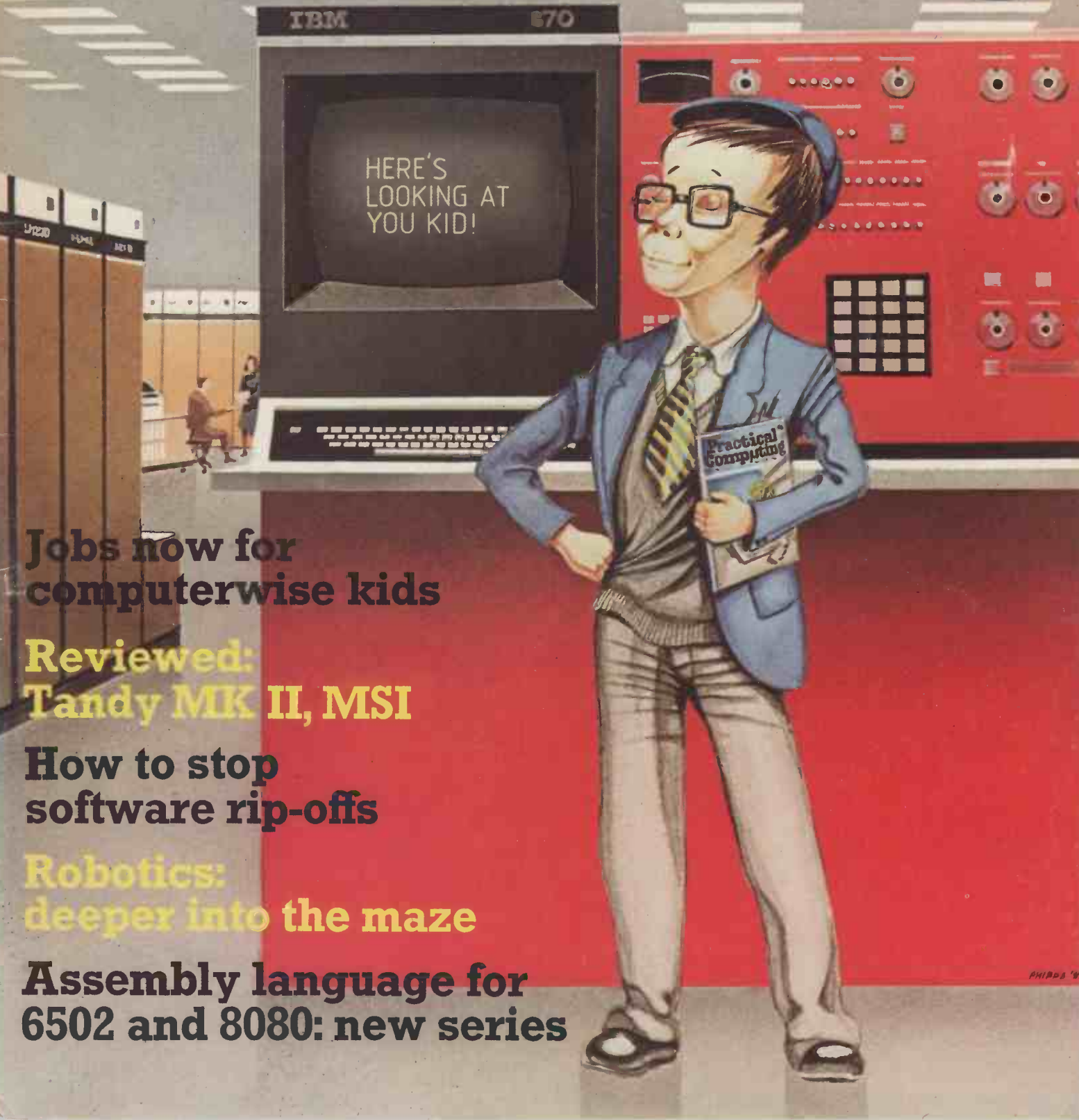


Practical Computing

March 1980

Volume 3 Issue 3



Jobs now for computerwise kids

Reviewed: Tandy MK II, MSI

How to stop software rip-offs

Robotics: deeper into the maze

Assembly language for 6502 and 8080: new series

PHIPPS '80

The computer with growth potential

The System Three is Cromemco's best selling small business computer. It's easy to see why.

Not only is it ideal for the first time computer user. But perhaps more important, it can be expanded into a comprehensive business facility servicing many varied company requirements.

Single-user system

You can start small. A 64K computer with a megabyte of floppy disc storage costs under £4,000.*

Perhaps your initial reason for choosing Cromemco was its flexible database management system—ideal for client records, order processing, sales analysis, inventory control, and many more business uses; or you might have required the full screen word processing system, capable of printing up to 20 original letters an hour; possibly you needed Cobol, Basic or Fortran, to develop your own customised packages.

Easy to use

Whatever the reason, you were highly impressed with the ease with which your very first computer application got off the ground. So you added another. And another. And pretty soon quite a lot of company business was running on your Cromemco.



Single-user System Three, with 64K memory, 2 discs, terminal and printer. Ideal for small businesses.

Will it expand?

It was then you discovered that the terminal is the limiting factor, because of the time taken to input data. If only you could connect a second terminal you could double your system's workload. . .

Multi-user system

Fortunately, we can readily expand your Cromemco. Unlike other makers' systems, all we need to do is add some memory and a ® TU-ART interface, and the multi-user system is ready to run . . . with a printer and up to 7 terminals, each with up to 48K.

New operating system

Moreover, your terminals can function quite independently of each other. Under Cromemco's new operating system they can be used to update and interrogate the company's database; for correspondence, with the word processing system; for data entry, using the full screen editor; or indeed for running any combination of CP/M software, *simultaneously*.

Up to 72 megabytes

We can increase your floppy disc storage to 2 megabytes if necessary. And if that's not enough, we can also add Cromemco's hard discs to provide you with up to an amazing **72 megabytes** on-line.

Rely on MicroCentre

Remember—at MicroCentre we fully understand Cromemco systems. That's why we're Cromemco's top UK distributors. So trust your initial Cromemco investment to MicroCentre. And call us any time to discuss your hardware enhancements or software needs.

Your company's future growth may depend on it.



Multi-user System Three, with 320K memory, 4 discs, 7 terminals and fast line printer. Each terminal has its own operating system, and can run any software package independently.

*Price excludes VAT and delivery. Terminals and printers to be added according to user requirements. ® TU-ART is a Cromemco trademark.

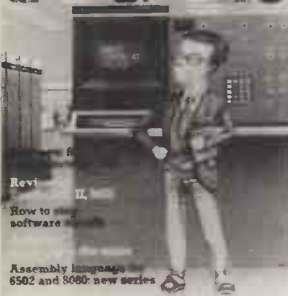
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Micro Centre

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Practical Computing



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

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This month's cover shows the bane of micro-computer shows — the fourteen year old who knows it all. But still, at this juncture in our island history, we seem to need him. Inside this issue: how to get started in computing, even if you aren't still fourteen.

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- 03 = *ENTER PURCHASES
- 04 = *ENTER A/C RECEIVABLES
- 05 = *ENTER A/C PAYABLES
- 06 = ENTER/UPDATE INVENTORY
- 07 = ENTER/UPDATE ORDERS
- 08 = ENTER/UPDATE BANKS
- 09 = EXAMINE/MONITOR SALES LEDGER
- 10 = EXAMINE/MONITOR PURCHASE LEDGER
- 11 = EXAMINE/PRINT INCOMPLETE RECORDS
- 12 = EXAMINE PRODUCT SALES

SELECT FUNCTION BY NUMBER—

- 13 = PRINT CUSTOMER STATEMENT
- 14 = PRINT SUPPLIER STATEMENTS
- 15 = PRINT AGENT STATEMENTS
- 16 = PRINT TAX STATEMENTS
- 17 = PRINT WEEK/MONTH SALES
- 18 = PRINT WEEK/MONTH PURCHASES
- 19 = PRINT YEAR AUDIT
- 20 = PRINT PROFIT/LOSS ACCOUNT
- 21 = UPDATE END MONTH FILES & MAINTENANCE
- 22 = PRINT CASH FLOW FORECAST
- 23 = ENTER/UPDATE PAYROLL (NOT YET AVAILABLE)
- 24 = RETURN TO BASIC

WHICH ONE? (ENTER 1-24). SUB MENU EXAMPLE: 01 = EXAMINING: 02 = INSERT: 03 = AMEND: 04 = DELETE
05 = PRINT (1,2,3): 06 = NUMERIC COMBINATIONS: 07 = SORT.

*VERY FLEXIBLE. ADD YOUR OWN FUNCTIONS. EASY TO INTEGRATE.

All programs in BASIC for CP/M • PET • 6800.

**PRICES: Programs 1-23 excluding (19,20,22,23) £475 inclusive £575.
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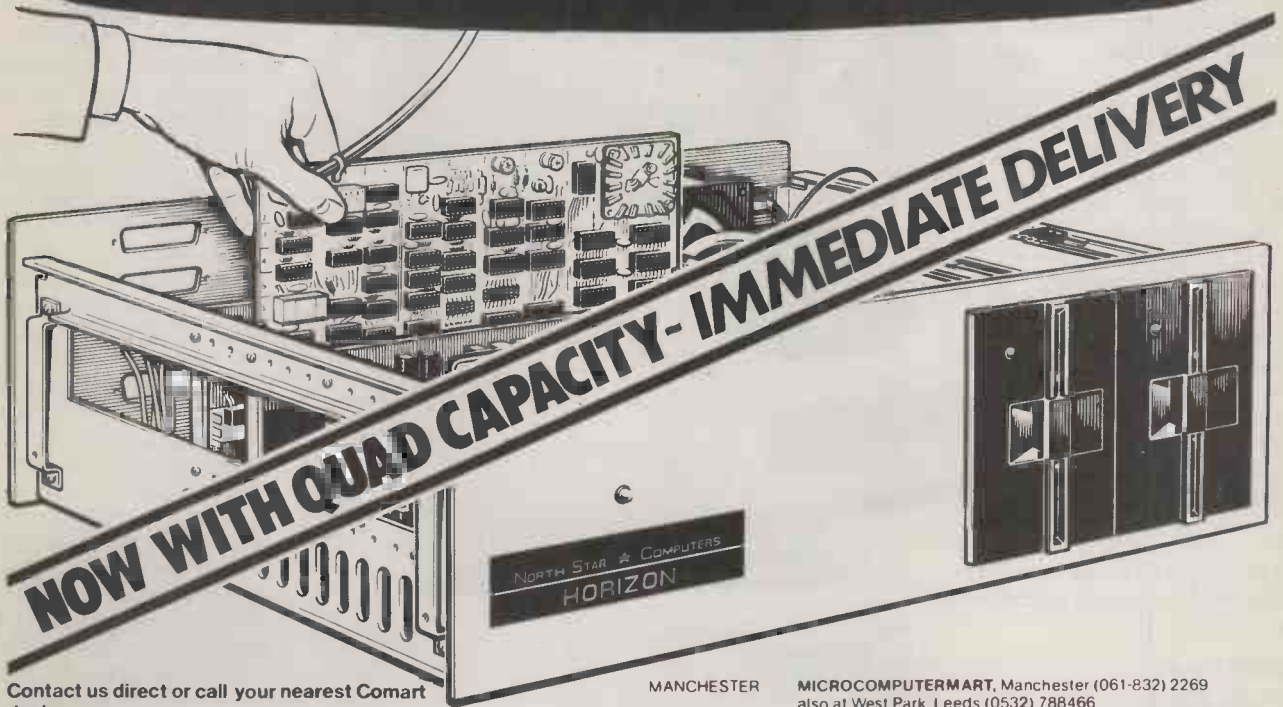
Dear Sir

The benefits of word processing are here for all!

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The VDM transforms the Horizon into a valuable word processor yet change the diskette software and it resumes its role as a general-purpose Computer **Real Flexibility!**



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• Circle No. 103

Scotland 18, 19, 20 March – Albany Hotel, Douglas Street, Glasgow
 North West 11, 12, 13 March – New Century Hall, Corporation Street, Manchester
 Midlands 4, 5, 6 March – Albany Hotel, Smallbrook Queensway, Birmingham
 London 25, 26, 27 March – West Centre Hotel, Lillie Road, London SW6

COMPUTERMA

Your first computer?

If you're thinking about your first computer for home or office, a visit to Computermarket will save you time and money. You'll be able to compare prices in just one visit, see who is committed to your area, meet people who have installed the sort of equipment you are considering, check out after sales service arrangements with more than just one potential supplier and see computers performing the applications of interest to you. You'll see micro-computers from just a few hundreds of pounds and highly sophisticated systems costing hundreds of thousands. You'll be able to examine the enhancements you may later wish to add to your computer and check out that the system can be upgraded, investigate the availability and cost of the supplies that you'll need to get and keep your computer running. You might even actually see a silicon chip!

OEM/System builder?

Hasn't your marketplace changed since you first thought about the business you're in? 16 bit micros, midi-computers, bread-boards for peanuts, matrix line printers, smart VDUs for the price of dumb ones, famous names that you hadn't heard of only months ago. Customized or off-the-shelf, it must sometimes look like the world and his wife is starting a systems house. Who is in your business in your area? A visit to Computermarket will tell you and a lot more besides including who can supply at least cost and fastest delivery.

Computer user?

If you've already got a computer, you'll know who gives the best service on supplies in your area – won't you? You'll already know where you can get short delivery and best terms on the peripheral enhancements you plan – won't you? You'll be aware of the software packages that are available for your existing equipment – won't you? You've probably thought about the additional processor (or its replacement) you will need before too long – haven't you? Why not check and be sure. A visit to Computermarket will confirm that you are right and will continue to get the best deal on peripherals, ancillary equipment, services, software, supplies . . . and it will give you the opportunity to see micro and mini based systems in operation just to keep up-to-date and for interest's sake – won't it?

Communications user?

Are you getting the most from your system? An acoustic coupler can cost very little and yet be the start of a communications network. Modems, multi-plexers . . . the hardware of data communications is developing fast and so is the environment in which the equipment may be employed. Communications experts will be at Computermarket so if it's a terminal in another part of your building, distributing data processing or starting your own satellite communications network (!), a visit to Computermarket should prove to be a worthwhile investment and a chance to study PRESTEL at first hand.

Who will be at Computermarket?

Advertisements such as these are prepared many months in advance of the exhibitions described, but it is already certain that Computermarket will be bigger than ever before – more than twice as big overall. Companies that had already reserved stands as at November (almost four months before the 1980 series of exhibitions) included:-

- Zygal, Wootton Jeffreys, Willis Computer Supplies, Which Computer?, Wespac, Wang, Versatec, Tullis Neill, Terminal Display Systems, Telema, Tektronix, Tann Synchro-nome, Systeme, Sumlock Bondain, Star Computer Centre, Scotia Data Products, SEMS, Selborne Computers, SEL, Rostronics, Robox, Rair, Q-Pac Services, Pragma, Post Office, Plessey Peripherals, Peterborough Data, Richard Norton, Northern Software Consultants, Newbury Laboratories, Nashua, Nascom, NSC Computers, Modular Technology, Modem,



- Midlectron, Micro Media, Micro Data Products, Micro Centre, Micro Bits, MCS Mini Computer Systems, Lynwood Scientific Developments, Lyme Peripherals, Linn Products, Information Equipment Maintenance, ITT, ICS, Harwoods Business Machines, Hamilton Rentals, John Goldsmith, General Audio & Data Communications, Geest Computers, GEC Computers, Excel, Eurocom, Equinox, Digidata, Digico, Datum, Data Design Techniques, DRG Business Machines, DML, Cytek, Cost Effective Computing, Corner Computer Services, Computing, Computer Workshop, Computer Weekly, Computer Management, Computer Ancillaries, Computastore, Comp

MARKET '80

Shop, Commodore Business Systems, Comma Computers, Cole Electronics, Cifer Systems, Camden Electronics, CPS Data Systems, CPN, C.A.R. Business Systems, Byte Shop, Benson Electronics, BL Systems, B & B Computers, Andrews Industrial Equipment, Anadex and A.I.R.

Accountant?

If accounts, payroll, invoicing, credit control, ledger maintenance . . . figure in your life, then an hour or two at Computermarket should be an absolute must. A micro-computer can cost as little as a calculator did just a few short years ago. Trial balance and Profit and Loss statistics can be generated at the touch of a few buttons. Computers can cost hundreds or hundreds of thousands of pounds, save or even sometimes, heaven forbid, squander. You should know what computers are doing today, you might want one or have to use one tomorrow. Your advice may be sought – should be sought – by your own company or that of a client. Admission to Computermarket will cost you nothing, but could very well be worth a great deal in the future.

Data processing manager?

How much would a ten per cent saving on your stationery budget mean to your annual costs? There may be an exhibitor who could achieve that if the two of you met. Is your next peripheral going to be supplied on the most favourable terms? A visit to Computermarket will give you the confidence that you are doing the best for your company. Wouldn't it help if only other Managers in your company could see what it was you were talking about when describing printers/plotters/displays/. . . ? Why not bring them along to Computermarket and show them what you've told them about? Does your chief analyst realise how software packages can be run on your hardware? Wouldn't you both benefit from a visit to Computermarket?

Your own business?

Like it or not, computers are affecting your business and that of your clients, suppliers and competitors. A computer can offer the businessperson much more than automated accounting. It can provide accurate, up-to-the-minute details on the performance of the company, flash warning signals over stock levels, credit-worthiness, supplier shortfalls . . . handle payroll, revenue and VAT returns . . . generally give you more time to run the business you know rather than processing paperwork. See the systems at Computermarket.

Computerising correspondence?

Computer control has received a lot of publicity since the advent of the silicon chip, but micro-processors have also made an impact in the office. Word Processors are able to increase the efficiency of typists to varying and often staggering degrees. Where repetition occurs in letters, reports, contracts, etc., a Word Processor can frequently pay for itself in a matter of months. Many of the small business computer systems now available include a word processing facility, thereby offering what is almost a complete 'work processing' system for a cost equivalent to, say, a new company car. Witness work processing at Computermarket.

In the Midlands?

Computermarket '80 opens at the Albany Hotel, Smallbrook Queensway, Birmingham on the 4th, 5th and 6th March between 10 am and 5 pm daily. The Albany Hotel has excellent facilities and is very conveniently located for car parks and New Street Railway and Bus Stations.

In the North West?

The Manchester venue of Computermarket '80 is the New Century Hall (at the foot of the C.I.S. building) in Corporation Street, opposite Victoria Station, close by car parks and connected by bus with the Piccadilly Station. Computermarket – North West is open 11th, 12th and 13th March 10 am to 5 pm.

In Scotland?

Regarded as Glasgow's finest hotel, the Albany in Douglas Street (on the corner of Bothwell Street) houses Computermarket '80 in Scotland. The hotel is within walking distance of the major railway stations and well provided with car parking and motorway access. Computermarket – Scotland is on 18th, 19th and 20th March between 10 am and 5 pm each day.

In London?

Biggest of all the Computermarket '80 venues is at the West Centre Hotel, Lillie Road, London SW6. The West Centre Hotel is a few minutes walk from West Brompton underground station and is also convenient for the Earls Court underground. Limited car parking is available at the hotel itself. For those visiting London Computermarket is open 25th, 26th and 27th March as with all venues, the exhibition is open from 10am to 5pm each day.

For FREE Admission and complimentary catalogue, complete the coupon and return it to:
Couchmead Limited,
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London W1V 7PA.



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Job Title _____

Organisation _____

Address _____

Postcode _____

COMPUTERMARKET '80

It is regretted that in order to preserve the businesslike nature of Computermarket, admission is not open to persons under 18 or to student parties.



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authorised dealers

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£675.00
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£795.00

BASIC SYSTEMS

PET 2001-8 (PET with 8K memory + integral cassette) £515.00
PET 3008 (8K) with large keyboard £475.00
PET C2N External Cassette Deck £53.00

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IEEE/RS232 Serial Interface 'B' Input/Output £186.00
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IEEE-448/Centronics type parallel Interface £45.00
IEEE to Pet Cable £19.00
IEEE to IEEE cable £24.00
PETSET 1 16 Channel AD Converter c.w. all interfacing requirements £166.00

TRS 80



from
£365

From Radio Shack Corp.

TRS 80, 4K Level I consisting of Keyboard with 4K memory, Video Unit, Cassette Drive and 240v power supply unit £365.00
TRS 80, 4K Level II (as above with Level II Basic) £425.00

BASIC SYSTEMS

TRS 80, 16K Level II (as above with 16K memory) £499.00
TRS 80, Expansion Interface with 16K RAM £275.00
TRS 80, Expansion Interface with 32K RAM £360.00

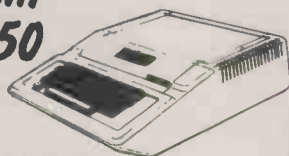
ACCESSORIES

TVJ 232C serial Interface £35.00
Centronics Parallel Printer Interface (direct to keyboard) £40.00
TRS 80, Voice Synthesizer £345.00
TRS Voxbox - speech recognition system £135.00
TRS 80, Numeric Key Pad supplied and fitted £49.00

Radio Shack Phone Modem £160.00
UHF Modulators (encased with leads for 625 lines) £20.00
RAM upgrade (4-16K, 16-32K, 32-48K) supplied and fitted at our premises (Kit £80.00) £85.00
S100 interface for TRS 80 (6 slots) £375.00
TRS80 CPU 3 speed mod. £26.00

APPLE II

from
£750



apple & ITT 2020
authorised dealers

Apple II Plus computer - APPLESOFT

BASIC SYSTEM

extended basic in ROM - (16K RAM) - video output £750*

ACCESSORIES

Apple black and white modulator for domestic TV £20.00
Eurocolor card - provides colour on domestic TV £69.00
Parallel Printer Interface Card £110.00
High Speed Serial (RS232C) Interface Card £110.00
Communications Card £132.00
Centronics Card £110.00
Integer Basic Firmware Card £110.00
PASCAL language system - includes language card to provide user with PASCAL, PALSOFT & INTEGER BASIC £296.00

Real time clock/calendar card - 1/1000 sec to 388 days with interrupt, software controllable £140.00
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Supertalker - adds human speech output! £205.00
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Hobby Prototype Card £20.00
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from £740



Exidy
authorised dealers

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BASIC SYSTEMS

Sorcerer 32K RAM (inc. UHF Modulator) £840.00

ACCESSORIES

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CP/M for Sorcerer on Disk £145.00

COMPUCOLOR

from
only
£999



8
for computer with colour monitor, keyboard and integral disk drive. Second disk drive £316.00

ADVANCED SYSTEMS

Altair, Equinox, Billings, Heath, Rair, Horizon.
Installations include hard disk and multi tasking. Prices on Application.

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P.O.A.

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Consultancy and Competitive Prices.

Registered business name



DISKS

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Computhink (dual drive) 400K storage	£895.00
Computhink (dual drive) 800K storage TRS80	£1145.00
Shugart drive	£315.00
Micropolis drive	£315.00
Percom FD200 drive 110v	£299.00
Micropolis Dual Drive (394K storage)	£995.00
Corvus Hard Disk (11mb)	£3500.00
APPLE	
Apple Drive - 116K storage 1st drive	£398.00
Apple Drive - 116K storage 2nd drive	£355.00
Corvus Hard Disk (11mb)	£3500.00
SORCEROR	
Exidy - 143K storage	£495.00
Exidy Dual drive (630K storage)	£1195.00
Corvus Hard Disk (11mb)	£3500.00

PRINTERS

PET	
CBM 3022 (80 col with PET graphics - tractor feed)*	£675.00
TRS80	
TRS 80 Screen Printer (text + graphics) (110v)	£445.00
New Radio Shack Micro Printer	£245.00
GENERAL	
Teletype 43 KSR Serial (pin or pinch feed, 132 cols)	£825.00
Teletype 33 KSR Serial (110 Baud) Reconditioned	£450.00
OKI - parallel/serial (pin or pinch feed, 40, 80, 132 cols selectable)	£499.00
Centronics 779 parallel (tractor feed, 132 cols)	£825.00
Anadex DP 8000 serial/parallel (112 cps bi-directional tractor feed, 40, 80 cols selectable)	£560.00
Centronics Micro Printer (20, 40, 80 cols selectable)	£395.00
Heath WH 14 serial (80, 96, 132 cols selectable)	£475.00
QUME daisy wheel printers	P.O.A.
TCM100/MICROHUSH Thermal Printer (40 cols) inc. interface for PET/APPLE/TRS80	£266.00

ETC.

Diskettes 5 1/4" (blank) boxed (min order 10) each	from £3
C12 Cassettes (min order 10) each	£0.35p
Ansaback 'phonemate' telephone answering machine, voice operated twin cassette	£190.00
Pace EZ-PHONE - Cordless Telephone	£225.00
Computalker Speech Synthesis for S100	£350.00

BOOKS - Large range of microcomputer related books and magazines

TERMINALS

Pentland V1, 80 char./24 lines 2 page memory	£580.00
--	---------

IF YOU DON'T SEE IT - ASK IF WE HAVE IT

SOFTWARE

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PETSOFT authorised dealers - over 160 programmes on cassette and disk. Send for catalogue.

STAGE ONE COMPUTERS S/W dealers - PETAID, Stock Control, etc. Send for list.

74 Common BASIC Programs on one tape £15.00

PETACT Business Software - Sales and Purchase Ledger P.O.A.

CBM DISK-BASED BUSINESS SOFTWARE:-

Commodore Word Processor powerful word processor package £75.00

CSTOCK - STOCK CONTROL - gives complete stock report £150.00

CBIS - BUSINESS INFORMATION SYSTEM - Storage & Retrieval of all types of company records £150.00

COM ACCOUNTS - Full Financial Business Accounting System incl:

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PAYROLL - Handles hourly, weekly or monthly paid employees (Tape) £50.00

(We are authorised CBM Business Software Dealers) Send for List.

GD 1001 - Assembler Development System £50.00

GD 010 - Lisp Interpretive Language (Artificial Intelligence) £75.00

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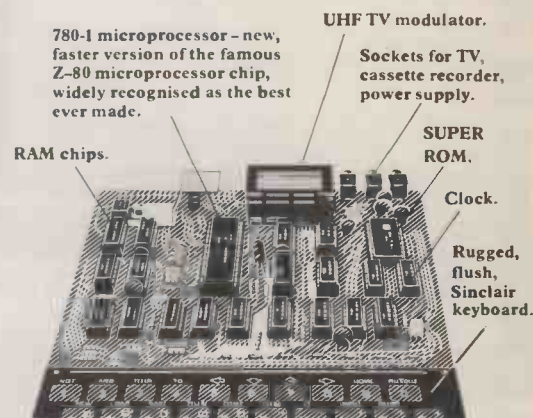
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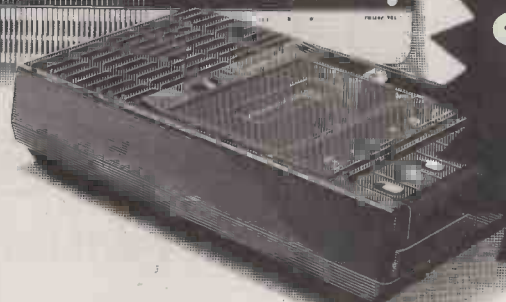
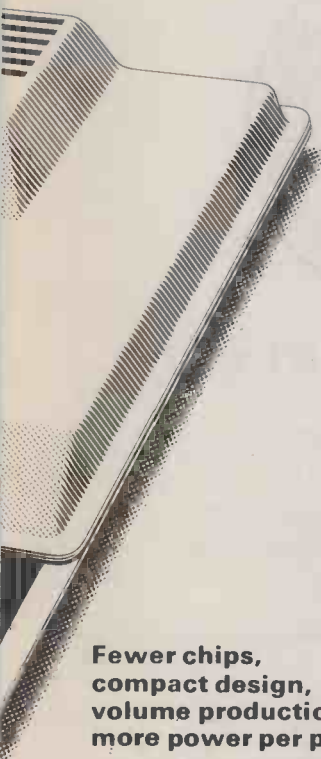
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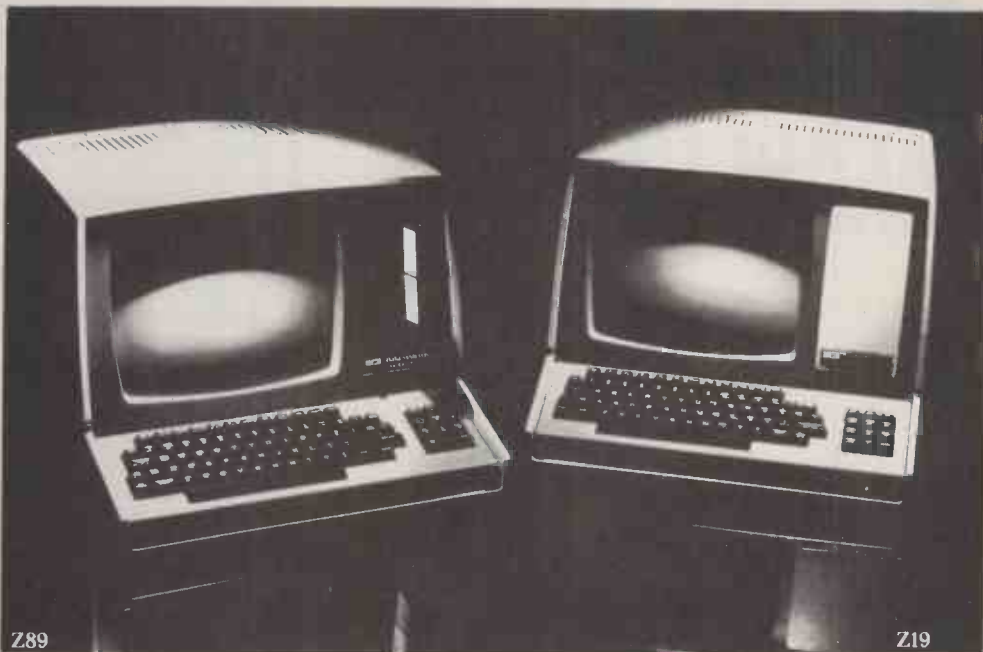
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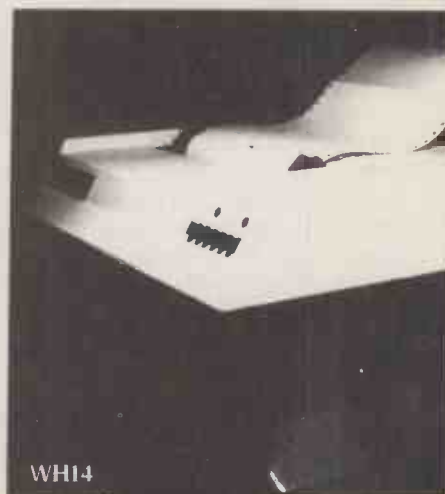
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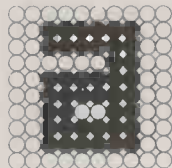
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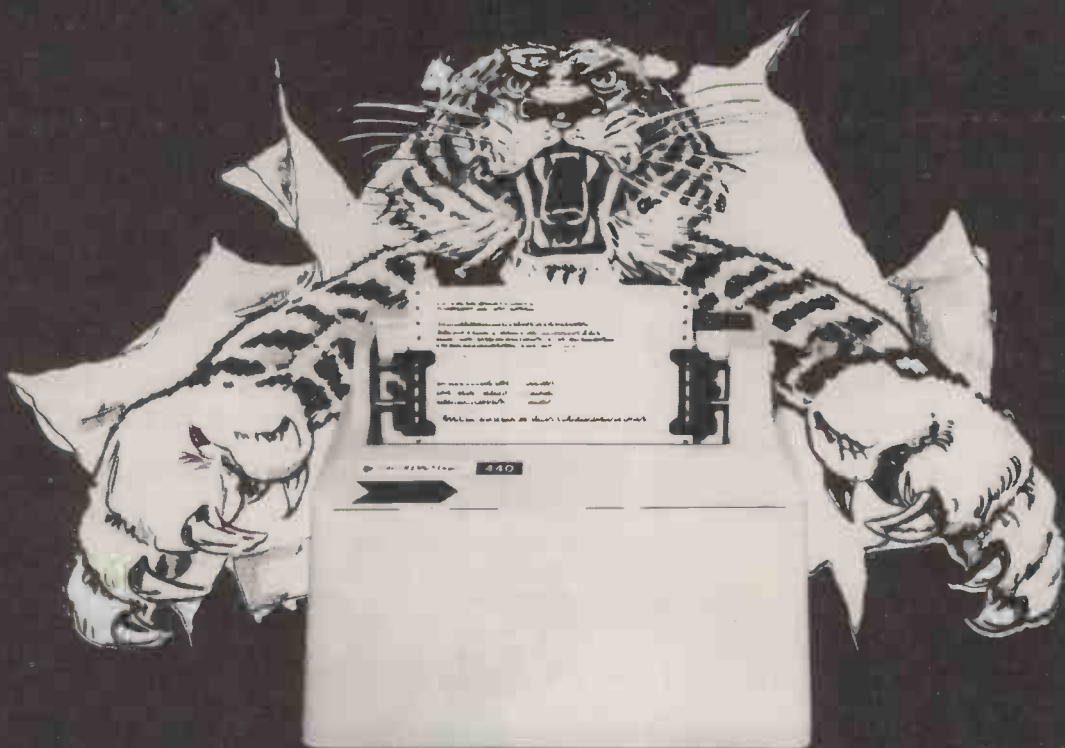
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Throughput, lines per minute @ 10 char./line @ 132 char./line	275 42	100 40	Data not available	440 64	130 21
Parallel and RS-232 serial interfaces standard	YES	NO	NO	NO	NO
CRT screen buffer	OPTION	NO	OPTION	NO	NO
Footprint (W x D = sq. ft.)	1.37	3.45	3.18	3.58	2.44
Weight (lbs.)	20	64	50	55	45
Forms length control	YES	OPTION	YES	OPTION	NO
Full dot plotting graphics	OPTION	NO	NO	NO	NO
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Comparison data from manufacturers' current literature for 60 Hz operation.

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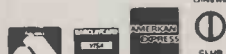
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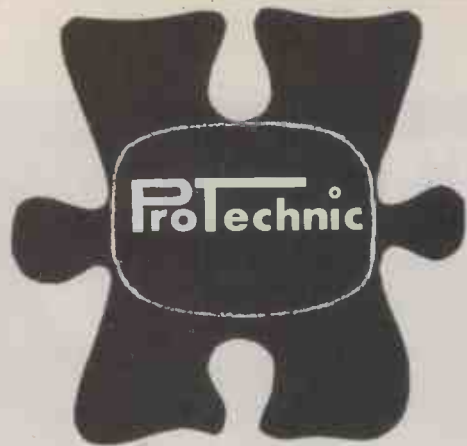
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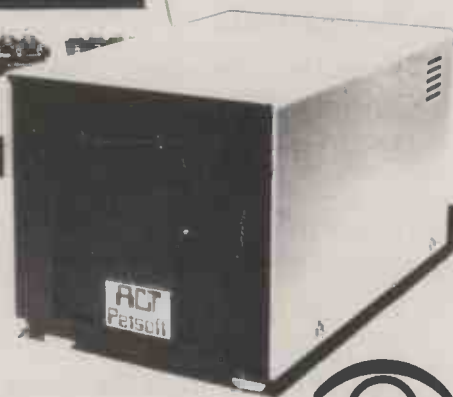
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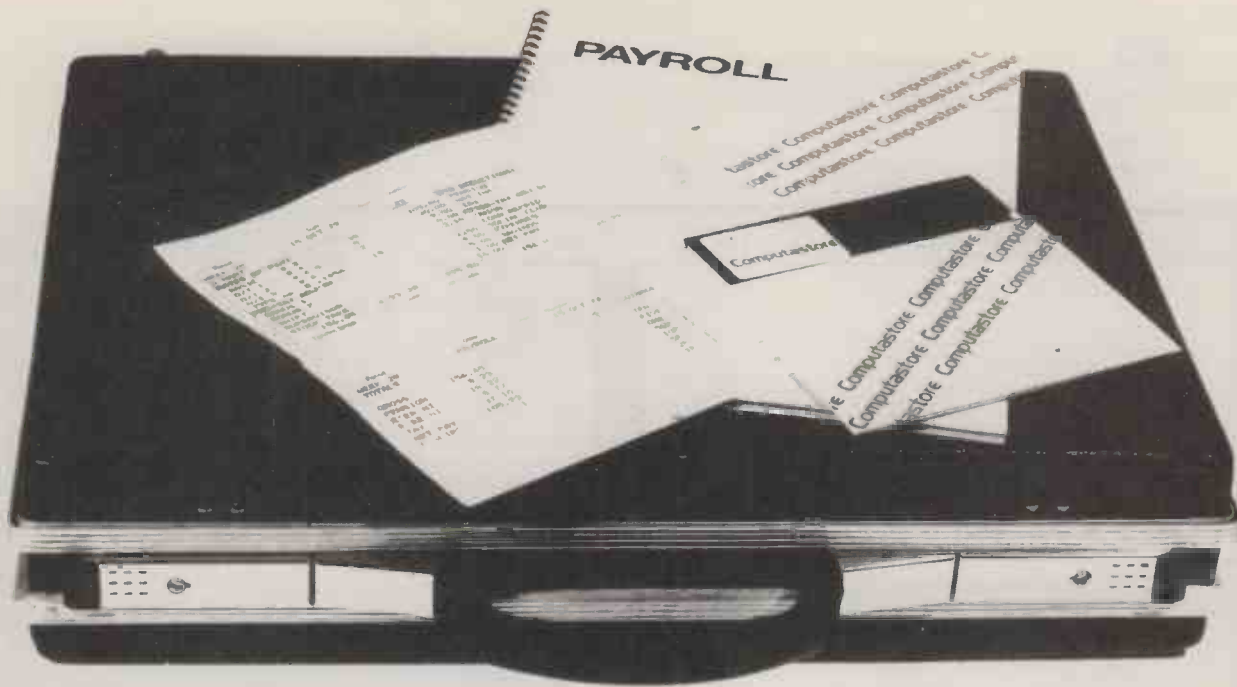
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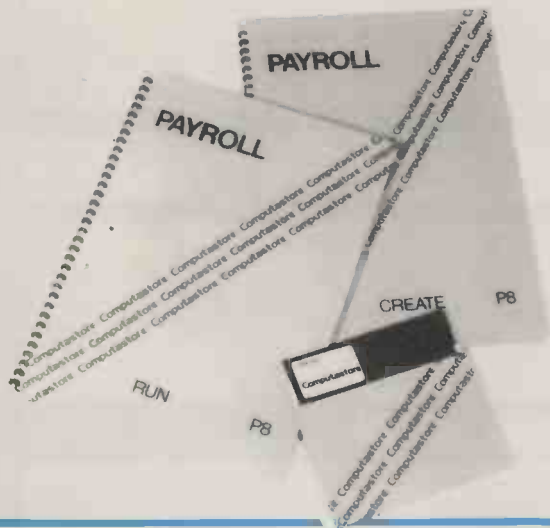
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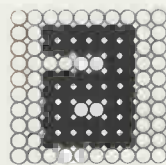
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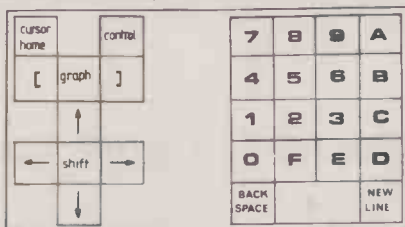
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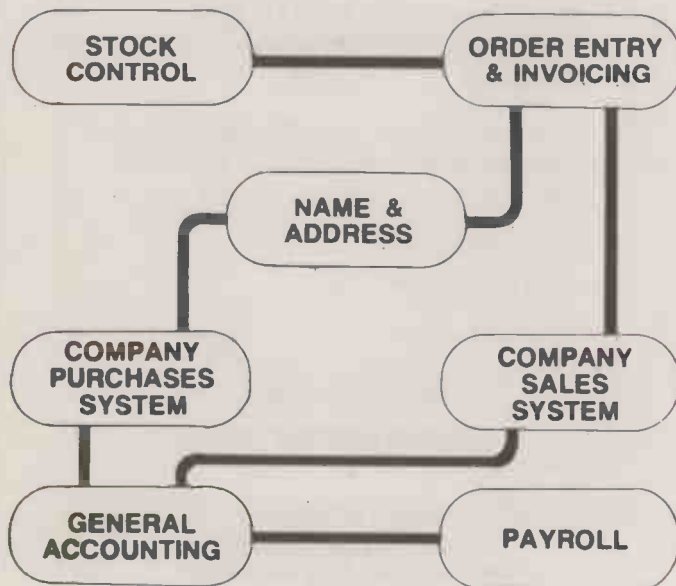
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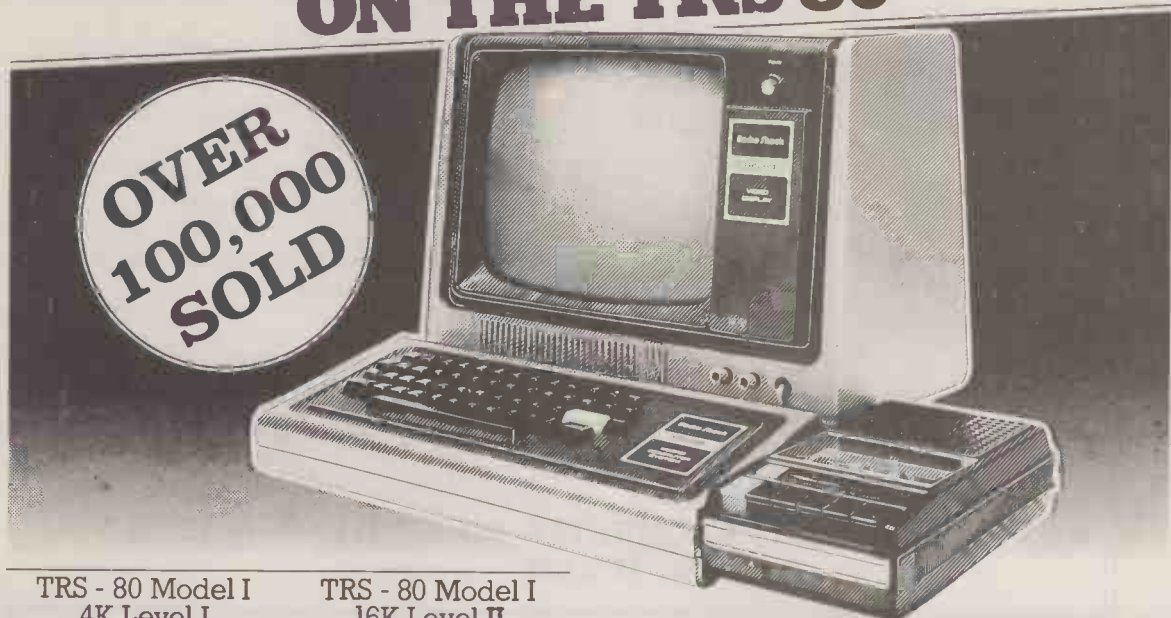
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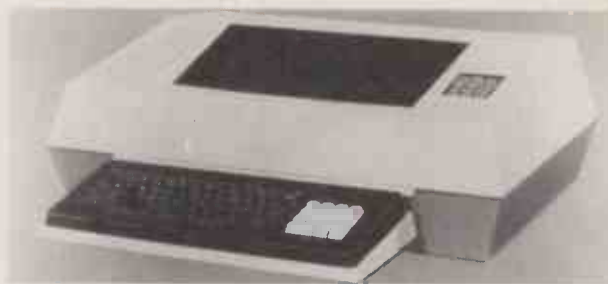
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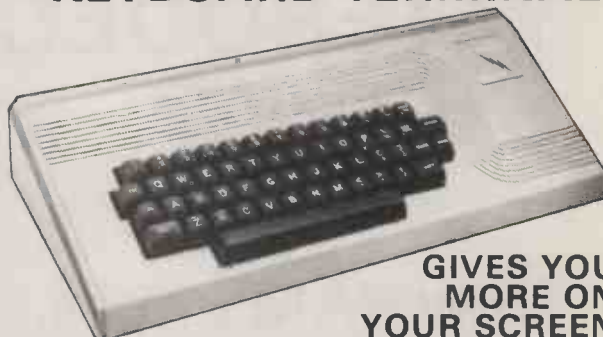
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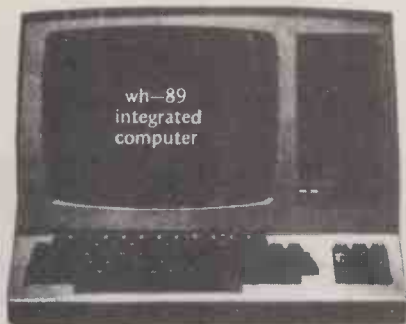
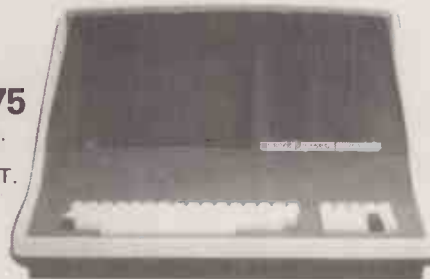
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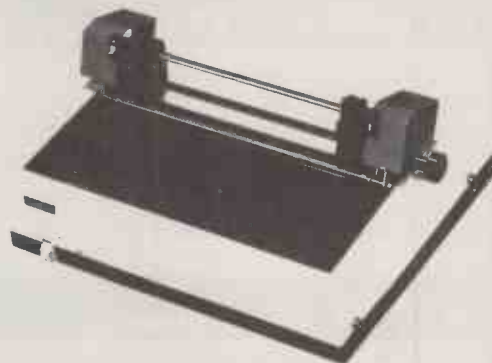
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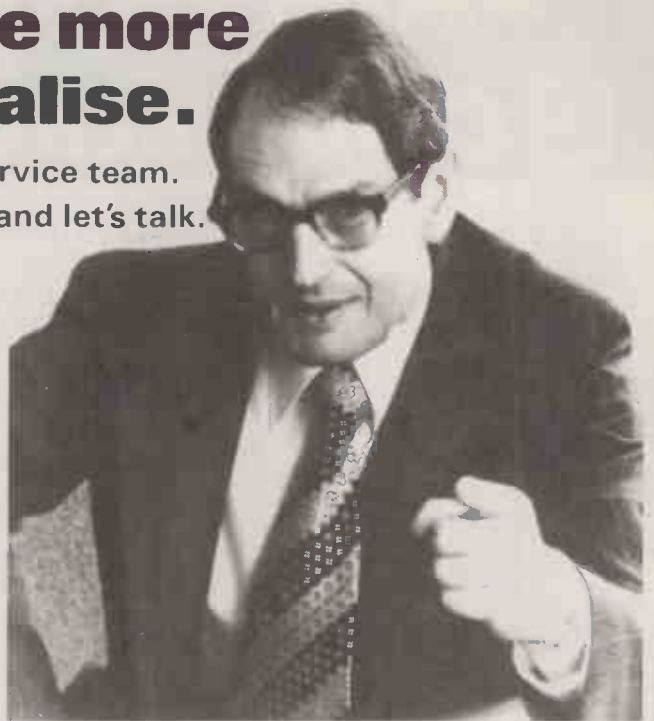
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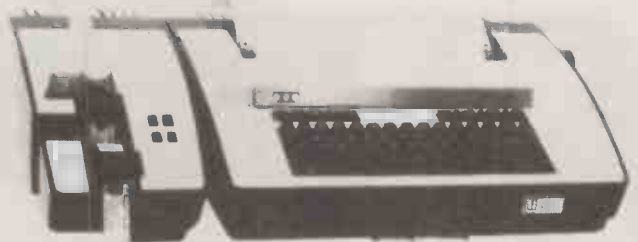
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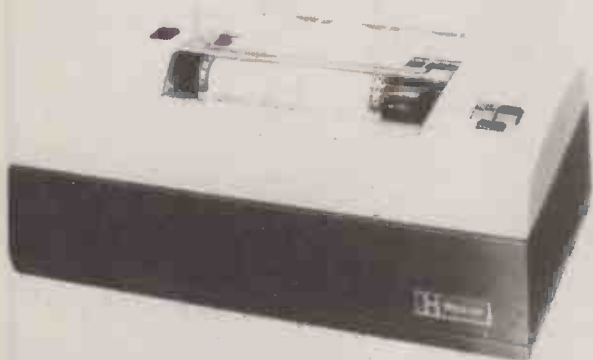
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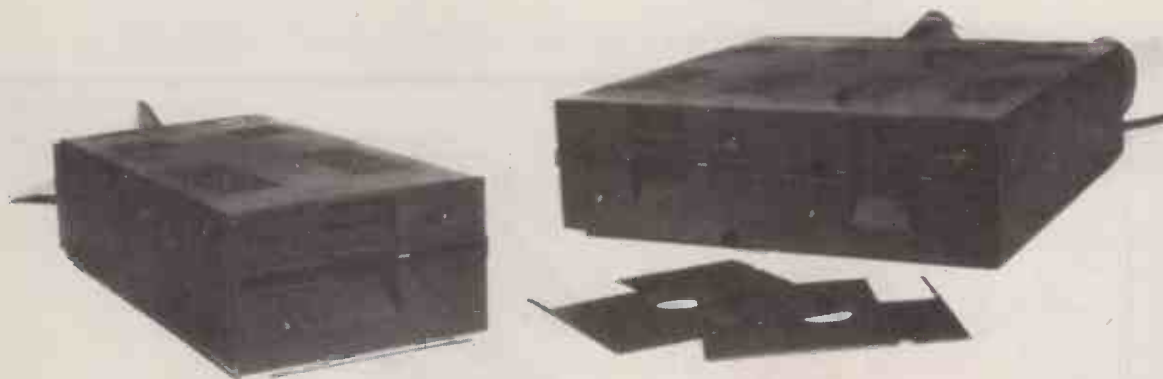
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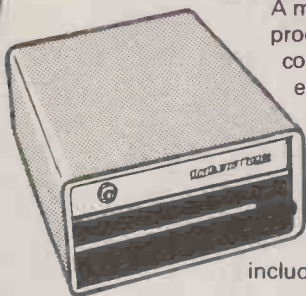
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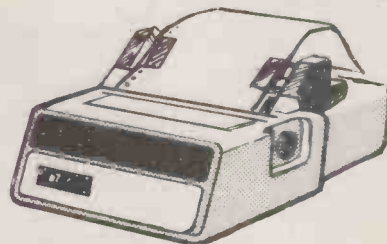
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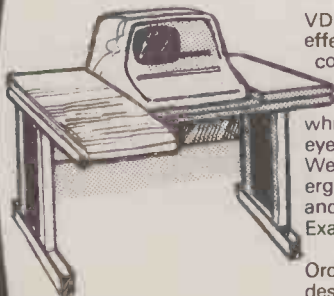
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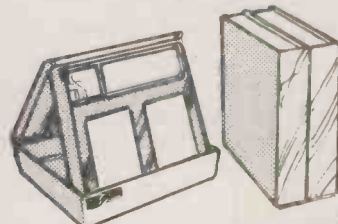
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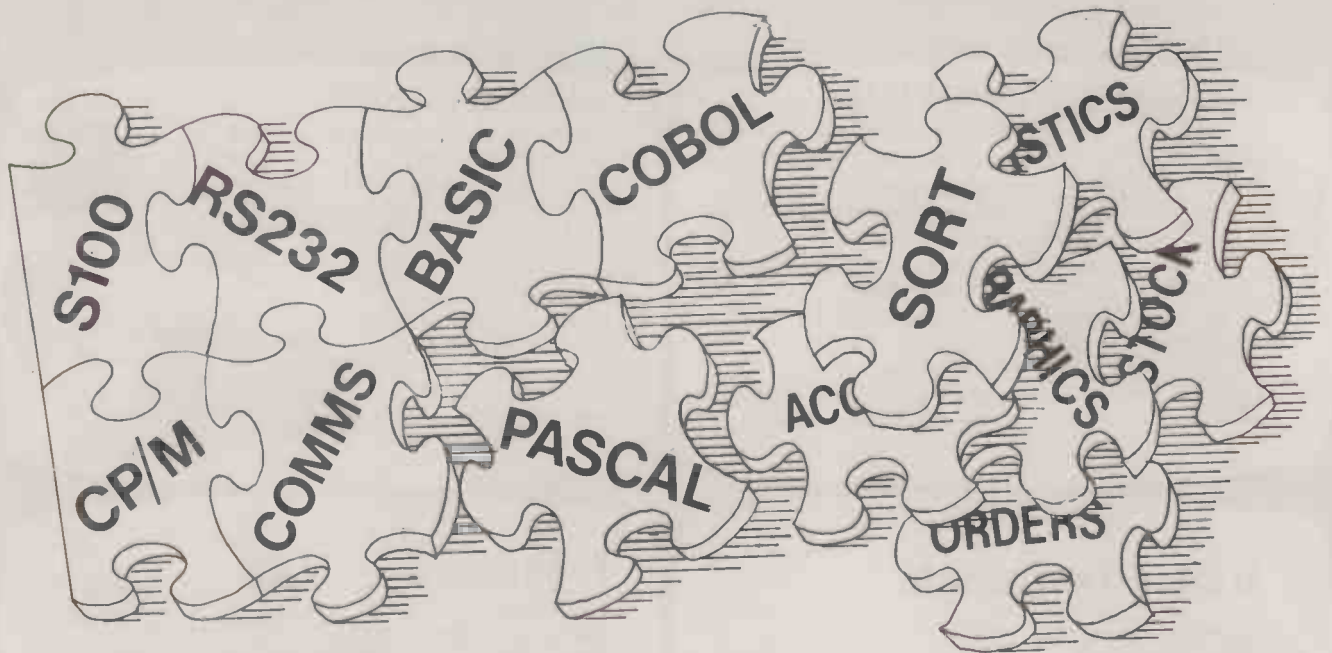
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All work and no play

