Computer Store (01-388 5721) sole supplier.	£2,700 exc VAT.
NETRONICS	**Elf II:** single-board computer in kit form or assembled. RCA Cosmac 1802 processor, hex keyboard, 256 bytes RAM; options include up to 64KB, ASCII keyboard, cassette and RS232 I/O, and video output. Machine code or Tiny Basic. Promoted as a teaching system in minimal form, but expandable for more general use. Sole U.K. distributor HL Audio (01-739 1582).	Basic kit £115·50 inc VAT, p & p, power supply. Assembled plus user manuals, £164·10. I/O board adds £40·95; Basic is £14·95.
NEWBEAR	**7768.** CPU board, 4K memory, cassette and VDU interfaces. Range of Basics and games, British-manufactured system for hobbyists. Expandable to 64K memory, available only in kit form. From Newbear; also from Bearbag dealers, Microdigital, Microbits.	From £45
NORTH STAR	**Horizon.** Min size: 16K memory; Z-80A processor, single minifloppy disc drive (180KB). Max size: 56K memory, four minifloppy disc drives (180KB), any acceptable S100 peripheral boards. Basic (includes random and sequential access), disc operating system and monitor. Options: Basic Compiler, Fortran, Cobol, Pilot, PASCAL and ISAM. The system is suitable for commercial, education and scientific applications. Application software for general commercial users. Twenty distributors.	£995 to £2,500.
OHIO SCIENTIFIC	**Ohio Superboard II:** Min size: 6502 processor. 8K Basic in ROM; 2K monitor in ROM; 4K RAM; Cassette I/F; full keyboard; 32 × 32 video I/F. 8K Basic in ROM; Assembler/Editor; American single-board system with in-board keyboard. Aimed at hobbyist/small business. Ohio makes games, personal maths tutors, and business programs. This and other Ohio products have six U.K. distributors.	From £298.
	Challenger C24P: similar to Superboard but with a 32 × 64 character set. Supplied as two separate boards with open slots for expansion. The 'professional portable'; similar to Superboard but packaged and ready to use. Aimed at small business, education, research.	£620 to £1,595.
	Challenger C28P: similar to 4P but expandable to include two 8in. floppies, allowing use of Ohio software. Personal computer for larger business/commercial programs. Aimed at small business, education and research.	£825–£2,670.
	Challenger C3. Min size: 32K RAM, dual 8in. floppies, triple processor architecture (6502A, Z-80, 6800). Max size: 768K RAM, 74MB hard disc, multiple terminals, printers. Can run virtually all 6502, 6800, 8080 and Z-80 code. Runs Basic, Cobol and Fortran under OS CP/M. Full business software packages available, including word processing and database management. Multi-programming available.	£3,425–£13,000.
PERTEC	**System 1300.** Min size: 32K memory; dual minifloppy discs 71 bytes each, formatted; serial interfaces. Max size: 64K memory; four serial ports. Basic (single and multi-user), Fortran, Cobol. The hardware for Compelec Altair systems is from Pertec but the software is Anglo-Dutch. Sole distributor Compelec (01-580 6296).	£3,000–£5,500.
PROCESSOR TECHNOLOGY	**Sol.** 808-based S100 microcomputer packaged with cassette and video interfaces (including graphics), keyboard with numeric pad, and 16KB RAM. Basic, assembler, word processors. Floppy disc systems available. Several distributors including Comart (0480 215005), which can offer nationwide maintenance contracts.	From £1,750 (excluding monitor and cassette). Complete floppy disc systems with word processing about £5,000.
RAIR	**Black Box.** Min size: 32K memory dual minifloppy discs, 80K bytes each; two programmable serial I/O interfaces. Max size: 64K memory; eight serial interfaces; 1MB disc storage (or 10MB hard disc); range of peripherals. Basic, Fortran IV; Cobol. Hardware distributors are being signed and agreements made with software houses to add software. A warranty and U.K.-wide on-site maintenance is given. From manufacturer (01-836 4663) and systems houses.	From £2,300.
RESEARCH MACHINES LTD	**380-Z.** Min size: 4K memory; 380-Z processor, keyboard. Max size: 56K memory. Options: cassette, single or dual minifloppy discs, dual 8in. double-sided discs (1MB); serial interfaces; parallel interfaces; analogue interface; printer available. Basic Interpreter, Z-80 Assembler; interactive text editor: terminal mode software; data logging routines; CP/M, DOS, text processor, C Basic, Fortran, Algol, Pilot, Cobol, CP/M users' club library. Sold principally to higher and secondary education, and for scientific research, data processing and data logging. Available from Sintel and the manufacturer.	From £830–£3,500.
	280-Z. Board version of 380-Z system. 4K or 32K (identical in performance to the 380-Z). Interfaces, software as for 380-Z.	4KB version at £398; 32KB for £722.
RCA	**Elf II:** RCA 1802 micro with hex keypad and output to TV screen. Assembler and machine code programming; options include Tiny Basic. Available by mail order from HL Audio (01-739 1582).	From £99·85 in kit form; £164·10 including postage and VAT.
ROCKWELL	**Aim-65:** Kim-compatible with full keyboard and on-board printer. 1K or 4K RAM. The 4K version is described as a development system rather than a personal computer. Assembler, editor, Basic. Available from Pelco and Microdigital.	1K—£249·50. 4K—£315.
SCIENCE OF CAMBRIDGE	**MK14:** SC/MP processor, 256 bytes user memory; 512-byte PROM with monitor program; hex keyboard and eight-digit, seven-segment display; interface circuitry; 5V regulator on board. To this can be added: ¼K RAM (£3·60); 16 I/O chip (£7·80); cassette interface kit (£5·95); cassette interface and replacement monitor (£7·95); PROM programmer (£9·95). No software provided but a 100-page manual includes a number which will fit into 256 bytes covering monitors, maths, electronics systems, music and miscellaneous. Based on American National Semiconductor chips. Science will soon have a VDU interface and large manual on user programming. Mail order from manufacturer (0223 312919) and by selected dealers.	£39·95 basic.

