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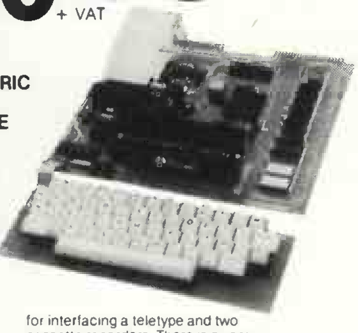

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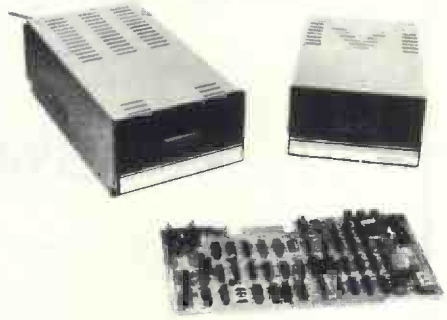

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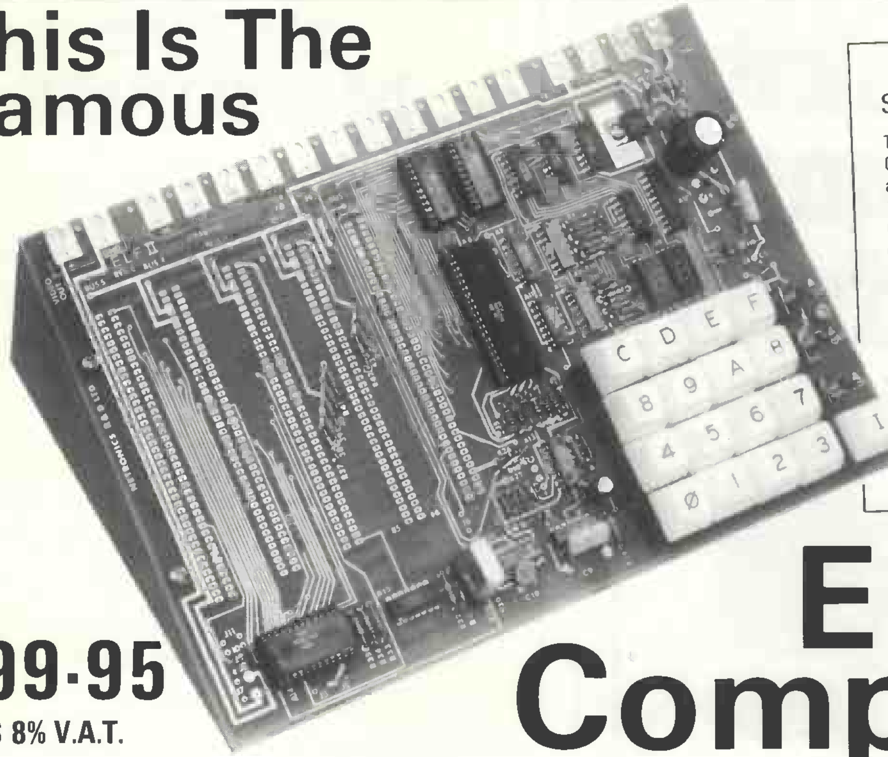

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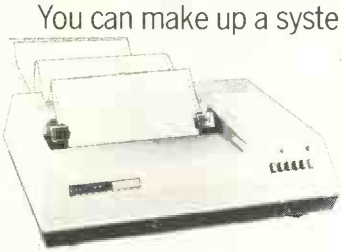

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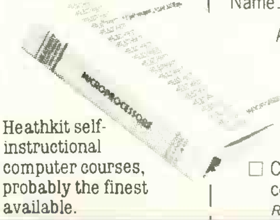