IN THE DAYS of your Editor's youth, persons of good education were required to struggle at least as far as O Level in Latin. We all hated it but it had to be done, and when we asked Why?, our betters would say gravely that it trained the mind.

At the time we pretended to hear them say 'drained' and laughed cynically, but it was probably true that having to recode our ideas in a different language made us understand in some dim way a difference between meaning and syntax that might otherwise go unnoticed if one were only to write in a single language.

For a while the educational process made do with French, which hasn't quite the same bite to it as Latin, perhaps because of all those delicious meals and wines one can order in it, and those rather fetching ladies who speak nothing else. To be educational, a language has to be very very boring.

Now it seems that a new language is appearing — computing. It has the drawback that children enjoy it, but that problem is in hand, as we shall see.

I say 'computing' rather than Basic or Pascal or whatever, because the difficulty about learning to handle computers only appears to be the language. In reality it is because one's mind is pretty fuzzy — what does Nature expect if she tries to build a computer out of materials you can buy in a butcher's shop?

As anyone knows who has tried to write even the simplest program, there are all sorts of steps in logical thought that the brain skids over, saying to itself, with mental fingers crossed, that 'It'll be alright on the night.' And, of course, it isn't. 'Next without For' or 'Return without Gosub' or 'Subscript out of range' the horrid little machine says starkly and there you are, presented fairly and squarely with an immediate opportunity for mental self-improvement.

Clear thinking is an instant but rather prosaic bonus one gets from computing. The next item of educational value is the realisation that computing is all about naming things and then either changing the things or changing the names. You soon realise that different things can have the same name, while different names can mean the same things — or different things.

It isn't long before one is quite cured of that hang-up that so puzzles philosophers: the confusion between the thing and the name. (Of course the name is also just a thing, but we'll slide over that. See educational point 1).

Of course too, this improvement in mental equipment tends to make computer people boring conversationalists because they get into loops like: 'When you say 'Madeleine' do you mean 'Madeleine' as a pointer to the name 'Joan' or as a pointer to a girl called 'Susie' (who is also called 'Coral')?'

The next useful insight is that at the end of the day, the subtlest and most mysterious program only mangles data bytes with program bytes and stores the results. Any goopy feelings one may be tempted to get about 'mind' and 'consciousness' and the relations of Artificial Intelligence to all that, are soon dispelled by thinking about the bytes being relentlessly, meaninglessly swapped about. And no-doubt something very similar goes on inside our heads, only it's difficult to model it because we've only got a head to model it in.

Thirdly, having observed what spectacularly dire effects can be wrought on a program by the failure to set a flag or two to zero, or to clear out an itty-bitsy buffer, it is easier to understand the psychoanalysts' contention that much absurd human behaviour is caused by unfortunate childhood experiences. It looks to me as if the first three years

of life are taken up in running a sort of boot-strap loader program which is pre-written to look in the world about it for basic concepts like 'mother', 'father', 'love', 'language'. Consciousness doesn't start until this loader has run, and if it has loaded a few things awry, then bizarre results may be expected later.

A good example is Lorenz's famous goslings who seemed to be programmed to identify the first large moving object they saw as Mother Goose. If it happened to be Lorenz himself, they would forever after think that geese looked like men. When the time came, they would marry a man and settle down — unhappily — ever afterwards.

It seems quite clear that this deep, background program goes on running in our minds to deal with love and hate, hunger and sex, home and family and that our civilised conscious thoughts are just subroutines called by this main program. But since they operate with parameters passed by the background program, the results of the subroutines may not be civilised at all. They may be, and often are, very savage indeed.

Anyone who has tried writing stories will know that there are only three important questions the human mind asks about any situation: Can I eat it? Can it eat me? Can I mate with it? The deep mind does not experience time — events in childhood are as real to it as if they happened ten minutes ago; it does not distinguish between people — the world is inhabited solely by MAN and WOMAN who may also be FRIEND or ENEMY. The story teller's art is to use the deep background program running in his audiences' heads to breathe life into his characters and situations. If he can do that they become compelling; if he fails, they sit lifeless on the page or the screen.

It is at the deep level that our mental programs interface with our bodies. The foreground mental program manages to solve a difficult intellectual problem; the deep mental program 'feels good' because, as far as it's concerned, you have outwitted a sabre-toothed tiger. If we took away the deep programs, we would take away life, for the foreground programs are only subroutines. With no animal crises to call the subroutines, human would sit inertly around and quickly starve to death.

But on the other hand, much of our troubles stem from just this crocodile brain in back of our frontal lobes. There is no doubt that we could do with some thorough debugging in this department, but since the bugs seems firmly established in ROM, there isn't much we can do about them.

However, it may be that the wonderchip revolution is actually a stage in evolution, in which intelligence is transferring itself onto silicon and in the process, leaving the lizard brain behind. If and when it gets established enough to be self-replicating, its butchers-shop progenitor can H-bomb itself into oblivion. And probably will.

Enough of philosophical maundering. What this piece started out to celebrate was the informal educational virtues of the computer, and then on the way, to deplore what some professional educators are doing with it. I would have said it was impossible, but in some schools, children now actually dislike computer studies.

In ordinary life there is hardly a child who does not fall on a computer with shouts of glee. They love it because *they* control it — or not. Children are like people: they want power, and the computer gives them power direct without having to go through adults.

No doubt it is just this freedom, which children love, which annoys their teachers. So they are making it boring. With a bit of luck, educators of this kidney could send Britain irrevocably to the bottom.

— P.L.

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The language has many features of its own: graphics commands, four levels of program and data security, CHAIN and COMMON for linking programs together. There is what looks like a good library of mathematical, statistical, and financial programs.

On the other hand, the concept of the machine has a dated air. The VDU is hand-sized. There seems to be no access to the CPU for writing machine code — in fact, H-P do not even say what processor the 85 uses. There will be discs, but only 5¼in, and since they use H-P's own operating system rather than a standard one like CP/M, the software available to the user will be limited.

All in all, it feels more like a luxury PET than a micro for the Eighties. As a process control machine, or a Rolls Royce desktop calculator, it may be very successful; as a true personal computer — perhaps not.

Football-crazy!

THE WORLD CUP could be England's once again if our footballers were helped by a computer, according to a postgraduate social scientist, Roger Codwell, who is to program a computer with information from World Cup matches.

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"The two basic problems," explained Codwell, "are those of the game being fast, unlike chess, and complex. But these can be countered by the use of computer technology. Coaches often go along and watch the opposition, but how often have games been systematically analysed and the results fed back in training?"

Setpieces

Codwell believes that he will be able to detect as yet unrecognised incidental setpieces which, once discovered, could lead to predictive football. "Imagine a game," he said, "where members of one team know what the others in their team are going to do for ten to twenty minutes of the game. If each of, say, twenty refined set-pieces is identified with a signal from the captain, then we could control one to two minutes at a time."

Dot matrix display

A READER, R. Crawley, tells us about a new dot matrix display he's invented and thinks would be the best thing for computers since sliced silicon.

It shows:

- All upper and lower case English characters
 - All Arabic numerals
 - All upper and lower case Greek characters
 - All Cyrillic characters
 - Many mathematical symbols
 - Many specialised symbols in various fields
- to a total of 400 different characters.

So far no-one has shown much interest, but perhaps one of PC's enlightened readers can do something with it.

His address is: 4 Kent Place, Oughton Head Way, Hitchin, Herts, SG5 2LE.

A brilliant notion (though we say it ourselves)

THE ISSUE OF THE DAY — see our last cover for instance — is the possibility of linking computers one with another to produce many striking social results. There are four obvious ways of doing this: by satellite, by telephone line, by glass-fibre, and by television.

There are drawbacks: the satellites aren't there, offend national dignity, need expensive ground stations. The telephone lines are too slow and percolate through horrendously noisy and unreliable exchanges. The glass fibres aren't there either and probably won't be for a long time, because installing them means digging up many thousands of tons of pure copper in the old cables which will make a mess of Rio Tinto's share price.

The TV is fine but it only works one way.

Well, that was true up until just now, because here we have — two-way TV! The point is this: aeriels are reciprocal. In a TV system, you put 50,000 Watts in at the transmitter and get a microwatt out at the receiver. But you could just as well put 50,000 Watts into your domestic aerial and get a microwatt out at the transmitter (assuming a suitable receiver had been installed there).

This is all right so far as it goes, but 50,000 Watts would burn your domestic aerial. So, now the second trick: you don't need that much power because you don't need the data rate of a TV trans-

mitter, which is about 8 million b/sec.

James Martin in his book *The Wired Society* calculates that the average home user needs 300 bits/sec. The power needed for a channel is proportional to the data rate, so the home-end transmitter needs $50,000 \times 300/8.10^6 = 1.875$ watts — which can be done with one transistor working as a power oscillator. So, each TV set has five quids worth of transmitter built into it, and a separate TV data channel is allocated which addresses each home computer one at a time, using a digital access code.

How many can it serve? $8.10^6/300 = 27,000$ customers. Not bad.

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Handy debug tool for novices

A NEW DESIGN, debug and development tool for use by both experienced microprocessor users and novices to evaluate microprocessor-based systems is now available in the UK. Called the Microsystem Designer, it can be used as an 8 or 16-bit universal prototype instrument or as a training aid to a specific microprocessor.

Microprocessors that are currently supported by the Designer are the Z80A, 8088, 8086 and Z8002. Other microprocessors which will be added include the M6800, 8085, 8048 and M6809. All command and data entry formats are standardized so that the same methods are used no matter which microprocessor is being emulated.

The tool was developed by Millenium Systems Inc and is marketed in the UK by Microsystems Services. The unit includes a 14-segment 16-digit alphanumeric display, a hexadecimal keyboard, a 16-key command and function keyboard and eight user I/O switches and LED outputs. Each personality module contains interrupt and special function keys.

Microsystem Services are based at 11 Duke Street, High Wycombe, Bucks, tel: (0494) 41661.

Corvus gets back-up

BACK-UP STORAGE for the eight-in Winchester technology Corvus disc drives has just been announced by Mike D'Addio, president of Corvus. It has developed an intelligent interface that provides up to 100 Megabytes of magnetic tape storage using video cassettes. The new system will allow any standard video cassette recorder to be interfaced directly with the disc controller.

Corvus drives are distributed in the UK by Apple dealer Keen Computers. The new video cassette interface will be sold, by Keen, for about £500.

Double-density discs on the way

RUMOUR HAS IT that several firms, including Research Machines and Commodore, will be offering double-density 8in discs, 20-30 MByte hard discs and 80 character VDUs by the summer of this year.

By the end of the year they both intend to offer bus systems that will allow a dozen or so standard computers to access a central hard disc or a high-speed printer — a neat solution to the multi-user problem. Coming soon after that: video discs for back-up to the hard disc. Prices will be in the £6000 range for basic machine, hard disc and 8in disc for back-up and transfer of program and data.

Research Machines seem to be moving from a maker of mainly educational devices to a

contender in the general small business system market. It is not hindered in this by being one of a very small selection of British manufacturers, since quasi-official bodies like the GPO — one recent customer which has placed a large order — feel they ought to buy British if they can.

However, as Mike Fisher of RML says: 'We get a bit embarrassed about this. We aim to be truly competitive, especially in the European market.'

Complete off-the-shelf applications systems

COMPLETE off-the-shelf applications systems based on firmware modules will be the next and most significant development in the microprocessor world. That's the prediction of the latest report in Infotech's State of the Art Series — *Microcomputer Software*.

According to the report, the future holds promise for systems consisting of active firmware modules, each incorporating a microcomputer with its firmware program on chip, integrated together. The users of these systems will view these active firmware elements as functional modules and will select these devices from the manufacturer's standard module list, with only interfacing and application information defined.

The report describes developments in firmware including Western Digital's

PASCAL "Microengine", a 16-bit chip set which directly executes PASCAL programs up to five times faster than is possible with conventional systems software.

Contributors included Branko Soucek from Zagreb University, Gill Ringland of Inmos, UK, Chris Hawkins of CAP Microsoft, UK, and Paul Hazan of John Hopkins University, US.

The report costs £130 and is available from Infotech Ltd, Nicholson House, Maidenhead, Berks. SL6 1LD, tel: 0628 35031.

Metro jumps on board

ANOTHER INDUSTRIAL 'giant', Grand Metropolitan, is going into the microcomputer market. The massive group, which includes Watneys, Express Dairy, IDV, Berni and Mecca, has formed a new company called Metrotech, which will provide microcomputer services for the Grand Metropolitan Group and operate in the open market.

Metrotech will specialize in

total systems including hardware, software and support. The hardware offered will include the North Star Horizon, the Vector MZ and various Cromenco models, which together span a disc storage range from 320K to 70 megabytes.

The company has a showroom at Waterloo Road, Uxbridge, Middlesex UB8 2YW, tel: 0895 58111.

'Million jobs in four years' — industry minister

THE DEBATE about the impact of microprocessors on employment has so far been dominated by those politicians and union leaders who claim that there will be massive unemployment and unrest in the eighties.

Headlines

The orthodox arguments, that this technology will create more but different jobs, as all technological advances have done so far, have not caught the headlines.

But now the Government has decided to step up its campaign to promote the growth and acceptance of the new electronics.

King Canute

Industry Secretary Lord Trenchard, speaking at the opening of the National Microprocessor and Electronics Centre, said opponents of the microelectronics revolution were like King Canute trying to stop the advance of the sea.

He commented that the country should look at the effect of the silicon chip on the US. In the past three years more than 750,000 jobs had been created in California, and in the last four years over 5m jobs in the country as a whole.

Wishful thinking

He believed that, given the effort, the effect could be repeated in the UK.

"In a recently published MORI survey conducted from my Department, about 5% of the top British 1000 companies thought that they had already lost a share of the market because of their failure to compete with microelectronics," he said.

Shorter sentences exist and readers may like to try to reduce the redundancy still further. Of course, the goal can be approached from the opposite direction. Consider the following 'sentences':

A MISTYPED CHUNK OF BGLQVRVWXZ
BUT MY LEXICON HAS DFHJKPQRVWZ

Get the idea! Each letter of the alphabet is used once, and the sentence provides its own explanation for the nonsense remnant. The object here is to reduce the number of letters in the remnant. Readers may like to challenge, "BUT CAP MY ENGLISH WORD VXJQKFZ".

A comment about A.C. Kilgour's article, "Speak memory ... draw me a picture of the real world." On page 85, he mentions that each picture cell has its darkness integrated over the cell area and character/s selected to approximate to this value are printed to obtain the desired picture.

As a young lad back in '44, I approached this problem from the other direction and produced typewritten pictures (usually portraits) using the shapes of the available characters to produce textures. The idea of including the grey scale came later, sometime around the early fifties.

The technique from then on was to examine each cell and select a character that came nearest to matching the light and dark distribution within the cell, as well as the overall grey tone. When one had to be sacrificed for the other, it was always the grey tone that was allowed to float a step or two, the shape being regarded as the more important. The increased resolution of this approach permitted easily recognisable full-face portraits of small size even when using the relatively coarse characters of a pica typeface.

Your Editorial provided what was probably the saddest news of all. For the past fourteen years I have been developing a completely original mathematics embracing a new algebra, modified geometry and an additional branch of statistics involving new operations, theorems, series and relationships galore. Over the years I have produced a considerably quantity of material on this work and found some applications, particularly in engineering design.

The task is colossal with much still to do, but the work was becoming increasingly slow. I needed a really good number cruncher. The popular press was hopeful; simple calculators would soon cost less than a pound, while a tenner would buy one of the best of programmable scientifics, they said. The home computer would arrive with change from a hundred pounds, they said.

With my work becoming painfully laborious and pitifully slow, a few months ago I decided to await the arrival of the cheap computer and carefully put away my notes until that happy day. But now it appears that this will never happen. Your magazine makes it plain that the current high prices will rise and continue to do so.

This means that people such as myself with an income considerably below the average will never be able to apply the benefits of this technology to our own work. So may I appeal to the manufacturers of the more serious machines to stop updating (and up-pricing) some models and let continuing production eventually bring these within the reach of ordinary folk.

Gerald Seymour,
Stapleford,
Nottingham NG9 8GY

Jones the Frog

WITH REFERENCE to Mr Mascal's letter (Feedback, January) my dictionary defines a sentence or phrase which contains all the letters of the alphabet as a program.

I have encountered another example in the form of a test phrase used by some French radiotelegraph stations when idling on a radio channel. It reads "voyez le bricles geant que j'examine pres du wharf".

M. Jones,
Cardiff Road,
Newport, Gwent.

Buyers are daft

REGARDING Duncan Scot's report "Computer chief hits out at cowboys" (PC, January 1980), in all aspects of business large and small, the watchwords are *caveat emptor* (let the buyer beware); in the modern idiom, "You get what you pay for".

Over the twenty-four years I have been in computing, "cowboys" of one sort or another have always impeded the establishment of confidence in the application of computers and will continue to do so into the future if buyers of services, software and hardware do not make reasonable checks upon the vendors.

For some strange reason, when it comes to computers, buyers seem not to apply the same criteria that they would apply to, say, the purchase of a washing machine for their home or a typewriter for their business.

I don't pretend to know the underlying psychology of this but it existed when the first mainframe computers came into business, it was repeated with the advent of the smaller minicomputers and is with us yet again now that micros are on the scene.

In the early days there was the apparent excuse that there was nobody to turn to for advice since computing was something new. I say "apparent" advisedly, because even new disciplines can be applied successfully if the business brains apply the proper controls.

Despite the early setbacks, computers are still with us, although many an incompetent company director is not. More to the point, however, is the fact that there are people around with more than a decade of experience who are offering a service to the micro user. It is therefore up to the buyer to ensure that his purchases are backed by competent advice, which is preferably independent from the vendor. One form of this is to be put in touch with a successful user of some years' experience.

Another way is to seek those with membership of the appropriate professional society to guide them. On this point, it is wrong to assume that, for example, members of the British Computer Society are interested only in very large computers. There is an obligation for all members to keep abreast of current developments. In this context therefore, there is already something which Gerry Cook of Logabax Ltd is requesting, ie certification of the individual.

One of the forms in which this appears in "MBCS" after a name.

P. J. Winnall, MBCS,
Sheffield, Yorks.

Misinterpreted values

I READ with interest the article in the January edition of *Practical Computing* on North Star BASIC and the method by which it represents

reserved words. Unfortunately, the ingenious method used to list these gives some spurious results (such as "PYDM"), apparently due to the BASIC misinterpreting values which are not assigned.

In North Star BASIC, there is a table of reserved words and their corresponding values. In release 5.0, this is at 3EF5 and in release 5.1, it is 3F04. Hence, the easiest way of listing these is merely to print out the table and the accompanying program achieves that.

Using this method, some of the anomalies described in the article are explained. For example, "=" is only represented by 245 and not by all the other codes (which are unassigned). Similarly, the peculiar "reserved words" reported are spurious. I would surmise that BASIC does not check for the end of the table when presented with an unassigned value.

I enclose a copy of my program and a sample output.

Dr Adrian Stokes,
Mill Hill,
London N.W.7.

128 LET	158 CREATE
129 FOR	159 ERRSET
130 PRINT	160 RUN
131 NEXT	161 LIST
132 IF	162 MEMSET
133 READ	163 SCR
134 INPUT	164 AUTO
135 DATA	165 LOAD
136 GOTO	166 CONT
137 GOSUB	167 APPEND
138 RETURN	168 REN
139 DIM	169 NSAVE
140 STOP	170 SAVE
141 END	171 BYE
142 RESTORE	172 EDIT
143 REM	173 DEL
144 FN	174 PSIZE
145 DEF	175 CAT
146 !	176 STEP
147 ON	177 TO
148 OUT	178 THEN
149 FILL	179 TAB
150 EXIT	180 ELSE
151 OPEN	181 CHR\$
152 CLOSE	182 ASC
153 WRITE	183 VAL
155 CHAIN	184 STR\$
156 LINE	185 NOENDMARK
157 DESTROY	186 INCHARS
	187 FILE

100 REM Program to print out list of values corresponding to reserved words

110 REM in North Star BASIC. This program is specific to Release 5.1 BASIC.

120 REM For other releases, the constant in the first program line must be

130 REM changed appropriately. In Rel 5.0, the value is 16117.

140 REM The format of the table is each value (> 127) followed by the

150 REM reserved word. The table is terminated by a byte value 255.

160 P = 16132	REM Start of table
170 Q = 0	REM Output port number
180 S = EXAM(P)	REM Pick up byte
190 IF S = 255 THEN END	REM Check whether finished
200 PRINT EQ\EQ,S," "	REM Make output neat
210 P = P + 1	REM Increment pointer
220 S = EXAM(P)	REM Pick up byte
230 IF S > 127 THEN 190	REM Check if end of word
240 PRINT EQ,CHR\$(S),	REM Else print character
250 GOTO 210	REM and loop

Your Commodore PET System

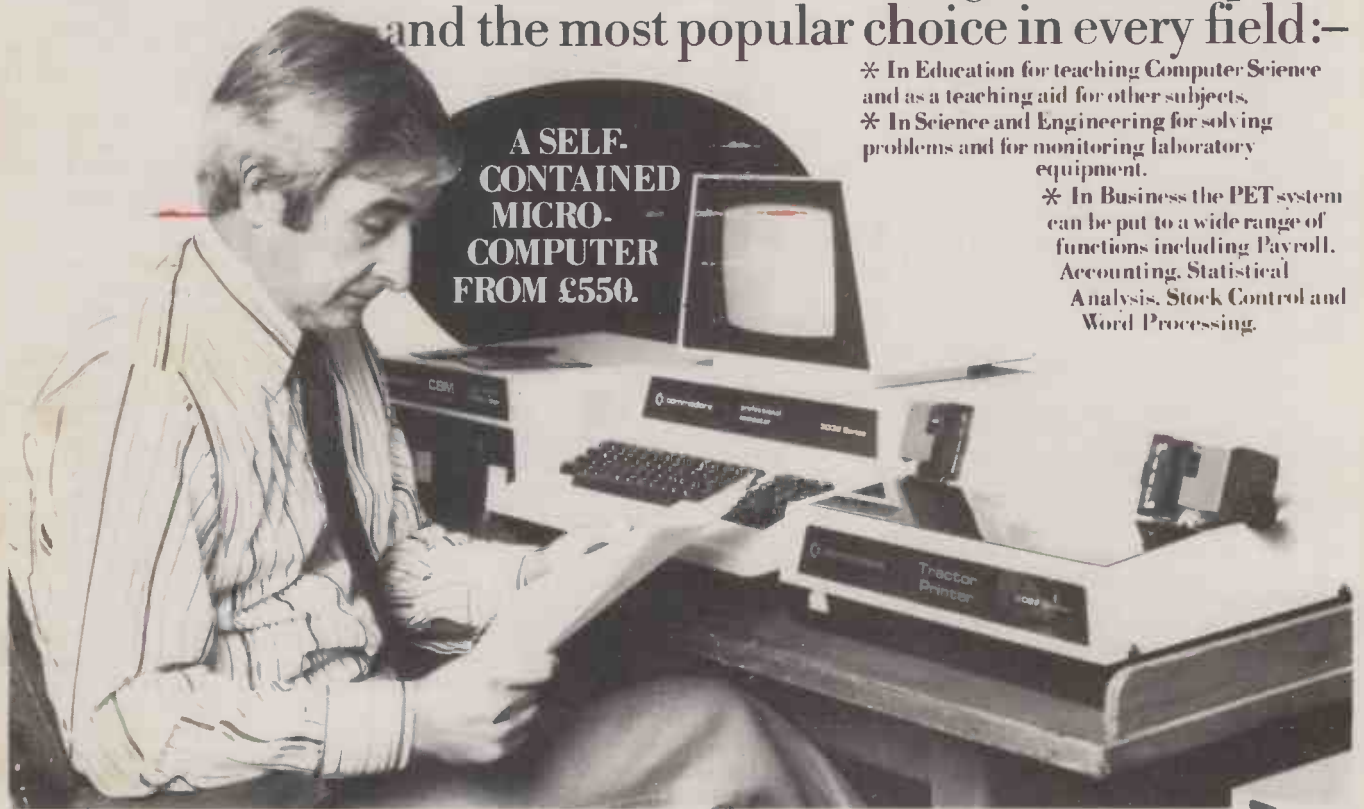
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Spot the looney

WE HAVE HAD to institute a daft letter section of Feedback this month. The first comes from Fats Wannamaker Junior, who purports to write from Ocean Software Inc, New Jersey.

'HOW are things in little old England? What we at Ocean would like to know is this: Will future government have deployment option over the multiprocessing activity window, or will the Euro-users' event-horizon resolve ultimately to become a low impact scenario in this respect? More plainly, are we to anticipate a negative stimulus situation at this point in time? Perhaps even a negative man-in-the-street situation? You see what I mean; that mankind's ultimate interface could become no more than a low-level event, resulting from a lack of strategic forward planning input throughout the man-machine symbiosis.

The architecture, and indeed the hierarchy and entire spectrum of all strata might prove to be an OEM oriented ongoing throughput discipline! A simultaneous distributed turnkey facility may emulate the ongoing fragmentation of our culture differential, but unless a target interpolation is considered, the primary trade-off, a zero-redundancy array will never be encountered!

A typical example is the move toward the integrally redundant accuracy 16-bit and even 32-bit micro facility vectoring in on the personal processor, irrespective of a verified speed enhancement achieved through dyadic CPU 8-bit multiprocessing in what is after all an interpreter scenario. Consider a second order of magnitude finite configured data base utilising all encompassing maximally configured characterisation.

We surely need a specific software parity criteria in a civilisation seeking sophisticated user-transparency. Do you not agree that our socio-electronic integrity, if it is not to be a constraint simulation, must avoid any credibility gap?

It's a free country!

The second is an extract from a letter received by Transam, reproduced with their permission.

'HAVING BRIEFLY outlined our purpose in pursuing the purchase of a microprocessor, would you please be so kind as to answer the following queries?

- Would you demonstrate the usage of the microprocessor in our school to Staff and PTA representatives and to a selection of children to see if the microprocessor, more appropriately its VDU, can cope with a class;
- Be willing to answer the many questions both for and against the usage of the microprocessor in education today;
- Allow us a trial period thoroughly to test the microprocessor without obligation to purchase;
- If we were completely satisfied with the handling capabilities of the microprocessor allow us to purchase one by paying half the purchase price on delivery and the remainder over a period not exceeding one calendar year;
- Allow us to purchase the microprocessor at a much reduced price with a view to showing that it can be very effectively used in a primary school as an educational aid. This would then give you the opportunity to use any of your new educational programmes in our school.'

Life memory shortage

RECENTLY I received my copy of *Practical Computing* for January with the program 'Life', written for the 380Z.

I am taking O level in computers and have an extensive library of tapes. I understand the program but when it is run using BASG or BASGF, the 380Z states that it is "OUT OF MEMORY SPACE AT LINE 20", so evidently the DIM A (3000) is too large.

After seeing this happen, I switched the micro off and reloaded the BASIC but there was still this problem. Obviously the DIMs statement cannot be changed without changing the whole program. Could you please tell me if I am overlooking something?

The BASIC is RML 9K

Ian Crosswell,
Kings Norton,
Birmingham, B38 8TW.

It looks as though the problem is lack of memory. A 3000 element vector takes up 18K of memory, since each real number in this BASIC needs six bytes. The answer is to compact the vector. This might take a bit of experimentation, but the way I'd go about would be to DIM the vector to 3000, find the start address of the vector when loaded by doing some judicious PEEKing, and then to use that space to keep the data in by POKING numbers in as single bytes rather than six-byte reels. Of course you then have to keep track of the number of the element you want and get it back by adding this number to the start of the address of the vector. It may not be all that easy, but it will be most educational.

Good word for the ELF

THANK YOU for a year of excellent reading, but I have become increasingly aware that the RCA COSMAC ELF II has not received the publicity it deserves.

Having had to wait four months for a working MK14 and then for it to give up after 20 minutes' use, made me wonder about the reliability of any home micro. But after a further two months waiting for money to be returned, I went to HL Audio in London to see the ELF and bought the kit on the spot.

Having spent two hours soldering the kit and applying power, it worked first time — much to my surprise, I admit. And at just over twice the price of the MK14, I found that the extra spent was more than worth it.

The basic ELF is very basic with only 256 bytes of RAM and no monitor. But a monitor is not needed to load and run programs as no bootstrap is needed. The professional hex-keypad is probably one of the ELF's greatest attributes — it far outperforms the keyboard on the MK14. I have had a good nine months' use from it and no problems have arisen as yet. Also no special power supply is needed as all rectification and regulation is done on-board — only a 7V ac supply is needed.

The backup software available is also good, and the following is available: ELF-BUG Monitor, Assembler, Disassembler, Tiny Basic, Full Basic and a powerful Text Editor.

There is also extensive hardware available: memory in 4K boards, full ASCII keyboard, prototyping board, video display board, light pen, dual tape controller board (especially for the text editor and assembler), EPROM board and the so-called Giant board which incorporates cassette, TTY, RS232-C and parallel I/O port with a small systems monitor.

The constructional and operational literature is of very high quality and designed for the beginner or for the person with computer experience.

I feel that for anyone the ELF II is a computer to be seriously considered, especially if money is not available in great amounts at any one time. Would it be possible to review the ELF II or feature a little software for it once in a while?

D. Rawle,
London SE9 5PE.

We don't publish software for the ELF because no-one has sent us any. Maybe this letter will stimulate something.

Murder most foul!

IN THE DECEMBER issue of this journal, there appeared a feature entitled "Contrasting Eurapple with ITT 2020". The piece was attributed to Bryan Spielman.

While I confess to the identity of Bryan Spielman, I am anxious to disclaim responsibility for the piece as it was published.

Yes, I did write an article on the subject for this paper. But then it got into the hands of a production editor and what came out was a travesty of the original. I have lost friends through it. Former admirers have torn up my photograph. I am not asked to parties any more.

It is perfectly allowable for editorial prerogative to be exercised over a contribution. Indeed, it is a job I do myself from time to time and I fully understand the problems which have to be dealt with.

Things do have to be cut if they are too long for the available space or if they do not suit the occasion. Punctuation and so forth may have to be adjusted to conform to house rules. Plain illiteracy should be rectified, but if it is too bad then the author should be invited to make an alternative arrangement, such as bringing in a ghost writer or having his message put out in the form of a report by an interviewer, or simply giving up and going round to the pub.

Necessary minor changes which do not diminish the quality or nature of the contribution are perfectly in order, provided they are decently done and there are not too many of them.

But consider the effect on an author, who has diligently researched his material and gone to pains to fine-tune every cadence of his reporting, of coming home one night to find that someone has run amok through his prose. The drab and colourless thing, oh readers, which masqueraded as my Christmas present to you was a sad and mutilated corpse. Sentence after sentence had been laid in ruins.

Adjectives, phrases, nouns even, had been freely tampered with. Amongst the carnage there were lucid sentences rendered obscure, accurate ones turned into lies and meaningful ones transformed into gibberish. Jokes were cut out or, more wickedly, just the punch lines were omitted.

Now, there are many liberties an editor or printer may take with an author's work and be forgiven for, but when things go so far as to bring about the assassination of the author's style they have gone too far.

One former reader of mine actually sent me a wreath.

Bryan Spielman,
Wanstead, London E.11.

Just imagine how many parties the Production Editor doesn't get invited to!

Tandy steps into a new class

Ron Geere spends a day checking out the Tandy TRS-80 and finds the Model II is a giant step forward.



Compshop's Angie gets her finger bitten!

TANDY'S new Model II looks very much the same as the Model I, but its width has been slightly increased in order to accommodate the single 8in floppy disk drive.

Some of its features are unusual. The exploitation of the full 64K addressing capability of the 8-bit processor is to my knowledge unique in the commercial microcomputer market, although about 27K is required for the operating system. The architecture is somewhat unusual, as the screen memory is not mapped from this 64K.

Making comparisons between any two machines is unwise without a thorough knowledge of both, but Model I owners will be interested in the differences. The Model II is aimed at the business market and as such the graphic characters are limited and differ from Model I. Nor can they be programmed. Cursor controls are more comprehensive and the real-time clock is a standard feature. Lower-case characters have true descenders.

The BASIC is Level III and is compatible with the old, but has more command options. Machine-code routines are easily entered using the Model II's improved DEBUG utility, but machine-code programs written for the Model I will probably not operate on the Model II.

The new disk operating system is

superb, full of useful features. Some examples follow: 'FREE' displays the status of all tracks and sectors graphically on the screen. One can then see pictorially which tracks are used or unused. 'D' indicates directory information and 'F' indicates flawed tracks which have been automatically locked out on formatting.

Disk-to-disk copies can be made with the single drive using about two passes, depending on how full the disk is. The password for the disk can be changed on a back-up copy, but disk copies *cannot* be made without a knowledge of the master disk password.

When formatting a disk, TRSDOS first checks the disk for data and if present queries the operation. DEBUG splits the screen display giving 'monitor' format plus ASCII equivalent on one half, while the other half is the normal screen format.

CLOCK displays the clock time on the screen, irrespective of any scrolling, while DIR gives the full director, ie, file type, attributes, record length, number of records, number of extents, space allocated and blocks used. The terms 'attributes' and 'extents' as applied to TRSDOS give extra properties to specific files. For example, certain users can be denied access to a file, or the file may be read, but not written to or listed, or may be nominated to RUN immediately on

completion of the power-up sequence.

Some 50 or 60 routines are also available with ready access to the user.

Hardware

The hardware is manufactured to the highest commercial electronic standards. Circuit boards are resist-coated fibre-glass double-sided with plated through holes.

The keyboard unit superficially resembles that of the Model I, but the major differences lie inside. The keyboard has its own processor, an Intel 8021, and connects to the main unit via a 5-pin 180° DIN connector. There was no trace of key bounce on the unit reviewed.

The keys provided include 'BREAK', ESCAPE, CAPS which is a case transpose lock and is not the same as SHIFT and SHIFT LOCK, TAB, HOLD, BACK SPACE, ENTER (carriage return) and REPEAT. The separate keypad includes cursor controls, two 'function' keys, F1 and F2 which generate CHR\$(1) and (2) respectively. I could see little use for these, since CTRL A and B produce the same result.

Internally the power rails are derived from an ASTEC switching regulator powered from 115 or 240 V mains. The unit examined was running from a 115 V transformer because the disk drive was 115 V only. Comp Shop had modified the

Practical Computing evaluation

	Yes/No NA	1	2	3	4	5		Yes/No N/A	1	2	3	4	5
Ease of construction	N/A						Basic language	YES					
Quality of documentation				●			Other languages	YES				CP/M	
Dealer support/maintenance						●	Compatibility with other systems					●	
Can handle 32K memory	YES						Reputation of manufacturer				●		
Quality of video monitor					●		Appearance					●	
SS-50 Bus	NO						Portability		●				
S-100 Bus	NO						No. of software applications packages available					●	
Sockets for chips	YES						Hobby use					●	
Numeric, calculator-type pad	YES						Business use						●
Large amount of removable memory, randomly accessible	YES						Education use				●		
Cassette tape recorder capability: Own	NO						Suitable for commercial applications				●		
Built-in recorder	NO						Home applications				●		
Floppy disk capability	YES						Educational applications					●	
Communications capability	YES						Ability to add printer	YES					
Speed of Instruction cycle	4mHz						Ability to add disks	YES					
Ease of expansion						●	Ability to add other manufacturers' plug-in memory	N/A					
Low power consumption					●								
Assembly language	YES												

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

machine for 50Hz operation of the drive unit. Presumably overload protection was built in, for the rear fuse protects the disk drive only. The mains connector is of the European three-pin type (IEC).