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MANUFACTURER	HARDWARE/SOFTWARE & APPLICATIONS/AVAILABILITY	PRICE
SDS	**SDS 100.** Single unit containing 32K memory (expandable to 64K); up to 8K PROM; twin double-sided floppy disc drives of 500 bytes each, serial and parallel RS232 interfacing; keyboard; 12in. video display; power supplies; SD monitor program; line printer available. CP/M, 8080 assembler, E Basic, Editor supplied with system; M Basic, Fortran, Cobol available for business use, industrial process monitoring and control (with additional hardware). All CP/M games and business packages. Sole supplier Airamco (0294 65530).	From £3,750 (basic machine) plus £890 (printer); £4,500 combined.
SORD	**M100.** Min. size: 16K RAM; 4K ROM monitor; full keyboard plus function keypad; two-channel joystick dual cassette I/F; 11K EBasic on cassette; video; graphics; printer; S100 bus; converters; speaker; 24-hour clock. Max size; 48K RAM; 8K ROM; black and white or colour graphics; mini-floppy discs. Suitable for OEMs, small business, education, laboratory and scientific and home computing. Main distributor is Dectrade, but for London and South contact Midas Computer Services (0903) 814523.	From £726.
	M222. Min size: 64K RAM; VDU; full keyboard; numeric keypad; graphics; real-time clock; 70K minifloppy disc drive; audio cassette interface; two serial ports; programmable 110 to 9,600 baud; three S100 slots; power and interface for two external minifloppy drives; ROM bootstrap. Max size: 70K byte minifloppies; black and white or colour graphics; bar code reader; TMS-1000 development system. EBasic interpreter; compiler EBasic; matrix Basic; Fortran; Cobol; assembler editor; re-locatable linker/loader; debugger. Application software includes word and graphics processor; business demonstration packages and games. For small business; industrial/research, education; software houses OEMs.	From £3,450–£4,123 including desk and printer.
	M223. Min size: 64K RAM; hardware as M222 plus one or two 350K byte minifloppy drives. Max size: Four 350K minifloppies; up to four 11·4Mb hard discs; range of S100 devices. As M222 plus Cobol-80, CAP-CPP BOS MicroCobol. Application software includes word and graphics processor; personal information processing system; games; CAP-CPP range of MicroCobol software.	From £3,775–£4,448.
SYNERTEK	**Sym 1:** 6502 chip and keypad with memory available in 4K blocks to 64K. Any Kim software. American, meant to be the foundation system for very small business and hobbyist users. Available from Newbear (0635 49223).	From £200.
TANDY CORP.	**TRS-80.** Min. size: Level I 4K memory; video monitor; cassette; power supply. Max size: Level II 48K up to 350K on-line via floppy discs; line printer; tractor feed printer and quick printer; floppy disc system. Modem, telephone interface soon available. Basic; some business packages. Level I aimed at the hobbyist and education market and Level II at small business applications. Hundreds of dealers.	Level I–£499 Levell II–from £578–£4,700.
TRANSAM COMPONENTS	**Triton:** British-made kit computer. Up to 65KB. Full graphics capability, 64 characters. Power supply; cabinet. Communications interfaces. Tiny Basic or 2K Basic, 1KB monitor plus new option 4K firmware on board. Available from manufacturer. (01-402 8137.)	£286 kit with 5KB.
VECTOR GRAPHIC	**48KB RAM, Z-80 micro:** 63K bytes, mini-discs are standard, Options: graphics. Monitor, MDOS, Basic; business packages from dealers. Several distributors.	£2,300