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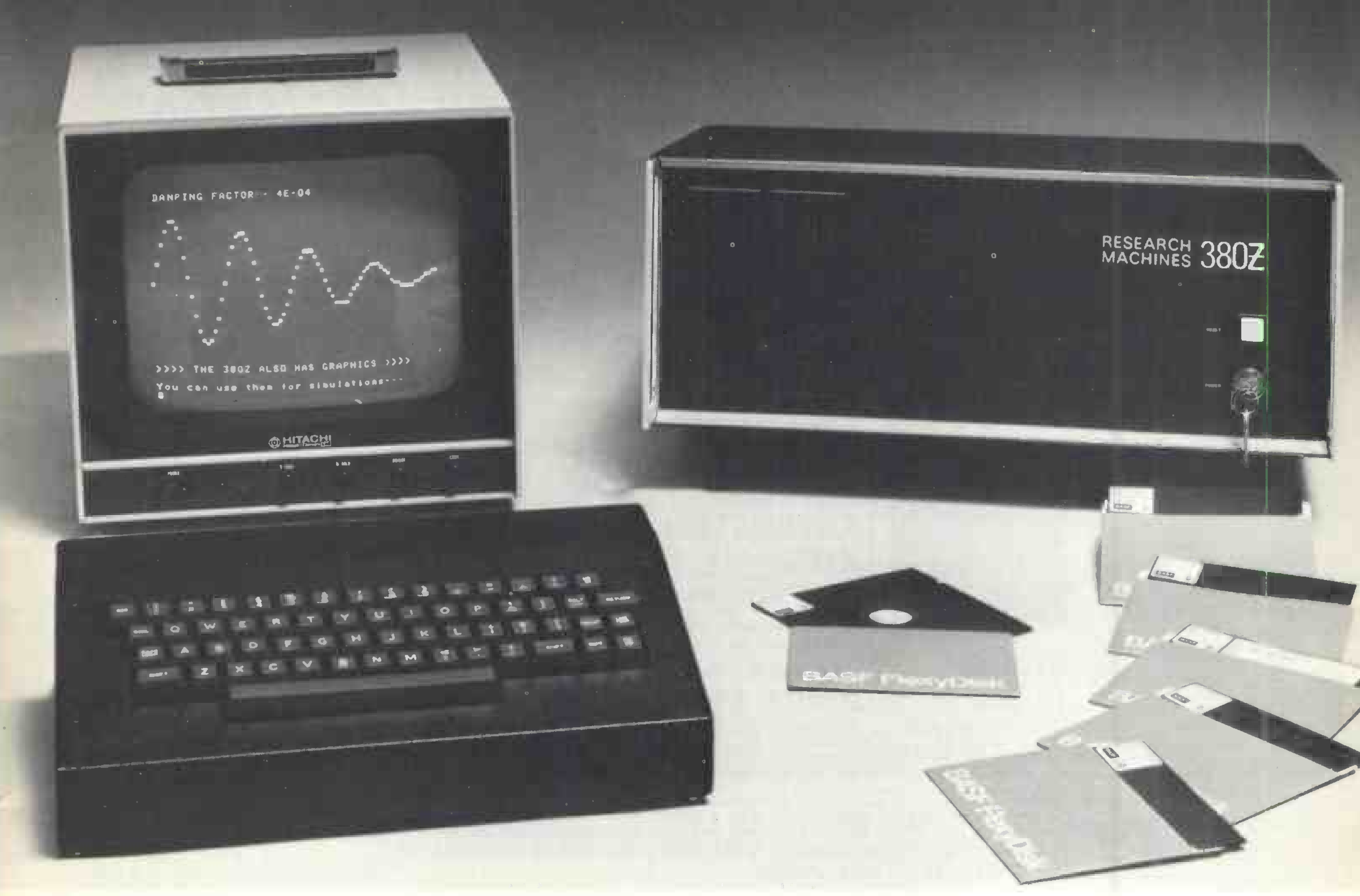

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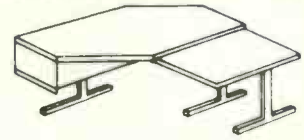

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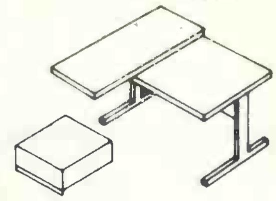

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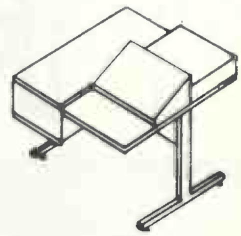

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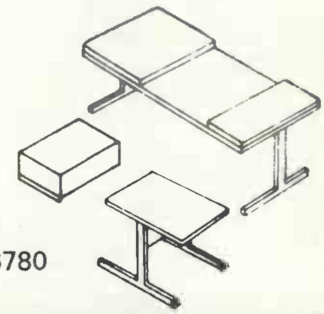

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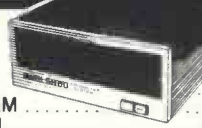

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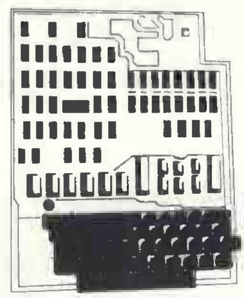

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● **Circle No. 136**

Publisher's Letter

AS THIS 108-page issue of *Practical Computing* bears witness, the microcomputer is very much alive and well in Britain.

There is a tremendous choice of low-cost computers on the market—see the Buyer's Guide on page 98—and better, smaller, more powerful processors and peripheral equipment are being announced regularly.

Much of the equipment is being designed in this country and there are many first-rate designers and technicians following in the trail-blazing footsteps of the late John Miller-Kirkpatrick and others.

Factories are being built to ensure there is enough production to meet the growth in demand. In our schools, the next generation is already being trained in the design and programming of micros. Whether enough resources are being put into this training is another question—see Education article on page 76.