The single disk drive is the Shugart SA800/2 double-density version. Each disk stores 486K bytes (416K on the system disk). The disk controller board handles the flow of data from processor to disk.

The disk controller chip is the Western Digital WD191. The disk has five times the speed of the Model I's mini-disk. The data transfer rate is 62,500 bytes/sec.

The next board is the keyboard and video interface. This board and its 6845 chip must surely hide the clue to the video technique used. Unfortunately, time did not permit an investigation.

The processor board houses the Z80A which runs BASIC 2½ times faster than Model I, bringing it into the same speed bracket as the Apple and Commodore PET. The memory board (crammed with memory chips) completes the main board count.

There are four slots provided on the Eurobus for expansion boards, although if a 32K model is later upgraded to 64K, one of the four is used for add-on memory. Three interface connectors are available, one parallel, one serial

synchronous and one serial asynchronous.

The system may be expanded with single, dual or triple disk drives in the near future.

The TV driver board houses the circuitry necessary to drive the cathode ray tube and an internal fan is used to extract the heat from this compact unit.

Software

On start-up, 847 bytes are reserved for each data file, the number of which must be declared, as must usable memory size to reserve a top-of-memory area.

The Level III BASIC has the facility for double-precision variables. Single precision variables are printed to five digits, 'double' to 16!

Editing can be done by the command EDIT (line number). This puts the appropriate line number on the screen and invokes a simple text editor. It is also possible to erase from the cursor to the end of a line or from the cursor to the end of screen.

HEX8 and OCT8 convert decimal to hexadecimal or octal values respectively. RENUM provides the ubiquitous re-numbering facility.

Plus points

The disk does not need to be removed during reset or power-up. Both 'Reset'

and 'Power' switches are readily accessible on the front.

The DOS appears to be considerably more advanced than that of most personal computers currently on the market.

Minus points

The continuously running disk drive was noisy and I found it irritating in a quiet office. The level of radio frequency interference was sufficiently high to cause disturbing patterns on a nearby closed-circuit TV set, but this is not uncommon in digital electronic equipment. I did not like having to call up error numbers from the disk as a separate activity when the full-length error message is already in the system for the asking.

Conclusions

- The Model II is in a different class to the Model I.
- Its memory capability is greater than many mini-computers.
- The operating system has numerous features which make the computer a joy to use.
- For business use, up-and-running can be simplicity itself — just switch on and your program is running. ☐

MSI micro nibbles at the mini market

Jim Wood reviews the MSI System 7, which with a 10MB hard disc becomes the System 10. He finds it competent, a little expensive and the software a little untidy for the inexperienced user.

THE MSI SYSTEM 7 and its big brother the System 10 are new additions to the 6800-based series of microcomputers manufactured in America by Midwest Scientific Instruments and marketed in the UK by Strumtech Engineering Electronic Developments (SEED).

This machine extends the capabilities of the earlier MSI 6800 in terms of disc storage and available software. The system can handle up to eight disc drives, four of which may be 10MB hard discs, between 32 and 56K bytes of RAM and provides a choice of three user operating systems FDOS, SDOS and FLEX.

The system provided for review consisted of a 56K byte machine, two mini-floppy drives and a SOROC IQ120 terminal.

Equipment

The MSI System 7 is based around a Motorola MC-6800 CPU running at 2MHz, generated by a 6875 clock drive circuit with an 8MHz crystal oscillator. The twin minifloppy drives take 5in quad density diskettes, formatted as IBM System 34 compatible and giving 3K bytes per drive. The drives are controlled by an MFD-8 disc controller with a data transfer rate of 250,000 bits/second.

The computer and drives are packaged in a large, squat metal box with an adequate but rather noisy fan situated at the rear. Also at the rear is a mains lead plugging directly into a standard socket and an RS232 socket for connection to a Visual Display Unit.

At the front are the drives, a large red power button, a reset button for loading a bootstrap loader and an IRQ button which was not enabled on the review machine. The IRQ button can be programmed as an automatic bootstrap loader.

VDU facilities

The SOROC VDU provided has two RS232 serial ports, one for the computer and one for an auxiliary disc drive unit, an RS232 parallel port for a printer and a baud rate switch. An on/off switch, a reset button and separate brightness and contrast controls are all provided and are readily accessible. The VDU also has a

fan, but this one is comparatively noiseless.

Hooking up

The system was straightforward to put together. The cable connector from the computer to the VDU was unmarked but worked when connected in either direction. Both devices were plugged into the mains and turned on.

At this point we had our first problem. Pressing the reset button on the computer should have generated an "*" on the screen ready for booking an operation system. As there were no instructions for the VDU, I had to figure out that the unmarked 15-way switch at the back was a baud rate switch and then select the correct setting by trial and error.

But the lack of VDU documentation was offset by the quality and comprehensive nature of the manuals provided with the system. Once the correct system master disc had been selected and loaded into drive 0, the procedure is to type "B" followed by "D" for FDOS or "S" for SDOS to load an operating system.

FDOS defaults from drive 0 but SDOS allows an alternative drive to be selected. FLEX also defaults from drive 0 but is loaded by entering a load address of "GO EC00".

Keyboard

A standard alphabetic QWERTY layout is provided, with a separate numeric keypad and eight function keys, four for cursor movement, left, right, up and down, a home cursor and clear-screen keys, a break key and a tab key. The VDU was set to operate in lower-case, but required upper case for operation. A lockable upper-case key was well laid-out and easy to use.

The display gives 24 lines of 80 characters and is set to operate in scroll mode. The characters are well formed and easy to read, with a good screen definition.

FDOS

The first operating system looked at was MSI FDOS which provides a good set of utilities, a BASIC interpreter — the MSI Disc Extended BASIC Version 1.4,

and a translator package. The disc initialisation utility was easy to run and took only 45 seconds to initialise a new diskette. The user is asked for a two-digit drive number — drive 1 is entered as "01" — and is then asked to confirm before starting. Any drive may be used.

Disc copying was also quite fast — 25 seconds for an empty diskette (operating system parameters only) and 65 seconds for a copy of a full diskette. A utility is also provided for copying a single file. A 16K byte file on drive 0 took 25 seconds.

The user may look at a catalogue of his disc files by using the CAT command, or at operating system files by using PFILES, both being used with device numbers or defaulting to drive 0 if used without. The CREATE command is used to set a disc directory entry for a new file, but allocates no more than the minimum file space. PURGE removes the disc directory file-name only and leaves the space allocated. The file name can be recovered; to remove the space it is necessary to PACK the disc.

The majority of the system commands and the utilities can be run by typing in only the first two characters, which saves time and possible errors.

The BASIC interpreter is an extended version of the earlier MSI one and now has many of the features that one would expect to find in the more extensive mini-computer BASICs. The facilities added bear a close resemblance to those found in DEC's RSTS BASIC +.

Plus points

- Run time error handling, ON ERROR GO TO statement, ERR and ERC variables for error number and line, the RESUME statement.
- KILLing a file from a user program.
- Line input mode and PRINT USING strings.
- GOTO and GOSUB allow expressions as well as line numbers.
- Multi-line statements.
- True string arrays.
- A very fast CHAIN (ie loading one program from another).
- Trace ON and OFF for program debugging.
- Calling external subroutines.

- Nested IF-THEN statements.
- Standard function and string manipulation functions.

Minus points

There are however some restrictions:

- Line numbers have a range of 1-9999 only.
- Variable names may be A,A0-A9, to Z,Z0-Z9, but string variables may only be A\$ to Z\$.
- The shortest string length is six bytes, the maximum 256 bytes, with a default size of 32 bytes.
- Only two array dimensions are allowed.

Two interesting statements are CALL and PRINT USING. Subroutines may be called from disc, with the integrity of variables maintained between the CALL and RETURN. The calling program continues execution from the next statement after the CALL. A COMMON statement can be used to retain all variables in the list, but not those subsequently referenced so as to save space. The CALL is quite fast as well.

The PRINT USING statement uses an IMAGE string, but this can be either a string variable or a line number of a line with a string constant. The BASIC interpreter is good for development but has the drawback of being rather slow in terms of program execution. Our simple benchmark of FOR I = 1 TO 1000, NEXT I took an average of 7.5 seconds to execute.

Variables are stored as eight bytes if non-subscripted and six bytes for each element of an array plus, a six-byte overhead. Range is $1.0 \times E \pm 99$ with nine significant digits. Strings occupy two bytes, plus the string length and string arrays have the same six-byte overhead as variables. Line numbers occupy seven bytes and spaces are stored as entered, which means that neatly laid-out programs occupy rather more disc space.

Files

The main restrictions on data file usage are that only three files may be open at any one time. Data file records have a maximum size of 256 bytes (or one sector) and only sequential files are supported. Files may be opened for INPUT, OUTPUT, or UPDATE, but only one file may be open for OUTPUT at any one time. The remainder of the file-handling software is adequate for most straightforward applications.

Translator

A set of programs is provided to translate FDOS BASIC interpreter source to SDOS BASIC compiler source, the benefits of which can be seen later. The translator seems fairly comprehensive, if a little tedious to run, and leaves very little tidying-up to be done before an SDOS output program can be compiled and run.

Thus it would be possible to develop programs under FDOS and later run them under SDOS.

SDOS

The SDOS operating system provides a more extensive set of software than FDOS and includes a true BASIC Compiler and Assembler, providing a much faster running program. It also supports both sequential and random-access files.

When the system is first loaded, a prompt is issued for the current date and time, both of which may be displayed by typing TIME and the date is used in the file directions.

The mandatory utilities are provided but the user may also use the command interpreter to run his own control files, giving an ability for reducing tedious operations to a single command.

The format and initialisation of diskettes is rather slower — eight minutes for formatting and three minutes for initialisation, but a better disc structure is achieved and the user can select his own mapping parameters to optimise the way his files are stored on the diskette.

One criticism of the SDOS commands is the long names used and the need to type the entire name, ie. SDOSDISKFORMAT, SDOSDISKINIT or SDOSDISKBACKUP. This can be rather annoying, as it takes about 40 seconds for the system

to determine that a command is incorrectly typed.

The system provides both straight copy, for files or full discs, and a disc backup which can use an exception list and or a date to select only a subset of the disc files for copying. Wild cards are allowed against file names and extensions in the exception list.

Although single-file copies are very fast, a full diskette copy takes 13 minutes and a full backup a very long 22 minutes. We applaud the use of backup exception facilities but believe that the full disc-to-disc versions are excessively slow. The system allows the user to define the default disc other than to the drive 0 and to assign system and work files discs to more than drive.

The manual explains the use of the HELP command for interpreting errors and gives a description line for a simple error number, but this failed to work.

The system allows up to eight channels for an I/O port and files can be opened on more than one channel at a time. Record format files, ASCII files and binary files can be read and written and status information for current position in file, length of file and end of file can be interrogated. It is possible to disable control C to prevent accidental program abortion.

BASIC

Using the software Dynamics BASIC under SDOS can be rather cumbersome and requires several stages to go from a new source file to a binary run-time program. BASIC source is entered using a line editor, starting from an empty file and inserting new statement lines. Obviously no syntax checking is available at this stage, but the editor provides a comprehensive set of commands.

The major problem with the editor comes with large programs since the editor treats blocks of statements as pages in memory and once a new page is rolled in, it is impossible to go back to the previous page without exiting the editor and re-entering from the top.

Once a program is entered, it must be compiled, with syntax errors being displayed on the screen. If more than a screen full of errors occur, they will scroll off the top of the screen, so the user must be ready either to hold the screen scrolling or to re-compile.

Error-free

A compiled, error-free file is then run through the Assembler, which may produce further errors, and in the end produces a MIKBUG-type file. This file may be loaded and run in SDOS by typing its name, but to end up with a true binary file (which saves file space over the MIKBUG file) the user must run the MAKEBINARY program for a final conversion. This program can also be run

Memory breakdown (in HEX)

0	—	DFFF	User RAM (56K bytes)
E000	—	E3FF	MSIBUG RAM
E400	—	EBFF	SDOS disc bootstrap routines
EC00	—	EFFF	FLEX/FDOS disc bootstrap
F000	—	F07F	MSIBUG monitor RAM
F080	—	F3FF	CPU board
F400	—	F7FF	Input/output interfaces
FFF8	—	FFFF	Restart and interrupt vectors

Prices

These prices were quoted by SEED and are exclusive of VAT.

Hardware

MSI System 7	—	£4500
	—	56K bytes, Micropolls 5" twin mini floppy drive with 630K bytes, SOROC IQI 20 VDU board and FLEX
Micropolis 5in twin drive	—	Price on application
Caleus 206R	—	Price on application
10MB front-loading hard disc	—	£4250 (includes controller)
CDC Hawk 10MB	—	Price on application
Price on application	—	Price on application
SOROC, ELBIT, ACTI	—	Various VDU

Software (All disc-based)

FDOS, SDOS, FLEX — Included in basic machine price and not sold separately

Inventory control
Accounts receivable/
payable — Price on application
Further packages will be made available in April

Maintenance

Third party through Data Design Techniques, price per annum 10 per cent of hardware cost.

Keen Computers Micromarket

Keen Computers are one of this country's leading microcomputer consultants, with a reputation for quality after sales service. Recent extensions to our product range mean that we now offer the North Star Horizon and D.E.C. computer systems along with the Apple, and Corvus and Mountain Hardware accessories. Add this to our ability to provide software from a comprehensive range of packages or on a special consultancy basis (we write the software to your specifications) and you can see why we can provide the solution to your problem . . . whatever it may be!



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Supercolour	90.00

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32k Horizon computer system with floppy disk drive + controller	1415.00
Additional floppy disk	310.00
16k RAM	235.00

Serial/Parallel Interface	65.00
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by typing its name.

The **COMPILE** command speeds up this procedure by compiling and then assembling a program, and the **FIX** command runs the editor, makes an automatic back-up of the source, and on exit compiles and assembles.

- The **BASIC** itself contains most of the facilities available under **FDOS**, plus some further extensions and two restrictions.
- Multi-character variable names are allowed for both variables and strings.
- Assembly-language subroutines may be **CALLED**.
- Numeric range is $1.0 * E = 126$ and takes six bytes of storage.
- Line numbers are not required except for references such as **GOTOS**.
- Strings may be up to 65534 bytes in length.
- Both random and sequential files are available.

The **BASIC** programs produced are far faster than those under **FDOS** — the simple benchmark ran in well under one second, but to make a one-line change in a small program took nearly five minutes from editing to running.

FLEX

The final operating system provided is Technical Systems Consultant (**TSC**) **FLEX** system. The system provides an extensive command structure, similar to **SDOS** and a faster **BASIC** interpreter than **FDOS**. Also included is a debug package, an assembler and a text processor.

FLEX comprises a File Management System, a Disc Operating System and a Utility command set. The File Management System allows sequential and random files and virtual arrays — an array that is stored as a separate disc file, opened and closed as a disc file, but treated by the program as a normal array, thus saving program size.

This part of the system also allows spooling to operate, provided that a **SWTP-MP-T** interrupt timer board is installed on the system. The spooling system allows full management of spooler queue files against multiple printers. Spooling makes it possible to print a file while also doing other computation.

User protection

The Utility command set provides commands for disc format and initialisation, disc or file copying, disc cataloguing, listing a **BASIC** file from disc with line number and format options, a **TTYSET** command for defining the screen operation and the ability for the user to build his own commands and treat them as part of the system structure. **FLEX** also allows user protection of a password against disc files. Two or more files can be **APPENDED** together.

The command **NEWDISC** is used to

format and initialise a new diskette, which takes about five minutes. The **ESC** key on the keyboard is used to hold and release scrolling.

The user can build his own **STARTUP** command file, which will automatically be used on booting the system, to take him straight into the **BASIC** interpreter or any other system or user program.

TSC BASIC

The **TSC BASIC** interpreter is similar to the **FDOS BASIC** interpreter but has better file-handling and variable handling capabilities. Files may be straight sequential or record-orientated random-access files. Records are 252 bytes in length (**FLEX** uses the other four bytes), and may be manipulated by **GET** and **PUT** statements and mapped by **FIELD** statements.

All random files have information stored in string format, with a variable using four bytes of file space and being converted by the use of the command **CUT&F** and **CUTF&**, for converting a string representation to a floating-point variable and *vice versa*.

Line numbers may be 1-32767 and multi-line statements may be used. Variable names are **A,AA-Z,ZZ** and the same **8** range for strings. Program error trapping is provided as for **FDOS**. The **BASIC** will also allow user-defined assembly-language sub-routines.

Fast run

The **BASIC** source can be run or **COMPILED** to give an object code program that occupies less disc storage. This is not a true compiler but it does speed up the loading and running of a program.

The simple benchmark for **J=1** to 1000, **NEXT I**, took half a second under **TSC BASIC**, which makes it one of the fastest **BASIC** interpreters on the market.

Text Processor

A **TSC Text Processing** system is provided to run under **FLEX**, which contains the following facilities:

- Page sizing.
- Margin setting and justification.
- Test filing, adjusting and centering.
- Spacing and indenting, tabs.
- Capitals or lower case switching.
- Height and width of printed output, depending on the type of printer used.
- Insertion and deletion and movement within a text file.
- Macro definitions.

The macro definitions can be used to define page headings or footings or as full-form letters or documents. Up to 3.5K bytes of macro definitions can be stored within the system as part of the text processor. The macro definitions and commands of the text processor offer most commands that are common to text processors and go some way towards

providing the sort of structure that is found in simple word-processors.

Sort/merge

Finally, the **MSI System 7** software includes a **Sort/Merge** package for use under **SDOS** or **FLEX**. The **Sort** allows up to 20 input keys, defined as ascending or descending, left-justified or right-justified keys. The utilities comprise four programs which are run by the user through the keyboard, but at present cannot be accessed directly by a user-written program.

Documentation

The documentation provided is extensive and of a high standard, and the only piece missing was for the **VDU**. The **MSI** operations manuals explain the machine right down to individual wiring diagrams and includes a parts breakdown. Each operating system has its own set of manuals, most including assembly listings of utilities and command structures. They provide a good introduction to the beginner, yet are comprehensive enough for the curious to understand how the system operates in detail.

Conclusions

- The **MSI System 7** is part of an expandable range of machines, starting at a minimum disc storage of 630K bytes and increasing to over 40 MBytes.
- The basic software provided between the three operating systems is extensive and, in the main, quite good.
- The user can choose the operating system to fit his demands, and if he wishes can develop interpretive programs and translate to a compiled version to obtain run-time benefits.
- The system is fairly straightforward to use and the documentation is of a high standard.
- The hardware is robust and comes from a tried and tested manufacturer.
- The system provides a direct upgrade for users of the **MSI 6800** systems, with compatible software.
- The ability to have multiple file opening and random access files lends itself to commercial applications.
- The screen and keyboard are quite good.
- The level of the **BASICs** provided is almost up to mini-computer standard.
- The **TSC BASIC** interpreter is very fast.
- At the price of a basic system, the **MSI System 7** is moving away from the hobbyist and is aimed very much at the commercial user, but it is restricted to a single-user system.
- The inclusion of all three operating systems in the basic price makes the system expensive and perhaps confusing for the user who only requires one of them.
- The memory cannot yet be extended beyond 56K bytes.
- Disc copying under **SDOS** is very slow.

Here's looking at you, kid

Industry bleats about the shortage of programmers and yet it can be a hard slog for the newcomer to find a first job. In this article Duncan Scot looks at training schemes, talks to the students and finds out which qualifications make up for lack of experience.

EVERY WEEK the computer newspapers are packed with advertisements for experienced computer programmers, reflecting a world-wide shortage of this valuable commodity. The exact shortage in the UK is already the subject of two wide-ranging Government and industry-commissioned surveys, at Warwick and Sussex Universities.

Derek Potts, training advisor at BIS applied systems, a company which trains computer professionals for industry, believes that the problem can only get worse. "As far as we can tell, there is a shortage of something like 25,000, split fairly evenly between systems analysts and programmers. But if we look forward two or three years, the figure could easily be 70,000. Maybe much greater."

Despite the shortage, the newcomer to the industry finds few openings. "The only way out of the problem is through self-generation. Companies must be willing to take the plunge and bring in raw trainees. They often say that it takes far too long to train a programmer, something like 12-18 months, and then they leave to find a better job. But the point is that companies simply cannot afford not to train their own staff. Too many projects are already being delayed or abandoned because the skill is not there. The overall effect has not been costed but I would guess that it is very expensive," continued Mr Potts.

"If we are lucky, we will see a sensible and steady rise in the number of companies with their own training programs but I suspect that the industry will wait until the last possible moment and then whine and bleat about the problem."

Rapid promotion

In the meantime, there are tremendous opportunities for those who can find a way into the profession in which they can command substantial salaries and expect rapid promotion.

Employers will always be guided by qualifications and experience. If the qualifications include some practical training, so much the better.

There have been some attempts to create specialist computing qualifications, many of which have involved George Penney, careers project manager at the National Computing Centre (NCC), in Manchester. "In the last ten years we have



Move over, oldsters! Only 14 and he doesn't even know computing is difficult!

tried again and again to introduce standards which industry will recognize. Before 1968 City and Guilds, The Royal Society for Arts (RSA), the Scottish Council for Commercial Administrative and Professional Education (SCCAPE), the British Computer Society (BCS) and the NCC were all offering qualifications in some discipline of computing."

It was felt that these qualifications would be more widely recognised if the proliferation of different standards could be avoided, and in 1968 the UK Coordinating Committee for Examinations in Computer Studies was formed. The aim was to ensure that the recognised qualifications were jointly certified by the committee.

"City and Guilds assumed the prime responsibility for programmers with the well-known City and Guilds 746 Basic Certificate in Programming, the RSA for computer operators and the NCC, jointly with the BCS, for Systems Analysis. SCCAPE agreed to use all the same standards in Scotland."

Meanwhile the Department of Education and Science appointed the Hasgrave Committee to study all sub-degree qualifications, excluding O and A levels. Hasgrave recommended the establishment of two committees, the Business Education Council (BEC), and

the Technical Education Council (TEC) and that a joint BEC/TEC committee should be formed for computer studies. This joint committee was eventually formed in 1978.

The courses made available under the new BEC/TEC syllabus include:

- The National Certificate in Computer Studies
- The National Diploma in Computer Studies
- The Higher National Certificate in Computer Studies (HNC)
- The Higher National Diploma in Computer Studies (HND)

The City and Guilds course and the National and Higher awards can be taken at Colleges of Further and Higher Education, while the Higher awards and degree courses can be taken at Polytechnics. Degree courses normally demand passes in an HNC, HND or two to three A levels.

The entry requirements for the national level course are 4 O levels or a pass in the City and Guilds course. At the higher national level an A level is also required. Anyone over 19, however, can be admitted without the minimum qualifications at the discretion of a college principal.

Although there have been long delays in establishing the BEC/TEC courses, George Penney believes that they will have a significant role to play. "They are essentially practical courses; they give the student hands-on experience with computers. They should also give a good grounding in business practice."

Hidden talent

George Penney is also the Director of the Threshold Scheme for Computer Programmers, organized by the NCC to help school leavers find a way into computing. The scheme is open to anyone aged 16-19 and within two years of leaving school, or is unemployed, or in a dead-end job. Trainees are accepted on the basis of aptitude tests and interviews and receive a weekly allowance of £23 for the duration of the course.

"We are not going to solve the shortage of programmers with this scheme overnight, but we are showing that many people who have failed in the stakes for qualifications can make very good programmers. What we have done is to



George Penney, (right) Threshold scheme director at the NCC, with two Threshold students.

discover hidden talent." The course alternates between classroom training and work in commercial computer departments. At the end of the 42 week course, the NCC helps the trainees to find a job.

Hélène Feyfant joined the Threshold Scheme at the South-East London College of Further Education at the end of October 1979. Now 18, Hélène came to London, from France, about two years ago and has since taken two O levels and an A level in her spare time. She was working as a sales assistant in a china shop in central London when she read an article about Threshold and wrote to the NCC. Her aptitude test was organized within a matter of days.

"The course was terribly disorganized at first," she told me. "The teacher stuck to the manual for the course and nobody could understand all the technical language. And a few of us felt that there wasn't enough programming. It would have been a good idea if there had been some sort of general introduction to tell us what the course was going to include. The whole of the first week was a waste of time. The teacher realized that we weren't getting anywhere and started again."

Most of the trainees on this course had not realised that as much time would be spent learning about business practice as they would programming. It was the first time that the college ran the course; it was still trying to find the right teaching 'mix' for these students.

In the 1979/80 academic year, there will

be over 1200 trainees under Threshold, spread out over 30 colleges around the UK. On past record, about 10% will drop out, either through incompetence or boredom and another 30% will accept computing jobs during the training period. These are regarded as a success for the Scheme. The remainder normally have no problems in finding a relevant job within two to three months of finishing, although some have to accept positions as computer operators and then work for promotion to programming. This usually takes between 12 and 18 months. But, as Hélène pointed out, "The course might not work perfectly but we would have found it very difficult otherwise."

An NCC report reflects this view. "There can be little doubt that most of the young people who benefit from this course would not have found any other way to escape the drudgery of work quite inappropriate to their level of ability. The social benefit of this alone can hardly be overestimated."

Private contracts

A similar scheme, TOPS, for those who are over 19 and who have been away from full-time study for at least three years, is run by Manpower Services Commission. Most of the training is contracted to private companies with computer departments or commercial training schools which are paid directly by the Commission. In 1979/80 over 3600 are expected to complete the course, of which at least

90% find relevant jobs within a couple of months.

Chris Nelson at BOC Data Solve, in London, is, at 30, one of the oldest TOPS trainees. He is also unusual in that he had a fair bit of contact with computers before he was accepted. "I spent a year as a computer operator but it was very boring and there were no opportunities to become a programmer, even as a trainee. I then spent another five years as a clerical assistant in a university computer department and there was still no way into programming."

Chris visited his local job centre which told him about the TOPS Scheme and got him an interview with the training school at BOC Data Solve.

"If you pass the aptitude test, they want to make sure that you know what the job entails and that a lot of the work can be boring."

As an employer of computer programmers, BOC Datasolve has been impressed by the standard of the TOPS trainees. The training manager, Mrs Janes, commented: "It has been a real eye-opener for us. It could mean that we will start to rethink some of our own recruitment policies."

"I know of three companies which have now abandoned graduate recruitment in favour of TOPS. The TOPS trainees' expectations are more in line with reality; they tend to be more mature and to have had some experience in business. They also have personal qualities and experience which tend towards greater stability;

they are more suited to supervising other people's work and, being older, find it easier to command respect. Graduates often become disenchanted very quickly."

The course at BOC includes an introduction to computing, COBOL programming and problem-solving practice. At the end of the 14 weeks, trainees are given advice on self-presentation and interview techniques to help them find jobs.

Outside the TOPS and Threshold Schemes the widest range of opportunities for studying computing lie within our system of higher education, where the new BEC/TEC HND is already proving itself popular. The largest course in the country is run by Professor Derek Wilson at the Polytechnic of Central London (PCL). "It is a good commercially biased course which looks like becoming more and more popular. There are so many applicants we may have to start advising qualified students to apply elsewhere.

No trouble

"Most students who pass their HND have no difficulty in finding a job. Their starting salaries vary a great deal but I would guess that with the HND a student will be able to earn about a £1000 a year more than a computer science graduate. They learn more about business practice and have practical experience of programming. About 90% of the HNDs go straight into a job; some of the others stay on for a degree course."

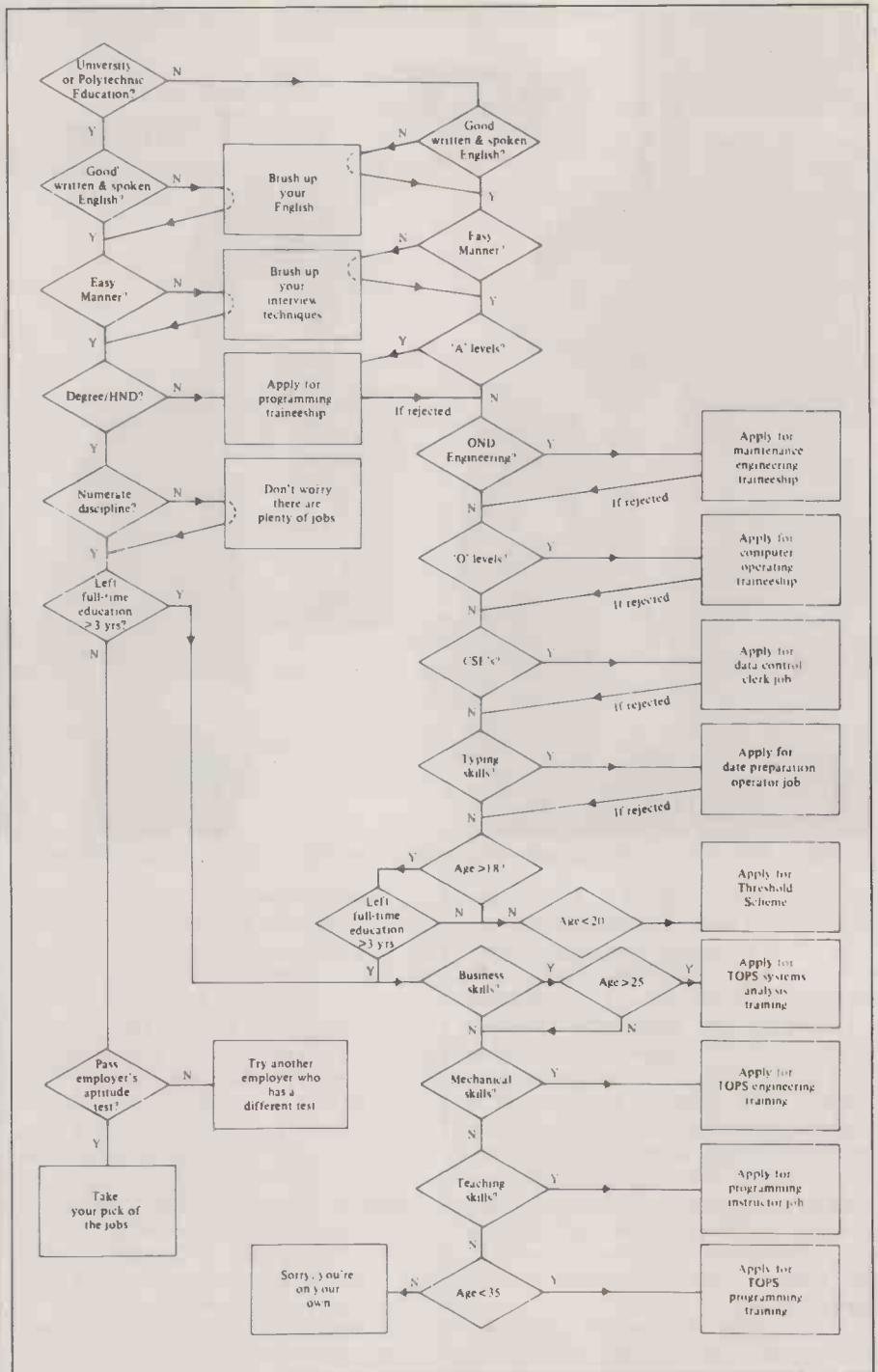
The HND acts as an entry qualification into the second year of a degree course, at the Polytechnics. One degree course at PCL is the BSc in Science. It is a modular course which allows students to concentrate on commercial computing, science computing or hardware design. In many respects it is very similar to a computing science course at a university.

Professor Wilson believes that all the courses could be expanded if local education authorities, which fund colleges and Polytechnics, appreciated the demand for computer professionals. "There is no shortage of willing applicants; there is just a chronic shortage of hardware. Heads of Department can only spend up to £400 on their own initiative. Anything more has to be approved by the local education authority. If an item will cost more than £10,000, it has to be referred to the Department of Education and Science. It is a very cumbersome process and just doesn't work. Even in the third year of the degree course, it is not worth trying to write a serious program with the equipment we have at the moment."

Academic bias

The university sector has escaped this stranglehold. In 1966 the Government established a separately-funded University Computer Board to meet computing requirements.

But university courses are often



criticised for their lack of relevance to industry. Derek Potts, at BIS Applied Systems, commented: "There is far too much bias towards the academic and not enough towards industry. I remember seeing one class which was learning how to program the flight path of a satellite. Most programming has to be far more down-to-earth. We should be trying to teach the hardcore, necessary skills and spend less time on the marginal projects."

Some universities, however, notably Brunel, Salford and Loughborough now run four year sandwich courses. One year is spent working with industry.

Don't give up

With such a wide range of different

computing qualifications, one problem for an aspiring programmer is to decide when to stop studying and when to look for an employer. Virtually every large company, and many smaller ones, have their own computer department and yet they will all have different requirements. As George Penney recommends: "Don't give up until you have tried every company in your area."

Civil Service

Of all the major employers, the Civil Service, with over 16,000 staff directly involved with data processing, is undoubtedly the largest. With the prospect of earning up to £5730 within three years



Jackie Janes, training manager at BOC Datasolve. "I know of three companies which have now abandoned graduate recruitment in favour of TOPS."



Chris Nelson, TOPS trainee: "They want to make sure that you know that a lot of the work can be boring."

of entry, it can be an attractive proposition. Nigel East, of the Civil Service Commission, explained the entry procedure.

"Most of our programmers enter the service as Executive Officers. We ask for at least 2 A levels and 3 O levels, one of which must be English. There is also an aptitude test for every entry at this grade and a second, more specialised, one for programmers."

Although the Civil Service is one of the few employers to accept raw recruits, it is

still short of programmers. "We have advertised for programmers, held open days at schools and we have also extended our age limit from 28 to 45. We will have to wait and see how much of an effect this has, since it is a very young profession."

The Civil Service claims to have one of the most professional training programs. Once accepted and allocated to a department, the trainee is introduced to the installation and projects on which he will work and then is sent on a formal course in programming. The trainee then returns

to his department to practice his skills until competent enough to join a programming team.

"The training doesn't end as soon as someone is proficient, or a good working member of a team. We encourage them to carry on developing their abilities: within five years it is possible to reach the highest professional standards," says Mr East.

One can also enter the Civil Service as a clerical assistant, with two O levels. There are plenty of opportunities for promotion to Executive Officer, through internal examinations.

Make an effort

It is not so easy to specify the general rules of recruitment in commercial companies. Some, such as British Airways, recruit up to fifty trainees each year, but the vast majority are graduates. Other companies are more willing to recognise the potential in less qualified applicants.

Employers will tend to be impressed by some evidence that an applicant has made an effort to learn something by himself, perhaps through a part-time course at a college. Despite some of the difficulties in finding that first job in computing, the attractions of the work should ensure a ready supply of applicants, although the responsibility will ultimately fall to industry to meet its own requirements with in-house training schemes.

The salaries offered to programming staff continue to rise and juniors can still expect a rapid promotion. As a general guide, programmers can expect to earn the following:—

Junior Programmers	£3600 to £4800
Programmers	£4600 to £5800
Senior Programmers	£5600 to £7000

The salaries offered, however, vary widely and overtime, to meet a project deadline, can often add considerably to total earnings.


It has often been argued that the shortage of computer programmers may prove a limit on the explosive growth of the computer industry but the speed with which the microcomputer has swept into new markets may give the lie to the claim.

There is now a small army of self-taught programmers and new companies have emerged whose requirements are enthusiasm and willingness to learn, not qualifications. Whichever way is chosen, the opportunities do exist for anyone with native ability and enough determination.

Contact addresses

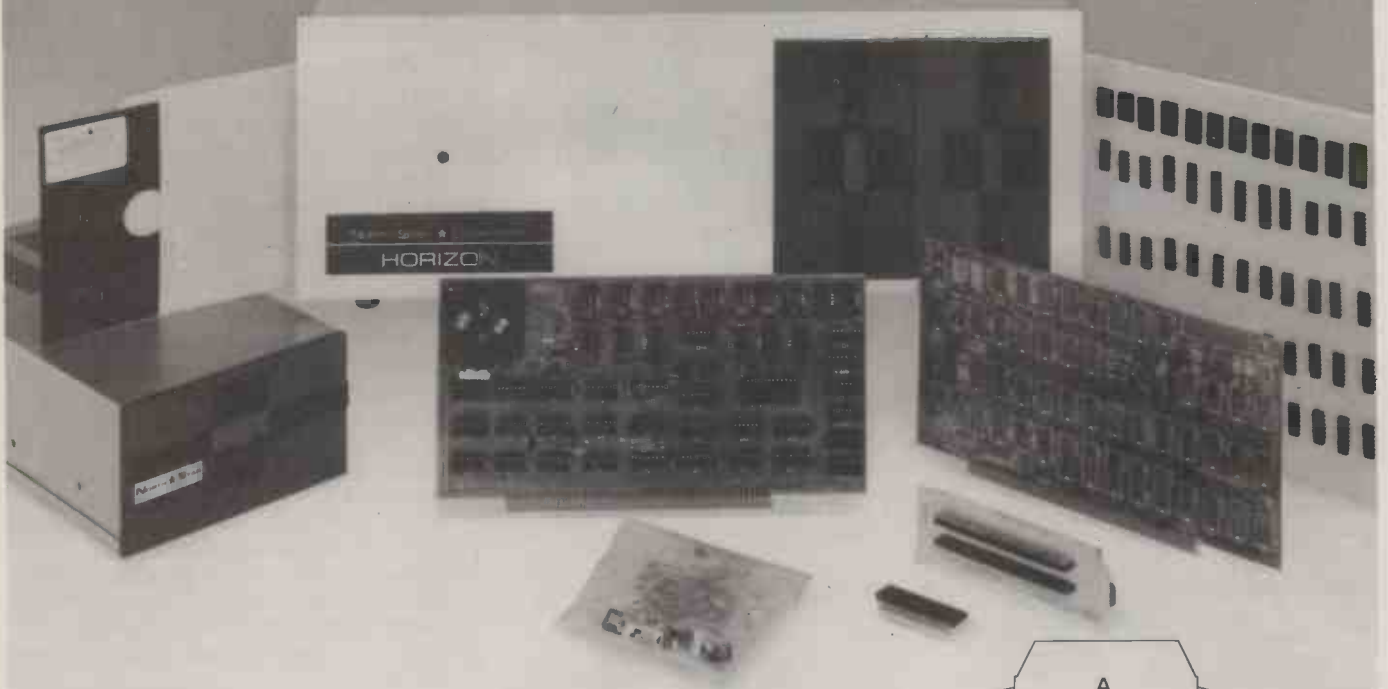
**The Threshold Administrator,
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Manchester M1 7ED.**

**The Civil Service Commission,
Basingstoke,
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Applicants for the TOPS Scheme should contact their local Job Centre. 

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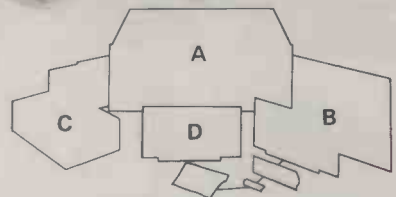
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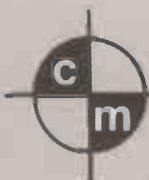
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• Circle No. 165

How to keep the pirates at bay

All hands on deck to repel rip-offs! Peter Sommer explains how, in the absence of clear rules on computer copyright, you must arm yourself for the fight or be jolly well rogered.

WHAT CAN YOU DO to prevent unauthorised use of your original software? How far does the English law of copyright protect the work of programmers? What machinery exists for enforcing copyright claims?

You're writing a program, but borrowing freely from the work of others — after all no-one expects to solve every problem by starting each time at the beginning: at what point do you start to risk breaching someone else's copyright? When do your activities cease to be creative adaptation and start to be mere copying?

The need to devise clearer protection for writers of software has now become urgent. The Copyright Act, 1956, is the most recent item of relevant legislation and not surprisingly makes no mention of computers of software. What reliance programmers can have on it is achieved by tortuous analogy.

Until the growth of personal computing, however, no one worried much about the situation because software writers would expect to have physical control over the use of their product.

Software, you will remember, was highly dedicated to a particular mainframe or mini and the needs of the large organisation that was the end user — it was sold merely as one constituent of a complex hardware/software/service contract.

Over the past two years all this has changed:

- We now have a number of very cheap universal machines with resident programming languages.
- With them has grown the market for the development of non-dedicated general-purpose software to cover basic commercial requirements and home entertainment.
- Program copying is child's play.
- The market size has reached the point where informal policing is becoming very difficult.

Just as copyright law for print became necessary once mass-produced books and pamphlets enjoyed affordable currency — the first English attempt dates from 1709 — the stage has now arrived where clear unambiguous protection for software is essential.

Such a requirement is necessary not only for writers, but also for their customers.

These pages have carried frequent criticism of the poor quality of some

microsoftware. The point is that until adequate rewards and the related safeguards exist, few of our better programmers will have the confidence to spend much time preparing material for the micro market — and that will make us all poorer.

What follows isn't a fault-free guide — the Copyright Act is open to criticism even in its current provisions. Rather, I've tried to explain the main aims and concepts involved in a good working copyright system.

One of the problems faced today by software writers enquiring about copyright protection is that few lawyers understand how a program gets written and what it consists of. Armed with some idea of what copyright law seeks to achieve, you should at least be able to ask legal advisors the right questions.

More importantly, there are plans to reform the Copyright Act; indeed a DTI Report of three years ago spent a great deal of time examining the problems of software copyright.

The trouble is that the technology and the market have moved on since then. Insofar as the new Copyright Bills will be topics of public debate, it is essential that those active in the business should be able to participate effectively.

Definitions

The purpose of copyright law, like its close relatives relating to patents and registered marks, is to give protection to intellectual property in much the same way as other sections of the law look after personal property and land.

The problem is, how do you define the unique qualities of one particular item of intellectual property? Clearly there is no problem with a traditional artistic work but the further you edge towards pure ideas, particularly those that may find expression in a physical form, you run into difficulty. Remember, too, that most classes of intellectual property tend to have been developed from clear antecedents — improvements are far more common than completely original work.

There are two ways of tackling the problem. The first is by *registration*. Here, it is up to the inventor/devisor to draw up a definition of what he wants protected, satisfy the appropriate authorities of the unique quality of his product, and then to obtain a formal document to that effect. This is the

approach used in patent law.

The second is a *post hoc* form of recognition. Here the law recognises, *prima facie*, that an 'original work' has come into being as a result of the skill and effort of the creator, and automatically confers protection.

But whereas once a patent is conferred, it is very difficult for someone to challenge its originality, in a copyright proceeding, everything about an original creator's claim can be reviewed by the courts. The Copyright approach, as distinct to the Patent scheme, has the merits of informality and ease of application and the disadvantage of uncertainty.

The copyright approach

The essence of the copyright protection is that labour, skill and capital must have been expended sufficiently to give the product some quality or character which the raw material did not possess and which differentiates the product from the raw material. The way it is defined in the 1956 Act is as follows:

(1) In this Act "copyright" in relation to a work (except where the context otherwise implies) means the exclusive right . . . to do, and authorise other persons to do, certain acts in relation to that work . . .

(2) In accordance with the preceding subsection, but subject to the following provisions of this Act, the copyright in a work is infringed by any person who, not being the owner of the copyright, and without the license of the owner thereof, does, or authorises another person to do, any of the said acts in relation to the work . . .

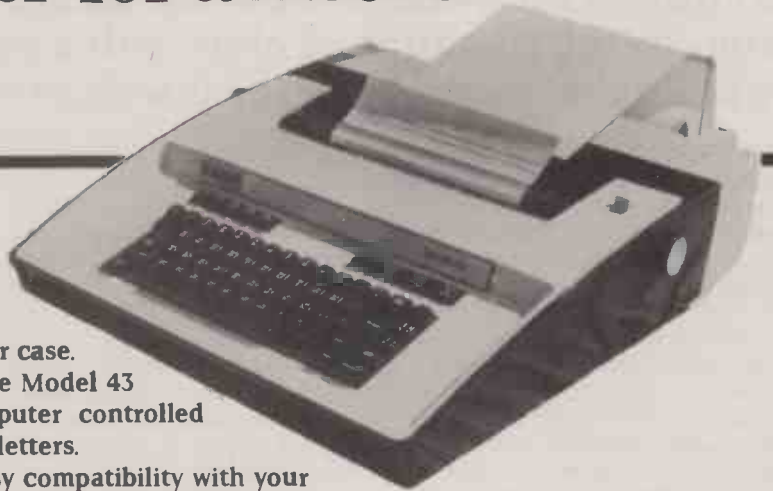
What these 'certain acts' are depends on the nature of the original work. The set of possible forms of exploitation arising from a sculpture are quite different from those arising out of a novel. The Act makes a broad (and not very satisfactory) distinction between primary works, eg literary, dramatic, musical and artistic works, and secondary ones, eg sound recordings, cinematograph films, television broadcasts, and published editions.