A PRACTICAL GLOSSARY

Continuing the terminological gamut with I

Increment

To augment or increase—that's all. It is used freely for several internal operations but it still means to add something—usually to a particular register (qv) or memory location.

Index

There are a number of occasions in computing where you will come across an index. Wherever it is used, the term means that something indirect is happening. That is analogous to a book index—to find a reference to 'Aardvark' you could read every word in the book, or you could go to that summary of key words at the back and be directed to the correct page number. The direct mode takes you straight to your Aarvark without intervening stages; the index mode puts in an extra step or two but simplifies things.

Index hole

Remember the piece about hard-sectoring in the Glossary item on H words? Hard-sectoring means that your floppy disc has a hole punched into it to indicate to the drive where the data starts. That hole is called the index hole.

Indexed addressing

A computer instruction which references an address can do so directly, which means that the memory location is stated in the instruction specifically—like 'store the contents of this variable in memory location starting at number 3,517'. The problemwith that is two-fold; the way the computer handles instructions may not allow enough bits to contain large addresses—which is why eight-bit micros typically cannot access more than 64KB of memory. In any case, direct addressing can be a little unsubtle—you have to know practically everything about the address before you can reference it.

Indirect addressing is the alternative, and indexing is one form of it—the computer calculates the desired address by adding the contents of an index register to what is called a 'displacement' value in the instruction. A special location, the index register, is set up; it points to a particular memory location, and the displacement value in the instruction is added to that to produce the address you want.

The contents of the index register are usually called the base address, and obviously by modifying them—and/or setting up more than one index register—you can set this to point to alternative memory locations.

To put it another way, it is not unlike sending a letter to 'The Brown House next to the pub on Noel Road'. Indirect addressing means that the memory location to which a particular instruction refers will not be included in that instruction. The computer will have to work it out by reference to other memory locations.

Indirect addressing thus means that the instruction references a memory location which contains the address of data rather than the data itself.

Indexed sequential

There are three widely-used ways of getting at data stored as records and files in a computer system. Sequential mode means that your program starts at the first record and reads through the lot until it hits the one it is looking for. Direct access or random mode means that you can get straight to the record you want without having to read anything else first, but the way you reference a particular record has to include a key from which the actual location of the record on backing store can be calculated.

Ordinary sequential access is simple and well-suited to cheap storage media like cassette but it is slow. Random access is fast but it is complicated and if you have too many records the algorithmic calculation can be a bit silly.

The wonder solution fitting between them is indexed sequential access. Records are stored sequentially in some kind of logical order, just as with plain sequential mode, but the records can be accessed selectively, so that unwanted records can be skipped past quickly.

The point is that you use the filing system to set-up indices which point to the records, just as a book index points to the terms referenced. So your program goes to an index, looks for the location of the data it wants, and then goes directly to that location.

Indexed-sequential file access is slower than random mode and more complicated than sequential mode but it provides a reasonably quick way of reaching large amounts of data, and so it is practically a pre-requisite in commercial systems, where a great deal of file accessing on many files is taking place.

Information

The straight definition says that information is any electrical signal or bit pattern with 'defined meaning'. The emphasis goes on the word meaning, of course; the distinction between data and information is that data has no inherent meaning, while information is meaningful data.