With the equipment being developed, the production capacity being created, and future users being trained, one major question mark remains over the future applications of microcomputers. It concerns the key issue of the design of the thousands of applications crying-out for computerisation now that the price of the equipment is within everyone's reach.

As Dr Tim Keen put it succinctly at the *Practical Computing*/ECORS Managing with Micros conference, the purchaser of a drill is not looking primarily for drills, but for holes.

Similarly, the purchaser of a computer normally is not looking primarily for a computer but rather for solutions to his problems.

Applications will determine the success or failure of the microcomputer revolution. There will be a desperate need for people with experience in the real world of industry, government, commerce and education who can relate the potential of the market to the needs.

If you have such experience, and you keep up-to-date in the microprocessor field, you will be one of the people in great demand in the 1980s.

The Publisher

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

Cheaper storage

I WAS interested in Bert Martin's article. I am thinking of buying a personal computer but the cost of disc storage horrifies me, and as a result I've been trying to find an acceptable method of using cassettes as a cheaper bulk storage medium. Martin's discussion of using both tracks of a stereo cassette deck makes a lot of sense and I would like to mention a few ideas of my own.

My main feeling is that any given point on the cassette should be "self-identifying" and so I propose that the cassette should be divided into a number of discrete blocks of data, and the address track should contain, perhaps among other things, an absolute block number, say, every 10 data blocks, and a block-start sentinel every block.

This information would be read by the recorder in FAST FORWARD/REWIND mode to identify the start of the required file. The first 10 blocks on the cassette would be reserved for the volume index, giving:

a. filename
b. file type (i.e. binary dump, data, program source)
d. no. of blocks occupied.

for each file on the cassette.

It would be preferable if the size of the data blocks were to be standardised to aid transfer between differing systems. A block size of 267 bytes—why such an odd amount follows—would enable genuine double-buffering to be used by the Operating System, if required, without excessive storage outlay. Why 267 bytes? The block layout I propose would be:

1. Header	
a. Block length	2 bytes
b. File number	2 ,,
c. Block no. in file	2 ,,
d. File type	1 ,,
e. address for start of program dump	2 ,,
2. Data	256 bytes
3. Trailer	
a. checksum	1 bytes
b. end-of-block marker	1 bytes
Blocksize	267 bytes

Most of the fields are self-explanatory. The block length would be of more use in program dump files where the whole 256-byte data capacity need not be required. In non-program dump files it, e (i.e.) would be hex zero H "00". The checksum in the trailer is formed from exclusive OR'-ing each byte of the Header and Data but not the trailer, giving an eight-bit parity check.

Assuming that each data block is separated by 250 ms of blank tape to enable it to be over-written where necessary, the following table applies to one side of a C60 cassette:

Baud	No. blocks per side	Useful data*
2,400	1,578	401,664
1,200	888	224,768
600	473	118,528
300	244	59,904

*Useful data size is in bytes, with the 10 blocks for the volume index omitted.

This table compares favourably to Martin's value of 432K bytes. So, it seems, with effort a suitable cassette recorder can hold more data than most floppy disc units, although in spite of high-speed searching, the latency time, to use disc parlance, would be between 15 sec. and 65 sec. on average, depending on the re-wind speed for a cassette.

I would be most interested in hearing any views or comments. In the meantime, thanks for an excellent magazine.

**Paul Wilson,
Hove,
E. Sussex.**

Tape speed

BERT MARTIN seems unaware that in the audio type of cassette recorder, the tape is not in contact with the head during fast forward or rewind.

He seems unaware, too, that the speed of the tape past the (non-contacting) head of such recorders is varying continually from one end of the cassette to the other, as the diameter of the tape wound round the heel increases from minimum to maximum.

And he also seems unaware that digital cassette tape handlers have long been available, incorporating high-speed search, read, and write, with one track used for addressing. Three which have been advertised for microcomputer use are:

Phi-Deck: Triple I Co., P.O. Box 25308, Okla. City, OK 73125, U.S.A.
Digital Group, P.O. Box 6528, Denver, CO, 80206, U.S.A.
Model 3M3A: National Multiplex Corp., P.O. Box 288, So, Plainfield, NJ, 07080, U.S.A., or G. Ashby, 172 Ifield Road, London SW10 9AG.

No need to re-invent the wheel. Caution is advisable, however, with respect to life in service, as the Phillips cassette was never intended for high-speed use, and tape wear is at least proportional to speed, if not greater, and is the reason why floppy discs were invented.

**Frank Chambers,
Westport,
Co. Mayo.**

Good idea

MARTIN's idea is a good one, but in the form suggested it would not work. Fast forward and fast re-wind speeds are not in the least constant, due to variations in the size of the roll of tape on the take-up side in the order of 5:1 or even more.