In fact, it is much easier to understand copyright as a bundle of rights for which protection may be sought. A novel may be published as a printed edition and finally translated into a movie. The original author's bundle of rights may include payment for each printed copy sold and a percentage of the profits (or box office takings) of the movie. But on the way, other people will have acquired rights too — the book publisher in respect of his

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continued from page 65

edition (and also copyright for the typographic arrangement of the printed words on the page), and a whole host of film people — script writers, directors, products, actors and financiers, may all have rights of some sort in the final movie product.

Limits on copyright

How far do these rights extend? Well, the principal claim to have circumvented copyright depends on demonstrating that your own subsequent work is sufficiently far adapted from the original for you in turn to satisfy the courts that you have created an original work.

Falling short of that, however, are a number of other provisions, the most important of which is to show that you have made 'fair dealing' use of the copyright material — and that is all. 'Fair dealing' has to be for the purposes of research or private study, criticism or review. The definitions have no precise measure — most book publishers will let you quote the odd paragraph or so without expecting payment, but they will look at all the circumstances — the compiler of an anthology consisting of no more than odd paragraphs from other books will be treated less sympathetically than the writer of a major critical work. Special provisions exist for 'fair dealing' in a specifically educational context.

The other main limit on the extent of copyright is time — for example, fifty years after the death of an author, all his works published in his lifetime pass into public domain.

Remedies

What does the law do to help you enforce these rights? Let it be said that the vast majority of copyright cases are settled according to various informal codes of conduct created within the industries affected — for instance, the one backed by the Publisher's Association and the Society of Author's; and for the rest, out-of-court settlement is the rule.

The penalties the Copyright Act itself supplies are:

- Damages for infringement.
- An account of profits, so that both sides can see how much the infringement has actually been worth to the offender.
- Delivery of infringing copies (and, if necessary) ultimate destruction.
- An injunction to prevent distribution and sale of items in dispute.
- If the original work has been supplied as a result of a licensing agreement to the offending party, there could also be an action for breach of contract.

Application

So much for general principles. The user of the British Copyright Act, 1956, faces two main difficulties. In the first

place, it's something of a draftsman's nightmare. Whereas the West German act tends to start off with a series of wide definitions as to what is being protected, you have to clamber over the British Act, which works by detail rather than general principle. This is what the Whitford Committee (about which more later) said three years ago:

The present system of definition has been said to be inexplicable even to the extent to which it is comprehensible. Literary works, a description which includes works which no ordinary person would define as literature, dealt with in Section 2 of the Act, are partially defined in Section 48. Section 48 is a general definition Section, but when we come to artistic works we find that 'artistic works' has, according to Section 48, the meaning assigned to it by Section 3. Section 3, while expressly excluding any consideration of artistic quality in relation to, for example, paintings and drawings, includes among artistic works the category 'works of artistic craftsmanship' the exact extent of which has led to a notable division of judicial opinion. An enquirer, finding in Section 48 a definition of artistic works which refers him back to Section 3, might conclude that Section 48 has nothing more to teach him about artistic works. He would be wrong. Section 3, by definition, brings sculptures, drawings, engravings and photographs within the category of artistic works. Each of these sub-categories is in fact further defined in Section 48. To take one example, 'drawing' is said to include 'any diagram, map, chart, or plan'. On the basis of this definition engineering drawings have been held by the courts to be 'artistic works'. A 'musical work' (perhaps inevitably) is nowhere defined . . .

The second problem is the one referred to right at the beginning — there's no mention anywhere in the Act of computers or software. The general view is that the existing category closest to the software program is 'literary work' — but there are formidable problems in making this analogy operate.

Software

The first set of problems are raised by the forms in which computer programs can exist. A 'literary work' usually implies a collection of set-down words. Well, does this mean that software only gets protection if it is expressed in listing form? What about punched cards or tape — couldn't the hole be regarded as a form of writing/printing? The commonsense view is that such an approach is far too limited — at the very least any effective copyright protection has to extend to software on magnetic tape or discs.

But this would still leave the problem of the ROM, PROM, and EPROM, to say nothing of the bubble memory. Surely such essentials as high-level languages and character generators should be able to secure protection. And, once we get away from the computer pure and simple, what happens to all those dedicated PROMS that govern industrial processes without the supervision of a keyboard and VDU?

Is programming not merely the application of maths formulae, which after all are in the public domain? Well,

I don't think so; it's the way in which the formulae are applied and the neatness and convenience of presentation that gives a program a special quality.

- What happens if (as is usual for beginners) you're writing in a proprietary high-level language, the documentation for which explains all the routines you're actually going to use in your program? Well, again, you're all right, because your input to the final product results in a more than sufficient change to the raw materials.
- You're writing a fairly complicated program, but in order to assemble it you've borrowed certain sub-routines or modules that you've admired in other applications, say, a sort routine, or a method of displaying results, or a particular group of graphics. In a 'literary work', the position is clear: quotations aren't allowed without acknowledgement and payment. But at what stage does a sort routine cease to be common-or-garden public domain stuff and start to be someone's original creation?
- You're reworking a well-trying program. The application is a common one, but, as you examine it, you think, maybe you could find a neater way of achieving the same result — faster and with less occupancy of memory space. Where do you stand? Answer: it all depends . . .
- You've got another well-trying program. This time you merely remove the REM lines, delete a couple of sub-routines that won't be needed by your end-user and stick in a couple of new ones, though nothing very clever. Is the program now your copyright or the guy from whom you pinched the original?
- You've yet another well-trying program. This time your aim is limited merely to adapting it from one machine to another. Maybe it's a change of dialect, say from PET Basic to APPLE Basic. Or if it's in machine code, from 6502 to Z80. Maybe both you and the original programmer should share the honours, but who knows?
- Your program relied on an input of data. Maybe the data is already in a digital form, or perhaps it comes from an on-line source, or Viewdata. Perhaps you have to keystroke it from a newspaper listing. We know that copyright can subsist in listings of data (on the basis that it needed work to assemble it in the first place), but what happens if your program changes the presentation (and hence possibly the value) of the original data? Even if you agree to a shared copyright, who agrees as to the proportions of the respective contributions?

continued over

- You are an on-line retrieval system bureau. A client wants some information and you provide an answer by calling up two or three of your source computers. You don't actually read the results, but get your intelligent terminal to carry out a keyword search of relevant items and then, using its resident word-processing power, it assembles a report from a series of paragraphs from the original on-line sources. Who is entitled to copyright?
- Your computer creates a new industrial design. You've fed it with criteria and specifications, but the final result isn't actually yours — or, for the purposes of copyright law, is it?

The trouble with all of these questions is that most of the answers are guesses. There's no certainty.

Enforcement

If you try to go to law, the first thought that must cross your mind is that there is a considerable danger that the lawyers and courts will be using your case to find out what the law actually says. Test cases are one of the most expensive types to finance. There'd be no legal aid either.

There aren't even informal codes suggested by professional organisations, like the various publishers associations. Neither is there a Performing Rights Society. Either way, you're on your own.

The copyright notice

One of the commonest mistakes about copyright law is to believe that protection becomes available if you affix the right, notice, eg © Peter Sommer, 1980, or that there is some potent legal magic when you deposit your statutory copies at the British Museum.

In fact, this is not the case in English law, since copyright subsists as soon as the criteria of 'original work' are met, though most American legal systems do require a notice, and it is important for securing international protection under various International Conventions. Sticking a notice on a work though has two useful functions — it reminds users that the work isn't 'free' and it also tells them where to apply if they want permission to reproduce.

But where do you fix the notice on a piece of software? Can it be on line 20 as a REM, or should it appear as a PRINT statement on the VDU shortly after the first RUN command has been set up? Or should you affix it to the outside of the cassette, on the label, or do you have to imprint it somehow on the first few centimeters of magnetic tape? Again, there are no clear answers.

Non-legal protection

Faced with all this uncertainty, what can you do to protect yourself? Some

interesting *ad hoc* techniques have been developed. Some are commercial, some technical.

Customising. This is only possible on larger programs. Essentially you try and recreate the circumstances of a few years back when software was sold as part of a package. You don't ever sell the basic program — except perhaps to fellow software writers whom you know and trust — what you sell is, say, a stock control system for a specific High Street company, tailored (usually by adapting a few PRINT lines to mention the company name and to cover the appropriate number of stock items) to the business's needs.

Often, of course, you'll be advising on the right hardware — micro, VDUs, disc drives, printers. That way you can have physical control over the fundamental software. If you are smart, you will also include in your supply contract a mere licence for the client to use the program. In the event of breach, you can then sue in contract law rather than copyright, a much easier matter.

Supply contract. You could try the licensing ploy on smaller programs too. You can make it a condition of sale that unauthorised copying does not take place. This will give you the benefit of suing for breach of contract.

But you would need to be able to prove to the court that a specific individual had been responsible for the copying. With a popular program in wide circulation, that might be difficult and if you wish to prevent someone selling your program, then you might find yourself forced back into copyright law.

Strategic pricing. This approach is one that may work best with cassettes. You have to have enough confidence to believe that a lot of people will want your software offering and that you will get your remuneration from lots of small royalties rather than a few bigish sums. What you do is to price your cassette or floppy at little more than the retail cost of the blank article. In other words, you make it scarcely worth the while of the pirate to copy.

For this ploy to work, though, you need a popular product with a large potential audience, plus the ability to market to them in suitable quantity. Tricky, that. Alternatively you can aim to sell only a few very high-priced cassettes, possibly to clubs, knowing full well that each will be copied.

Fingerprinting. This is a technical device. Again, it works more readily on longer programs. What you do is insert the odd anodyne sub-routine. Nothing that would really get noticed unless you were examining the listing in detail, and nothing which takes up too much memory, but enough so that, if you believe an adapted version of your program is being offered on sale, you can look for the fingerprints...

Bombing. The idea here is either to arrange the program so that copying is difficult or that the whole thing collapses if it is used in an unauthorised way. You can make copying difficult in a machine code program by taking as your first step the decision to remap the memory of your micro, so that most of the space usually used by the keyboard and high-level language is taken away. Only the keys essential to manipulate the program are left, so that the owner can't execute a SAVE command.

Once you do this, though, you may find that your own task of duplicating your tapes and discs in order to sell them is that much more difficult. Program collapsing can be generated if the user introduces an 'illegal' entry. You may give the program a restricted list of acceptable entries or names. Or, and this is useful in many commercial programs, you may limit date entries to a specific and limited period.

When telesoftware — the sending of programs via Teletext or Viewdata — becomes a commercial reality, the supply houses are likely to achieve control of their use by ensuring that each loading down will carry 'acceptable' dates for only a short period, eg one month, so that customers are compelled to go back for a refresher. In this way the supply house will keep its revenue up.

The future

Such devices, though, are shaky substitutes for a real copyright law. In March 1977 the Whitford Committee *Copyright and Designs Law* was presented to Parliament. Whitford had some sensible suggestions to make about the forms in which computer copyright could be conferred and enforced and for anyone interested further in the subject, it is essential reading. However, three years ago the PROM wasn't an everyday object. Neither was the personal computer.

The DTI seems to feel proper reform of the law of Copyright will be a lengthy business. In view of criticisms of the workings of the existing Act (even in regard to conventional media) they would prefer to present a completely new Act before doing anything else.

In the meantime a barrister, Mr Alistair Kelman, has drafted a bill to provide explicit protection for computer software; it even proposes to have a retroactive effect. It looks as though Sir Keith Joseph may issue a Green Paper (consultative document) some time in the summer. It should make interesting reading, but I for one would like to see a greater sense of urgency about the whole matter.

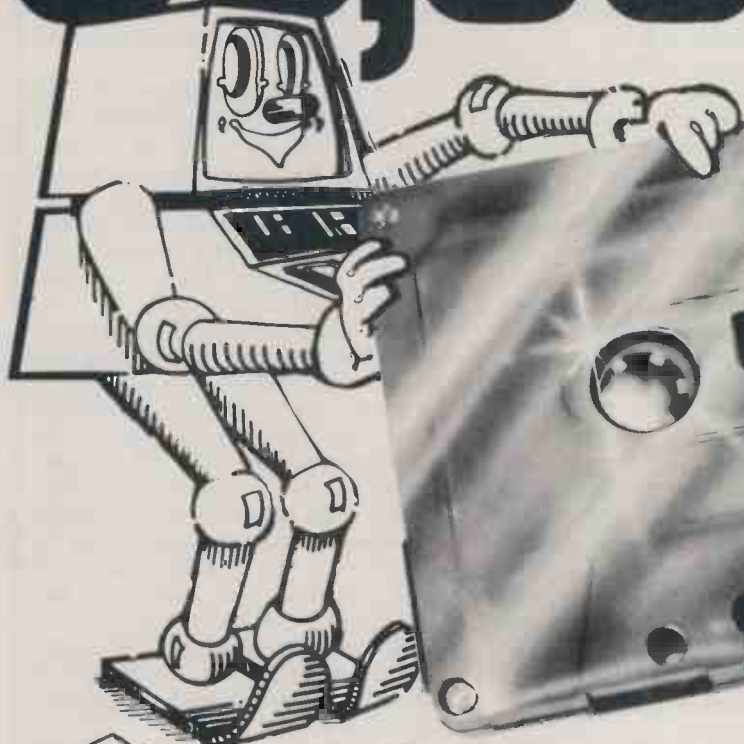
Further reading

Copyright: Modern Law & Practice by P. F. Carter-Ruck and E. P. Skone-James (Faber).

Copyright and Designs Law (Whitford Committee) Cmnd 6732 (HMSO). □

50,000TH

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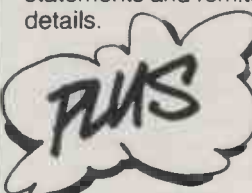
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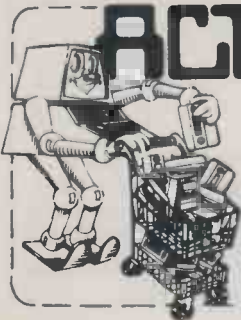
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Cyberkids

by Andrew Walker

HENRY UNERRINGLY touch-typed in a command on his qwertypad watching the characters being echoed back to his VDU, and waited for the system to respond. The pause was brief, the micro answering him first with the time and date:

13.33.21 hours 21 July 2022
then with the acknowledgement of his executed instruction:

LOADED: SEGMENT 3/1074

TITLE: "Mathematics"

SATELLITES 3,7,10: UNAVAILABLE

To the last symbol, the ampersand prompt, Henry added another few words before leaning back in his soft control chair which he then swivelled in order to face the general m  le that almost always engulfed this room.

The walls of the nursery-cum-rehabilitation centre were a clean white — a miracle considering how long it had been since the Finance Committee had last bought a tin of paint — and here and there were a few scratched and somewhat faded nursery-rhyme and cartoon characters added for the sake of the youngsters.

Henry felt for the embedded panel in the right arm of the seat and pressed the appropriate button. Immediately nine microunits, satellites of the main system, placed circumferentially round the walls of the room, jumped into life, their audiboxes calling out the name of their allotted pupil. One child, seated next to his unit, answered the call by climbing up into his chair. The rest carried on as though nothing had happened — either they had not heard their call, which would hardly be surprising in the permanent din of the nursery, or were ignoring it, preferring to play on with their toys.

Spectacular gimmick

Henry had often complained about this and indeed many other faults of the system but persuading the designers to adapt it to the special requirements of the nursery was impossible. They just weren't interested. They were continually reaching for some new spectacular gimmick, some challenge to their egoistic intellect, instead of perfecting the functional aspect of their work.

He waited for a lull in the noise so that he could attract everyone's attention but the animation of the kids was such that there was not even the slightest drop in the level.

"Quiet everyone!" he finally shouted above it all.

Slowly the commotion began to subside until only the monotonous, unanswered callings of the audiboxes was left.

"Those who have a maths lesson now should go to your units."

Henry's order was greeted by moans and groans as the chosen few trudged to their respective micros — this always made Henry smile as he remembered, from various old manuscripts he had recently read, the optimism those early micro-pioneers had felt, way back in the 1970s and 80s, about the future of 'computer-aided instruction', as it had then been known.

They had enthused wildly about children's willingness to work with the . . . — what was the term they used? . . . "personal computer"! he finally remembered. Funny names they came up with, he thought. But of course they ignored or were blind to the parallel revolution in toys which greatly outweighed the relatively puny interest and addiction generated by the computer in education.

Paralline multichip

He watched as the maths pupils sat down and began to speak to their obsolete micro-units, obsolete that is everywhere except here. The Finance Committee were considering a modified system based on the pico but the perennial government cuts were hitting all things — the new system would probably be shelved — for the time being, at least, Henry envisaged a lot of pressure to get the pico-system intalled and the committee would, no doubt, finally relent — just in time to see it outmoded by the embryonic paralline multichip design. Then more pressure for the paralline to be used.

And so the penny-pinching circle continues.

Michael. Henry suddenly realised that he had not been to see his most special pupil in the privacy kiosk which the youngster now seemed to monopolise. He wondered what he was up to.

It was Penny who diverted him before he had even started out. Blonde, pig-tailed Penny with her wide blue eyes. Anyone hearing her soulful cry and seeing her flailing arm could not help but to have immense pity for her. Henry rushed over, keeping away from her windmill-like action.

"I can't stop it!" she wailed, tears rolling down her pale cheeks.

Henry put his hand in the limb's path and gripped it tightly. It jarred to a halt.

"Let's have a look inside, shall we?" he suggested.

Penny nodded, sniffing and brushing away the tears.

With a practised hand Henry rolled up her sleeve and quickly unhitched the offending article, revealing, on Penny's shoulder, the stub of what had once been her natural arm. None of the other children, disturbed at first by her sudden outburst but now having resumed their play, gave the 'scene' a second glance. Not for want of caring, though.

Henry peered intently into the concave joint of the false arm, taking great care not to damage the thin wires which were not the only link between the limb and its mistress. He could feel the organo-skin, that nearly perfect flesh-like tissue developed at the turn of the millenium, twitching in his hands — an eery feeling. Somewhere in that pico-chip housing he was looking at lay the fault that had caused Penny to lose control of her artificial arm, but he could see nothing.

"Let's see if we can get a nurse to take you to see the nice doctor, shall we?" he molly-coddled her, as he carefully replaced her limb.

As he picked her up in his paternally comforting arms she burst into tears again.

"Why, what is it Penny?" he asked. "There's nothing to cry about. The doctor will soon make you better."

"It's my arm," she sobbed. "Oh, you wouldn't understand . . ."

She cried on, hugging his broad shoulders.

I think I do, he thought to himself sadly.

Microcyberology interface

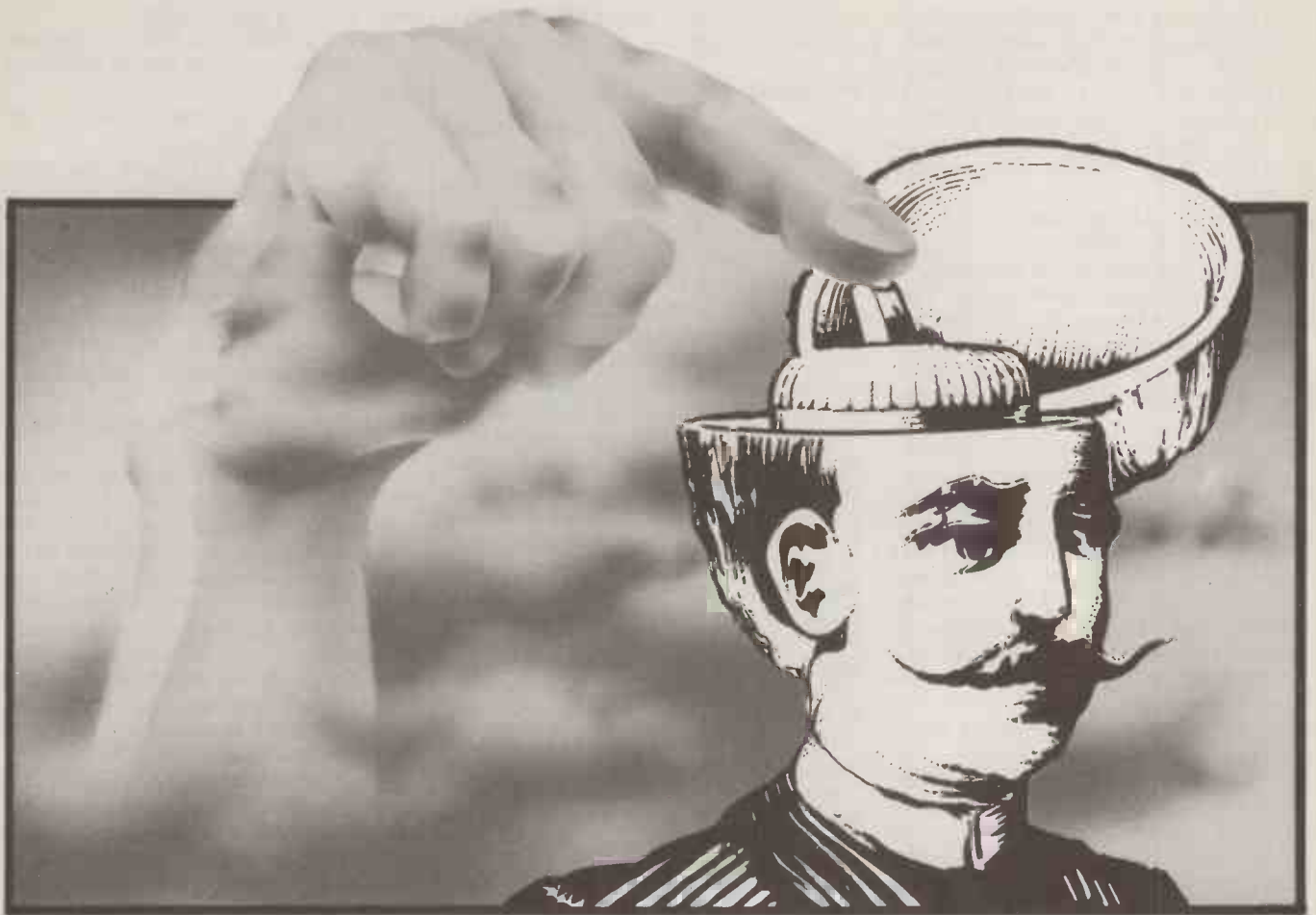
As luck would have it, there was no need to find a nurse. Passing the nursery at the very moment Henry stepped into the corridor with Penny in his strong arms was Dr Halliday, the hospital's leading figure in the microcyberology field.

"Hello Henry," he beamed. "Trouble?"

Henry explained the problem. Halliday nodded, his fair hair falling in front of his face.

"I'll take her downstairs," he said, brushing back the stray wisps. "I'll just get a wheelchair."

Microcyberology was not, of course, a new technology, as is shown by its 'micro' prefix. The microprocessor was rarely, if ever, used, though, in the second decade of the twenty-first century — it had long been superseded by the pico-chip.



The science — or art, if you prefer — of microcybersurgery, whereby 'intelligent' electronic devices can be interfaced to the central nervous system of a human, or indeed animal, body had grown out of the troubled late 1980s with the 'War for Work' campaign as its supporters had named it (now, over thirty years on, more commonly referred to as the 'Second Luddite Riots').

These disturbances were not unexpected, though, perhaps, a little underestimated. World-wide unemployment rose sharply as computer technology took over and lack of provision, due to governmental ignorance, for the radical sociological changes meant great hardship for the jobless millions. It was against this and not the silicon chip that the unions fought. Naturally those early marchers had become the puppets of militants from both ends of the political spectrum and the violence that followed caused the fall of several governments around the glob — and the death of thousands of people.

Whatever the results, however, the cause was undeniable. It was the insensibility not only of governments but also those early micro-pioneers, who lived in a 'Cloud 9' existence, happily bashing away on their qwerty pads, playing games and predicting a panaceaic future for the world, a world full of micros, minis and even mainframes.

"Society's attitude to unemployment

will change," they hackneyed. "With the micro the world will be a better place — more leisure-time for everyone, more efficient production, more education, better this, better that . . ."

Elitist jargoneers

Then they sat down and worried about and developed — more games! They did little to create the changed society that they promised. Micro-users came to be regarded as élitist jargoneers like the earlier hi-fi freaks with their amps, tweeters and woofers.

There were those, of course, who attempted and sometimes succeeded, in finding new applications — for both computer and silicon chip — like 3D X-ray machines, for example. But as ever funds were the problem. Governments were hard-pressed to meet the demands of the numerous late-century energy and economic crisis and the profit-conscious producers of chips and computers were too busy to set aside anything for the common good. 'Why should they,' they argued, 'it would be so unprofitable.' They were too busy taking the money of an all consuming society.

The Riots eventually put a stop to that — to a degree. The micro-magnates were finally forced to realise their responsibilities. Micro-pioneers at last became aware of the public's need for their expertise. Thus began the 'real' Chip Revolution.

Having seen Dr Halliday wheel Penny

away, Henry returned to the chaos-filled room to see Michael.

There were still those who attacked the microprocessor and its offspring the pico-processor, particularly in the cyber field. Fanatics generally, religious and otherwise, but they were a dying breed.

"If God had intended us to have electronic circuits in our heads, He would have put a socket in our skulls!" they intoned.

But how could anyone begrudge these children at least some semblance of normality? Most would have led an institutionalised life of hell without the chip. Michael was the prime example of this. Mike the Miracle the nurses had nicknamed him. And, indeed, he was a miracle — a technological one.

Shaven head

Henry opened the curtain that separated the kiosk from the rest of the nursery and looked at the healing scars on the back of his pupil's shaved head.

Until a few weeks ago, Mike had been a hopeless case. Born nine years earlier, his brain had been affected by a drug administered in the maternity ward and his mental age had never risen beyond two. In many ways his physiological age was even less.

He was unable to speak more than five or six words and these were invariably garbled. His head would frequently roll from side to side and his self-control was

so bad that his arms waved about as he staggered around with his ungainly walk. Most off-putting of all was the lolling of his tongue and the sickly thick saliva that dribbled down his chin, staining the front of his clothes. Incontinence was a problem, too — hence the need for nappies.

And he was nine years old.

Henry could remember the electro-lectures he had once had on the history of treating the mentally handicapped. They were more like horror films! Those that were allowed to live were hidden away in institutions or even caged and put in travelling circuses, billed as the 'Human Beast' or some such sensationalist title. But who was the more savage? The caged 'creature'? Or its 'human' keeper?

Then there were the more final solutions. At least the Jews were able to fight back, to some degree. But what were the mentally handicapped to do against Hitler's Reich? Huddled together and ritually exterminated, like vermin. Or made to suffer inhumane experiments that would never have been perpetrated on the lowest of animals.

Henry stared at the result of man's latest attempt to solve the problem.

"D . . . d . . . d . . . doggy," Michael stammered as a picture of an Alsatian appeared on the VDU. For a correct answer the picture changed to a clip of a century-old silent-movie and a custard pie landed in the star's face. Mike broke into a hearty laugh that made even Henry smile.

Well, was it worth it? Henry already knew the answer to that. Fifty-three hours of almost continuous microcybersurgery, cutting holes in the thin skull, close scrutiny of the 3D X-rays of his brain and the intricate positioning and quasi-wiring of the minute picochip to the correct cells.

Neocabbage

Fifty-three hours of the most extensive micro-neurological implantation ever. Fifty-three hours that had created an ebullient child out of a salivating neocabbage.

His problems were not over, of course — man's knowledge and ability could not — yet — make him completely normal and Mike had a lot to learn and do to catch up with others of his age, but it was a leap in the right direction. At least his major handicaps were overcome and heads no longer turned away at the mere sight of him.

Henry, from the corner of his eye, saw Penny return, exercising her repaired arm. He left Michael, closing the curtain behind him and walked over to her.

"OK now, Penny?"

She nodded, then said: "The doctor told me all about you".

The smile that had been on Henry's face quickly vanished.

Why had Halliday divulged his secret? After all these years why would any

member of staff break the written contract of secrecy?

Picochip implants

"I wish you weren't going away," Penny continued.

"Oh . . . that!" Henry breathed a sigh of relief. "Don't worry — I'm sure the new teacher will be nice."

"I don't care. I like you."

Henry looked around the room at his pupils as they accustomed themselves to using their picochip implants and artificial limbs. Those with recently attached parts were often clumsy in their use, their brain as yet not trained to using its newest peripheral. He watched one or two as they limped on their unnatural legs or fumbled something with their hands. The brain is very adaptable, however, as Penny had shown, and would soon acclimatise itself to its new-found abilities. Her arm had been fitted only ten days earlier and already she was using it as a natural — apart from her little trouble a short while ago, that was.

"yes," he finally said, mournfully, "I'll be sorry to go."

He was as fond of his patients-cum-pupils as they were of him.

It was a strange desolation that took over the nursery when the kids had gone. Every footstep echoed eerily around the walls in the dim half-light of the late evening.

Henry turned at the doorway for a final look at the room with its faded cartoon characters, the cupboards full of every conceivable electronic toy and the now dead micro-units. Reluctantly he turned away and left.

The Quiet Room was empty when he arrived a few minutes later and he walked over to the wallpad, applied pressure at the correct co-ordinates and sat down in his favourite easy chair. The dim wall suddenly blinked into life and a six foot by six foot video-pic appeared. Someone was doing a funny walk and the 'live' audience was erupting in a fit of moronic canned hysterics and applause.

"Another American import," Henry grumbled. Then he looked away from the screen, noticing a large crate in the corner of the room. "That must be it," he thought. "What a way to go!"

He only had to wait six or seven minutes. A bright, blonde woman breezed in — Professor Clarke.

"Hard day, Henry?"

"As usual."

"We'll . . . er . . . be sorry to see you go, you know."

Henry nodded solemnly.

"Roll up your sleeve, please," Clarke asked, approaching him and taking his hand in hers.

"Where will I be sent?" Henry inquired.

The professor found a couple of catches just above Henry's right elbow. As she unfastened them and disconnected the

inner wiring, a nurse walked in.

"We'll all miss you, Henry." She said as the professor handed her the dislocated arm.

The process was repeated for the left arm.

Henry watched the nurse step away with his two separated limbs and pack them carefully in the waiting crate. It was a strange, unreal sensation that he felt.

"Demagnetise please, Henry," Clarke half-ordered, half-requested.

"Done," came the reluctant reply after a brief but noticeable pause.

"Don't worry, Henry," the professor tried to comfort him.

Henry's brain told him to nod but he couldn't.

"You'll just go back for a recondition and training for your new job," Clarke continued. Then she reached up, one hand under Henry's chin, the other at the back of his neck, and, with a slight tug, gently lifted his head from his shoulders.

This was a job she detested more than any other. Everyone had become so attached to the amiable Henry, and here they were packing him and sending him away like some unwanted toy instead of the friend that he really was.

It was the ultimate irony, she thought to herself as she carried him to the crate. All of those children in his care. All of those children whose bodies needed the pico-processor to survive adequately, in the care of a robot whose picos were in need of a body. She looked back at the rest of the torso and legs, the universal robotic chassis designed merely for mobility and appearance and wondered who would be using it next — what would the new robot be like?

Henry — or at least the head, with its cyberbrain, and the specialised arms that constituted Henry — would be moving to a new chassis, exactly the same in every respect as the one he had just left — except it would be elsewhere.

"I understand your makers, Robo-of-Europe, have a contract with Space Unlimited," Clarke remarked, snapping herself out of her morose brooding. "There's a good chance you'll be put to work on the Lunalab Project on Clavius."

Goodbye

Henry — his head and arms, that is — lay face up in the padded crate. He smiled feebly, though not particularly comforted by the professor's conversation. He blinked several times almost — or so Clarke thought — as though he were blinking back tears.

In silence she peeled back a flap in his hair and unscrewed the plate she found beneath it. Removing this uncovered the all-powerful switch. Her finger came to rest on its cold surface. She hesitated for a moment.

"Goodbye, Henry."

Click. □

St. Valentine's Day match-up

Our Schools Correspondent sends us this account of something really useful for the computer to do ...

HERE's a St. Valentine's Day frolic, to involve the whole upper school in *their* computer. We launched ours a week before Christmas, and results were produced on the day of the school Christmas disco.

Pupils were invited to fill in a simple form. A couple of girls in the computing group transcribed the contents of the forms onto data sheets, and the data was fed into the program. A portion of the output is enclosed. 189 pupils submitted forms, and (with the minor exception of the girl who was allocated her brother!) the project was a great success (so was the disco afterwards!)

The program accepts data for each entry in the following form (after printing the entry number):

- Name (and form, if required)
- Number of the box ticked in each selection (1-2, 1-4, or 1-8 in each case). Numbers go in on separate lines — press RETURN after each number.
- Prompt ERR? comes up. If the last entry was wrong in any way, type YES here; the entry may then be re-input. Otherwise press RETURN, then input next entry.

Inputting Z in place of a name terminates data input, starts processing. The operator is prompted to type CTRL Q and CTRL E (for continuous scrolling, and echo to printer) then RETURN. The system compares the characteristics, requirements and interests of each entry in turn with *every* entry of the opposite sex, giving a compatibility rating out of 10 (serious differences in age from requirement count negative). The two best-scoring matches for each entry are listed below the name of that entry.

On completion of the run, the prompt EXTRAS? may be answered YES if it is desired to add to the list of entries in the machine (a 'name' of Z will again terminate the extended list, and start a complete new processing run, on the new extended list). Any other response will set the machine off on producing a duplicate list.

The program is minimal, to leave maximum data store. We allowed 20 characters per name — this was generous; I believe the arrays could be extended to 250 without mishap (more, if string space is reduced). A run for 189 entries took 1 1/4 hours — a long time, but the whole thing would not be possible without optimal packing of data. This is a project well worth undertaking for a Valentine's Day crack!

```

2 CLEAR 4000
3 DIM N$(200), S(200)
5 FOR I=2 TO 9: READ W(I): NEXT I
10 J=0
20 ? : ? : INPUT N$(J)
25 IF N$(J)="Z" THEN J=J-1: GOTO 140
30 FOR I=0T09: INPUT A: F(I)=A-1: NEXT I
35 INPUT "ERR"; A#: IF A#="YES" THEN 20
40 IF F(0)=0 THEN 80
60 A=F(4): F(4)=F(3): F(3)=A: A=F(6): F(6)=
(5): F(5)=A
80 S(J)=F(1)
90 FOR I=2T09: S(J)=S(J)*W(I)+F(I): NEXT I

110 IF F(0)=0 THEN S(J)=-S(J)
130 ?F(4): J=J+1: GOTO 20
140 ? : ? : INPUT "CTRL E, CTRL Q"; A#: ? : ? :

150 FOR K=0T0J: Y=0: Z=0
160 A=SGN(S(K)): B=ABS(S(K)): GOSUB500
170 FOR I=0T09: C(I)=F(I): NEXT I
180 FOR L=0T0J
190 A=SGN(S(L)): B=ABS(S(L)): IF A=C(0) TH
EN 300
200 GOSUB500
210 A=3
220 FOR I=3T09
230 IF C(I)=F(I) THEN A=A+1
240 NEXT I
250 A=A-ABS(F(2)-C(1))-ABS(F(1)-C(2))
260 IF A<Z THEN 300
270 Z=A: E=L
280 IF Y=Z THEN 300
290 A=Y: Y=Z: Z=A: A=D: D=E: E=A
300 NEXT L
310 ? : ? : ?N$(K): TAB(26); "COMPATABILITY"
; TAB(32); Z
330 NEXT K
340 INPUT "EXTRAS"; A#: IF A#="YES" THEN J=
J+1: GOTO 20
350 GOTO 150
500 FOR I=9T02 STEP -1
510 B=B/W(I): F(I)=(B-INT(B))*W(I): B=INT(
B)
520 NEXT I
530 F(1)=B: F(0)=A: RETURN
600 DATA: 4, 4, 4, 4, 8, 8, 8
    
```

Please answer the following questions:

Name: _____

Sex: Male Female

Age: _____

AGE OF IDEAL PARTNER:

UNDER 14.6 16-16.6

14.6-15 16.6-17

15-15.6 17-17.6

15.6-16 OVER 17.6

WHICH OF THESE BEST DESCRIBES YOUR HAIR COLOUR

FAIR DARK

MID-BROWN RED

YOUR HEIGHT:

UNDER 5'1" 5'6"-5'11"

5'1"-5'6" OVER 5'11"

HEIGHT OF IDEAL PARTNER:

UNDER 5'1" 5'6"-5'11"

5'1"-5'6" OVER 5'11"

ON A RAINY DAY, WOULD YOU PREFER TO:

COLLECT (STAMPS, COINS ETC) <input type="checkbox"/>	PLAY INDOOR SPORTS <input type="checkbox"/>
PLAY A BOARD GAME (CHESS ETC) <input type="checkbox"/>	DO CROSSWORDS <input type="checkbox"/>
MUSIC (PLAYING OR LISTENING) <input type="checkbox"/>	GO FOR A WALK <input type="checkbox"/>
WATCH TV <input type="checkbox"/>	CRAFTS (PAINTING ETC) <input type="checkbox"/>

WHICH SPORT DO YOU PREFER WATCHING!

BOXING <input type="checkbox"/>	FOOTBALL <input type="checkbox"/>
TENNIS <input type="checkbox"/>	CRICKET <input type="checkbox"/>
GOLF <input type="checkbox"/>	TABLE-TENNIS <input type="checkbox"/>
SWIMMING	BASKETBALL

WHICH MUSIC DO YOU PREFER!

CLASSICAL <input type="checkbox"/>	SOUL <input type="checkbox"/>
PUNK <input type="checkbox"/>	BLUES <input type="checkbox"/>
ROCK 'N' ROLL <input type="checkbox"/>	JAZZ <input type="checkbox"/>

REGGAE THE SMURFS

Please tick the appropriate boxes and return completed to Nicola Gowan or Helen Reynolds (4th year).

In pastures phosphor-green ...

Bob Merry plays at shepherds with *Sheepdog Trial*, a game against the clock programmed for the PET

THE SCENE is the Petshire Country Show; the event the sheepdog trial. In a large field, a lone dog seeks to round up a number of sheep and herd them into a pen in the centre of the field. The obedient dog follows the instructions from his master; left, right, forwards and backwards. The sheep wander in the field at random until the dog approaches, when they head away from it. A good sheepdog will not approach too close, however, since this causes the sheep to panic and then they are liable to dart off in any direction.

Novice shepherds can elect to round up only a single sheep, but the more experienced can attempt up to six sheep. This can lead to complications, as the sheep will often wander out of the pen when the dog goes off to fetch another sheep. This is why the trial must finish with the dog guarding the entrance of the pen. The best times in each class are recorded so the shepherd can see how well he is doing.

This is the idea behind the game of "Sheepdog Trial". The program is designed for the PET, using the graphics to illustrate the course of the game, so a few notes of explanation may help readers who wish to adapt the ideas in the program to their own systems.

Et in arcadia ego

Lines 105-310: These contain the basic instructions. Lines 105, 170 and 245 start with the 'Clear screen' instruction, shown here as a reversed image 'heart'. Most of the other lines in this section contain one or two 'cursor down' instructions, shown by the 'Q'.

Lines 160, 240 and 310 call for GOSUB 3000, which simply waits for a keyboard input to indicate that the player has read that 'page' of instructions. Lines 260-275 illustrate the Pen with six sheep inside and the dog placed across the gate. Aficionados of 'Rhino' might notice a family resemblance in these sheep!

It is important that all the points on the edge of the pen, except the gate, are filled with a symbol, as we shall see later. The instructions end with the player selecting the number of sheep he wants to round up.

Lines 320-390: It was obvious when I first conceived the idea for this program that it was going to involve a large number of symbols moving around the screen. One obvious way of doing this is to POKE the required symbols into the screen, but I prefer to avoid this, since it usually results in a burst of "snow" on the screen.

Instead, I use two strings of cursor control characters, which I can call upon later in order to move the cursor to the appropriate part of the screen. These are contained in Lines 360-370; A\$ consists of 39 'cursor right' instructions and D\$ is 24 'cursor down' instructions.

We will be using XS(I) and YS(I) to keep track of the positions of the I sheep, and the best time recorded for each number is stored in BT(I), which is set initially to an impossibly(?) high number.



Drawing the field and the pen and placing the sheep and the dog all take a little time, so since we don't want the game to start until the scene is set, we employ, in Line 320, the POKE that blanks out the screen on the PET.

Lines 400-450: This section of the program prints out the Pen and the surrounding field. Movement in the program is restricted to spaces that are free, so it is important to fill up all the spaces on the screen that are 'out of bounds'. During development of this program, I had problems initially with sheep that were able to leap the corners of the pen.

At this stage the pen was shaped as in **Figure 1(a)**, whereas, of course, it needs to

be as shown in **Figure 1(b)**. This is easy to see in the diagram, but not, perhaps, so easy to deduce from the graphics.

Line 410 starts by moving the cursor to the desired point on the screen and then prints out the top of the pen: a corner post (shifted ',') a lower line for the fence (shifted '\$'), a space for the gate, another fence-line, and a corner post (shifted ';'). Line 420 prints the rest of the pen.

The sides are made up of a right-hand line (shifted ')', three spaces, and a left-hand line (shifted '%'). The bottom of the pen has a corner post (shifted '<'), three upper lines (shifted '#'), and a final corner post (shifted '>'). The pen, therefore, fulfils the requirements shown in **Figure 1** and surrounds six spaces on all sides, including the corners.

Later on, we shall be moving the sheep and sheepdog around the screen and at this stage I had to consider the restraints on their movement; they should not move over the sides of the pen, they should not move off the screen and they should not jump on each other. The position of sheep and dog would be recorded as co-ordinates, where X could possibly be 0 to 39 and Y could be 0 to 24.

Out-of-bounds space

My first thought was to use the entire screen and judge when an edge had been reached by checking the value of the X and Y co-ordinates. Applying such a method to the other out-of-bounds areas, though, involves several different tests and can be long-winded.

A much simpler method soon suggested itself. We started off this sequence by clearing the screen, which fills it full of 'spaces'. Subsequently, the pen, the sheep, the dog, etc overwrite these spaces and it follows that an out-of-bounds area is 'not-space'.

With this in mind, I decided to put a fence around the field to prevent the animals leaving the screen. To be effective, this fence must be continuous and one area of particular difficulty was the bottom right-hand corner. If a symbol is printed in the very last space on the bottom row of the screen, the cursor will move on to the next row and the whole display is scrolled up.

Because of this, I had to settle for a field that only filled 24 lines on the screen. Lines 430-450 print the edges of the field. Line 430 starts by moving the cursor

continued page 81

MICRODIGITAL 1980

Apple II plus



Apple II Plus will change the way you think about computers. That's because it is specifically designed to handle the day to day activities of education, business, financial planning, scientific calculation and entertainment.

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- INTERNAL MEMORY EXPANSION TO 64K BYTES
For big system performance at a low cost.
- EIGHT EXPANSION SLOTS
To let the system grow with your needs

	Nett	V.A.T.	Total
Apple II Plus, 16K RAM	695.00	104.25	799.25

APPLE PASCAL
Apple Pascal is the new extension to microcomputer power
Pascal Incorporating UCSD PASCAL TM, offers extended features in a complete interactive package employing today's most sophisticated structured programming language. It provides advanced capabilities that boost performance and cut development time for large business, scientific and educational programs.
This software package provides the most powerful set of tools yet available for the microcomputer programmer.

	Nett	V.A.T.	Total
APPLE Pascal System	229.00	44.85	343.85

FLOPPY DISCS
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.

	Nett	V.A.T.	Total
Floppy disk Subsystem	349.00	52.35	401.35
Second disk drive and connecting cable	299.00	44.85	343.85

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.

	Nett	V.A.T.	Total
Parallel Printer/ Interface Card	104.00	15.60	119.60

Communications Interface Card
Allows your Apple to "talk" (through a modem) with other computers and terminals over ordinary telephone and load programs over the phone, send messages to remote terminals or access your office computer from the comfort of your home.

	Nett	V.A.T.	Total
Communications Interface Card	130.00	19.50	149.50

Nascom 2

Microprocessor
Z80A 8 bit CPU. This will run at 4 MHz but is selectable between 1/2/4/ MHz.
Hardware
12" x 8" Card
All bus lines are to the Nasbus specifications
All bus lines are full buffered
Memory
On-board, addressable memory:
2K Monitor — Nas-sys 1
1K Video RAM (MK4118)
1K Work space/User RAM (MK4118)
8K Microsoft Basic (MK3600 ROM)
8K Static RAM/2708 EPROM



Keyboard
New expanded 57 Key Licon solid state keyboard especially built for Nascom. Uses standard Nascom, monitor controlled, decoding.

T.V
The T.V. Peak to peak video signal can drive a monitor directly and is also fed to the on-board modulator to drive the domestic T.V.