As an example, take the number sequence 170179. This is data, but it is just a bunch of numbers. It becomes information when someone tells you it refers to January 17, 1979.

Input/output

What happens when a computer communicates with the outside world—the transfer of data between a processor and peripherals; wait to P for definitions.

Two means of I/O are available—programmed and automatic. For programmed I/O, all information is passed as a result of executing programmed instructions. For automatic I/O, all information is passed as a result of executing programmed instructions. For automatic I/O, control information is passed to a controller for a particular device, like the screen, keyboard, or cassette unit.

That information will specify the mode of operation, the memory area involved in the transfer, and the amount of data to be passed. Once the transfer operation begins, it needs no further intervention by the program; completion of a data transfer often causes the device controller to signal that the device is available for another transfer.

Fast devices, such as discs, usually require automatic block I/O. Slower devices can operate under either regime. Since hardware controllers for block I/O are relatively expensive, the control information for automatic transfers can be put into special memory locations associated with one or more data channels, or it may reside in the device controllers.

Inquiry

Or, more often, enquiry. Either way it means accessing information stored by the computers. In practice, the term applies particularly to *ad hoc* inquiries, which means getting information as and when required. Typically this will involve some keying-in at a VDU; the alternative is pre-meditated, formally-structured, pre-written reporting functions.

Inquiry is a helpful concept because it allows your system to look interactive. File inquiries do not alter anything, unlike file updates so you can have a batch computer system—with all alterations and amendments done in batch mode—with interactive inquiries without it being a 'true' on-line system.

Truth tends to reside in the eye of the beholder. In our view, however, an on-line system is one in which a file update is entered and processed immediately. That's also called transaction processing (qv), and we'll talk more about it when we reach T.

Instruction

Tells the computer what to do, so it's an apposite term. More explicitly, an instruction is a single program step; a program is composed of a number of instructions.

One instruction may not correspond to a single basic computer operation, and indeed it probably will not. This is because a high-level language instruction by its very nature is executed or implemented by several internal operations. On the other hand, a low-level language like an assembler (qv) will have instructions which correspond closely to computer operations.

Integer

A whole number. Well, there's nothing wrong with short definitions, is there?

Integrated circuit

An electronic circuit formed on a single chip of semiconductor material. Frankly we do not intend to become involved in a heavy discussion on electronics so you cannot expect a definition of a circuit or a discussion of the properties of semiconductor materials. The chip in question is usually fabricated chemically from silicon (a clever version of rock) and the resultant IC is generally characterised by very small size, very low cost, very little heat dissipation, and comparatively simple electrical requirements. Computer manufacturers buy ICs in bulk; there are only a few manufacturers and they deal in extremely large production volumes.

It is an interesting sidelight on the economics of IC manufacture that something over 99 percent of normal production comprises unserviceable chips which are thrown away because it is not worth repairing them.

The big semiconductor houses include Intel (qv) Fairchild, Motorola, Texas Instruments and IBM. Apart from IBM, all make ICs for other people as standard catalogue products; they will include memory and CPU chips. They also become their own customers; all of them assemble computers and all will shop from each other for standard components, if necessary.

Intel

Intel a contraction of INTegrated Electronics. It began life only in 1969, produced the world's first microcomputer which leads its market, and last year earned $44·3 million on a $400·6 million turnover.

Intel founders used to work for Fairchild. The pioneering Intel 4004 (circa 1971) was the first micro, a four-bit device. Intel also had the world's first eight-bit micro. Apart from micros and microcomputer components, Intel's other main product line is semiconductor memories and last year it shipped 200 billion bits.

On the micro side, Intel has 175 products. The principal ones are the 16-bit 8086; the trusty 8080A, current version of the eight-bit processor-only chip, and the faster 8085; and the 8048

(*continued on page 121*)

(*continued from page* 119)
family, which gives you memory on the processor chip.

Interesting goodies in Intel's future include the takeover of a Texas software house, MRI. This has a well-known database manager called System 2000 which runs on big IBM computers. Intel apparently bought MRI because it intends to develop a micro-based box containing the database manager; that would plug into the IBM mainframe and allow the user to operate a database system without all the overheads of a software database manager.