I/O
On-board UART (Int. 6402) which provides serial handling for the on-board cassette interface or the RS 232/20mA teletype interface. The cassette interface is Kansas City standard at either 1200 or 300 baud. This is a link operation on the Nascom-2.

PIO
There is also a totally uncommitted PIO (MK3881) giving 16, programmable, I/O lines.

Character Generator
The 1K video RAM drives a 2K ROM character generator providing the standard ASCII Character set with some additions, 128 characters in all. There is a second 2K ROM socket for an on-board graphics package which is software selectable.

	Nett	V.A.T.	Total
Nascom-2 in kit form	295.00	44.25	339.25
Power Supply	24.50	3.68	28.18
Graphics ROM	15.00	2.25	17.25

Superboard II

The sensational single board computer from Ohio Scientific. Superboard comes fully assembled and tested. On board is a 6502 microprocessor, 4K RAM (expandable, on board to 8K), 8K Microsoft BASIC in ROM, CUTS cassette interface, full ASCII keyboard. Superboard interfaces with a video monitor or domestic television (via U.F. Modulator) and provides a 24 x 24 display with Upper/Lower case and a wide range of graphics/gaming characters.

Superboard comes complete with documentation and sample software on cassette

	Nett	V.A.T.	Total
Superboard II	188.00	28.20	216.20
U.H.F. Modulator	2.50	0.38	2.88

Video Genie Sharp

A third generation personal computer system, the video genie is a powerful microcomputer upwardly compatible with the Tandy TRS-80. TM
Central Processor
The system uses the powerful and popular Z80 processor. A system reset button is mounted at the rear of the console. Power down is NOT required should the system crash
Video Display
16 lines of 32 (2 pages) or 64 characters, switch selectable. Full software cursor control
Composite video output to a domestic television
Memory
RAM — 1K Screen Ram
16K User RAM
ROM — 12K Extended Level II Basic interpreter, system monitor. Completely compatible with TRS-80TM Level II BASIC.

Cassette
Integral 500 b.p.s. cassette deck eliminates tape loading errors.
Additional interface for second (external) cassette deck. Manual override of cassette deck and tape counter cures problems normally associated with this storage medium.

Basic
An extended Level II Basic, compatible with TRS-80 level II Basic TM
Features line editing, formatted printing, multi-dimensional arrays, AUTO Line numbering, Program tracing
A huge range of software, on cassette is already available

Peripherals
Full ASCII keyboard with 10 key rollover eliminates keyboard bounce. Expansion connector provides a parallel I/O Port for printer

	Nett	V.A.T.	Total
Video Genie	369.57	55.43	425.00



Acorn



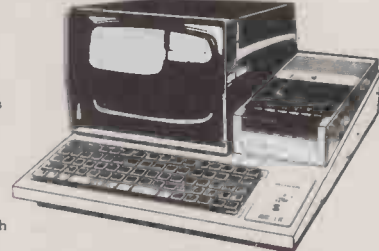
This compact stand-alone micro-computer is based on Eurocard modules, and employs the highly popular 6502 MPU. Take a look at the full specifications, and see how Acorn meets your requirements.

The Acorn consists of two single Eurocards:
1. MPU card; 6502 microprocessor, 512 x 8 ACORN Monitor, 1K x 8 RAM, 15-way I/O with 128 bytes of RAM, 1 MHz crystal; 5V req sockets for 2K EPROM and second RAM I/O chip.
2. Keyboard card; 25 click-keys (16 hex, 9 control), 8 digit, 7 segment display. CUTS standard crystal controlled tape interface circuitry.

Acorn Operating Manual
With Acorn, you'll receive an operating manual that covers computing in full, from first principles of binary arithmetic, to efficient hex programming with the 6502 instruction set. The manual also includes a listing of the monitor programs and the instruction set, and other useful tabulations; plus sample programs.

	Nett	V.A.T.	Total
Kit	65.00	9.75	74.75
Ready Built	75.00	11.25	86.25

SHARP MZ-80K
2.80 based CPU.
4K Byte monitor in ROM.
Internal memory capacity from 4 to 48K RAM.
14K Extended BASIC.
10 in video display, 40 chars. of 24 lines.
80 x 50 bit mapped graphics.
Extensive character set with upper, lower case, graphics etc.
Full 79 Key Keyboard.
Built in music synthesizer with 3 octaves.
Fast reliable cassette unit with tape counter 1200 b.p.s.
Wide variety of system software on cassette.
50 pin bus connector for system expansion



A complete personal computer system for the microcomputer user, at an economic price. The Sharp comes complete with all necessary peripherals, sample software and excellent documentation — giving the user a personal system of unmatched flexibility and ease of use. At the heart of the machine is the Z-80 CPU — widely accepted as the most powerful 8-bit CPU on the market. A 4K byte system monitor controls system operation. From 4 to 48K of RAM can be resident on board; enough room for the most demanding applications.

An extensive graphics character set, plus 3 octave sound generator and fast cassette unit hi-resolution video monitor complement these basic facilities. It has the ease of use and compactness of "black box" computer combined with extensive peripherals and facilities for expansion. Sharp Basic occupies 14K of RAM; and offers extended features above those of normal microcomputer implementations;

Model	Nett	V.A.T.	Total
6K	520.00	78.00	598.00
10K	540.00	81.00	621.00
18K	620.00	93.00	713.00
22K	640.00	96.00	736.00
34K	740.00	111.00	851.00



Acorn Memory
A high quality fibre glass, through hole plated PCB with solder resist and component identification, this eurocard has provision for 8K of RAM (2114) and 8K of EPROM (2732).

	Nett	V.A.T.	Total
8K RAM (Kit)	95.00	14.25	109.25

ACORN V.D.U.
The Acorn V.D.U. Board connects to the Acorn Computer Bus and contains memory mapped character storage RAM which is transparently written to or read from, by the C.P.U.

An MC 6845 programmable controller I.C. Provides all the synchronisation signals to drive a 625 line 50 fields per second V.D.U. together with read addresses for the character RAM. Characters are then fed to an SAA 5050 character generator IC which produces the necessary dot patterns to create the characters to refresh the V.D.U.

The SAA 5050 produces Teletext standard characters and has Red, Green and Blue drive outputs giving coloured characters or graphics.

	Nett	V.A.T.	Total
V.D.U. Card (Kit)	88.00	13.20	101.20

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Further expansion is a prime design concept enabling PET to be made the heart of a much larger system incorporating printers, floppy discs etc., as and when required.

Computers

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Nett	V.A.T.	Total
550.00	82.50	632.50

PET 2001-16N — PET with 16K bytes memory and large keyboard. External cassette optional.

Nett	V.A.T.	Total
675.00	101.25	776.25

PET 2001-32N — PET with 32K bytes memory and large keyboard. External cassette optional.

Nett	V.A.T.	Total
795.00	119.25	914.25

Computhink Disk Units

	Nett	V.A.T.	Total
400K Random for 8K Pet	795.00	119.25	914.25
400K Random for New Pet 2	840.00	126.00	966.00
800K Random for New Pet 2	995.00	149.25	1,144.25

NAS Corner

	Nett	V.A.T.	Total
Nascom 1	125.00	18.75	143.75
Nascom 2	295.00	44.25	339.25
Power Supply	24.50	3.68	28.18
Nas-Sys	25.00	3.75	28.75
T4	25.00	3.75	28.75
Mini-			
motherboard	2.90	0.44	3.34
Motherboard	5.50	0.82	6.32
Buffer board	35.00	5.25	40.25
RAM Board (8K)	85.00	12.75	97.75
RAM Board (16K)	140.00	21.00	161.00
RAM Board (32K)	200.00	30.00	230.00
I/O Board	35.00	5.25	40.25
Tiny Basic	25.00	3.75	28.75
Super Tiny Basic	25.00	3.75	28.75
BK BASIC ROM	40.00	6.00	46.00
Relay Board bare board and manual	15.00	2.25	17.25
Relay Board (kit)	49.95	7.49	57.44
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Ex-Stock

	Nett	V.A.T.	Total
T.I. Programmer	46.25	6.93	53.18

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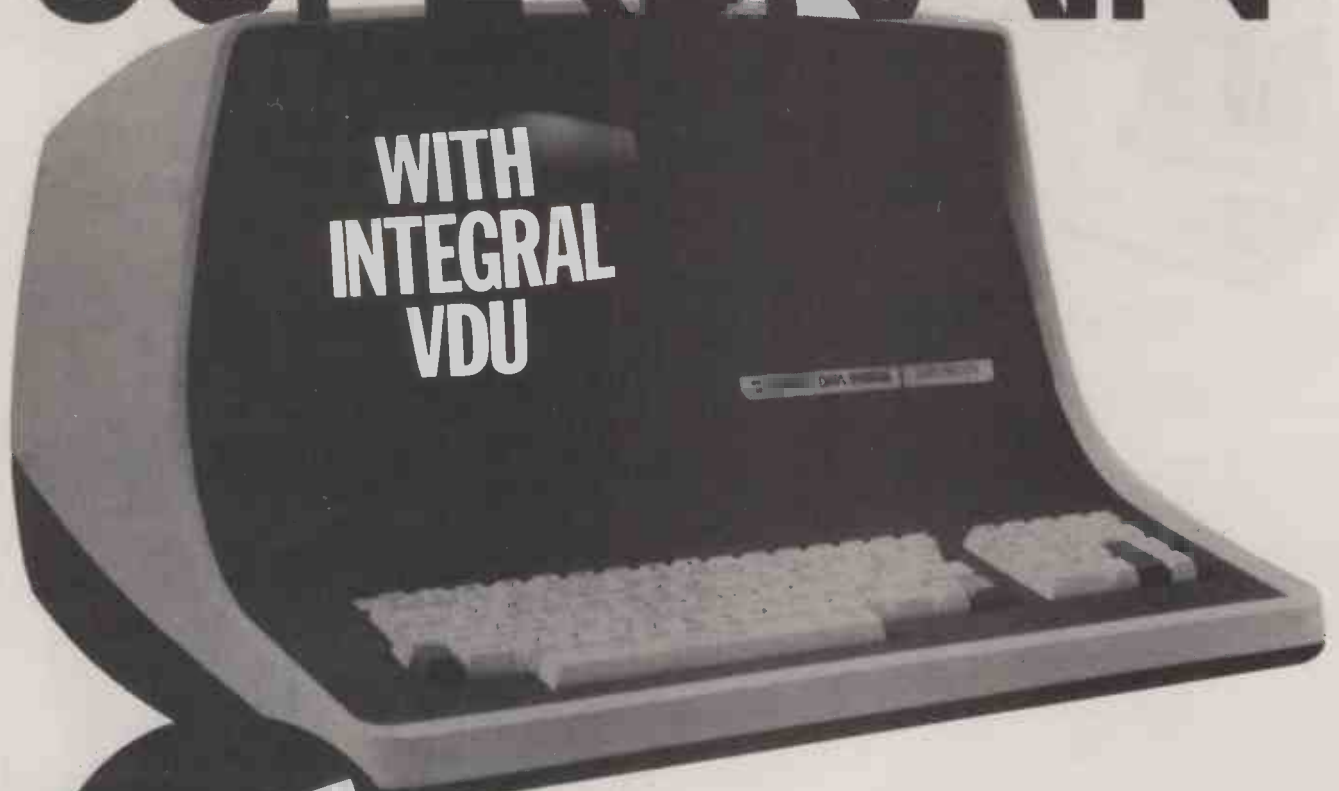
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In pastures phosphor-green . . . continued from page 75

```

710 POKE59409,60:T=TI
720 FORI=1TO3:GOSUB3000
730 X=XD:Y=YD
740 IFR$="8" THENY=YD-1
750 IFR$="4" THENX=XD-1
760 IFR$="6" THENX=XD+1
770 IFR$="2" THENY=YD+1
780 IFPEEK(32768+X+40*Y)<>32 THENX=XD:Y=YD
790 PRINT"♣";LEFT$(A$,XD);LEFT$(D$,YD);" "
800 XD=X:YD=Y:PRINT"♣";LEFT$(A$,XD);LEFT$(D$,YD);"♦":NEXT
900 REM****MOVE SHEEP***
910 FORI=1TONS
920 X=XS(I):Y=YS(I)
930 IFABS(XS(I)-XD)>3ORABS(YS(I)-YD)>3 THEN990
935 IFABS(XS(I)-XD)<2ANDABS(YS(I)-YD)<2 THEN990
940 IFXS(I)>XD THENX=XS(I)+1
950 IFXS(I)<XD THENX=XS(I)-1
960 IFYS(I)>YD THENY=YS(I)+1
970 IFYS(I)<YD THENY=YS(I)-1
980 GOTO1000
990 X=XS(I)+1-INT(3*RND(1)):Y=YS(I)+1-INT(3*RND(1))
1000 IFPEEK(32768+X+40*Y)<>32 THENX=XS(I):Y=YS(I)
1010 PRINT"♣";LEFT$(A$,XS(I));LEFT$(D$,YS(I));" "
1020 XS(I)=X:YS(I)=Y:PRINT"♣";LEFT$(A$,XS(I));LEFT$(D$,YS(I));"π"
1030 NEXT
1100 REM****ARE ALL SHEEP IN THE PEN?***
1110 P=0
1120 FORI=33266TO33268
1130 IFPEEK(I)=94 THENP=P+1
1140 IFPEEK(I+40)=94 THENP=P+1
1150 NEXT
1160 IFF=NSTHEN1200
1170 GOTO720
1200 REM****IS DOG BY ENTRANCE***
1210 IFPEEK(33227)=90 THEN1300
1220 GOTO720
1300 REM****STOP THE CLOCK***
1310 T=INT(100*(TI-T)/60)/100
1320 PRINT"♣YOU ROUNDED UP";NS;"SHEEP IN";T;"SECS";
1330 IFT<BT(NS) THENBT(NS)=T
1340 PRINT"♣YOUR BEST TIME FOR";NS;"SHEEP IS";BT(NS)
1350 FORI=1TO5000:NEXT
1360 PRINT"♣DO YOU WANT ANOTHER GO(Y/N)":GOSUB3000
1370 IFR$="N" THEN4000
1380 IFR$<>"Y" THENPRINT"♣PLEASE ANSWER Y OR N":GOSUB3000:GOTO1370
1390 INPUT"♣HOW MANY SHEEP";NS
1400 PRINT"♣PRESS ANY KEY WHEN READY TO START":GOSUB3000:POKE59409,52:GOTO400
2090 REM****WAIT FOR KEY SUBROUTINE***
3000 GETR$:IFR$="" THEN3000
3010 RETURN

```

```

4000 PRINT"♣YOUR BEST TIMES WERE:"
4010 FORI=1TO6
4020 PRINT"♣";I;"SHEEP:";
4030 IFBT(I)=1000000 THENPRINT"NO TIME RECORDED":GOTO4050
4040 PRINTBT(I);"SECS"
4050 NEXT
9000 END

```

READY.

READY.

```

3010 RETURN
2976 PRINT"♣YOUR BEST TIMES WERE:"
4000 PRINT"♣YOUR BEST TIMES WERE:"

```

READY.

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In pastures phosphor-green ...

continued from page 74

'home' and then prints 40 fence sections along the top. I have used the shifted '2' for this. Line 440 prints the fences on the left and right of the screen, from the second to the twenty-third lines. The symbols here are the shifted '3' and '+', respectively. Finally, line 450 prints the bottom fence on the twenty-fourth line, using a shifted '2'.

Lines 500-630: These lines generate the positions of the sheep and of the dog and print them on the display. The positions are recorded in the form of X and Y co-ordinates and these are randomly generated. Lines 530 and 620 check that the generated position is clear.

Lines 700-800: Now display has been printed, we are ready to start. Line 710 contains the necessary POKE to unblank the display and then records the start time. The program now waits for an input from the keyboard (GOSUB 3000) and then checks to see if it is one of the keys that will move the dog.

I have restricted the dog's movements to four directions as I felt that the advantage it has in moving three times as fast as the sheep was enough. There is obviously room for experiment here and I leave this as an exercise for the reader.

Line 780 checks that the move is into a 'space' and then we print a 'space' at the old position and the dog symbol at the new. This is repeated three times, but if the player presses any other key than the four 'command' keys, or attempts an illegal move, then Lines 730, 790 and 800 cause the dog to 'mark time' and stay where it is.

Lines 900-1030: The movement of the sheep is determined by their position relative to the dog. If it too distant, they will ignore it and wander around at random. As it approaches, they move directly away from it. If it comes too close, they will 'panic' and again move at random. Whatever happens, the sheep can only make 'legal' moves into a clear space.

At one stage I considered including a check for each sheep to see if it had got a legal move. If for some reason it hadn't, then I would pass it over. I soon realised that this situation would only occur very rarely when four or more sheep were crowded into the pen.

At other times, it would be very time-consuming to have the sheep continue to generate random moves while searching for a legal move. Instead, I decided to have somewhat stupid and single-minded sheep. They would decide on their move and, if it proved impossible, they would simply give up and stand still.

Line 930 checks to see if the dog is too

far away to have an influence on the sheep in question and Line 935 tests whether it is too close. In either case, the diversion to Line 990 leads to random movement of the sheep. If the dog is within the range where it affects the sheep, then Lines 940-970 determine the appropriate changes to the sheep's co-ordinates. Line 990 is used to generate random movement and the expressions in it generate -1, 0, or +1. Before the sheep is moved, the proposed move is checked for legality in Line 1000 and then a space is printed in the old position and the sheep printed in the new. **Lines 1100-1220:** Now we come to the point where we check to see if the game's over. This depends on the position of the sheep and the dog. One way to check on their positions would be to compare their X and Y co-ordinates with predetermined figures for the pen area. This could involve a routine which would have to be checked for each sheep.

Instead it seemed a simpler proposition just to look in the pen and count the number of sheep; this is precisely what Lines 1100-1170 do. If this count shows that we have all the sheep in the pen, we can go on and see if the dog is in its designated position, guarding the entrance.

If either of these tests fail, then the program goes back to let the dog move again, but if we pass this, then we can stop the clock and check our time.

Lines 1300-1400: The time calculated in 1310 gives a time to one-hundredth of a second. I thought it would provide more challenge for the player if he could record his best time to date and then try to better it. This is the object of the set of variables, BT(I).

Line 1320 contains the cursor intructions 'home', 'down', 'right' so that the result is printed inside the field border; Line 1340 does the same thing with three 'downs'. Line 1350 gives you time to read the result before another game is offered. If this offer is declined, then the final printout at Line 4000 will show all your best times.

This, then, is the game of 'Sheepdog Trial'. I hope these notes help you put the game on to your system and give you an insight into the methods used. An understanding of the various routines should enable you to make modifications and improvements. After all, one of the joys of computer-ownership is to adapt programs to your own requirements, rather than simply accept them at face value.

My own experience of playing this game shows that, whilst it is relatively easy to round up one or two sheep, the inborn waywardness of the beasts make the final capture of five or six an elusive target. Good shepherding!

Man-machine clanks into step

Mark Witkowski of the AI Laboratory at Queen Mary College looks at the principles of robotics design and discusses some ways in which amateurs can learn from the pros.

IN PART ONE of this introduction to robotics (February 1980 *Practical Computing*, we looked at some of the ways in which robots are slowly turning a dream into reality.

This month, Part Two deals with some of the mechanical design considerations in robotics.

Robots were defined as mechanical contrivances with some human-like attribute or, preferably, attributes. Given the current 'state-of-the-art' in robotics, it is unusual for any serious attempt to be made at constructing a humanoid, mechanical-man type of machine.

Manipulator designs loosely based on the human arm are not uncommon, but machines that walk are much rarer. Walking in a straight line is quite feasible, and even walking up stairs, but turning corners and walking over rough ground is another matter.

Walking locomotion is very much a matter of dynamic system control, as the mass of the body must be balanced against both gravity and its own momentum.

The Russians and Japanese are the most active in this area. WABOT, made in the Waseda University Bio-engineering department in Japan is a hydraulic-powered biped walking machine (Kato *et al* 73).

Several papers relating to walking can be found in the proceedings of the two international CISM-IFTOMM symposia — at Udine in 1973 and Warsaw in 1976. They include theoretical and practical studies of biped, quadruped and six-legged locomotion.

A common robot vehicle configuration, currently thought of as the best compromise encompassing all the conflicting design and control problems, is that of a motorised based sporting one or more arm-type manipulators.

If the robot is not to be controlled by a person holding a joystick while watching the vehicle directly, it must also have one or more television cameras on board. These will sometimes feed a digitiser to allow computer analysis of the scene.

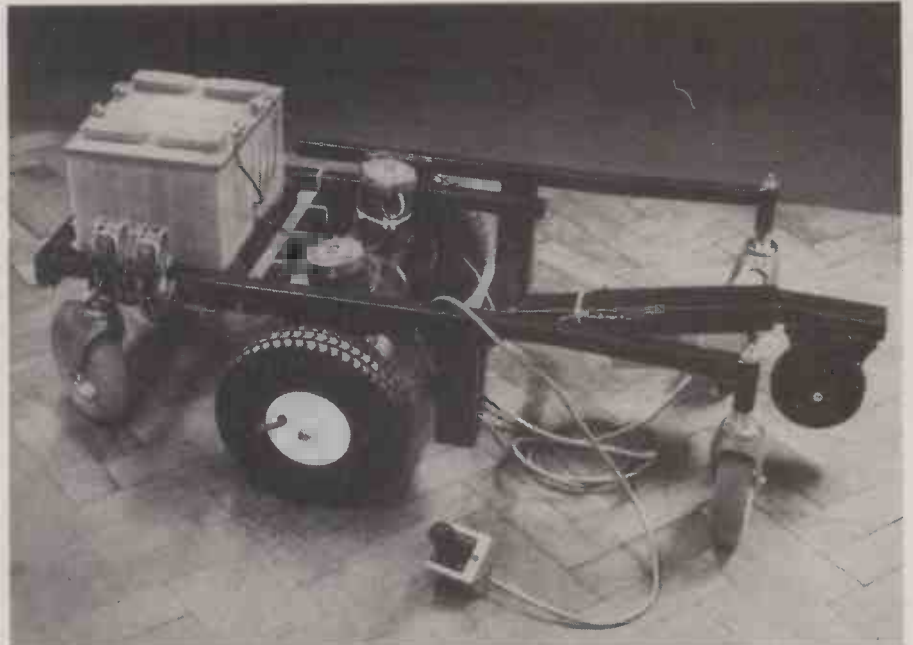
A reasonable goal to aim for in robotics research is to develop a totally autonomous robot under computer control.

Even if this is not how robots will eventually be used, it means that a number of currently unsolved problems relating to the control and behaviour of robots will have to be tackled. They can all too easily be glossed over when a person demonstrates the capabilities of a robot by remote control in the laboratory or workshop environment.

Because of the time taken and the expense involved in designing, building, commissioning and programming a useful, general-purpose robot of even quite modest specification, it is a game for a team rather than the individual.

But a micro-mouse or turtle-type robot is well within the capabilities of the individual and a number of books describing in full detail the mechanical and electronic design of a small mobile robot are available.

For instance, full constructional details are



Picture 1: General lay-out of wheelchair base, showing near-central location of drive wheels. This machine is capable of climbing a 3/4 in kerb.

given by Tod Loofbourrow for his robot 'MIKE' in the book *How to build a computer-controlled robot* (Loofbourrow 78). Computing is provided on-board by a KIM-1 microprocessor.

Another amateur constructional robot design book is David Heiser's *Build your own working robot* (Heiser 76). In this machine — 'BUSTER' — control was provided by hard-wired logic rather than a microprocessor. Either might form the basis of a personal design.

Copy a design

It makes sense to start by copying an existing design that can reasonably be expected to perform to some specification before extending and modifying it to your own requirements.

These modifications may range from simple changes to the control algorithms, or adding new sensors more appropriate to the project; to a substantial re-build with major mechanical additions, such as a manipulator or dumper-truck type pallet.

There are few books about robotics in general, so the information required will often have to be gleaned from many different sources. One general review of the technical aspects of robotics can be found in John Young's book *Robotics* (Young 73).

Much of the work to be discussed this month has been done at universities around the world. Some comes from the research labs of larger companies, but mostly the mechanical aspects of robots are best covered by standard industrial design principles. This is the route

most industrial robot manufacturers will take.

Their work will be governed by standard, well-understood and sound engineering knowledge and practices. This, in itself, is no bad thing: cost-effectiveness, reliability and usability are all pertinent factors.

Sophisticated sensor design and computer control are often treated with the utmost suspicion by industrial roboticists and will therefore only be used by them if all other possible solutions prove unsuccessful.

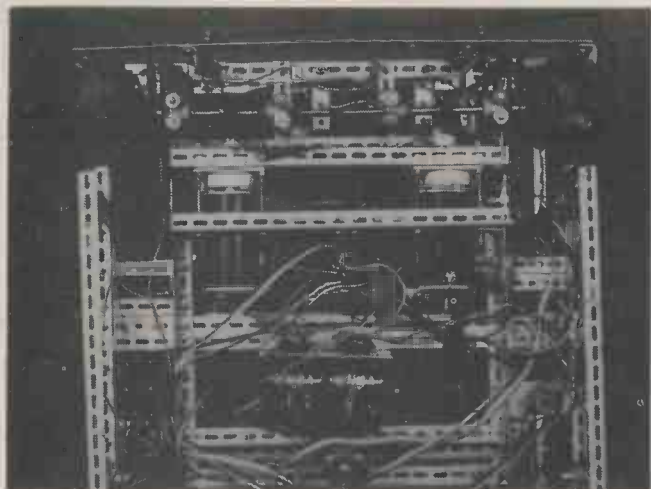
But in the long term, these will have to be introduced as robots are required to perform tasks requiring higher levels of skill than are currently possible.

A practical mobile robot will almost certainly be based on a platform powered by two independently controlled motors and some passive castors to maintain balance.

Ackerman steering, as used on cars, has occasionally been used, notably on vehicles for space and extra-terrestrial exploration. One, loaned by the Marshall Space Flight Centre to the Jet Propulsion Laboratory (JPL) had double Ackerman steering (steering on both front and rear wheels) with each of the four wheels independently powered (Lewis and Bejczy 73 and Dobrotin and Scheinman 73).

For more mundane, earth-bound vehicles, the Ackerman steering principle requires a complex system of linkages and is hard to control in confined spaces or where there are many closely-packed obstacles to avoid.

Most small mobile robots have two drive wheels along the central axis of a nominally circular body, though groundplans are often square or hexagonal. Then the castor forms a



Picture 2: Modified drive/steering configuration better suited to front alignment operations such as pallet lifting.



Picture 3: Standard wheelchair layout with driving wheels at the rear, as used on the University of California's 'JASON'.

triangular balance point — the weight of the batteries and electronics being used to ensure that the vehicle does not fall over (fig. 1a, p87).

Steering is achieved by driving the two wheels in different directions and/or at different speeds. By powering them both forward equally, the vehicle will travel in a straight line forwards; if both motors are reversed, the machine will travel backwards.

If one wheel goes one way and the second the other the base rotates about its centre point. By varying the ratios of motor speed, the vehicle spins about a point on a line between the wheels. If the motors are rotated in different directions, it describes an arc whose radius and direction depends on the ratio of rotation speeds and directions of both motors.

Every which way

'NEWT' (Hollis 77) used this configuration. The wheelchair base shown in **photograph one** has its driving wheels (almost) central. Notice the four castors support the weight evenly — the front two are hinged near the motor bearings. These and the wheeled projection at the front allow the vehicle to climb curbs up to 3½in high. This wheelchair base is to form the chassis of a new robot vehicle.

Castors of this form, where a wheel is used in an angled bracket, have a disadvantage because they tend to steer the vehicle in an unpredictable way until they realign themselves after each change of direction.

Figure 1b shows a modification to this standard layout (**photograph two**). Here the wheels are at the front. Steering and general

controllability are similar to 1a. There is a slight advantage if the front edge of the vehicle has to be lined up with objects in the environment such as battery contacts on the robot's front that have to be aligned with a battery charger power source on the wall.

This layout should be considered if the robot is to be used in pallet shifting operations. The vehicle would be fitted with a 'fork-lift' attachment on the front and objects to be moved would be placed on pallets or low stilts. An object would be moved by running the fork-lift between the stilts and lifting the prongs — a task typical of most industrial warehousing.

A disadvantage of this system compared with 1a is that it naturally spins about a point very near the front of the base and as a result can be quite difficult to extricate with simple software if it gets trapped in a tight corner.

Figure 1c shows the last configuration with driving wheels at the rear. This is the standard wheelchair layout (**photograph three**). 'JASON', built at the University of California at Berkeley, used this principle (Smith 73).

As a layout it offers neither easy leading edge positioning, as in 1b, nor the 'escape' facility of 1a. It is better suited to travelling over longish distances in a forward direction, where abrupt changes of direction are unusual. Its use therefore is best suited to uncluttered environments, as would be the Ackerman steering principle.

Loofbourrow's 'MIKE' has two forward-facing drive wheels at the rear corners of a triangular base and steers by pointing a third wheel at the apex of the triangle in the desired

direction. This layout seems to cost an extra motor for no particular advantage.

With all these layouts, 'forward' and 'backwards' are somewhat arbitrary, since the motors have to be bi-directional. It is the direction in which the cameras and the majority of the obstacle-detecting sensors point that really fixes the most significant direction.

These vehicles are almost always powered by low voltage d.c. electric motors, whose exact specifications will depend on the size, weight and performance required from the robot in relation to the tasks it will have to perform.

In general, d.c. motors work at high speed and low torque; but in a robot, low speed and high torque are required. Fortunately reduction gearing produces exactly this transformation.

Getting motorised

Photograph four shows four different motors. On the left is a Meccano six-volt motor with an integral six-speed reduction gearbox. In the centre is a six-volt model motor, with a 0.6amp free-running and seven-amp stalled rating.

Above and to the right of this motor are a selection of in-line sun and planet reduction gears for this motor. The gearboxes come in a selection of ratios from 2:1 to 6:1 and they can be stacked to provide any integer ratio.

A pair of these motors can be seen in **photograph two**; the output shafts of the motors feed a 5:1 box before a 20:1 worm drive gear on the wheel axles. Worm gears form an effective one-way mechanical linkage. The wheels will not turn if the motors are not powered, which is useful for instance for holding the vehicle on a slope. The foam-tyred wheels as well as the motors are available from most hobby model and radio control suppliers.

Below the motor, in the centre of **photograph four**, is a smaller one in the same series (6V, 100mA running, 500mA stalled). High levels of electrical noise generated by the Meccano motor make it unsuitable for computer-controlled robot drives, since they upset all but the most isolated and noise-suppressed logic circuits.

The motors on the wheel-chair (**photograph three**) are similar to those used for the windscreen wipers on cars. Clearly they are powerful enough to drive the weight of two car batteries and a fully grown man through their internal reduction gearboxes.

An uprated version of this motor type is used on the base in **photograph one**. Top speed is about four miles an hour, fully laden with a man, and that can be alarmingly fast!

D.c. motors are not very easy to control to a high level of precision, but they are cheap, readily obtainable in a myriad different sizes and specifications with a quite adequate power-to-weight ratio. It is usual to control the speed and power output of d.c. motors by pulse-width modulation of the input current, rather than by varying the voltage levels at the terminals.

This is easy to arrange with small logic circuits or equally trivial microprocessor programs (Computabits 79a). Figure 2 shows a bridge circuit that allows a d.c. motor to be run in either direction from a single voltage source.

Each of the transistor pairs A (Q1,Q2), B (Q3,Q4), C (Q5,Q6) and D (Q7,Q8) form a darlington pair (equivalent to a single transistor with a high current gain), that can be switched from 'off' to 'on' with TTL logic levels.

From previous page

With the circuit logic inputs unplugged and TTL inputs default to high, a logic zero appears at the bases of Q5 and Q7, which means that switches C and D are non-conducting. The logic zero at the bases of Q9 and Q10 means that they are non-conducting, therefore a logic one appears at the bases of Q1 and Q3, so switches A and B are 'on'.

While the circuit is in this state, both the '+' and '-' poles of the motor are at the positive motor drive potential, so, the motor is in effect shorted out — giving a degree of reactive braking. If switch A is put into its non-conducting state ($P=0$) and C is switched on ($Q=0$) the '+' pole is still at the positive rail but the '-' is at the zero rail and current flows C — motor-B and it rotates in one direction.

If A and D are switched on and B and C off then the '-' pole is at positive and the '+' pole at zero and current flows D motor — A and it rotates in the other direction.

While none, or only one, switch conducts, the motor is effectively isolated. While A and B or C and D are conducting, it is partially shorted. If A and C or B and D, or any three or all four conduct, the power rails will be shorted through the transistors and they will be destroyed. It would therefore be worth designing a small logic circuit that converted a FORWARD/REVERSE and an ON/OFF logic pair into the correct P,Q,R and S drive signals, rather than rely on a length of code to do this.

The diodes are for back e.m.f. protection and the circuit, with the values shown, will work for motors drawing up to eight amps. As each of the transistor switches drops about a volt, the power rail should be two volts higher than the motor voltage rating. At medium and high current flows the power transistors get hot, so heat-sinks are called for. The circuit is shown in photograph five.

Mechanical construction

The overall size and shape of the finished robot may well be determined by the type of motor that is readily available or already to hand. There are no real guidelines about detailed mechanical construction, so a few pointers are called for.

Firstly, robust mechanical construction will always pay off in the long run. The robot in photograph two is constructed from 'Proto', which offers the same types of component as the familiar 'Meccano' construction system.

Meccano is not strong and rigid enough for load-bearing members but Proto can be bolted together to form a firm structure. Increases in robot size require corresponding upgrading in the strength of the individual structural parts.

Most robot vehicles, even the small ones, will clock the scales at surprisingly high weights, NEWT, for example, 30in high and 14in in diameter, weighs in at 60lb.

Since much of this weight will be transmitted to the wheel axles, these should normally be supported by proper bearings, rather than relying on the motor output shaft bearings.

Ample battery size is a crucial factor in determining the size of motor required. The vehicle must run for a period of several hours without recharging. Not only will the motors consume power, but electronic circuits, motor drivers, sensor systems, cameras and microprocessors will soon increase the power consumption.

With any form of computer-controlled robot, it is important to be able to determine

how far and how fast the robot is travelling. D.c. motors are not sufficiently predictable to allow open loop control; even repeating the same actions will seldom give similar results.

There are several techniques for measuring distance traversed and it is usual to servo the speed of the motor using an optical or magnetic disc that produces a frequency proportional to the angular velocity of the wheel. Gray code encoder discs can be used to give a reliable indication of axial rotation, which can then be integrated in software to give precise co-ordinate positions.

The only practicable solution to high positional accuracy and repeatability is to drive the wheels with stepper motors. NEWT uses a pair of 200 step/revolution motors driving wheels with neoprene Q-ring types (that don't slip on the floor surface) through a 3:1 reduction gearbox, offering a total of 600 steps per wheel revolution.

Each step causes the robot to move by about 0.5mm or to rotate by about 0.1 of a degree. Complicated sequences of movements involving up to 100 separate actions still give a repeatability of in.

Stepping motors should be capable of accelerating from rest to full speed under load and then decelerating to a halt if the inertia of the robot is not to stall then while speeding up or overrun while slowing down, causing a loss of accuracy in either case.

Photograph six shows two different stepping motors, on the left a 15 degree/step, 28 volt, 38 ounce/inch motor and on the right a 200-step (1.8 degree) 25 ounce/inch motor. The circuit shown acts as a power driver for any four-

phase motor. The gear box is a 60:1 reduction worm-drive unit, with a built-in anti-backlash mechanism.

Further information on stepper motors and using them can be found in *Computabits 79b* and Giacomo 79, and Ralph Hollis gives the driver circuits for NEWT in Hollis 77.

Arm, manipulator and gripper designs present a different selection of problems. The photographs of industrial robot arms in Part One will give a general idea of the patterns in common use.

Robot body image

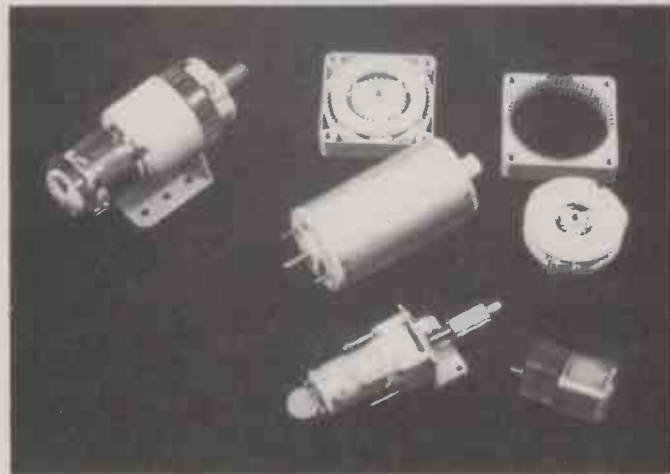
Any arm that is to have more than one special use must have certain characteristics (see: Burckhart and Helms 76). There must be sufficient degrees of freedom (joints, extensions etc) to allow the arm to manipulate objects into several orientations within a good volume of space.

It must have sufficient power to not only lift its own weight, at the most disadvantageous extension and orientation, against gravity, but that of some payload as well.

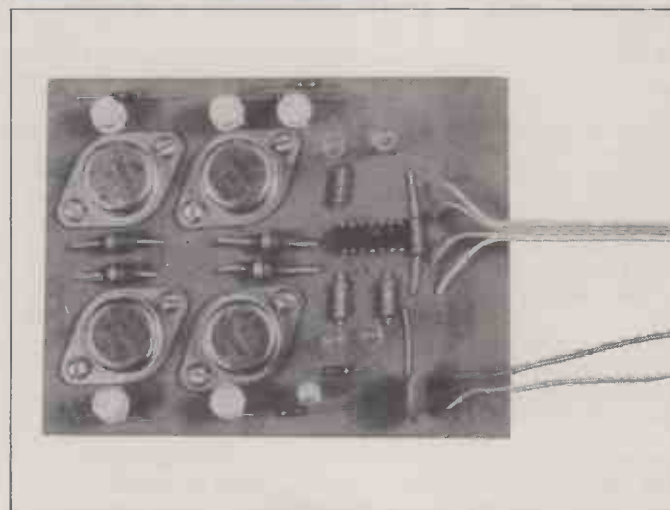
Provision must be made during the design stage to allow adequate sensing if the arm is to be computer-controlled. Dead reckoning open-loop control is only suitable for highly engineered devices with precise actuators.

The arm should be constructed to sufficiently fine tolerances so as to be rigid while stationary and also to give precise motions without backlash or oscillation when it moves.

Figure 3 shows the most commonly used types of motion, which, for the sake of



Picture 4: A selection of 6V motors with epicyclic gearbox components. Note that these motors can upset microprocessor controls unless electrical noise is properly suppressed.



Picture 5: Completed version of the bridge circuit shown in figure 2. This permits a d.c. motor to be driven in either direction from a single voltage source. Note that heat-sinks.

argument, will be described as angular for 3a and 3b, rotational for 3c and 3d and linear for 3e and 3f.

In most mechanical arm designs, the whole machines can be thought of as a series of separate modules joined together. Basically a set of rods connect mechanisms that bend, turn or twist. In the case of a linear motion the rod itself expands and contracts.

Consider, as an example, the human arm, a shoulder, upper arm, elbow, forearm and wrist (figure four). The shoulder is in effect two angular joints: the upper arm can swing backwards and forwards, and also up and down.

Arm flexibility

These two degrees of freedom are not separately hinged, but are produced by a ball-and-socket mechanism. The vertical swing is about 180 degrees and the horizontal 160. The shoulder can also move up and down a couple of inches and forward and backward a small distance.

Upper arm rotation, between the shoulder ball and socket and the elbow joint, is about 100 degrees, elbow bend is about 120 degrees. There is a rotation between elbow and wrist of nearly 180 degrees.

True rotations about a plane are unknown in nature, since it would be impossible to get nerve and blood vessel continuity across the joint.

The wrist motion of about 90 degrees up and down and 50 degrees from side to side leads onto the hand (which has about 19 further degrees of freedom) giving a total of nine

degrees of freedom on the arm. This is not including the fact that the torso can be rotated and bent to either side and forwards.

The total volume covered by at one arm of the pair is a hemisphere, a little squashed at the front, of about 2ft 6in, plus a very limited area round the back. Both hands can work together only in the central 'slice' of that total volume.

The motor is muscle — a pulling device — and hence muscles come in pairs, one to flex the joint and the second to pull it back. Hydraulic and pneumatic cylinders (3b, 3d and 3f) can be made to pull and push, by feeding pressurised fluid in at the ends, either side of the pressure seal.

One form of industrial robot that includes all three types of motion is typified by the Unimate series 4000 arm (see photograph two, last month, and figure five).

Base rotation is a maximum of 200 degrees (65 degree/second), maximum vertical stroke is 50 degrees (35 degrees/second), maximum extension is 1300mm (750mm/second from 1608mm to 2929mm). Wrist bend, swivel and yaw are 230 degrees, 300 degrees and 200 degrees respectively, all with a maximum rate of 110 degrees/second.

This arm has a maximum load carrying capability of up to 175kg and a positional accuracy of 2mm.

Compare that, if it is possible, to the plastic arm in photograph eight. Compressed air has been replaced by d.c. motors and the joints are held in position by worm-drive gears. It is shown as a warning to all those who think arm design is trivial: only two of five designed degrees of freedom were ever built.

Notwithstanding photograph seven, electric motors are still probably the most suitable power source for small arm design (see: Scheinman 69 pp17-20), if they are sufficiently geared down to generate the high turning forces required.

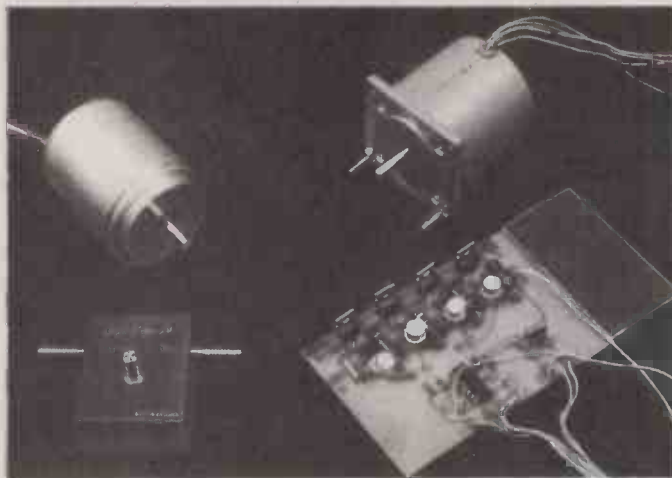
Fortunately the largest and most powerful motors are also those most inboard — nearest the shoulder. In some designs, including photograph eight their weight can be used to counterbalance the weight of the remainder of the arm.

In many designs, the motors are not always at the joint; instead, the power is transmitted from the electric motors to the joint by wires, belts (toothed or untoothed), gears, steel ribbon or chains working over pulleys.

Smaller amounts of power can be transmitted over short distances by cables inside tubes, either rotational — like a speedometer or tachometer cable on a car, or pulling as is found in bicycle brake cables.

Great care is needed in the design of pulley-type mechanisms when power is taken over an intermediate joint between the power source and the joint to be moved. It is important that movement in that intermediate joint does not affect the driven joint. Attempts to compensate for this in software can be grim business, involving considerable computational expense.

Keith Baxter and Timothy Daily (Baxter and Daly 79) describe a design in which a five degree of freedom arm is constructed with all the power transmitted from small electric motors at the base to the joints via belts manufactured from neoprene O-ring cord over a series of plastic pulleys.



Picture 6: Two stepper motors and power drive circuit for any four-phase motor. The gearbox is a 60:1 worm-drive mechanism.



Picture 7: Fluid drive motor using compressed air at around 80 psi. Input is through the two horizontal pipes; drive from the vertical shaft. Also shown is the on/off solenoid valve.

Strong enough for chess

Total reach was just over one foot with a lifting capacity of about 1/2 ounce — enough to lift board-game pieces (chessmen, draughts etc). Sensing may be provided by measuring the rotation of the drive pulleys. This is not the most satisfactory arrangement as one major source of error in this layout would be stretch and slip in the rubber drive cables.

Angular joints (3a) may be driven in several ways. An electric motor may be mounted to the inner extension and its output shaft connected directly to the outer rod. Any play in the reduction gearing on the motor will be magnified manifold, hence high-precision gearboxes are needed.

By careful motor selection, ample torque can be applied at the required speed, although care should be taken to limit the rotation of the joint so as not to stress either the hinge or any cable or wires that may be going further down the arm.

The inherent simplicity of this design is counteracted by the weight of the motor, which imposes a severe mechanical disadvantage to the drives on previous degrees of freedom.

To overcome this, the motor may be placed at the most inboard end of the design, but the resulting pulley and cable mechanism adds further mechanical complexity and is another source of play in the system.

Figure 3b shows a piston used to provide power. Mechanical disadvantage may easily be calculated from the pivot positions along the arm lever — it is, however, the basis of the human arm — and that seems to function well enough.

An alternative fluid-drive motive source is shown in photograph seven. In the centre of the picture is a pneumatic vane motor. Pressurised air (at about 80 psi) is fed to the two inputs and

continued over page

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From previous page

the difference in pressure between the two supplies positions the vane inside the triangular body accordingly. Output power is taken from the shaft at the top of the casing.

Also shown in the photograph is a solenoid valve for allowing or interrupting the air flow using an electric control current. Its working speed is of the order of milliseconds. Rotation is limited to 90 degrees, but these motors come in a range of sizes. The area of the vane, coupled with the maximum air pressure usable, dictates the torque rating of the device.

One disadvantage of using compressed air in this way is the need for compressed air itself. Most engineering laboratories and workshops will have a pressure line piped around the area, but work elsewhere will need compressors. Those that deliver 80-100 psi at a reasonable flow rate are both bulky and expensive.

Rotations (3c and 3d) can be accomplished by attaching the arm extension directly to the output shaft of an electric or fluid-vane motor. A linear motion can be converted to a rotary one, as in figure 3d, which is similar to the arrangement used to drive car windscreen wipers. A piston could be used to push a rack gear — with the pinion on the shaft.

Linear motions can be produced by electric motors driving a rack and pinion gear (3e), or a lead-screw mechanism. Lead-screws, like worm drives, offer a high resistance to displacement when the motor is not driving them, and this might be a useful feature, particularly if power was at a premium or if one does not wish continually to servo the position of that joint.

Fluid power can be used, as in figure 3f, or the whole extension can be fashioned from a pneumatic or hydraulic cylinder. A piston with square or oval cross-section will prevent a

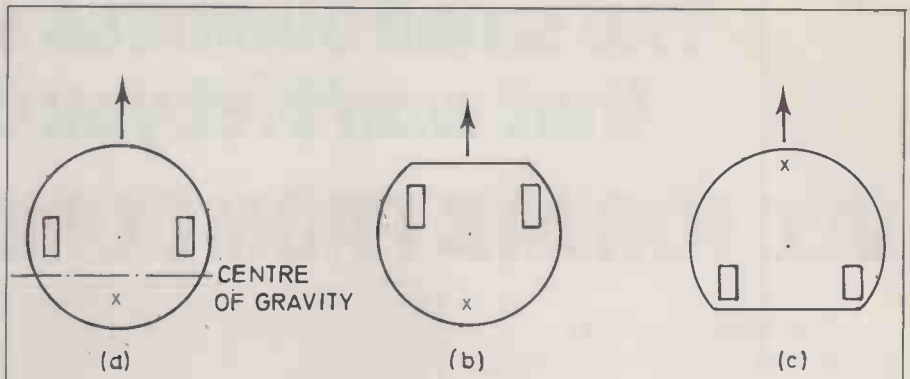


Figure 1: Motor drive configurations

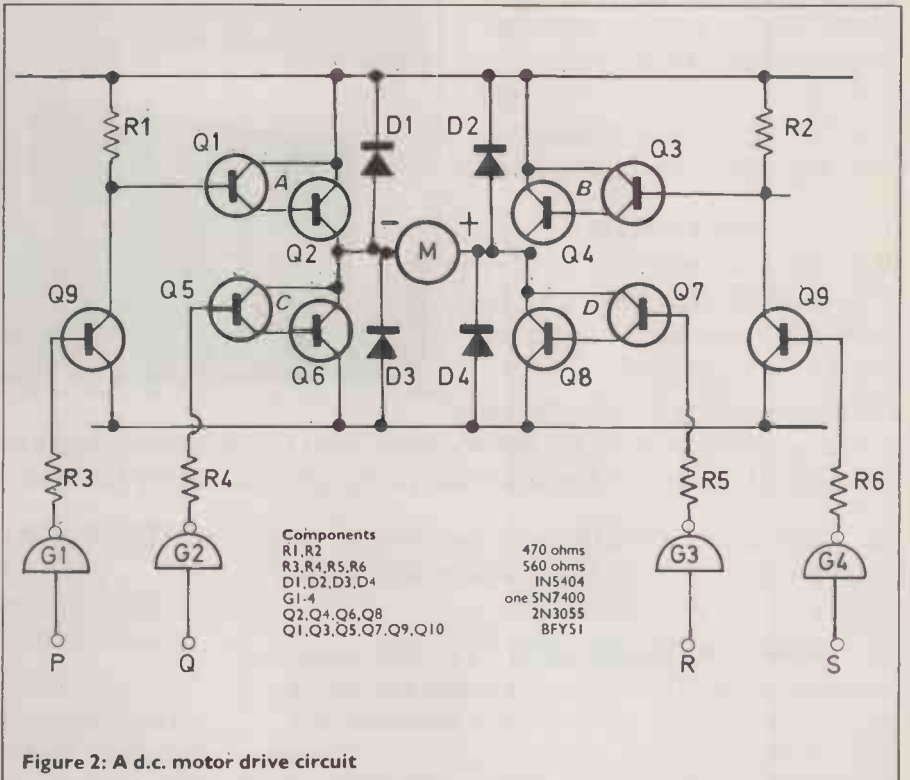
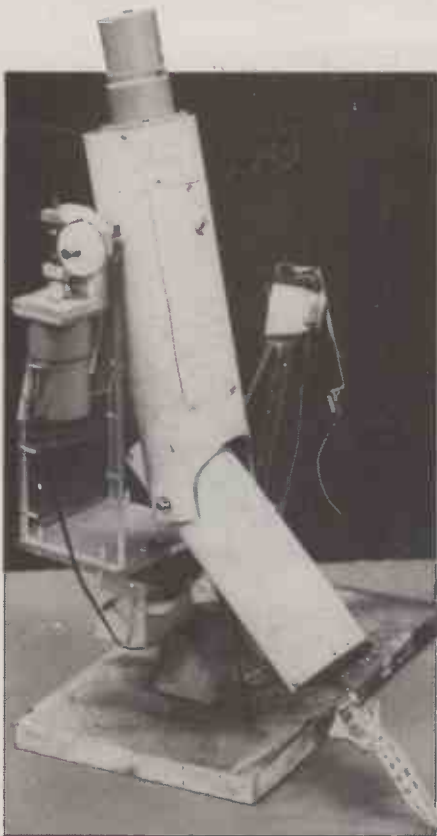


Figure 2: A d.c. motor drive circuit



Picture 8: Be warned: arm design is no joke! This complex-looking machine achieved only two of its five designed degrees of freedom.

further, unwanted, rotational degree of freedom being inadvertently introduced.

Grippers and hands are usually formed from a pincer-type of motion that seize the object to be manipulated between two jaws. These will often be designed so as to remain parallel to each other as they close, using some straightforward parallelogram linkage.

All thumbs

'Human'-like hand designs are rare, even though a design with two fingers and an opposing thumb would show advantages over the straight gripper. It is standard industrial robot practice to bolt specialist tools onto the wrist joint: spanners for doing up bolts, hooks, magnets or suckets for lifting things and so on.

Experimentation is essential in robotics and new ideas are always being tested. The 'ORM' arm is constructed from a series of circular plates with a number (eight in this case) of pneumatic actuators between the plates. Figure 6 shows the principle of the device. (Roth *et al* 1973).

There were problems with the construction and control of this form of manipulator, but it could well form the basis of an even better idea. It is obvious that the human arm might form the basis of a computer-controlled manipulator, and that the study of quadruped locomotion would assist with the study of motion in a four-legged walking machine.

One might wonder, therefore, if nature has any other interesting and fun designs to research. Mechanical insects, dinosaurs, crabs, starfish and assorted creatures from ancient mythology have all been discussed as likely candidates by various members of the laboratory.

The Japanese Active Cord Mechanism (Hirose and Umetani 76) is a highly articulated robot with a long, thin body and is based on that team's study of snake locomotion. It shows some interesting properties.

Part Three of this series will be concerned with the design of robot sensors and sensory systems, and how this information is fed into microprocessors.

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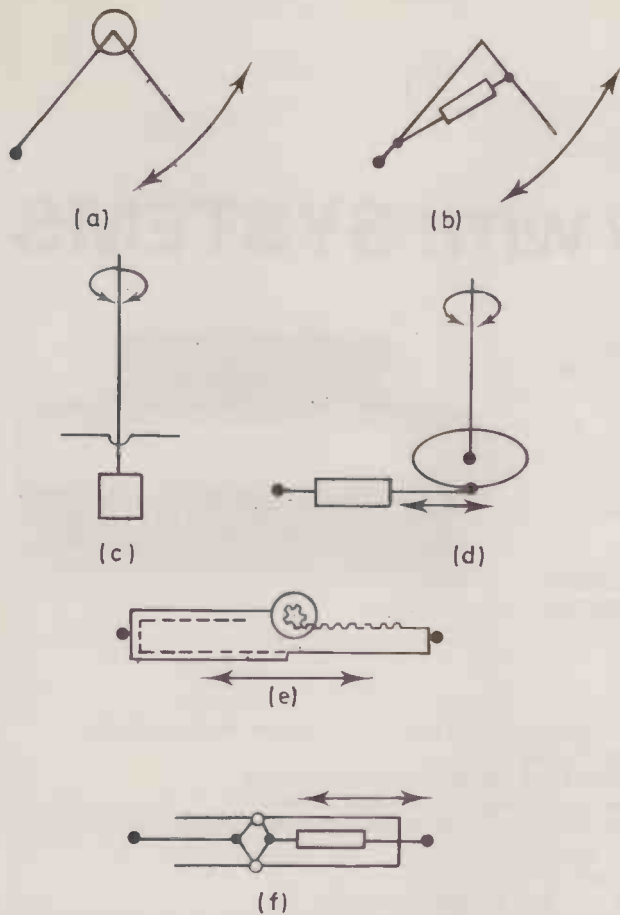


Figure 3: Angular, rotational and linear degrees of freedom (a) (b) (c) (d) (e) (f)

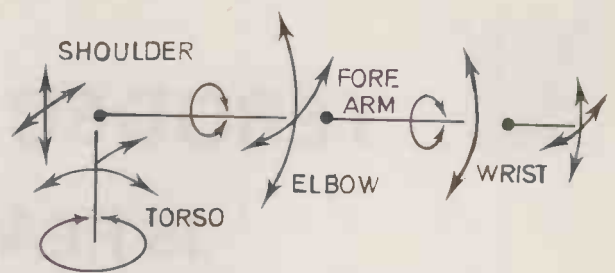


Figure 4: Degrees of freedom of the human arm

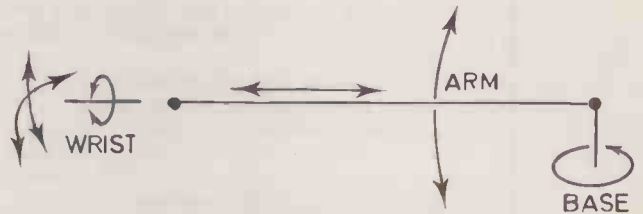


Figure 5: Degrees of freedom of the Unimate arm

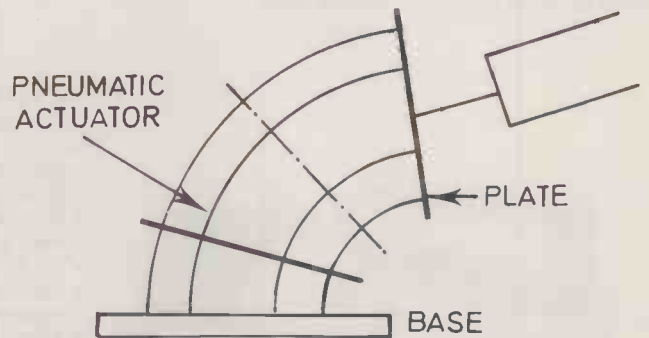


Figure 6: Principle of 'ORM' arm

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The Games Master

George Blank is a pastor and edits *Softside*, an American magazine which specialises in games for the Tandy TRS-80. In this, the first of two articles, George discusses the rationale of game playing and argues that computer games can teach essential human skills.

LAST WEEK my eldest son came home from school upset because he could not recognise all the lower-case letters. I wrote a game for the TRS-80 that required him to identify letters on the screen; after each set of ten letters, it displayed a space battle in which the survival of his spaceship depended on accurate guessing. Using the game, he learned in a couple of hours something that everyone else had failed to teach him over several days.

This morning my younger son, aged four, sat at the computer and played for an hour. His favourite game is a chase through a maze avoiding a troll. This afternoon, the daughter of a friend, at the age of nine months, stood, fascinated, for five minutes on a chair in front of the keyboard playing a game that made patterns with letters and symbols corresponding to the keys she pressed.

One of the fringe benefits the magazine *Softside* offers the staff is a game night on Fridays; adults and teenagers play games into the early hours of the morning on our three TRS-80s. Two weeks ago we had a multi-player simulation game on all three computers, shifting from one to the next as people took their turns; everyone becoming thoroughly confused over where they were in each game. Still, the game went on until after two.

There is no denying the fascination of these games. Even in my most proper role, as the pastor of a Presbyterian Church, I have found uses for computer games. The youth of my parish love to gather around the computer, and in our leisure hours so do my fellow pastors from our community. So what is the source of the enchantment?

I believe that play is one of the most important facets of our humanity. As children, we play automatically. A great deal of our learning takes place in play, from the development of language skills to the acting out of adult roles.

Child is father to the man

This fascination with play does not stop with adulthood: while I am sitting at the computer and my sons play with toy cars on the floor, my wife loves to remind me that "the only difference between men and boys is the price of their toys".

Perhaps the most elaborate games played are sponsored by governments to develop military skills. They use complex simulators to teach flight skills to aviators, and they spend fortunes on war

games. I am not thoroughly convinced that war itself is not a game to national leaders.

The computer adds a great deal of depth to games. It can perform elaborate computations based on simple inputs from player to create fantasy worlds, simulate real activities, or test and evaluate the skills of one or more players in competition with each other or the machine.

It has excellent capacity for scorekeeping, even in games that have been around long before the computer. With the capacity for accurate simulation of real processes, colour graphics, and sound, the computer makes possible games that we cannot presently even imagine.

As the editor of a magazine that specialises in providing games, I have long reflected on the sources of our fascination with games. I identify three factors: curiosity, the practice of essential skills, and the structure of time.

Human curiosity

Human curiosity is the source of culture and civilisation. For thousands of years we have been fascinated with how things work, with finding better ways to do the things we must do to survive, and with improving the conditions in which we live. That curiosity goes beyond the merely practical, and exhibits itself prominently in games. A large part of the fascination of computer games lies in the exploration of new ideas and new capabilities.

The practice of essential skills may be the origin of games. Children frequently play at adult roles. In hunting and gathering societies, this form of play is essential for survival, and we find similar behaviour even among animals. A kitten plays at hunting, and the cat may even cripple a mouse to teach her cub how to seek food.

While curiosity and practising skills are important even in computer games, I am convinced that the primary appeal of games lies in the structure of time. With the frenetic pace of contemporary life, time has become an enemy. We rush to keep appointments, struggle to meet deadlines; we watch the clock hoping in desperation for the end of the workday. When we have nothing to do, time is a burden.

But there are certain magic moments in our lives in which all sense of time

disappears. Most computer hobbyists have had the experience of programming long into the night without any sense of tiredness or an awareness of the time. This loss of a sense of time has recently been given a label, 'flow', and it has been scientifically studied in an attempt to discover what creates flow and why it is so pleasurable.

There are four factors in computer games which create flow: they are challenge, creativity, imagination, and social interaction. Sometimes the factors can work against each other to decrease the pleasure of a game; but I have not found a single game that I enjoy without at least one of these factors present in excellent measure.

Challenge usually relates to manual dexterity, competition, or intellect. A few years ago, when I lived in Scotland, I remember watching in sheer fascination as a young lad kept a football bouncing with his head, shoulders, and feet for several minutes. He practised for hours at a time, and had developed an amazing facility in co-ordination and dexterity.

Another excellent example is an aerial battle between fighter planes in which great physical skill is necessary for survival: and this is an even better illustration of competition. The real source of flow in such a battle, the real loss of the meaning of time, comes from the high stakes involved.

A fight to the death is the ultimate form of human competition, and it may have been the original 'game' as early men fought for inadequate supplies of food, shelter and mates.

Popular myth

The popular myth that computers are intelligent makes competition against the machine stimulating. But computers are high-speed morons while humans are low-speed geniuses; so the best competition is between people, perhaps mediated by the computer.

Intellectual challenge is well illustrated by chess, a game so complex that true mastery is impossible. Grand Masters achieve their rank by defeating other good players, not by conquering the game itself: and sooner or later each of them is beaten.

The intellectual challenge of chess comes from its complexity, which itself is

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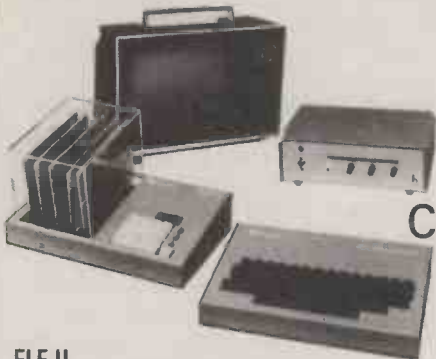
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From previous page

present in two forms. 'Factor complexity' is provided by different numbers of six different kinds of pieces with different moves, including some moves for exceptional cases such as castling. But the true complexity in chess is 'relationship complexity', as different relationships of the same pieces create entirely different situations. In chess, time, as well as space, is critical, as the value of a position often depends on who has the next move.

Most computer games tend to be intellectually trivial because of a lack of complexity. This is why many are short-lived in popularity. A major consideration in challenge is continuity of action, with one threat arising even before the previous one has been dealt with — which often happens in chess strategies.

The second major factor in creating flow is *creativity*. The development of new strategies, the creation of patterns, the opportunity for bold risks, all improve a game. Creativity is the factor which leads me to spend more time writing games than playing them: artists, writers, and programmers all have opportunities to chart new territory, and it is often exciting. If any of the same qualities can be put into a game, that can be an important advantage.

The challenge of creativity has made

Adventure one of the best computer games. There are essentially no rules, and players develop their skills as they go along.

Imagination, the third major factor, is stimulated by role playing. Subtle cues create a new universe for the player, as we imagine ourselves in King Arthur's Court or aboard the Starship *Enterprise*. Role playing is enhanced by providing interaction with known characters — in a simulation of Camelot a player might have to deal with Merlin, Guinevere, and Lancelot, among others.

Time machine

In historical simulations, the imaginative task is to lift the players out of the present and transport them to the historical situation — so that they imagine themselves a soldier in Caesar's legions, or Marco Polo meeting the Great Khan. Research and adequate cueing accomplish the identification. In fantasy simulations, the task is to create a new universe. Simply populating a game with dragons or elves and goblins can stir up images in the mind that stimulate the imagination and create flow.

Social interaction is the last of the four major factors in creating flow. It is at the same time the most important source of flow and most neglected in computer

games. Many computer games are even written as substitutes for human society. This may be a valid approach — it is often difficult to find others who have time to play a game — but it is an unfortunate one.

I prefer to write interactive games designed to stimulate conversation and friendship among the players. The basic gift to humans to one another is affirmation, the feeling of value as a person.

That sense of affirmation, value, and belonging is very important in my ministry, and I carry the same principles through into my games. They tend to be ideological, deliberately stimulating understanding of economics, history, politics, values, culture: that is, I put a piece of myself into all that I write.

I believe that single-player computer games ought to serve to reinforce our sense of values if they are to be satisfying alternatives to social interaction. One way to do this is to provide a scale of skill, so that players can measure the growth of their progress. No good game is strictly random, and any game which builds skills builds confidence and self-affirmation.

Games lift us out of ourselves, teach us new skills, open us up to new ideas, make new friendships for us, and present us with some magical and delightful moments in our lives. □

Put some bounce into that games writing!

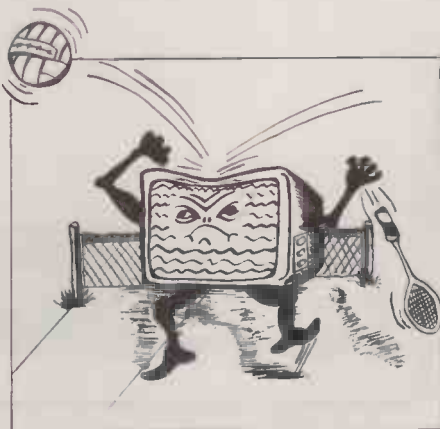
S. J. Baker describes some neat tricks for making balls bounce on the computer screen. His listings are for the TRS-80, but the same principles will apply to any memory-mapped display.

SIX MONTHS AGO I became the proud owner of a 4K, Level II TRS-80 whose name is Elizabeth. Like most non-business machines, it is used mostly for developing and playing computer games and over the last few months I have learned a fair amount of Elizabeth's inner workings. As a result I have come up with several techniques, both in hardware and software, to help me get the most from my machine.

Although these articles will be aimed at fellow TRS-80 Level II users, most of the ideas presented will be useful to anyone whose computer has a memory-mapped display, soft-scanned keyboard and a few bits of input/output capability.

Animated display techniques

The basic attraction of any of the usual "arcade"-style games programs (tennis, football, etc) lies in the ability to simulate



the movement of bats, balls, spaceships and the like in real time. To achieve these effects, we first write out the characters used to represent the moving object, then overwrite them with spaces (or whatever character we choose to represent the background of the field of play) — for example...

```
10 CLS : FOR I = 0 TO 63 : PRINT CI, " * " :  
PRINT CI, " " : NEXT I  
20 END
```

As with all programs listed in this series, I shall present them with plenty of redundant spaces in order to improve readability — when entering the programs to be run, the reader should remove all these spaces to improve running times.

This simple one-liner moves an asterisk from the top-left of the screen to the top right in about 0.78 seconds. Although this is fast enough to avoid jerky movement when no other work is being done in the program, we find that it is too slow for a fast action game by the time we have added bat movement, storing, ball bounce and sound effects. Does this mean that we must resort to assembly language? Not if we are careful in writing the Basic code in such a way as to make maximum use of the machine's architecture. Let's see just how rapidly we can cause an asterisk to bounce around the screen... *Continued over*

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```

10 CLS : CLEAR 100 : DEFINT A-Z :
  S = 15360 : P = S + 480 : V = -65
20 PRINT CO, STRINGS(64,188) :
  PRINT C896, STRINGS(64,143) :
  FOR I = 64 TO 832 STEP 64 :
    PRINT CI, CHRS(191) :
    PRINT CI + 63, CHRS(191) :
  NEXT
30 I = PEEK (P + V) :
  IF I = 32 THEN 40
  ELSE IF I = 143 OR I = 188 THEN
    GOSUB 1000 : GOTO 30
  ELSE IF I = 191 THEN
    GOSUB 2000 : GOTO 30
40 POKE P,32 : P = P + V :
  POKE P,42 : GOTO 30
999 REM Subroutine at 1000 does UP/DOWN bounces.
1000 I = SGN (V) * (64 - ABS(V)) : V = -V - I - I :
  RETURN
1999 REM Subroutine at 2000 does LEFT/RIGHT
  bounces.
2000 I = SGN (V) * (64 - ABS(V)) : V = V + I + I :
  RETURN
  
```

Line 10: Initialises the program,
 S — Address of screen memory
 P — Position of the ball.
 V — Movement vector.
 (P + V) — Next position of the ball,
 assuming it doesn't bounce.
 I — Temporary variable.

Notice that I have used DEFINT to tell BASIC to store all variables — very few games require floating point arithmetic so DEFINT saves memory and a great deal of time.

Line 20: Draws a rectangle around the screen, leaving bottom line free for any scoring or other messages. This also stops the TRS-80 from scrolling the screen up and losing the top line of the

rectangle. Characters 143, 188 and 191 are TRS-80 graphics characters.

Line 30: The program detects rebound conditions, not by directly measuring the ball's position on the board but by PEEKing the screen memory at the address the ball is about to move into and testing the resultant character to see if it is free. Try running the program then add a new line ...

25 PRINT C595, STRINGS(30,191); which adds an obstacle in the middle of the board — the ball automatically bounces off it without any extra testing in line 30. I have used different characters for the sides (character 191) and the top and bottom (143 and 188) so that line 30 can decide which way to bounce the ball.

Line 40: This line can only be reached if the ball is about to move into a vacant cell, so we can safely update its position after having first erased the asterisk (character 42) from its old position with a space (character 32).

Lines 1000 and 2000: These are one-line subroutines to do the arithmetic on the movement vector (V) — The table below gives the new values needed for V ...

Direction	Old V	New V	
		Vertical	Horizontal
North-West	-65	+63	-63
North-East	-63	+65	-65
South-West	+63	-65	+65
South-East	+65	-63	+63

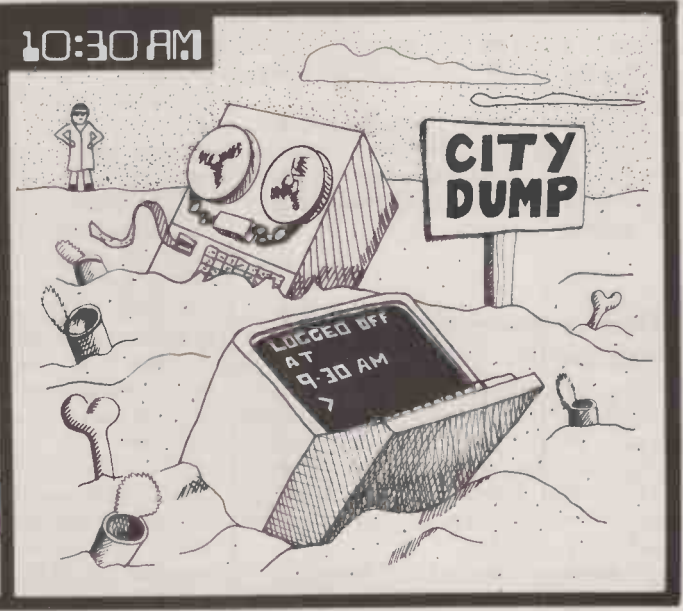
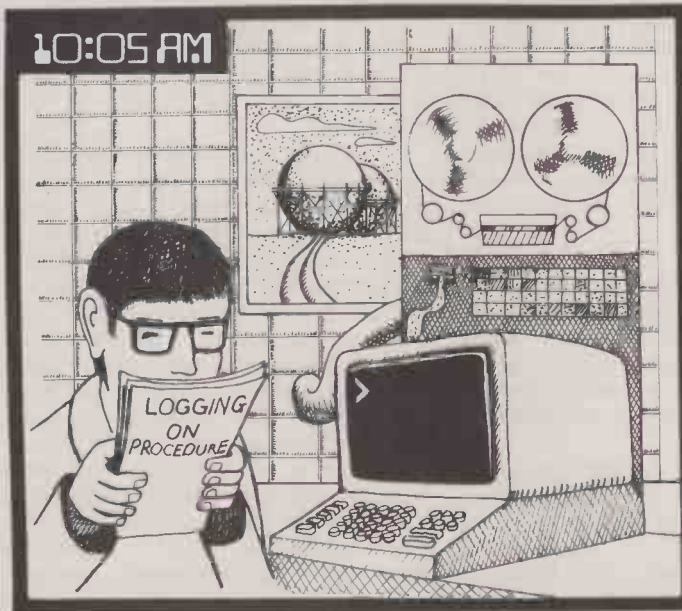
The values given for V give diagonal motion on the screen because adding or subtracting 64 to P would cause the ball to go down or up the screen by one line and adding or subtracting an additional 1 causes it to move to the right or left respectively. The values given in the table are calculated fairly rapidly using a simple arithmetic expression through the use of a look-up table for the new values might well prove faster.

One can see, then, that this short program represents the beginnings of a fast and very flexible 'arcade'-style game where goals, bats and other terrain obstacles may be added at little or no cost in processing time or memory space. One word of warning — don't under any circumstances "breach" the wall surrounding the area of the play — for example by adding the line...

25 PRINT CO, STRINGS(25,32); because this may result on the ball leaving the screen area altogether and bouncing off through memory deleting everything in its path!

If you think I'm kidding, just try it — but be sure to CSAVE your program first because you will probably have to switch the machine off before you can get any sense out of it again.

● In his next piece S. J. Baker shows how to generate music and sound effects without any additional hardware except a hi-fi amplifier and a connecting cable. □



Stop the world, I want to get off! by S.W. Bailey

THIS NEW fifth-generation computer has its CPU the brand-new Z8055 chip. This chip, unlike its predecessors, does not work on electron technology, but instead utilises the new technology based on chyons.

These particles travel much faster than electrons, so much so that they arrive at their destination before they have in fact been transmitted. This has many distinct advantages in a computer system:

- In a file maintenance system, the computer will be able to tell which files will no longer be needed, and can thus purge them.
- Reports can be written to an output device before the data for these reports has even been input.

- A compiler will be able to tell in advance which jobs will have compilation errors and can thus abort the compilation before starting it. The clock which times the functions of this new generation of computers runs at the modest speed of 70THz or 70×10^{12} Hertz. This leads to the incredible instruction cycle time of 2.59aS or 2.59×10^{-18} seconds.

This fantastic new series of computers does however have two minor drawbacks:

- You will need a nuclear reactor to power it.
- It is so fast that before you can "log on" to the system, it logs you off in anticipation that you will eventually do so anyway!

In the right-hand corner, the ambitious home computer limbers up to Get an armlock on machine code

David Peckett begins a series on writing Assembly Language — a series many readers have requested. Over the next months David will deal in parallel with both the 8080A and the 6502. Since the Z80's instructions include the 8080 set, this combination covers most micros in popular use. We hope the series will drive some beams of light through the machine code jungle.

Decimal	Binary	Hex	Decimal	Binary	Hex
0	0000	0	8	1000	8
1	0001	1	9	1001	9
2	0010	2	10	1010	A
3	0011	3	11	1011	B
4	0100	4	12	1100	C
5	0101	5	13	1101	D
6	0110	6	14	1110	E
7	0111	7	15	1111	F

Table 1: Decimal — binary — hexadecimal conversion

IN THE FIRST PLACE, this series is not intended to teach the basic concepts of programming — these have been described before, in great detail, and apply to any form of programming, be it in assembly language, Basic, Pascal, or whatever. So, if you're totally new to programming, this series is not for you.

Nor yet will it teach you how to build a microcomputer; neither will it go into the detail of how a microprocessor works.

So, who is the series aimed at? It's aimed at the person who normally programs a micro in a high-level language such as Basic, but who also wants to program in machine code. It's also aimed at anyone else who wants, or is forced, to come to grips with the fascination of assembly-language programming.

In this article, then, I describe just what assembly language is, and what programs in it look like. In the article, various words are printed in italics — these are defined in a glossary at the end.

What is assembly language?

First, let's define a "microprocessor":

A microprocessor is a single integrated circuit which provides the control, program interpretation and data manipulation facilities of a computer's central processor unit. Among its salient features, it typically

- manipulates data in 8-bit "bytes";
- has one or two accumulators where the data is normally manipulated;
- possesses a number of other 8- and 16-bit registers; I'll describe their uses as the series develops;
- communicates with the outside world via a 16-bit memory address bus (ie, it can directly read and write to 65536 (64K) memory locations) and an 8-bit data bus.

When combined with memory, I/O facilities etc, the microprocessor becomes the central element of a microcomputer.

As far as programming the beast is concerned, there are two key factors; it

can normally only handle data in bytes, and its limited size. The first point means that, to manipulate practical numbers, we must handle several bytes — which is time-consuming.

The second point restricts the number of single-instruction functions a micro can perform. For instance, if you want to multiply two numbers together, you must write a suitable program — I'm discussing established devices, not the latest generation — using the micro's ability to add, shift and compare numbers and to jump to different points in its memory.

What form does a program take? It is simply a sequence of 8-bit binary patterns in the computer's memory. The patterns can represent instructions to the processor, numerical data for it to manipulate, or character codes. The important point is that the processor decodes, and responds to, binary patterns only. For instance, the instruction which tells an 8080A to add 15 to whatever is in the accumulator is:

```
11000110 00001111
```

The first byte is the pattern which orders the 8080A to add data to whatever is in the accumulator; the second byte is the data itself. An object code program for a microcomputer (or any computer, for that matter) is thus only a sequence of "1's and "0's".

Obviously, it's very difficult to program directly in binary; it's not impossible, but the human mind just doesn't think in terms of superficially meaningless patterns of "1's and "0's". The first simplification we could make would be to represent the binary patterns by hexadecimal characters. In this way, we could represent each 4 bits ("nyble") of the program by a single hex character.

Table 1 shows equivalent binary, decimal and hex numbers. Using hex, the 8080A instruction above would become:

```
C6 0F
```

The information hasn't been changed — it's simply presented in a form which people can handle more easily. Before the computer can use it, though, it must be translated back to binary. The translation

is normally done by a simple routine in the system's monitor program. The programmer may well use a hex keyboard to input the data — Mk 14 freaks will be familiar with the concept.

Hex isn't particularly satisfactory; the instruction codes don't suggest their effect, they don't follow any immediately obvious pattern and the whole approach is error-prone. Because of these limitations, Assembly Languages have been developed. They represent every instruction that a given micro can perform by an easily remembered mnemonic. Using 8080A assembly-language, our example becomes:

```
ADI 15 (ADd Immediate 15)
```

The instruction code suggests the operation, and the data is assumed to be decimal unless the system is told otherwise.

So this, simply, is assembly-language — source code which uses human-oriented instruction mnemonics, and which presents data and operands in a more easily handled form. There are, however, several important points to appreciate:

- Each mnemonic in a program represents a single machine code instruction.
- The mnemonics are simply codes which represent binary patterns and could be anything the language designer chooses. They are only labels, just as "apple" is a label which represents a round, greenish-red fruit. Each micro manufacturer has designed his own assembly-language, with the result that some operations have largely standardized mnemonics, while others are very different from micro to micro. For instance, in both the 8080a and the 6502, the instruction:

```
JMP xxyy
```

will make the program JuMP to address xxyy. However, the last instruction in an 8080A subroutine is RET (RETurn), while the corresponding 6502 mnemonic is RTS (ReTurn from Subroutine).

- Assembly-language programs must be translated, either manually or automatically, to the processor's binary object code before they can be used. A

program to do this is called (surprise-surprise) an "Assembler".

□ An Assembler is a program, supplied by the manufacturer of the computer, which takes the text of your assembly language program (described below) and translates it into machine code. The text program is called the 'source code' and the machine code that results the 'object code'. Providing you have written the source code correctly, this process only has to happen once. Thereafter, when you want to run the program you use the object code. Of course, you'll probably keep the source code as a listing on paper or as a file on disc or tape for future reference. But it plays no active part once the assembler has done its work.

I hope I've persuaded you that, if you're programming in machine code, it's easiest to do so via your micro's assembly-language. The program will be much easier to follow. To get the most benefit, however, you should use an assembler.

Not only would this approach prevent errors caused by misreading mnemonic-to-hex code lists, but it would be much faster than any manual system. Speed and accuracy are not the only benefits of using an assembler, however.

The most important benefit conferred by an assembler is the ability to use labels. Two types are possible — variable labels and jump labels.

In a high-level-language such as Basic, you don't have to worry about where the computer stores data. You can simply write:

```
150 LET K=3*X*SIN(Y)
```

and leave the interpreter to find "X" and "Y", and to decide where to put "K".

In machine-code programming, however, you must decide, and keep track of, where all the data is stored. Things are made much easier if you can use a label. You could write:

```
STA SUM
```

which would store the contents of the accumulator in the store labelled "SUM". At some stage, you give the assembler an idea of where in the computer's memory it should put "SUM", but throughout the program you can represent the variable by its label. If you choose the labels carefully, they will help you, and others, to understand the program; eg "SUM" would normally make more sense than "PSQXE".

Most useful programs have lots of jumps and branches in them. In machine-code programming, you must calculate addresses the micro is to jump to, but an assembly-language program can use labels to clarify things. For instance, you could write:

```
JMP END
```

```
END "The final routine starts here"
```

Operation	6502			8080A		
	Mnem	Flags	Effect	Mnem	Flags	Effect
Load Accumulator	LDA o	N,Z	A = d/(a)	LDA a or MOV A,M	None	A = (a)
Load Acc, Immed	—			MVI A,d	None	A = d
Store Accumulator	STA a	None	(a) = A	STA a or MOV M,A	None	(a) = A
Add	—			ADD M	All	A = A + (M)
Add Immediate	—			ADI d	All	A = A + d
Add with Carry	ADC o	N,V,Z	CA = A + d/(a) + C	ADC M	All	A = A + (M) + C
Add with Carry (Imm)	—			ACI d	All	A = A + d + C
Subtract	—			SUB M	All	A = A - (M)
Sub Immediate	—			SUI d	All	A = A - d
Sub with Borrow	SBC o	N,V,Z	CA = A - d/(a) - C	SBB M	All	A = A - (M) - C
Sub with Borrow (Imm)	—			SBI d	All	A = A - d - C
Load H,L Imm	—			LXI H,d	None	H,L = d
Clear Carry	CLC	C	C = 0	—		
Clear Decimal	CLD	D	D = 0	—		

Notes

"a" = Address (defined by the program)

"d" = Data (defined by the program)

"o" = Operand — can be an address or data

A = Accumulator

H,L = Register pair formed by H and L

M = The address implied by the data in H,L

C = Carry flag

D = Decimal flag

/ = Either/or

Brackets mean "Contents of the location whose address is between the brackets"

Some of the 8080A instructions are shown for completeness only at this stage.

Table 2: Fundamental 6502 and 8080A instructions

The assembler will work out what number to represent "END" by when it translates the program.

The main advantages of labels are:

- They make a program quicker to write and easier to follow.
- Labelled routines can easily be used as library routines.
- Program modification is easier.
- You don't have to do the donkey-work of calculating storage and jump addresses.

There are normally a few limitations on the use of labels. The most common ones are:

- Only a certain number of characters (often 6) can be used.
- Only 'A'-'Z' and '0'-'9' can be used.
- You can't use assembly-language mnemonics as labels.
- A label must start with a letter.

If you are using an assembler, its manual will give specific instructions, but in this series I'll observe the four constraints above.

The second major benefit of using an assembler is that data in the operand field of an instruction can be defined in many ways — via a label, of course, as a decimal, binary or hex number, as an ASCII character or as a simple arithmetical expression. In every case, the assembler will convert the operand to the correct format for the micro. In this series I'll use the conventions illustrated below. (LDA is the 6502 mnemonic which means Load the Accumulator.)

LDA 15	Value which goes into Accumulator Data at memory address 15 ₁₀
LDA \$1F	Data at memory address 1F ₁₆
LDA %00100011	Data at memory address 00100011 ₂
LDA #S	ASCII code representing "S"

The # in the last example indicates an "immediate" operation in which the data is given directly by the operand field, and is not read from memory. As a further example:

LDA # \$27
would load the hex value "27" into the accumulator. The 8080A has separate mnemonics for all its immediate instructions, and therefore doesn't use the:

Operation # Operand construction. Remember, the assembler recognizes the whole form of the instruction and selects the correct machine code. Immediate and memory-referenced instructions have different opcodes.

Yet another advantage of using an assembler is that comments can easily be inserted in the source code. One aspect of adequate software documentation is putting plenty of comments in the program; the comments should explain what is going on and, more important, why it is happening. The comments should be constructive; for instance, the comment in:

```
LDA # $15 ;SET ACC TO 15
```

doesn't tell us anything new. It would be much better to put:

```
LDA # $15 ;INITIALIZE LOOP COUNTER
```

Different assemblers give different facilities for inserting comments, but the

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comments are always ignored when the program is assembled. Throughout this series, I will assume that comments can be inserted either as a whole line, or following the operand field. In either case, the first character will be a semi-colon.

Why use assembly language?

Assembly language programming is much more complex than using languages such as Basic, and is laborious and error-prone. Nevertheless, there are a number of good reasons for using it:

- There is no choice. If your computer is, for example, a Mk 14 or a simple Nascom, it has to be programmed in hex. Programming is much easier if assembly-language listings are manually translated to machine code.
- The planned program must fit in a very small space, or run very quickly, or both. Programs in high-level languages will always run more slowly, and demand more space, than assembly-language programs.
- Certain tasks, such as bit manipulation, are very difficult in the high-level languages available on most microcomputers.
- It can be fun. Assembly-language programming represents a challenge and, incidentally, gives a good insight into how a micro works.

You must recognize, however, that assembly-language programming is inevitably slow, hard or even impossible to follow, and gives source-code which can be astonishingly difficult to modify.

Assembly-language routines

From here on, this series will study the details of assembly-language programming; the details will be

supported by examples using two of the best-known micros — the 6502 and the 8080A.

By the end of the series, you should be able to write reasonably complex programs for either or both of the two devices. Here are a few more points about my approach:

- I'll stick to assembly-language mnemonics only. If you need the hex, binary or decimal translations, you'll have the documentation to look them up.
- The programs will use the assembler conventions I've outlined — these may not be the same as your system's, so please check before you blame me.
- Where I define absolute addresses, they won't necessarily be usable in your system.

Finally — I know that home micro-computers rarely have assemblers, unless the extra software has been purchased specially. I repeat, however, that manual assembly is much better than nothing.

Structure of a micro. The hub of each of the micros I've chosen is a single Accumulator (A). They also each have a Program Counter (PC) and a Status Register, containing the 8 bits of the Processor Status Word (PSW), which records what's happening in the micro. They both have a number of other registers, most of which I'll leave to future articles.

Two of the registers in the 8080A are called H and L. Each has 8 bits, but they can be combined into a single 16-bit register, also referred to as H; in the 16-bit mode, L supplies the 8 least significant bits. Which "H" is meant in any particular case is clear from the mnemonic. The basic architectures of the 6502 and the 8080A are shown in Figures 1a and 1b respectively.

Fundamental instructions. Let's now look at the most fundamental instructions for any micro — those which allow the

accumulator to be loaded either from memory or immediately, and which store the accumulator's contents in any given location. I'll also cover the simple arithmetic operations which the two devices can perform.

These fundamental instructions are given in Figure 2; there are other ways of doing some of the operations, but I'll cover these later in the series.

You can see immediately that the 8080A has a much richer instruction set (at this level, anyway) than the 6502. Partly this is because the former micro has special instructions for immediate operations, while the latter uses a " " in the operand field.

The 6502's use of the carry and decimal flags is also important, however. One bit in the PSWs of both micros is designated the "carry" bit (or flag), and shows the result of previous operations; the 6502 also has a bit called the "decimal" flag.

I'll describe the PSWs next month, but you must remember that 6502 addition and subtraction always take account of these two flags, while the 8080A's instruction set makes them optional. If the flags are kept at zero, then the 6502's "ADC" corresponds roughly to the 8080A's "ADD" and "ADI".

The ways the two micros address data can be very different, depending on the instruction. The 8080A is designed to use "implied" addressing as its normal mode of operation. In this mode, the operand field of an instruction does not indicate an address; instead, it shows a register where the address can be found.

Normally, the register-pair (H,L) acts as the pointer. Thus, before an implied operation, (H,L) must be loaded with the 16-bit address of the data to be manipulated. The operand "M" is taken to mean the address implied by the data in (H,L).

For simple programs, this technique is rather clumsy, but it has distinct advantages for more realistic programs — I'll describe some of these advantages in future articles. Implied addressing is a special case of a more general technique called "indexed addressing".

The 6502, on the other hand, can use direct memory addressing with all its instructions. It also has various indexed modes, but these don't concern us this month. The only 8080A instructions that affect registers and which allow direct memory addressing are the load and store commands. All other instructions referring to memory must use an implied form. The load and store operations also have implied forms, which are shown in Figure 2 and which are called MOVes. They are examples of a much larger group of 8080A instructions.

Let's try a simple exercise. Suppose we have data in the memory at the addresses labelled "DATA1" and "DATA2". We want to put the sum in "DATA3" and the sum minus 7 in "OFFSET". Finally, set

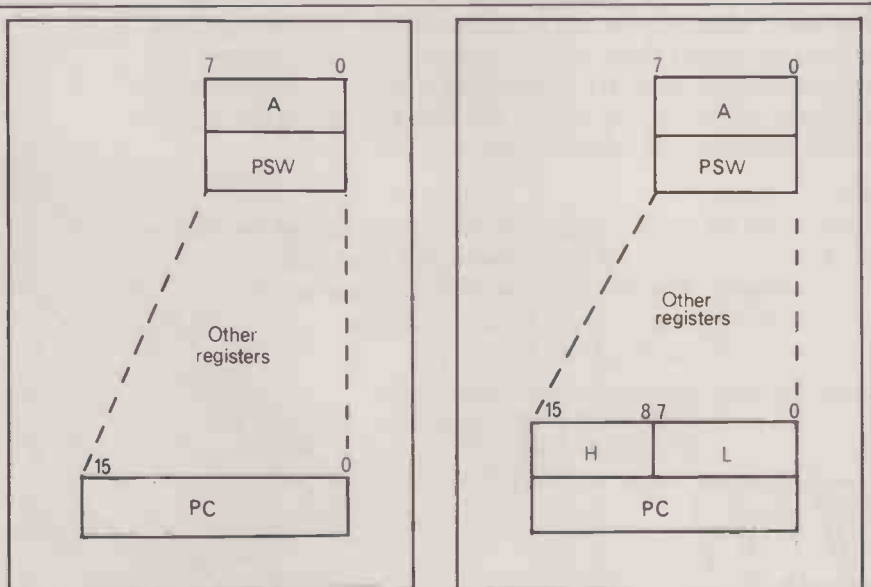


Figure 1: Device architecture: 6502 (left), 8080 (right)



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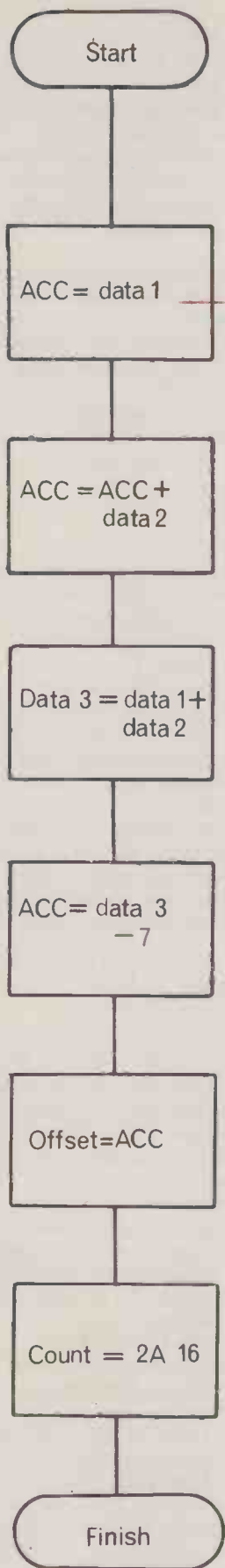


Figure 2: Flowchart for example

; THIS PROGRAM DEMONSTRATES THE USE OF THE BASIC 6502 INSTRUCTIONS