Intellec
Brand name for the Intel line of development systems. They comprise appropriate hardware and software to allow you to develop programs which will run on the relevant Intel micro. Like all development systems, the Intellec line is intended for people who build micros into other systems, which means that in operational use the processor will be invisible and unalterable, probably with a program stored irretrievably in read-only memory.

A development process employing a system like one of the Intellec line is used to get the operational aspects of that system to perfection before it becomes buried inaccessibly inside a weighing machine, a pocket calculator, or whatever.

Intelligence
Applied to computers or any mechanised or automated object, it normally means programmability—the ability to perform alternative courses of action on the basis of an internally-stored and theoretically-alterable set of rules.

Inter-leave
This has two alternative connotations, neither of which applies only to microcomputers. It can refer to memory, in which case it means dividing memory into two parts with separate data paths to the processor; this can sometimes speed throughput.

Alternatively, inter-leaving refers to some clever juggling with the execution of programs which definitely speeds throughput; parts of one program can be inserted into another so that the two can be executed more or less simultaneously. The system does this automatically.

Interpreter
Software which translates a program in a high-level language into machine code—the binary instructions which correspond directly to computer operations.

A compiler (qv) also does this but with a compiler you have to put your program through it (compiling) to obtain what is called an object-code program in machine code. You then run the object code.

With an interpreter, each statement in the high-level language program is translated and executed immediately. This means you can add or delete instructions and see the effect immediately, so it speeds the process of getting a program into its final state.

Interpreters might take-up some memory, since they have to be waiting to translate; and interpreted programs are certainly slower when it comes to run-time, because a program already in machine code is inevitably much more efficient.

Because interpreter languages do not require the compile process they are generally preferred for personal computers—they are simple and humane to use. Apart from Basic, you will find APL and PASCAL frequently in interpreter form.

You won't find many interpreters, however, for Cobol or Fortran. Those well-developed languages are very rich in user facilities and powerful commands; an in-memory interpreter capable of translating each possible statement as it is input would be enormous. It would occupy too much memory and the translation would be burdensomely slow.

Or you might say that compiler languages are verbose, unwieldy, have more than a little in common with the dinosaur age, and are rooted in old-style, inhumane, non-ergonomic batch processing.

Interrupt
What happens when something causes the temporary suspension of activities inside the computer. Usually control is passed to an 'interrupt handler' or 'interrupt service routine' which is part of the operating system. That decides what is going on and what ought to happen. When the interrupt has been handled, the original processor status is restored—all the relevant parameters having been stored as part of the interrupt handling—and the previously-executing program is allowed to continue from the point at which it was interrupted.

The interrupt signal is typically from an I/O device, like the keyboard demanding the processor's attention when you type something.

Interrupt handling can be a very powerful tool for doing many useful things in fairly complex applications. Looking after interrupts on a personal computer tends to be totally transparent to the user, for whom this information will be of academic interest only. If you are prepared to grub around in the innards of the operating system you might find the interrupt vectors, which are the memory locations at which the interrupt handlers start. So you might be able to force your own interrupts even if the manual does not exactly tell you how; you might set-up 'traps' related to a real-time clock, for example, to take snapshots of the system status during execution.

The other buzz phase you might encounter on the interrupt front is interrupt priority. It establishes a hierarchy of importance for attention-getting signals and allows the operating system to decide which to look at first. On a personal computer the number and variety of interrupts you might have are comparatively limited, so the operating system decides which interrupting device should be handled first.

More complicated systems use micro-coded or hard-wired priority systems, either pre-set—so that some types of interrupt always receive top priority—or alterable in some applications; the relative importance of peripherals will vary from program to program.

I/O
Conventional abbreviation for input/output.

Iterate
Means to repeat. It is sometimes used as a synonym for the verb 'to loop', meaning to repeat under program control a pre-determined set of instructions.

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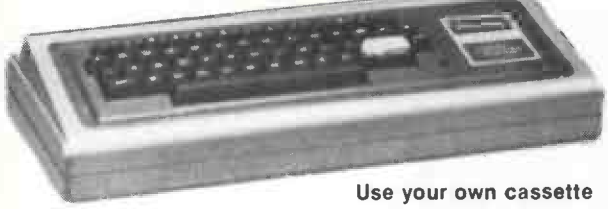

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