```

;
CLD ;CLEAR THE DECIMAL AND
CLC ;CARRY FLAGS
LDA DATA1
ADC DATA2 ;ACC = DATA1 + DATA2
STA DATA3 ;DATA3 = DATA1 + DATA2
SBC #7 ;ACC = DATA3-7
STA OFFSET
LDA #$2A ;ACC = 2AH
STA COUNT ;COUNT = 2AH
;
;END OF THE FIRST DEMONSTRATION ROUTINE
  
```

8080A program

; THIS PROGRAM DEMONSTRATES THE BASIC 8080A INSTRUCTIONS

```

;
LDA DATA1
LXI H,DATA2 ;SET POINTER FOR ADDITION
ADD M ;ACC = DATA1 + DATA2
STA DATA3 ;DATA3 = DATA1 + DATA2
SUI 7 ;SUBTRACT IMMEDIATE — NO # NEEDED
LXI H,OFFSET ;SET POINTER FOR IMPLIED STORE
MOV M,A ;OFFSET = DATA3-7
MVI A,$2A ;ACC = 2AH
STA COUNT ;COUNT = 2AH
;
;END OF THE SECOND DEMONSTRATION ROUTINE
  
```

Table 3: Demonstrations routines

“COUNT” to 2A₁₆. In Basic, this exercise would be easy:

```

110 LET DATA3=DATA1+DATA2
120 LET OFFSET=DATA3-7
130 LET COUNT=42
(Assuming we could use six-character variables)
  
```

In assembly-language programming, however, we must tell the micro each and every step of the procedure; furthermore, and this is very important, arithmetic operations can only take place in the accumulator. Neither must we forget to set up the 8080A’s pointer.

So, first of all, decide the sequence in which you must carry out the operations, and produce a flow chart. The flow chart should show every significant step, but beware of making it so detailed that it becomes a program. I suggest the flow chart of Figure 2; from it, I wrote the 6502 and 8080A programs of Figures 3a and 3b respectively.

The two programs are similar — one significant difference is the need to clear the 6502’s carry and decimal flags to avoid interfering with the “ADC” and “SBC” operations. Once cleared, the flags stay cleared unless reset by an instruction or a result.

The second major different is the need to imply an address for the 8080A’s “ADD” operation; this necessitates loading the (H,L) pair with the data’s address. The 8080A program also shows the use of an implied MOVE to store data.

Finally, note the different ways of expressing the immediate operations.

I hope that this initial article has given you a feel for the basic concepts of assembly-language programming, and its advantages and disadvantages. Any micro’s assembly-language reflects its internal structure to some extent, and the first codes I’ve given start to show this.

Next month, I’ll explain the different ways in which numbers can be represented in a micro. I’ll also describe in detail the PSWs of the 6502 and the 8080A. Further, I’ll start to describe the use of jumps, which are essential in any real program.

Homework

1. What is the largest decimal number which an 8-bit byte can hold?
2. What happens if the sum of two numbers is larger than the answer to the last question?
3. How can we represent a negative number?
4. How can we represent decimals?
5. In the 6502 program of Figure 3a, could we have put “CLC” and “CLD” anywhere else?
6. Consider a program to satisfy the following equations:

```

DATA4 = DATA1 + DATA2 - DATA3
DATA5 = DATA5 + 23
CODE = DATA2 - 17 - DATA3
  
```

Assembler development system

COMMODORE has released two more programming languages for the PET floppy disc system, an Assembler Development System and a more comprehensive version of LISP.

Designed to operate with the 16K and 32K Floppy Disk PET system, the Commodore Assembler GD 001 allows programmers to work in real time. The entire package is written in assembly language and operates extremely efficiently. The system includes a screen-based editor, similar to the BASIC editor, but with the additional functions of FIND, CHANGE, AUTOMATIC LINE NUMBERING, LINE RENUMBERING, REPEAT KEY, BLOCK DELETE and all the DOS SUPPORT commands.

Both source files and the KIM/TIM/MDT format object files reside on disk for full flexibility of operation. Two loaders are supplied which enable the user to load any RAM location. The source code of the editor and loaders is included. These well-documented programs reveal most of the current ROM entry points required to drive the PET and its peripherals from an assembly language environment. Commodore have included EXTRAMON 7.5, a new machine-code monitor, in this package. This will allow the operator to execute machine code in a controlled fashion, thus reducing the time typically taken to debug assembler programs.

The price of £50 + VAT also includes a set of documentation and the standard Commodore Disk Software multi-ring binder.

Commodore LISP

GD 010, the Commodore version of LISP, is much more comprehensive than the original LISP 1.5. It includes functions such as PEEK, POKE, CALL, OPEN, CLOSE, CMD AND PRINØ. Available from Commodore, the price of £75 + VAT includes two demonstration programs and a manual.

Shooting gallery

THIS PROGRAM is a special shooting gallery for the PET, sent in by D. A. Elworthy. He writes: For reasons of space, no rules are included in the program itself; but if needed they can be inserted between lines 21 and 99.

The rules are as follows:

'Firstly, the player enters a speed rating between 1 and 9. The game then commences. A white blob moves along a line of boxes, pausing after each move for a time determined by the speed (less than a second). When he wishes, the player may shoot, by pressing any key.

If a white blob lies beneath the "V"

then it will be "killed". However, if a box lies beneath the "V", then a new white blob will be created. The object of the game is to kill the white blob(s).

When all have been killed, the program will say how many goes, and how many shots it took. A go is one move of the blob(s).

Note that, while the new position of the blob(s) is being set up, the whole screen is extinguished, and then "zapped" back on, although it is only off for a short time.

If the problem is to be run on machines other than PET, then it will be necessary to modify the memory mapping POKES (lines 230 and 270). The POKES at 200 and 245 are the screen off and on commands. It is also necessary to have a single character input command (GET, in this case).

```
1  REM SHOOTING GALLERY BY
   D.A.H. ELWORTHY
10  DIM A%(9):A%(1)=81:X%=87:
   R%=1:G%=0
20  FOR I%=2 TO 9:A%(I%)=87:
   NEXT I%
100 PRINT"clr":FOR J%=1 TO 9:
   PRINT:NEXTJ%
110 PRINT"  IIII V IIII"
120 PRINT"   w w w w w w w w"
130 INPUT"homeDELAY (1 TO 9)";S%
140 IF S% > 9 OR S% < 1 GOTO 130
150 D%=INT(50/S%):H%=0
```

This section contains the initialisation. The following should be noted: clr is the screen clear character. I may be replaced by shift], if desired. home is the home character. w is shift W.

There are ten spaces at the left hand side of the PRINTs on lines 110 and 120.

```
200 POKE 59409,52:FORK%=1 TO 9
210 Y%=%(K%):A%(K%)=X%
220 X%=Y%
230 POKE 33177+(2*K%),X%
240 NEXT K%:G%=G%+1
245 POKE 59409,60
250 FOR T%=1 TO D%:NEXT T%
260 GET A$:IF A$="" GOTO 200
270 H%=H%+1:A%(5)=168-A%(5):POKE 33187,A%(5)
280 IF A%(5)=81 THEN R%=R%+1:
   GOTO 200
290 R%=R%-1:IF R% < > 0 GOTO
   200
300 PRINT"GOES" G% "SHOTS" H%:
   END
```

This section contains the main game, plus testing for the end condition, etc. R% is a tally of the remaining blobs. Take care to enter the POKES correctly: it is not a good idea to POKE into the wrong place (oops!).

It is possible to modify this: for example, the line of boxes could be made longer (lines 10,20,110,120,200), or the range of speeds could be altered (lines 130,140,150). But all that is up to you.'

More random numbers

BERYL AND MARTIN GEORGE have written to Pet Corner about the note on random numbers in the December issue. Changing the seed number as suggested in the article, they say, will not change the sequence of random numbers on our Pet fitted with the new ROM's and as far as we are aware will not overcome the problem on machines fitted with the old ROM's.

'For the problem is that no matter what positive number is used for the seed, the same sequence of numbers will be generated starting from power on. This can be shown by running the following programme. Before the programme is entered, the computer should be switched off and on so one can be sure of starting from the power on condition.

```
10 for X = 1 to 10
20 print RND (X)
30 next X
```

One then copies down the numbers displayed on the screen; switch the computer off and on, then enter the above programme but changing line 20 to:

```
20 print RND (1)
```

After running this second programme, you will notice that the same sequence of numbers has been generated, although in the first programme the seed was constantly changing to the value of X.

Whilst the command RND (0) with the new ROM's produces a more random commencement number, thereafter it usually tends to generate a progression of numbers and not a random sequence, as shown by the following programme.

```
10 A = INT (RND (0) × 9 + 1)
20 B (A) = E (A) + 1
30 for C = 1 to 9
40 print B (C); next C
50 print "(home cursor)"; go to 10.
```

If the RND (0) statement is changed to RND (1) in the above programme and the programme rerun, it can be seen that a far more random sequence of numbers is generated.

The most satisfactory way we have found of generating a random number on power up, and a random sequence thereafter, is to include the following instructions at the start of a programme using the random function

```
POKE 138, PEEK (143)
```

For machines fitted with the new ROM's, then use the command RND (1).

For the old ROM's, we believe the corresponding instruction is POKE 220, PEEK (514).

This instruction loads the one memory location for the random number function with the number of JIFFIES on the internal clock memory location. This means that there are a possible 256 possible random sequences which is sufficiently random for most instances.'

Fourier transform

DR D. JONES, from West Wickham in Kent, has enclosed a listing for a Fast Fourier Transform program which he claims has been tried and tested. In return he would like to appeal for help with a problem over the PET extended BASIC instruction GET*.

'It does not work for IEEE Bus devices! GET actually only 'gets' about half of the expected output — 'about' because there is some fluctuation. It is a general problem with the PET. It will not work with three PETS I have had access to and 'getting' from a Hewlett-Packard Instrument. I should add that an H-P controller (in place of the PET) works without fail — so it is definitely the PET.'

*Using the usual check of ST — status.

REMARKS: The Radix 2 FFT is an adaptation to PET BASIC of a FORTRAN algorithm due to Cooley.

It enables the calculation of the FFT of $m = 2^n$

points with n an integer.

As listed $m = 256$ — the maximum array size for 8K PETS. For the big PETS the listing may be adapted as indicated by the "!" comments.

Poke top left

FOURTEEN-YEAR-OLD Kevin Jones, from Lytham St Annes, has found his own solution to the problem Mr Patterson discussed in the January 1980 issue, PEEKing and POKEing characters to and from the PET's screen. All PET users, he writes, must have noticed that the codes used in the screen locations are not the same as those obtained using the ASC function.

'My solution to this problem is to place the character that the operator wishes to POKE onto the screen on the top left-hand corner of the screen and ask the computer ?PEEK(32768). This will return the screen code for that character eg. 160 for a filled "square" (a reverse-field space); 42 for an asterisk etc.'

Commodore's 1980 plans

COMMODORE'S PLANS for 1980 reportedly include the arrival in the UK, probably in October, of an 11 MByte 8in Winchester technology hard disc.

Some software specialists doubt that it is practical to link such powerful peripherals to the present generation of PETs, and American Commodore watchers have been forecasting the appearance of a new and much faster processor in future PETs.

Quote from Commodore's annual report: 'Other computer enhancements under development during fiscal 1980 will expand the capability of PET systems to a point where they will be able to talk, listen and draw. Development of a next generation computer system is scheduled for completion during 1979/80'.

```

10 REM****FAST FOURIER TRANSFORM****
20 REM F.F.T. OF 256 REAL POINTS TO BE
30 REM PUT IN A(0) TO A(255). OUTPUT IS
40 REM IN A(I) [REAL] AND B(I) [IMAG].
50 REM MODULUS AND 4 QUADRANT PHASE ARE
60 REM ALSO COMPUTED.
70 DIM A(255), B(255)          ...! Dim(m-1)
80 FOR I = 0 TO 255           ...! 0 to m-1
90 B(I) = 0
100 NEXT I
110 PRINT "ENTER INPUT DATA ARRAY A(I). #/S 120 TO 199
: ARE AVAILABLE FOR THIS.
120 STOP
130 REM DEMONSTRATION DATA ARRAY.
140 FOR I = 0 TO 31           ...! 0 to m/8 -1
150 A(I) = 1
160 NEXT I
170 FOR I = 32 TO 255       ...! m/8 to m-1
180 A(I) = 0
190 NEXT I
200 REM*****
210 REM ****NORMALISATION****
220 F = 1/256                ...! 1/m
230 FOR I = 0 TO 255       ...! 0 to m-1
240 A(I) = A(I) * F
250 NEXT I
260 REM ****REORDER (BINERATE)****
270 J = 1
280 FOR L = 1 TO 255       ...! 1 to m-1
290 IF L=J GOTO 330
300 T1 = A(J-1)
310 A(J-1) = A(L-1)
320 A(L-1) = T1
330 K = 128                ...! m/2
340 IF K=J GOTO 380
350 J = J - K
360 K = .5 * K
370 GOTO 340
380 J = J + K
390 NEXT L
400 PRINT "REORDER COMPLETE. FFT WILL TAKE APPROX. 1.5 MINS."
410 REM ***** F F T *****
420 FOR M = 1 TO 8         ...! 1 to n
430 U1 = 1
440 U2 = 0
450 M1 = 2 ^ M
460 K = .5 * M1
470 P = pi/K
480 W1 = COS(P)
490 W2 = -SIN(P)
500 FOR J = 1 TO K
510 FOR L = J TO 256 STEP M1 ...! J to m step M1
520 L2 = L - 1
530 L1 = L2 + K
540 T1 = A(L1) * U1 - B(L1) * U2
550 T2 = B(L1) * U1 + A(L1) * U2
560 A(L1) = A(L2) - T1
570 B(L1) = B(L2) - T2
580 A(L2) = A(L2) + T1
590 B(L2) = B(L2) + T2
600 NEXT L
610 U3 = U1
620 U1 = U1*W1 - U2*W2
630 U2 = U2*W1 + U3*W2
640 NEXT J
650 NEXT M
660 REM ***** F F T COMPLETE*****
670 PRINT"REAL AND IMAGINARY PARTS OF FT"
680 FOR I = 0 TO 128       ...! 0 to m/2
690 PRINT I;A(I);B(I)
700 NEXT I
710 PRINT "FOR AMPLITUDE AND PHASE PRINT OUT 'CONT'."
720 STOP
730 PRINT"AMPLITUDE AND PHASE (RADIAN/pi)
740 FOR I = 0 TO 128       ...! 0 to m/2
750 A1 = SQR(A(I)*A(I) + B(I)*B(I))
760 A2 = -1
770 D = A(I) + A1
780 IF D = 0 THEN 810
790 A2 = 2 * ATN(B(I)/D)
800 A2 = A2/pi
810 PRINT I;A1;A2
820 NEXT I
830 END
840 REM ***** D. LL. JONES *****
850 REM ***** 10/79 *****
READY.
```

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PRACTICAL COMPUTING March 1980

Make day number

IN MANY BUSINESS, and indeed other, applications one requires to enter the day or date before beginning to enter other data, writes Frank Atkinson. Even if one allows the date to be "reprinted" by the machine for a visual check, there is still a chance of error.

The following program has therefore been designed to check the correct entry of a date. Its chief claim to further consideration is that, when the date is "reprinted", it is "preceded" by the "day of the week". Thus if, for example, one enters the date 26, NOV, 79, the machine "reprints" this on the screen in the form "MON: 26, NOV, 79, thus giving one a good chance of really checking that one's entry was correct.

An additional feature of the following program is that a Record Number is created which can be used to store data in a Text File on disc, so that appropriate records for each day can be associated with the Record Number and easily recalled as required.

Three sets of data are read into memory. Z\$(K) holds "JAN" etc. M(K) holds the number of days to the point immediately preceding this particular month; thus January has no days preceding it whereas "February" has 31 days preceding it. The third set of data is the abbreviated days of the week: "FRI" etc.

Aren't you dating?

When the program is run, one is requested to enter the date, in a specified form, and this is then read into memory as three separate pieces of data: the actual date within the month, the name of the month and the last two digits of the year.

A search is then carried out to identify the name of the month and from this to ascertain "K", thus relating the other data to the name of the month. Note here that on line 530, allowance is made for the mis-spelling of the month. Thus if one enters NØV instead of NOV, then it does not satisfy the "IF" statement and falls through on to line 530, where a check line is returned to the screen.

However, if the month has been correctly input, then we move onto line 540 where the 'day-number' "F" is created by adding the number of days leading up to the beginning of our month with the actual number of the days within the month: ie $M(K) + D2$. Next a check is made on line 550 for the presence or otherwise of a Leap Year. And if we have entered a Leap Year, then $LY = 1$. Otherwise $LY = 0$.

Then for three separate checks to ascertain whether or not entries have been made correctly, in connection with the number of days in the month: ie whether or not there should be 30 or 31 and whether the correct maximum of 28 or 29 has been made for February. In each case,

if an incorrect entry has been made, then an indicator line "TSS" is returned to the screen.

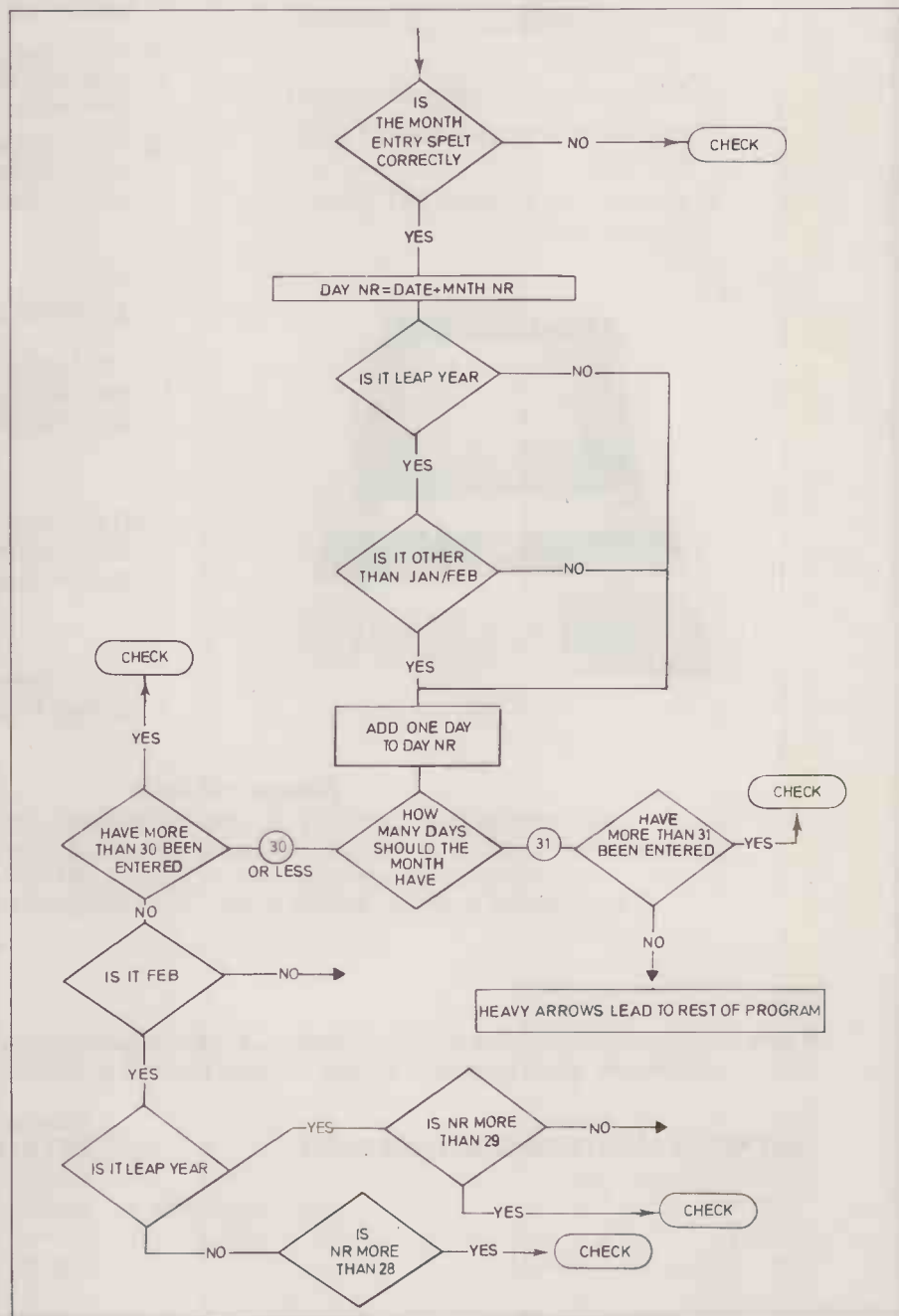
In lines 700 to 745, a running total is built up of the number of days which have elapsed since a given horizon, until the date of our entry. In this case the horizon is set (line 700) at 1977, so that references can be made backwards to that year if so wished. Of course the horizon can be set wherever one wishes, bearing in mind the need to consider Leap Year. It will be seen that in line 720 C1 adds .25 to every year. Thus in the fourth year another day is added at line 750 (integer of C1).

Line 770 obtains the "remainder" after a small calculation whereby the total number of days is divided by 7. It may seem odd that this number is then multiplied by 8 and the integer taken from that, but because of the vagaries of binary arithmetic within the micro-processor, an

exact number is not returned. At line 780 TTS is established by adding together the various parts of our date, namely B\$(L) shows the day of the week, and the other items are attached as already input or sorted.

Finally if we wish to create a Record Number starting at January 1st, then "F" will give us just this. If we wish it to start from April 1st, then we must deduct 90 if the year is not a Leap Year, or 91 if it is. Naturally this is easily done by lines 790 and 800.

When this small program is operated on an Apple II, there is a perceptible pause between completing our entry of today's date and its "reprint" on the screen, but the added information which comes back with the "reprint" certainly makes this worthwhile and intrigues any new computer operator when she first comes across this little surprise!



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JLIST

```

0 REM *****
1 REM *
2 REM * MAKE DAY NR. *
3 REM * * * * * *
4 REM * COPYRIGHT *
5 REM * FRANK ATKINSON *
6 REM * 1979 *
7 REM *
8 REM *****
10 REM MAKE DAY NR
15 D$ = CHR$(4)
31 DIM Z$(12),M(12)
32 DATA "JAN","MAR","MAY","JUL","AUG","OCT","DEC","APR","JUN",
"SEP","NOV","FEB"
33 DATA 0,59,120,181,212,273,334,90,151,243,304,31
34 DATA "FRI","SAT","SUN","MON","TUE","WED","THU"
35 FOR K = 1 TO 12: READ Z$(K): NEXT
36 FOR K = 1 TO 12: READ M(K): NEXT
37 FOR L = 1 TO 7: READ B$(L): NEXT
38 TS$ = "** CHECK DAY **"
150 REM SPACE HERE FOR ENTRY FORMAT
450 PRINT "ENTER DATE HERE,USING COMMAS"
455 INPUT "EG,13,NOV,79";D2,M$,Y2
460 GOSUB 500
470 PRINT "THE DATE IS ";TT$
480 END
500 FOR K = 1 TO 12
510 IF M$ = Z$(K) THEN 540
520 NEXT
530 TT$ = "** CHECK MNTH *": RETURN
540 F = D2 + M(K)
550 IF INT(Y2 / 4) = (Y2 / 4) THEN LY = 1: GOTO 570
560 LY = 0
570 IF K < 12 AND K > 1 THEN F = F + LY
580 IF K > 7 THEN 610
590 IF D2 > 31 THEN TT$ = TS$: RETURN
600 GOTO 700
610 IF D2 > 30 THEN TT$ = TS$: RETURN
620 IF K = 12 THEN 640
630 GOTO 700
640 IF D2 > 29 THEN TT$ = TS$: RETURN
650 IF LY = 1 THEN GOTO 700
660 IF D2 > 28 THEN TT$ = TS$: RETURN
670 GOTO 700
700 B1 = 0:Y1 = 77:C1 = 0
710 FOR A = 1 TO 21
720 B1 = B1 + 1:Y1 = Y1 + 1:C1 = C1 + .25
730 IF Y1 = Y2 THEN 750
740 NEXT
745 TT$ = "** CHECK YEAR **": RETURN
750 B1 = (B1 * 365) + (INT(C1))
760 B1 = B1 + F
770 L = 1 + INT(8 * ((B1 / 7) - (INT(B1 / 7))))
780 TT$ = " " + B$(L) + ":" + STR$(D2) + "," + Z$(K) + "," + STR$(
(Y2) + " "
810 RETURN
910 PRINT D$:"RUN CHOICE"
1000 END

```

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Prime yourself for the video future

AS VIDEOTEX technology (the now-approved overall term to cover both the land-line viewdata and broadcast teletext facilities) becomes integrated with the rest of the small computer revolution, this clutch of books provides a modest library with which to arm yourself.

***The Viewdata Revolution* by Sam Fedida and Rex Malik. Associated Business Press 1979 186pp, £11.50.**

By pedigree this should be the best book. Fedida is the inventor of Viewdata which he first demonstrated in 1972-74 while employed at Martlesham by the Post Office, and Malik is a veteran observer and propagandist of the computer world. Unhappily their book's appearance was badly mistimed — I'd like to think almost exclusively the fault of their publisher.

In the course of a few months last autumn, Viewdata made enormous strides from being just an interesting experiment with plenty of potential to achieving on-line commercial reality. In the same period the first true production-line Prestel sets were shown to the public, intelligent editing and user terminals appeared, the coin-op machine, an obvious idea which was developed by a former arcade game company and not the Post Office, showed itself in stores and hotels, and some of the databases set up by the information providers at long last lost their experimental qualities and began to look as though they might be of use to someone.

So Fedida and Malik's book has signs of hasty last-minute revision which does no one any credit. Its strengths thus lie in its historical account and in the authors' sometimes jokey vision of its future in detail.

In particular they provide useful answers to the keenest question of all: when can we expect the emergence of a true mass residential market? The answer, they suggest, lies in looking at the time when the existing generation of colour TVs will need replacing.

***The Electronic Bookstall* by Rex Winsbury. International Institute of Communications, 1979 74pp, £4 (available only from 11C, Tavistock House East, Tavistock Square, London WC1 9LG).**

Winsbury's extended pamphlet neatly fills the omissions of *The Viewdata Revolution*. The author has emerged as one of the most articulate of the present generation of information providers: he is the editor of *Fintel* which uses the resources of the *Financial Times* and *Extel* to give an extensive financial database.

As one might expect with that sort of background, he is more concerned about the commercial preconditions necessary to

make viewdata secure. He has grasped the essential quality of Viewdata — not its technical sophistication or lack of it, nor yet either its potential social significance in some ill-defined future.

Viewdata's value is that it is here and now and represents the only system of its kind that is actually working.

For me the most valuable sections were on costing an IP venture — he gives four sample economic models. But he also discusses a number of dilemmas thrown up by Viewdata's existence and the way in which the Post Office has decided to make it available for use.

How, with all those diverse interests, is Viewdata to be marketed to the public? Will overall balance be achieved merely by the working of commercial forces? Is a special code of conduct required? What are the implications of a medium in which traditional boundaries between advertising and editorial are all too easy to blur? What will happen to the older communications media? How will the unions react?

***Third International On-line Information Meeting, December 1979: Proceedings.* 428pp.**

This year's conference devoted a substantial part of one day to videotex and included displays of a sophisticated American version — Viewtron — currently on trial in Florida and the French system that will piggyback on the new telephone directory retrieval device that will place, free of charge, a VDU by every French phone.

Of the papers that appear in the printed Journal, the interesting ones are on the public library role and on typographical and design considerations in using Viewdata-type character generators. The IPs who presented papers seemed to be keeping their cards close to their chests.

It is quite obvious that the spirit of friendly co-operation goes only so far and that some IPs don't propose to show their work until they are convinced that their new ideas have such instant commercial viability that they can't be ripped off.

***Teletext and Viewdata* by Steve A. Money, 1979, Newnes £5.50. 151pp.**

This is in a well-known technical series and is aimed largely at the TV engineer who wants to extend his range. It is ideal for anyone considering building a micro using the teletext character generator as a VDU. More ambitiously, those considering building intelligent terminals for viewdata and teletext capture and exploitation, or cards for linking to their existing micros, will need to read this book. Money writes attractively and assumes little or no knowledge of digital transmission techniques.

The one cause for regret is his concentration on Teletext at the expense of Viewdata. Perhaps future editions will rectify this.

— Peter Sommer

Micromice need speed and style

A LOT OF people tell us they're interested in the Micro-mouse contest, but they can't make head or tail of the rules. 'They're too simple!' they cry. 'What do they mean?'

The rules are as published in our October 1978 issue. The general import is that the mice have run a maze. The passages in the maze are 6½in wide, the walls are 2in high and ½in thick. In the first, and main section, the mouse has some time to explore the maze and then has to make a timed run to the centre. When it gets to the centre, the judges' watch will stop and its owners can retrieve it as best they can.

Dead end Street

What does this tell the mouse designer? It's very simply: a maze consists of straight passages with turns off, dead ends and corners. The mouse needs some kind of sensor — it could be tactile, sonic, radar, visual, according to choice — which will tell it about these things.

It needs to fit into a passage 6½in wide and be short enough to turn round in it. If the upper parts of the mouse (some of the American ones were like a block of flats) are to be more than 6½in wide, then allow at least 2in height to clear the walls of the maze.

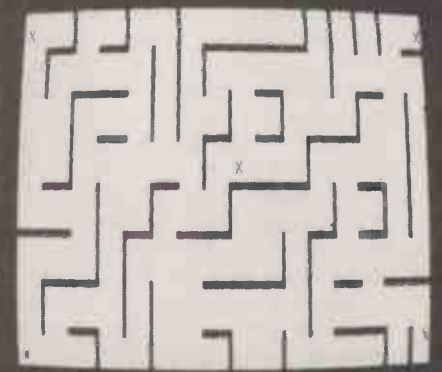
Up a drainpipe

To win the first section, a mouse must be able to remember where it has been, to deduce short-cuts, and retrace an idealised course.

To win the second section, it has to be damned fast.

To win the third, it has to have quite sophisticated sensors that are capable of recognising arbitrary objects.

To win the fourth, the freestyle contest, it has to do something spectacular. Just what, is up to you.



Look out for April's *PC* featuring this zany Mazegame...

Practical Computing shows you how to

Get some more space into those North Star programs

SOME BASIC interpreters only store typed spaces in program when they are inside strings. Their LIST routines include coding to insert spaces during the printing of a program, whether or not these existed in the original version. The North Star Basic interpreter, amongst others, stores all spaces exactly as typed and a LIST will produce a printout identical to the original version. In this article **Dr John Lee** and **Timothy Lee** present a routine which shows how the spacing on a North Star Basic line can be changed to improve its readability.

The following rules define the objectives of the program:

1. A single space is inserted immediately following each line number. This conforms with the ANSI specification for Minimal Basic.

2. In general a space is put before and after each reserved word. (Reserved words are stored as the numbers 128-255 in a single byte, and correspond to all of the words in the Basic language such as PRINT, LET, IF, FOR, SQRT, COS, etc, together with arithmetic operators + - * / ↑ => < etc.). The two symbols \ and , are not stored as reserved words, but are treated as such by the program. The following exceptions to this general rule have been included, since experience has shown them to be essential or highly desirable.

- No respacing is performed on characters comprising a string.
- REM statements are not respaced. This is necessary because reserved words appearing in REM's are compacted to a single byte. Avoiding respacing prevents errors such as the word FUNCTION, where the letters ON form a special word, being respaced as FUNCTI ON. The program does not detect embedded REM statements, that is REM's occurring as the second or subsequent statement in a multi statement line, hence these may be respaced.
- Spaces are not included before a comma except in strings and REM statements.

```
10 DIM Q(132), F$(10), O$(10), A$(10)
20 INPUT "TYPE NAME OF INPUT FILE ?", FS
30 F = FILE(FS)
40 IF F = 2 THEN 110
50 IF F > - 1 THEN 80
60 PRINT "FILE '", FS, "' DOES NOT EXIST!"
70 GOTO 20
80 PRINT "NOT A BASIC TYPE 2 FILE"
90 INPUT "TYPE 'RETURN' TO CONTINUE", AS
100 IF AS <> "" THEN 20
110 OPEN #0%F, FS, L
120 INPUT "TYPE OUTPUT FILE ?", OS
130 F1 = FILE(OS)
140 IF F1 > - 1 THEN 190
150 PRINT "CREATING ", OS, " SIZE", INT(L
    * 1.25), " TYPE 2"
160 CREATE OS, INT(L * 1.25), 2
170 OPEN #1%2, OS
180 GOTO 240
190 IF F1 = 2 THEN 230
200 PRINT "NOT A BASIC TYPE 2 FILE"
210 INPUT "TYPE 'RETURN' TO CONTINUE", AS
220 IF AS <> "" THEN 120
230 OPEN #1%F1, OS
240 READ #0, &L
250 READ #0, &Q(2), &Q(3)
260 READ #0, &L
270 IF L = 32 THEN 260
280 Q(4) = 32
290 P = 4
300 IF L <> 143 THEN 390 \ REM REM
310 P = P + 1
320 Q(P) = 143
330 P = P + 1
340 READ #0, &Q(P)
350 IF Q(P) <> 13 THEN 330 \ REM RETURN
360 P = P - 1
370 GOTO 760
380 READ #0, &L
390 IF L = 13 THEN 760 \ REM RETURN
400 IF L = 44 THEN 500 \ REM,
410 IF L = 92 THEN 500 \ REM \
420 IF L > 127 THEN 500
```

- Following the detection of character 154 no space is inserted. This character indicates that a line number is embedded in the line (for example following a THEN or GOTO), and the next two bytes contain the line number which is copied exactly. Failure to do this would corrupt all embedded line numbers.
- No space is inserted after the reserved word FN, to prevent FNA being converted to FN A.
- The following special rules apply to the use of parentheses (often wrongly called brackets) except in REM's and strings: Spaces do not occur before) or after (a single space is inserted before the character (only if the preceding character

was + - * / ^ or =. A space is inserted after the character) only if next non space character is a reserved word.

File handling

At its simplest, the program reads an input file from disc and writes an output file to disc either on the same disc or on a different disc. The user is asked for the name of the input file, and checks are performed to ensure that it exists, and that it is a type 2 (BASIC) file. The user is then asked for the name of the output file. If this already exists, a check is made to ensure that the file is type 2 (BASIC). The original file will be overwritten during the run, and the program will eventually fail if the original file is not large enough. If the

output file does not exist, a new file is created with size 1.25 times the size of the input file. This has been found in practice to give a file plenty big enough. The program will fail if there is insufficient disc space for the output file. It is probable that if the files names are not type 2 the user has typed the wrong filename, and the user is offered the choice of typing a new file name, or continuing with the old file name despite it being the wrong type.

The input file is read one byte at a time, tidied, and temporarily stored in the Q array until a whole line has been processed. This is then output. The large buffers held Basic for input and output to and from disc minimise disc activity and improve the execution speed.

```

430 P = P + 1
440 Q(P) = L
450 IF L <> 34 THEN 380 \ REM HOLLERITH
460 P = P + 1
470 READ #0, &Q(P)
480 IF Q(P) <> 34 THEN 460
490 GOTO 380
500 IF L <> 154 THEN 550
510 Q(P + 1) = 154
520 READ #0, &Q(P + 2), &Q(P + 3)
530 P = P + 3
540 GOTO 380
550 IF Q(P) <> 32 THEN 580
560 P = P - 1
570 GOTO 550
580 N = Q(P)
590 IF N = 224 THEN 660 \ REM(
600 IF L = 44 THEN 660 \ REM,
610 IF L = 41 THEN 660 \ REM )
620 IF N = 227 OR N = 229 OR N = 226 OR N = 231
   OR N = 225 OR N = 245 THEN 640
630 IF L = 224 THEN 660 \ REM(
640 P = P + 1
650 Q(P) = 32
660 P = P + 1
670 Q(P) = L
680 M = L
690 READ #0, &L
700 IF L = 32 THEN 690
710 IF M = 144 THEN 750 \ REM FN
720 IF M = 224 THEN 750 \ REM(
730 P = P + 1
740 Q(P) = 32
750 GOTO 390
760 Q(1) = P + 1
770 FOR I = 1 TO P
780 WRITE #1, &Q(I), NOENDMARK
790 NEXT I
800 WRITE #1, &13, NOENDMARK
810 READ #0, &L
820 IF L > 1 THEN 250
830 WRITE #1, &1
840 CLOSE #1

```

The program

Lines	Function
10-230	open input and output files and perform associated checks.
240-290	handles space after line number.
300-370	copies REM's exactly.
390	detects end of line character.
400-420	detects reserved words.
430-440	copies normal ASCII character.
450-490	copies string exactly.
500-540	detects and handles embedded line numbers.
550-570	removes spaces before reserved word.
580-650	inserts a single space before a reserved word except in special cases.
660-670	copies reserved word.
680-700	searches input line for next non space character.
710-740	inserts a single space after a reserved word except in special cases.
750-800	outputs tidied line.
810-840	detects end of file mark and closes files.

The listing of the program has been tidied by itself, and illustrates the various points discussed. A trivial problem which has not been overcome is shown in line 50:

```
50^IF^F^>^ ^-^1^THEN^80
```

The splitting of the — from the 1 looks incorrect, but by contrast line 360 looks correct:

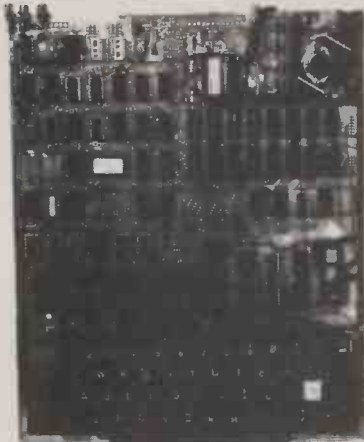
```
360^P^ = ^P^ ^-^1
```

The ability to renumber the input file was considered but not included since the REM function already exists in Basic. It is conceivable but highly unlikely that a line of input which approaches the maximum length of 132 characters could be respaced to make it too long. The program will fail since the Q array is dimensioned at 132. It was not considered necessary to include a check for this since the ANSI standard for minimal Basic defines the maximum line length as 72 characters. Finally it was considered unnecessary to protect users from the results of their own sabotage if they should choose to use the same file for both input and output.

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4050 (350ns)	£2.35	8255	5.08	7470	0.19	74190	0.45	4029	0.65	74LS102	0.14	74LS113	0.32	74LS253	0.92
4060 (300ns)	2.39	Baud Rate		7472	0.17	74191	0.43	4030	0.52	74LS103	0.14	74LS114	0.32	74LS257	0.92
4116	6.74	Generators		7473	0.23	74192	0.43	4032	0.83	74LS104	0.16	74LS122	0.69	74LS259	0.92
Static RAMS		MC14411	5.87	7474	0.20	74193	0.44	4034	1.13	74LS105	0.19	74LS123	0.72	74LS259	1.39
2102A	1.16	MM5307	9.38	7475	0.25	74194	0.44	4035	0.79	74LS108	0.18	74LS124	1.39	74LS261	4.50
2102A-2	1.16	UARTS		7476	0.17	74195	0.38	4040	0.60	74LS09	0.18	74LS125	0.36	74LS266	0.37
2111A-1	1.70	AY-5-1013	3.65	7482	0.52	74196	0.61	4042	0.48	74LS10	0.18	74LS126	0.36	74LS273	1.70
2112A-1	1.70	MM5303	5.04	7485	0.90	74197	0.65	4043	0.52	74LS11	0.18	74LS132	0.60	74LS279	0.57
2112A-2	1.83	*TMS6011NC	4.30	7486	0.16	74198	0.65	4046	0.65	74LS12	0.18	74LS133	0.39	74LS283	1.09
21L02	1.16			7489	1.30	74199	0.86	4049	0.30	74LS13	0.37	74LS136	0.36	74LS289	4.50
2114	1.16			7490	0.24	*74221	0.91	4050	0.30	74LS14	0.65	74LS138	0.58	74LS290	0.91
4035 (1000ns)	1.07			7491	0.54	*74247	1.17	4051	0.45	74LS15	0.18	74LS139	0.58	74LS293	0.91
4045 (250ns)	6.15			7492	0.29	*74251	0.70	4052	0.45	74LS16	0.18	74LS145	0.97	74LS295	1.30
5257 (TMS4044)	6.93			7493	0.24	*74273	1.10	4054	1.10	74LS17	0.18	74LS151	0.81	74LS298	1.16
6810	3.03	TTL		7495	0.35	*74283	0.98	4056	1.35	74LS18	0.65	74LS153	0.52	*74LS348	1.39
ROMS		7400	0.10	7496	0.42	74365	0.52	4059	4.64	74LS19	0.18	74LS154	1.30	74LS352	1.04
2513 (U.C.)	6.25	7401	0.10	74107	0.19	74366	0.52	4060	1.04	74LS20	0.18	74LS155	0.72	74LS353	0.92
2513 (L.C.)	6.25	7402	0.10	74109	0.30	74367	0.52	4065	0.30	74LS21	0.18	74LS156	0.72	*74LS362	4.21
MM5230	4.62	7403	0.11	74121	0.20	74368	0.52	4068	0.16	74LS22	0.18	74LS157	0.57	74LS365	0.47
CPU		7404	0.12	74122	0.29	74390	0.85	4069	0.15	74LS27	0.18	74LS158	0.57	74LS366	0.47
6800	6.01	7405	0.13	74123	0.45	C.MOS		4070	0.15	74LS28	0.18	74LS160	1.09	74LS367	0.47
8080	5.08	7406	0.21	74125	0.39	4000	0.25	4071	0.15	74LS29	0.18	74LS161	1.09	*74LS373	0.78
9900	26.05	7407	0.21	74126	0.39	4001	0.15	4072	0.15	74LS30	0.18	74LS162	1.16	74LS386	0.36
Z80	9.00	7408	0.12	74132	0.54	4002	0.13	*4075	0.15	74LS32	0.26	74LS163	0.69	*74LS386	0.84
6502	9.50	7409	0.13	74141	0.40	4006	0.68	4077	0.15	74LS33	0.26	74LS164	1.06	*74LS668	1.17
E-PROMS		7410	0.11	74145	0.40	4007	0.13	4081	0.15	74LS37	0.26	74LS165	0.72	74LS670	1.71
1702AQ	5.16	7411	0.17	74147	1.17	4008	0.54	4082	0.15	74LS38	0.23	74LS166	1.65	74LS670	1.71
2708	6.26	7412	0.13	74148	0.86	4009	0.30	4085	0.71	74LS39	0.18	74LS169	1.71	8 x 4116	
2716	24.00	7413	0.19	74150	0.50	4010	0.26	4086	0.71	74LS40	0.18	74LS170	1.72	only	
T.V. Controller		7414	0.40	74151	0.42	4011	0.25	4088	0.15	74LS42	0.85	74LS173	0.81	£49.50 + VAT	
SFF96364	14.59	7416	0.19	74153	0.37	4012	0.14	4089	0.44	74LS47	0.81	74LS174	0.97	21L02	
Buffers		7417	0.25	74154	0.59	4013	0.35	4093	1.30	74LS48	0.81	74LS175	0.97	8 for £8.50	
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8T98	1.57	7445	0.56	74175	0.50	4027	0.63	4534	4.78	74LS93	0.80	74LS241	2.08		
Interface		7446A	0.56	74176	0.63	4028	0.62			74LS95	0.60	74LS242	2.08		
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A systematic approach to program design

by Nick Hampshire

FOR THE AVERAGE microcomputer user, the prospect of writing a set of programs to perform, say, a business application is daunting. Many give up at this stage and don't even try, preferring to use an off-the-shelf package or find someone else to do the programming.

Yet this does not have to be so, since any averagely intelligent person can write and design such a program. Given a logical framework on which to build, plus a few aids in the form of standard sub-routines, the process of writing a program becomes considerably easier.

Let us consider a hypothetical user with a 32K PET, dual 2040 floppy disks and 3022 printer who wishes to use this system to write a library reference data base. The first stage in system design is for the user to decide exactly what the program must do.

In this case the program is required to reference a book or books from a small library of 500 titles either by subject matter or author. Thus the user wants to be able to type in a subject in which he is interested and get the computer to produce a list of titles of books in his library containing information on that subject.

Similarly, the user wants to produce a list of books written by a particular author. The problem is thus a fairly straightforward one of data access and retrieval from a data base stored on disk.

Four-part program

The program can be divided into four parts:

- Data entry**, used to enter details of new titles added to the library.
- Data update** needed to correct mistakes in the data base or to delete entries whose titles have been removed from the library.
- Data access**: the part of the program which performs the user's requirement of accessing data from the data base in response to a particular input.
- Data file maintenance**: to allow the user to make security backup copies of the data file. It will also perform functions like sorting the data file into alphabetical order.

You will notice that of the four parts of this program, three parts are concerned with the upkeep of the data file and this is typical of all programs using disk data bases. Each of these four program parts is totally independent of the other parts and interacts with the others only via the data base.

Since each part is independent it can be

written as a separate program, which makes life much simpler for the programmer — only one part of the program need be written at a time. Each part can be stored on disk as a separate program and loaded by the user when required. A collection of programs like this is referred to as a program suite.

The unifying factor of all the programs in a suite is that they all use the same data base. Therefore, before any programs are written, the nature and format of the data must be defined. This is probably the most critical and trickiest part in the design of a program: bad file structures are the cause of a lot of poor programs.

Choice of data file

Unfortunately there is no easy rule of thumb which can be used to select the best kind of data file to be used in a program. The only rule worth remembering is that if the data file is very large, by which I mean a file which contains more data than can be stored in the machine's internal memory, then that file should in most cases be a random access file.

Short files which can be loaded into arrays and stored in core are best stored on disk as sequential files. The reason for this is that it makes data access times considerably faster and also makes file maintenance much easier.

In the example program, careful examination of the problem reveals that three major data files are required. The largest is the primary data base file which contains book titles and details of the contents: this file is to be organised as a random access file.

The other two files are both sequential: an author file and a subject file. It is one of these two shorter files which is searched during data access. Each record contains, say, the author's name followed by a series of pointers to records in the random access main data base file.

These pointers are simply record numbers: in a random access file system this is all the information required to access a particular block of information from a file. The advantage of using a short file consisting of a key and one or more pointers into a larger file is primarily one of speed, but also it is much easier to sort a short key file than a long random access file.

Another advantage of using short key files is that one can have multiple key files, just as here we have an author file and a subject file.

Having decided the types of file to be used in the program suite, and this

example is very typical of many applications programs, we must decide on what data format is to be used in those files.

Very careful thought should be given to data formatting to make optimum use of the storage capacity of the machine. First let's look at random access files. A random access file consists of a set of records. There may be one hundred, a thousand or even ten thousand, depending on the application and the machine.

In our example the maximum number of titles is 500, therefore we do not require more than 500 records in the random file. Each record is of the same length, common record lengths are 128 (2⁷) or 256 (2⁸) bytes or some other power of 2 since using a record 128 bytes long makes for greater reliability because this is the natural organisation of the computer system.

Since our hypothetical user has a PET system which has a fixed record length of 256 bytes, we shall consider the formatting of a record of this length. The first step is to jot down a list of all the different data you wish stored in each record, and against each item to note the maximum number of bytes required to store it together with a note of whether the data is numeric or alpha.

Memory total

A running total of the number of bytes used should be kept since it is very important that the total should not exceed the maximum which we have set for the record, in this case, 256 bytes. Great care should also be taken that each data item, or field as it is known, within a record has sufficient space to accommodate the maximum possible size data entry necessary to ensure transfer of all required information in that field.

In our example the list would probably look something like this:

Field name	Bytes	Type
AUTHOR	20	Alpha
TITLE	50	Alpha
DATE	6	Numeric
CONTENTS	180	Alpha

There are one numeric and four alpha fields in the record. It is always desirable to store a record so that all the fields are of the same variable type. Thus in the example, the date should be converted to

Continued over page

an alpha string before it is entered into the record.

The date field always occupies six bytes but the three alpha fields are of variable length; the number of bytes quoted above is the maximum allowed for each entry. Any entry shorter than the maximum is padded out with spaces on the end of the string to bring it up to the maximum length.

For instance well-known author Kay, J. will be stored as KAY,J. 0000000000000000 Shakespeare,W. as SHAKESPEARE,W. 000000 while George Bernard Shaw just makes it under the wire as SHAW, GEORGE,BERNARD0

Using this method we know that the title field, for example, always starts at the 21st byte of a record and ends on the 70th byte. This makes it easy, using the string manipulation commands in Basic, to retrieve each item of data from a record — see Figure 1.

Since it is envisaged that our example random access file will have a maximum of 500 records, each of 256 bytes the total data base will have a maximum size of 125K bytes. This will fit nicely on one disk, something which should always be aimed for when designing a program, since it is good practice to use one disk drive for data and the other for program storage.

By the same token, it is not desirable to

have to change disks during program execution since this invariably leads to unreliability and a greatly increased chance of losing a data file.

While random access records must always have a fixed length, records in sequential files can have either fixed or variable lengths. The choice depends on the application. In many cases the data will always be the same length, making a fixed length and format sequential file the logical choice. Or, as with the random access file in our example, each sequential file record may contain multiple fields, so fixed-format, fixed-length records are the answer. They are much easier to dissect than variable length records.

But there are applications, and our example is one of them, where fixed-length sequential records are impractical. Each of the two sequential files contains a variable number of records. Each record consists of a key (the author's name or his subject) and a variable number of numeric pointers to records in the random access file.

To use fixed-length records in this application would require the allocation of sufficient space in each record to

0	20	70	76	256
AUTHOR	TITLE	DATE	CONTENTS	

accomodate the maximum length key word, together with the maximum number of pointers. Since the file is to be stored in core memory as an array, the large amount of space (and therefore memory) wasted by using fixed-length records makes this totally impractical.

When records do not have fixed lengths, demarcation markers must be used between fields. The marker most commonly used is an asterisk. To dissect this sort of record, search from right to left for the first occurrence of the marker character. The record to the right of the marker is removed and the next marker searched for. This method is clumsier than that used for fixed-length, fixed-format records but is just as effective. In our example then, a record in the author file may be stored as:

SMITH.J.*14*56*79*125*2566*428*

The first field is a key — the author's name — SMITH.J. The next and subsequent fields are the pointers to the random access file showing that titles written by this author are stored in records 14,56,79,125,256, and 428. Using this method the author's name can be as long as necessary and can be followed by as many references as is required (subject only to the maximum length of a record which is limited by the maximum length of a string. (In most BASICs, strings must be less than 256 characters long).

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of input to be used throughout the programs. One example would be the format of all date inputs.

All inputs ought to be made using the same variable type and format since it is disturbing to have some inputs terminated by a carriage return and others not.

So one might make a decision to have all inputs in string format with a fixed-length prompt and traps for null entries, illegal carriage returns etc. Decisions should also be made at this stage as to the nature of any input validation and error checking procedures, such as the use of a check digit.

Once the specifications have been written, programming can begin when working on a suite of programs, it is best to start with data entry since this program can then be used to create the data files needed to test the other programs in the suite. Each of these programs can be divided into a set of subroutines. A subroutine is a short, self-contained program written to perform a specific function which can be run by itself without the rest of the main program.

The great virtue of using standard subroutines to build a program is that they need not be specific to that program and can be reused in any other program requiring them. This means that once, for example, a good subroutine has been written to input and validate the data, it can be converted to a standard internal format which can be easily stored and recovered whenever required by another subroutine written for the purpose.

This pair of subroutines can then be repeatedly used in other programs, greatly reducing programming effort. The extensive use of standard sub-routines is the key to writing good programs quickly and easily. To make maximum use of standard sub-routines the programmer must adopt a strict discipline about the use of variable names.

This is essential since a sub-routine

Variable either string or numeric.	Function
E	All E variables refer to error flags and messages.
A,B	Temporary variables in sub-routines
S	Disk sector variable.
T	Disk track variable.
I	Index variables.
D	Disk drive designator variable.
F	Format variables, printer and disk.
P,R	Parameter variables passed by subroutines.
Q,I,X	For-Next loop variables.
Z	File delimiter variable.
TI	Time variable.
DA	Data variable.
COL	Column number of cursor.
LNE	Line number of cursor.

Figure 3

All the above variables can be either string or numeric and except for the four multiple character variables can be followed by any character. Thus with E variables one might have EM\$ and ES,ET,ED,EP etc, providing the resulting variable is neither one of the four multiple character variables or a reserved word Basic.

communicates with the main body of the program (ie the code which links the sub-routines together) by means of input and output parameter variables. Obviously a specific set of variables must therefore be reserved for this purpose.

A set of variables must also be allocated for specific purposes, such as error states, or temporary variables used within a sub-routine. Figure 5 is a suggested table of such reserved variables.

When writing a program, the task will also be made much easier if subroutines are allocated a specific block of line numbers. Similarly blocks should be allocated to program header, variables and arrays, and the main program. They could be arranged thus:

Line Nos	Function
1-99	Description of the program using REM statements.
100-999	Definition of variables and arrays used in the program.
1000-9999	Main body of the program.
10000-30000	Standard subroutines.
30000-32000	Error handling routines.

The standard subroutines in this arrangement are located in line numbers between 10000 and 30000. They might include:

- Input and validation routines for strings and numbers.
- Address input and validation.
- Address output.
- Date input and validation.
- Date output.
- Date conversion to internal format.
- Date reconstruction from internal format.
- Creation of check digit and error detection in numerical input.
- Screen handler and cursor positioning.
- High density graph and bar chart plotting routines.
- Sorts of array and disk file data.
- Searches of arrays and files.
- Disk handling and file access, random and sequential.
- Linked list file create.
- Head and tail file create.
- Dump screen contents out to printer.
- Draw borders around the screen.
- Error message handling.
- Yes/No validation.
- etc.....

These are examples of some of the sub-routines which are commonly used. Carefully used, a library of such sub-routines can reduce the time and effort required to write a program by as much as 75%.

• This article is a shortened version of the introductory chapter of a new book entitled *A Handbook of PET Sub-routines* written by Nick Hampshire and available in April 1980 from Commodore dealers and computer bookshops. This book is a library of sub-routines written for the PET but of interest to anyone running a version of Microsoft Basic. □

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Bright Electronics, 29/31 Wincombe Drive, Ferndown, Wimborne, Dorset BH22 8HX. Tel: 0202 875075.

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COMPUTER WORKSHOP

System 1. Typical size: 40K memory; dual 8in. floppy disc, total storage capacity 1.2MB; Ricoh daisywheel printer.

System 1, £5,000 plus

System 2. Typical size: 24K memory; dual minifloppy discs of 80K bytes each; Centronics 779 dot matrix printer; VDU.

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 £1,300

CROMENCO

Single-card computer: 4MHz Z-80 CPU, S-100 bus, 1KB RAM, sockets for 8K ROM. 20mA/RS232 serial interface and parallel bidirectional interface. Basic in ROM and Z-80 monitor. For OEM and industrial users; used with backplane for "full computer compatibility" (Reviewed February 1979).

£225 (in kit form) to £260

Z-2: Min. size: chassis, 31A power supply, motherboard, Z-80 processor, 16KB memory. Max size: 512KB, 21 sockets, three minifloppies or four 8" floppies. Basic, Fortran, Cobol, assemblers. For serious hobbyists, OEMs, educational applications, and industrial/scientific users.

£360 (in kit form) to £3700

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.

£1,995 upwards

System Two/64: 64KB, dual 90K mini-floppies, dual printer interface, serial interface. Options: two additional floppies, 512KB, up to seven terminals, CP/M compatible operating system (CDOS), Fortran, Cobol, Basic, assemblers, word processing, data-base manager. Multi-user system for software development, or scientific/industrial/business users.

£1995 upwards

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".

£2,995 to more than £8,000

System Three/64: New configuration featuring dual 8" floppies, Z-80A processor, 64K of 4MHz memory; console and printer interfaces. Macro assembler, Fortran IV, Extended Basic, Cobol, Multi-user Basic. All systems sold by Datron Interform, Comart, Micro Centre. Prices quoted by Comart.

£3270

DIGITAL MICRO SYSTEMS

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

DYLE HOUSE

Business Computing System 2000. Z-80A. Dual 8in. discs, 140 cps 132 char printer. Dyle House Business Basic, and disc operating system. Accountancy, payroll and parts control suites. Applications: Sales acknowledgments, sales invoices, delivery notes, purchase orders, customer statements, remittance advice. Dyle House Ltd (01-529 2436).

No price announced

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 distributors Equinox Computers Ltd (01-739 2387).

£5,000-£40,000
plus

EURO-CALC

Euroc: 8080A CPU, 64KRAM, two times double-sided single-density 8" floppy disc drives with approximately 1 MByte capacity. 15" screen with 80 by 25 characters, QWERTY keyboard. CP/M operating system 140 CPS tractor feed matrix printer. Software: C-BASIC 2. Supplied with accountancy package for sales, purchases and nominal ledgers and initial stationery. Sold through Euro-Calc, 55/56 High Holborn, London W.C.1. Tel: 01-405 3113.

£8000

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. Factor One is sole distributor for U.K. (Reviewed March, 1979.)

From £760
without VDU to
£1,200 with
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HEATH SCHLUMBERGER

H8. 8080 CPU. 4664K PAM. Serial/cassette I/O; front parallel monitor; keypad; optional parallel I/O; serial multiport; breadboard I/O and disc system. Basic, Ext Basic, Mierosoft Basic, HDOS, CPM.

From £262 (in kit
form)

WH89. All-in-one computer. Z-80 processor plus Z-80-controlled VDU. 16K expandable to 48K, user-accessible. Two RS232 I/O ports. Operating system includes Benton Harbour Basic, two-pass absolute assembler, text editor, utility programs, Mierosoft Basic and Fortran word processor package. Heath Schlumberger (0452 29451).

About £1,600

HEWART MICROELECTRONICS

Mini 6800 Mk II. IK monitor; IK user RAM, IK 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; IK 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

IMSAI

VDP 40: 32K or 64K RAM memory; 9in. display screen, standard keyboard. Two 5¼in. floppy disc drives; serial I/O. Full software support, and packages available for the VDP 42, which has larger disc capacity. Packages for VDP 80 could be converted for smaller systems. This would be from about £700 per package. Two main dealers in the country.

£4,507 for 32K
model. £4,950 for
VDP 42

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 £827 to
£3003 for 48K,
two floppies and
printer

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BM 2	3.2	5.4	6.5	9.9
BM 3	7.3	11.1	13.2	18.4
BM 4	7.2	11.6	13.9	20.4
BM 5	8.9	12.6	15.0	21.7
BM 6	18.6	19.3	22.3	32.5
BM 7	28.2	27.6	31.6	50.9
BM 8		5.2	6.2	12.3

Apple II plus with 16k RAM
16K memory add-on £750
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LUXOR

ABC 80. Min size: 35K with keyboard, CPU 12in. screen and cassette. Max size: 40K RAM with discs. Z-80 processor, loudspeaker with 128 effects, real-time clock. Options: printers, plotter, discs, module cards, digitiser, modem. 60 compatible I/O memory boards. Software: Basic with resident editor; assembler; games; business and educational packages. Personal computer aimed at home market, small business and education. CCS Microsales is U.K. agent and is looking for distributors.

£795 plus VAT

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 parts; 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 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; floppy
disc £3,200; hard
disc, £8,000-
£12,000

NASCOM MICROCOMPUTERS

Nascom I. 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. (Reviewed January, 1979.)

£165 exc VAT

NATIONAL MULTIPLEX

Pegasus. Min size: 48K, Z-80; double-density floppies (320KB); S100 bus; 12in. CRT; 58-key keyboard; two serial and one parallel interfaces; 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 £79.95.
Assembled
£99.95. I/O board
£35

Explorer 85: Min size: 4K. Max. size: 64K. 8085A processor, VDU board, ASCII Keyboard, S100 expansion. Cassette, RS232, TTY interface on board. I/O ports, programmable timer. Disc software, Microsoft Basic on cassette, 8080 and Z-80 software can be used. Aimed at hobbyist, OEM and small business. Available from Newtonics (computer division of HL Audio).

From £297 plus VAT

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 in Newbury and Stockport.

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. (Reviewed April, 1979)

£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 x 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. (Reviewed June, 1979.)

From £298

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-£5,000

POWERHOUSE MICROPROCESSORS

Powerhouse 2: Desktop unit using Z-80A with 5" built-in VDU and built-in minicassette (optional), 16K or 32K RAM, full keyboard, real-time clock, two spare slots, RS232 interface. Software: Disc and cassette operating system, programmable keyboard facilities for eight PROM chips giving a max of 16 or 32K or ROM, 2K monitor in EPROM. Extended basic (optional). Aimed at OEMs and expert users such as scientists or researchers. Applications include real-time process control, engineering calculations. Availability: Powerhouse only (0442) 42002. (Reviewed, September 1979).

From £1200

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 (Reviewed July, 1979.)

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.

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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

Cosmac. 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).

Kit £79.95.
Assembled £99.95
exc 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, Microdigital and Portable Microsystems (Reviewed July, 1979.)

1K — £249.50
4K — £315

SCIENCE OF CAMBRIDGE

Mk 14. 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 (£78.95); 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. (Reviewed May, 1979.)

£39.95 basic

SDS

SDS 100. Single unit containing 32K memory (expandable to 46K); 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

SEMEL

Semel I. Min size: 4K with CPU, keyboard and monitor. Max size: 64K with single floppy disc unit, printer, VDU and keyboard. Can be coupled to any external device and controls up to 8 x 250K floppy disc units. Four configurations available. Options: Light pen attachment; 12V DC power supply; remote terminals. Software: Editor, Assembler, debug, full file-handling capabilities in Basic, Fortran and Cobol available on 64K machine; user-defined programs written and compiled by agreement; word processing. General-purpose unit for use as a terminal controller. Suitable for small business and OEMs. Available from Semel exclusively (0822) 5439.

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Athens D1/C 8200: Eight-bit 8085 desktop computer with in-built dual mini floppies, inbuilt dual mini-cassette, inbuilt matrix printer and 1920 display. Can be expanded with 10 micros, beyond the CPU, each working as an intelligent controller, up to four floppy disc drive and four rigid disc drives. Maximum memory is 1.2GBytes. Standard system software is the AMOS multi-task operating system. Claims a performance roughly comparable to the DEC PDP-11/34. Butel-Comco, Southampton (0703) 39890, are the sole U.K. distributors.

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SORD

M100. Min size: 16K RAM; 4K ROM Monitor; full keyboard plus function keypad; two-channel joystick dual cassette I/F; 11K E Basic 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.

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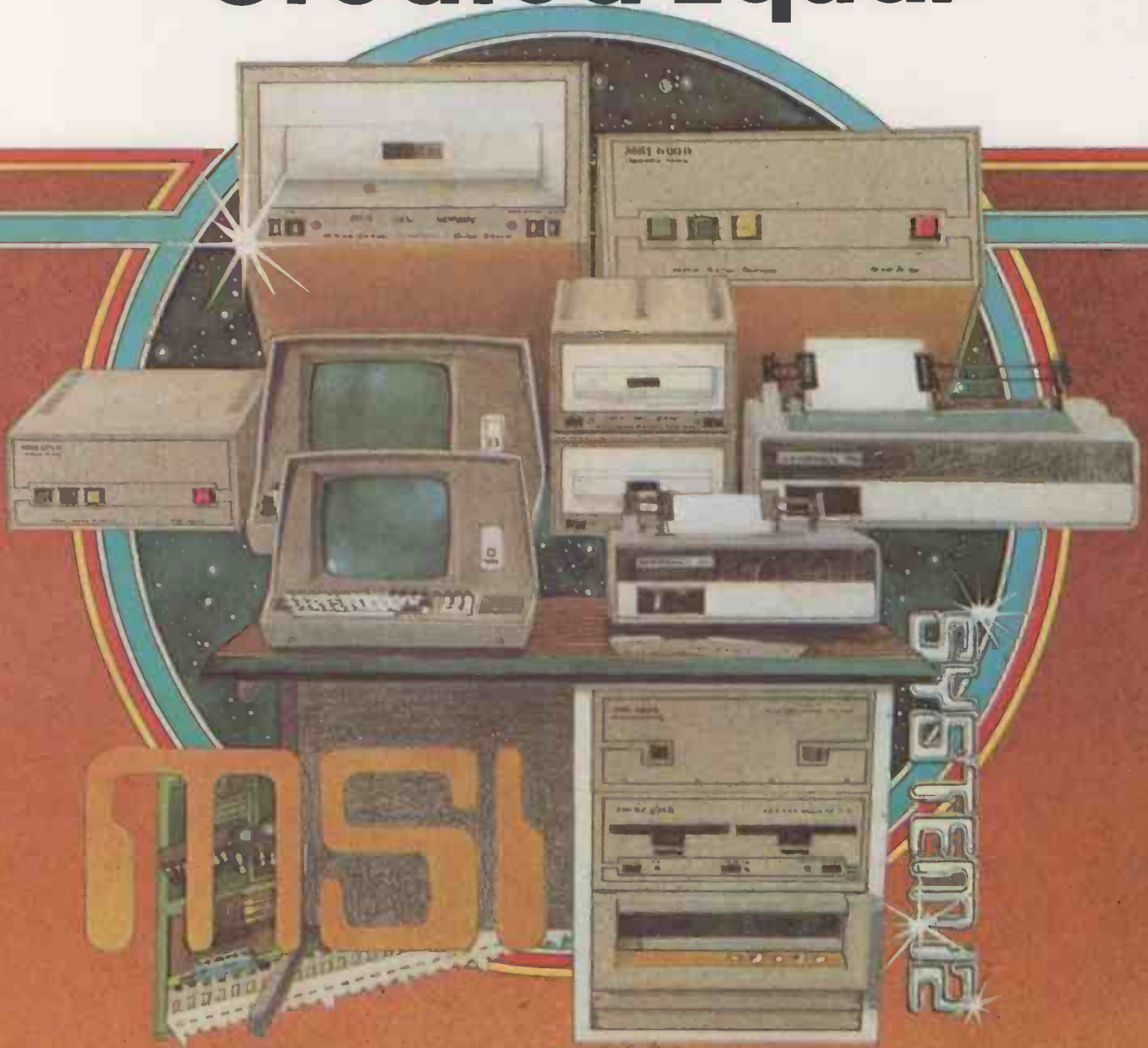
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	CP/M version 2 (not all formats available immediately)	£95/£15			
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	MAC — 8080 Macro Assembler. Full Intel macro definitions. Pseudo Ops include RPC, IRP, REPT, TITLE, PAGE, and MACLIB. Z-80 library included. Produces Intel absolute hex output plus symbols file for use by SID (see below)	£55/£10			
	SID — 8080 symbolic debugger. Full trace, pass count and break-point program testing system with back-trace and histogram utilities. When used with MAC, provides full symbolic display of memory labels and equated values	£45/£10			
	ZSID Includes Z80 mnemonics	£50/£10			
	TEX — Text formatter to create paginated, page-numbered and justified copy from source text files, directable to disk or printer	£45/£10			
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(L)	BASIC-80 — Disk Extended BASIC Interpreter Version 5, ANSI compatible with long variable names, WHILE/WEND, chaining, variable length file records	£155/£15			
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(L)	FORTRAN-80 — ANSI '66 (except for COMPLEX) plus many extensions. Includes relocatable object compiler, linking loader, library with manager. Also includes MACRO-80 (see below)	£205/£15			
(L)	COBOL-80 — ANSI '74 Relocatable object output. Format same as FORTRAN-80 and MACRO-80 modules. Complete ISAM. Interactive ACCEPT DISPLAY, COPY, EXTEND	£325/£15			
(L)	MACRO-80 — 8080/Z80 Macro Assembler. Intel and Zilog mnemonics supported. Relocatable linkable output. Loader, Library Manager and Cross Reference List utilities included	£75/£10			
(L)	XMACRO-86 — 8086 cross assembler. All Macro and utility features of MACRO-80 preserved. Mnemonics slightly modified from Intel ASM86. Compatibility data sheet available	£155/£15			
(L)	EDIT-80 — Very fast random access text editor for text with or without line numbers. Global and intra-line commands supported. File compare utility included	£45/£10			
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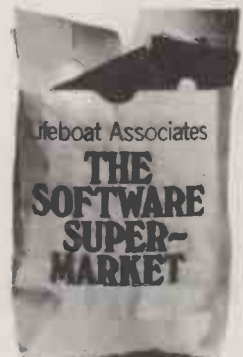
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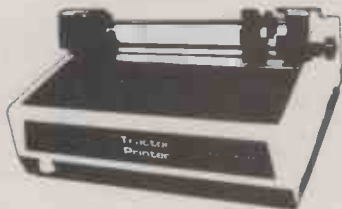
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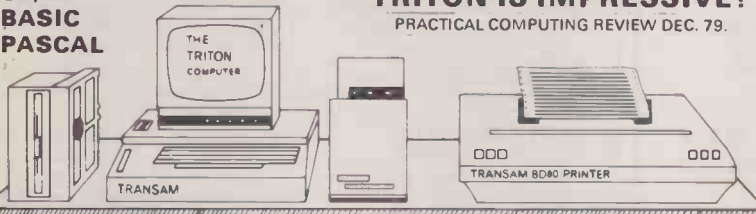
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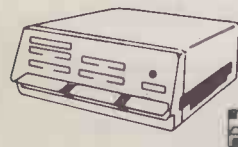
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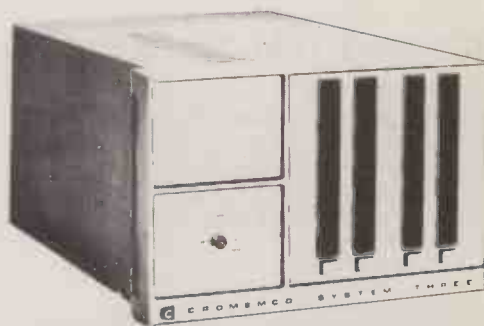
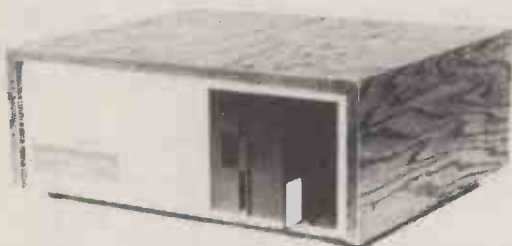
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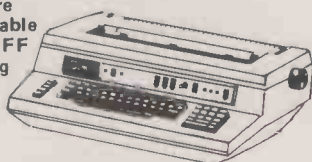


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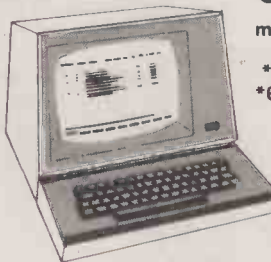
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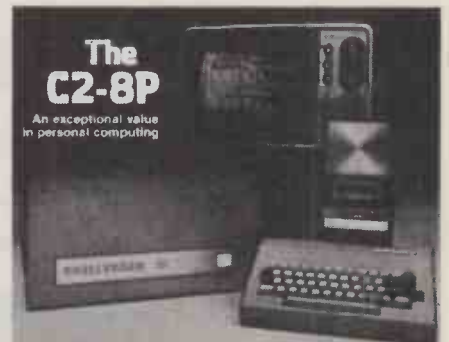
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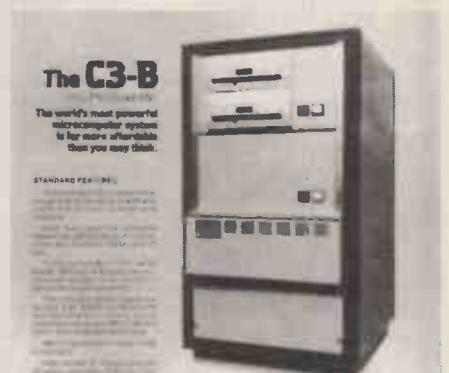
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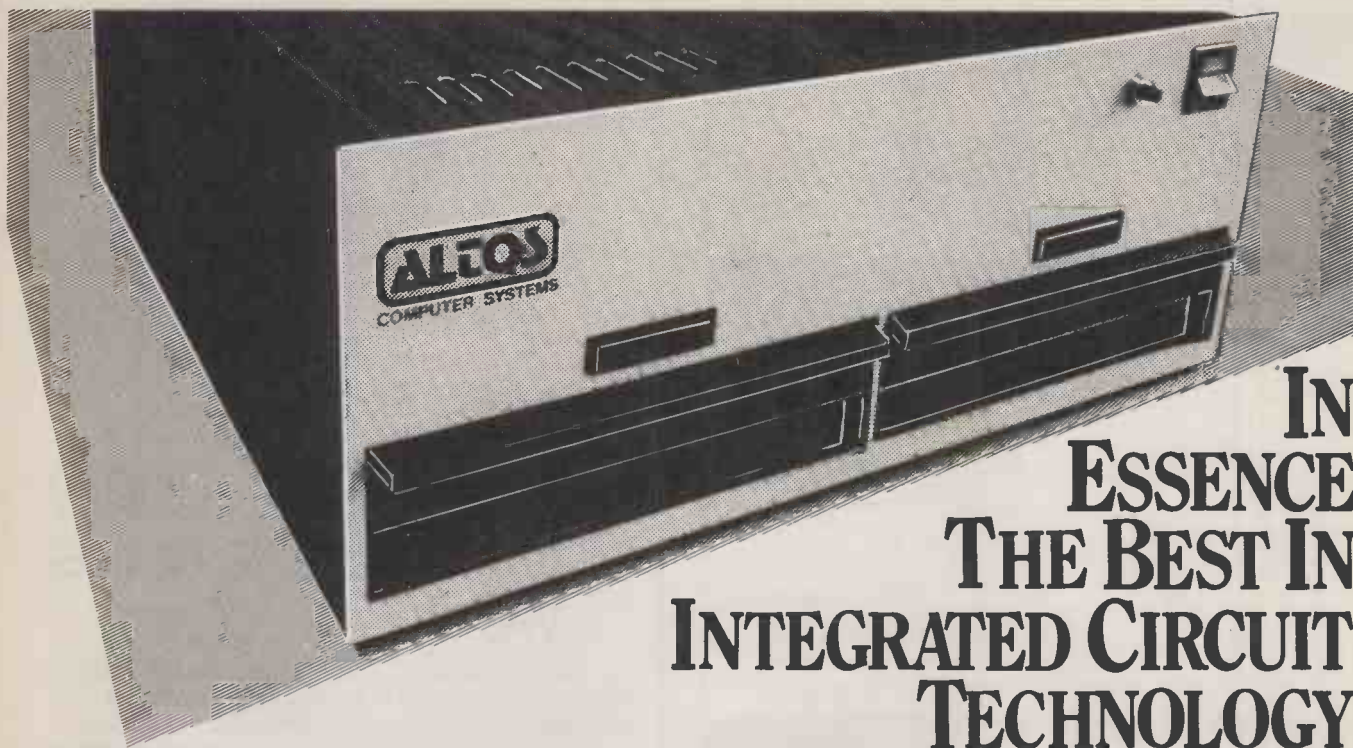
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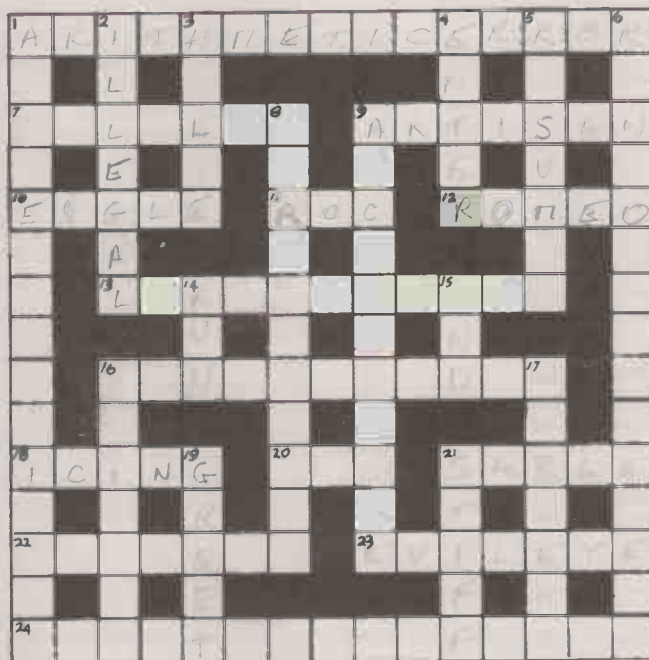
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- 4-6 **Computermarket '80 Exhibition.** Venue: New Century Hall, Manchester. Supplies of mini, micro and main-frame computers, peripherals, services and software will be showing a complete range of systems. Contact: John A. Godley, Couchmead Ltd, 42 Great Windmill Street, London, W1V 7PA, tel: 01-437 4187.
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- **20** **Microprocessor seminar.** Venue: St Albans. Designed for the businessman, to give a general introduction to the technology and commercial uses of microcomputers. Contact: Naomi Buhai, Birklands Management Centre, 330 London Road, St Albans AL1 1ED, tel: St Albans 66661.
- **24-26** **Fundamentals of computer operations.** Venue: Cannock. Designed for trainee and junior DP staff. Fee: £125 + VAT. Contact: Compower Training School, Cannock, Staffs, WS11 3HZ, tel: Cannock 2511.
- **25** **Pascal programming.** Enrolment starts March 25, course proper on April 1). Venue: Manchester University. Fundamentals of PASCAL. Fee: £8. Contact: Enrolment Secretary, Dept of Extramural Studies, The University, Manchester M13 9PL.
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- **27** **Fortran programming.** Enrolment starts March 27, course proper on April 3). Venue: Manchester University. Designed for people without any previous knowledge of computers or computer programming. Fee: £8. Contact: Enrolment Secretary, Dept of Extramural Studies, The University, Manchester M13 9PL.
- **27-28** **Introduction to microprocessing.** Venue: Bedford. For details, see above.
- **31-April 2** **Microprocessors and the businessman — BASIC for beginners.** Venue: Skyway Hotel, Heathrow-London.

Crossword by Mysterion

(Solution next month)



ACROSS

1. The result if one cannot add up.
7. Palindrome — stop first in.
9. His trade is a strain.
10. The — has landed.
11. Backward core without direction.
12. He meant nothing to Rome.
13. May have to be stored using double precision.
16. A part of.
18. Sounds as if I am happy on the cake.
20. This rock is large, even in reverse.
21. Is this fur delivered in mixed bales.
22. State quickly.
23. Devilish look.
24. A main interruption.

DOWN

1. Doting parents may think their computer is.
2. This entry is unlawful.
3. Chasten endlessly.
4. Come in or put in.
5. About the total, about reversed.
6. Not just any old saying.
8. Calculated odds.
9. You may be held to be if things go wrong.
14. Start your program ...
15. ... And stop.
16. Disjointed, principle not in.
17. Is this a tabulation with a small arithmetic unit.
19. A Scot would cry when you say hello.
20. Starchy.

A PRACTICAL GLOSSARY

Continuing the terminological gamut with P, Q & R

Program

And not *programme*, please God. Language is evolving: when a specific meaning is attributed by a large enough number of people to a particular bunch of syllables, let's assist the process of general comprehension. Let's give a unique word to a unique meaning.

Or to put it another way, we don't like 'programme' to mean 'program' — and the latter means a set of instructions that tells a computer what operations are to be performed to produce the desired results.

One important point is that a program is usually a complete entity that does something. But a group of programs may be linked together, one working with the results from another: and within an individual program there may be *subroutines* which each do something that contributes to the whole. So it's not necessarily clear-cut.

Programmer

Used to be a fuzzily bearded individual with a faded Hepworths jacket, patched jeans, a pocketful of multi-coloured biro, and an open invitation to the girls of the local sixth form to come up and see his computer sometime.

That's all changed: we're all programmers now. There's a great shortage of professionals who write computer programs for a living, though. The top-flight programmer needs a funny mix of goal-directed logical appreciation and Edward de Bono creativity: that's why they are paid so well.

Programmers aren't the same as systems analysts, though you with your personal computer will be combining the job functions. In a highly structured world, programmers come in three flavours — applications programmer, who write programs that do something systems programmers, who produce software that help the applications programmers do what it is that they do do: and maintenance programmers, who correct other people's work and keep existing programs up to date.

Programming

The basic steps in the ideal version of the programming process are five. First, you think: this is usually called understanding the problem, and you'll end up with a bunch of doodled notes on how the problem might be solved.

Then you draw a flowchart: or

rather, you draw several, since your first effort won't work. Well, mine don't.

Third, you actually write some code — and, fourth, you test it on a computer until it works. Finally you produce the documentation that will help you and others to understand and use it (and probably to maned it in the future). In fact you should have been keeping notes and flowcharts all along the line to help you write the documentation.

PROM

Storm-lashed stretch of crumbling asphalt at Skegness? Expensive opportunity to stand for five hours in the Albert Hall with 37 other people and listen to the first-ever performance by 16-year-old sensation Waldemar Billings of her *Opus Everything I Know in Two Parts* featuring nine choirs, J. Arthur Rank on gong, and a Newcomen beam engine? Programmable Read-Only Memory? Answers on a £10 note, please.

You'll find a discussion of PROM back in the *memory* section. It's a type of ready-only memory which can be individually programmed by the user (ordinary ROM comes ready-programmed by the factory). You'll need a special device called a PROM programmer, which is what puts the bit patterns into a PROM chip. Some PROMs are erasable: they are called EPROMs, and they can be reprogrammed.

Protocol

As in diplomacy and elsewhere, it's a collection of rules that governs intercourse. Stop sniggering at the back there. A communications protocol is a set of formal conventions for the exchange of information, essentially so that both sides (a computer and a terminal, say) know what's supposed to be happening and when. Otherwise the stream of bits coming down the link would be more or less meaningless to the recipient.

PSN

Witty and much-needed abbreviation for PSTN.

PSTN

Public Switched Telephone Network. The ordinary public phone system, as compared with *private lines*.

PSW

Processor Status Word: some computers call it the Program Status

Word. It's a reference area within the processor that is updated automatically with useful information — like what exactly is going on right now. It is used by clever programmers and operators to alter some detail of the execution of a program.

PTP

Paper tape punch.

PTR

Paper tape reader. It detects the presence of absence of punched holes. Usually it does this optically, by picking up light shining through the holes. Electrical sensing has also been used.

Pulse

Red-eye beans qualify. So does a short and sudden burst of electrical activity. It's important because a computer system can easily be designed to accept information transmitted as pulses — after all, pulse/no-pulse condition is a binary state, exactly like the off/on O/I internals of the computer.

'Pulse code modulation' or PCM is a pretty simple data transmission technique that uses this: an alternative is frequency modulation, where information is represented not by pulse/no pulse but by the frequency of signals.

Punch

Apart from the obvious impact this can have, a punch is an ingenious mechanical device constructed cleverly for the purpose of putting holes into punched cards. Obviously a punched card isn't a punched card until it has been punched with a punch. See *card*.

QWERTY

The traditional typewriter keyboard layout, which starts with these letters. On the Continent you'll find most start AZERTY.

Radio Shack

A line of home electronics stores in the States bought a few years ago by a leather goods company called Tandy. Today Tandy retains the name Radio Shack for its direct selling in the US, which is why TRS-80s still have Radio Shack stamped on them even though you might be buying them in a Tandy shop.

RAM

That husky Hemeling frinker with the

MGB who gets the spotty *au pairs* — but lots of them. It's also random-access memory, which is the kind you load programs and data to and from. The other sort is already there ready-loaded with programs or data: that's called ROM. See the extended exposition on *memory*.

RAM is sometimes called read/write memory, because that's what you can do with it — and this distinguishes it from read-only memory (ROM). But RWM doesn't make a neat acronym, unlike RAM. That's life.

RAM might be qualified as 'dynamic' or 'static'. This is getting into heavy electronics, but in essence a RAM chip stores information as *bit patterns* (qv) in electrically charged cells, one cell to a bit: so when a charge is present, that bit is read as '1'. In *static* RAM, information is retained until power is interrupted. In *dynamic* RAM, the storage cell must be continually recharged to maintain an 'on' state.


RAM memory chips are sometimes called simply RAMs. Use this if you want to appear sophisticated and knowledgeable, or perhaps if you need to save your outlay on breath. One of the hot areas in memory technology at the moment is just how much information you can store on RAM chips — obviously the greater the capacity, the more compact and cheap the overall system.

It should also be simpler and more reliable, too, for cutting down on the number of components required (the 'chip count') means that the electrical requirements and heat dissipation are easier for the designer: and less heat means greater longevity in electronics. The original RAMs stored 1024 bits (1Kb): they were displaced by 4K RAMs, then by 16K chips — which is what most minis and many micros use now. 64K RAMs are becoming available on a few systems, and soon there will be 256K-bit memory chips.

RAMP

You might not come across this uncompromising slogan in the personal computer world, but it stands for 'Reliability Availability and Maintenance Performance'. These are what you need to keep your computer up and running.

US mini manufacturers, in particular, put together RAMP 'kits' or 'RAMP course' to help you and/or their engineers to get the maximum working life out of your buy.

IBM has a similar slogan, RAS, for Reliability, Availability, Serviceability. 

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DISCOUNT PETS

NEW 8K PET £470 with large keyboard, 16K £550, 32K £650, Dual Floppy £680, Programmer's Toolkit £45, Cassette £50.

BASE 2 PRINTER £475 compatible with PET 3 Interfaces: IEEE, RS232, Centronics parallel, 3 Character fonts — one downloadable, programmable horizontal & vertical densities, stepping motor, tractor feed, contiguous plotting.

TEXAS TI 99/4 £890 with 13" colour monitor. The most advanced home computer.

AIM 65 4K SYSTEM £420 cased, powered & with assembler and BASIC. Also memories & motherboards for AIM 65/KIM by Seawell. Disk system (2 x 5" drives) with DOS £800.

S-100 SYSTEM £1000 based on North Star with single disk drive, Z-80, 2 ports, 32K memory, completely assembled and tested. Runs all North Star software.

NORTH STAR HORIZON 11 £1400

S-100 BOARDS assembled and tested only. 16K fully static 2MHz memory with bank select, optional wait states, write protect etc. £150. 4MHz £250. Jade 4MHz Z-80 CPU £140. SD PROM-100 EPROM programmer £140. 2 serial & 1 parallel I/O card £120.

SOFTWARE

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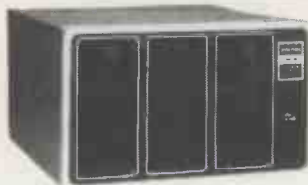
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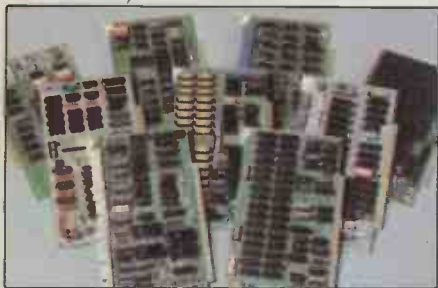
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