You could overcome this with a special machine but a better route might be to use numbered pulses as the identifying code. The number of pulses would be counted, and the differing interval between pulses ignored, up to a cut-off point which, if exceeded, would indicate pulse group ended, and machine would either stop, or continue search for correct pulse group.

Stopping is never instant and it takes a really good machine to do it quickly without beating tape but the lay-time could be allowed for easily at some expense in tape use. Not important. Glad to exchange ideas with Mr Martin, if he is interested.

**James Woodruff,
Bradford-on-Avon,
Wiltshire.**

Unrealistic

I HAVE read with interest the article by Bert Martin on a proposal for a new tape standard

(*continued on page 27*)

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1. Q. If a block of available memory begins at address 0416_8 and ends at 1100_8, how many bytes may be stored there?
   A. 307_{10}
2. Q. You have data blocks stored between the following addresses. How many total bytes of data are stored?

	BLOCK 1	BLOCK 2	BLOCK 3
Beginning address	200	4A0	1000
Ending address	3FF	599	2A00

   A. 7419_{10}
3. Q. What is 7_8 shifted 2 bits to the left?
   A. 348

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(*continued from page 25*)
for the microprocessor user. I feel that his proposals are very unrealistic. For a start, his system requires the purchase of a stereo tape recorder at a price of £176 – £420, according to his figures.

In addition, there would be needed a coder/decoder board to handle the interface to the processor, say £20, and a re-written monitor to cope with the new system. The price for the entire changeover is now in the vicinity of the price of a 5¼ in. floppy which will offer much better performance.

I agree that a new look at tape standards is called for and I understand the the ACC is organising it. The main fault of the Kansas City/CUTS standard is its slow speed—300 baud—but that is frequently uprated to 1,200 or 2,400 baud with good reliability. I have heard of people running their cassette interfaces at 4,800 baud.

Perhaps what is needed is a minor re-definition of fiequencies to allow a 4,800 baud rate, with improved performance. I notice on reading the specifications of some reasonably-priced and reasonable-quality monorecorders that they have rated input frequencies of 9,000 – 10,000 Hz. By using 4,800 baud we allow almost a 100 percent safety margin.

The CUTS system which uses a phased lock loop on the input to the processor allows for a substantial variation in record and playback speeds and if the basic oscillator for the drive and playback were crystal-controlled, compatibility would be assured between one machine and the next.

Next we should look at the dump or output format. Consider the Nascom under the Nasbug monitor—a rate of approx 25 characters per second is achieved. By using a different format as in the B.Bub, this rate is increased four times. With improved reliability in load and dump at high speeds, the hex redundancy of the slow rate could be abandoned. I would suggest that the dump block length should be shortened from 256 to either 128 or 56 bytes, and a system of headers decided upon which would allow a block search command in the monitor to search for a specified block title/reference number and then, on finding it, to begin load automatically.

Another function which could also be implemented is for the recorder to pick up the reference number of the previous block and increment it automatically on writing the header for the next block.

The hundreds of existing monotape recorders in daily use should not be overlooked in arriving at a new standard.

Rory O'Farrell,
Blessington,
Co. Wicklow.

Waiting list

I AM considering of buying an Ohio Scientific computer, the C3-S1/OEM, but I have not been able to lay hands on publications about this computer. This information I have from the manufacturer is not helping me any further. Is there somebody who has experience with this computer or a user group who can give me some additional information?

Do you plan to write/publish a review on this one, or do you know in which magazine such a review have been published? Please let me know.

Wishing you all the best with your superb magazine.

Barry Groenewegen,
Dundee.

● **There was a long waiting and delivery list for the Ohio computer. Our name is on the list and we shall be reviewing it shortly.**

Polarisation

DO I detect a growing polarisation between "serious" computer amateurs and "hobbyists"? More and more, one reads of people declaring that they have better things to do than to play games with their computers. Even magazine articles tend to make me feel guilty at spending £500-£1,000 on a computer to use it only as a toy.

Perhaps it would be opportune to see the matter in perspective. In the past, I have spent many hundreds of pounds on photography, purely as a hobby and with absolutely no serious intent. Similarly, I've spent hundreds of pounds on hi-fi merely to play badly-recorded pop music.

Again, the object was purely enjoyment and at no time did I feel guilty. Nor do I feel guilty at spending thousands on a motor car used solely for pleasure. The list is endless—the point, I hope, made. I look forward to the abolition of snobbery among hobby computer users. Let's be honest and admit it is fun and stop making me feel so damned guilty.

Brian Wall,
St. Helier,
Jersey.

Bank switching

I WAS surprised to read in the February Feedback that you do not understand what is meant by bank switching.

It is an old-established technique used for years in large mainframe machines. In essence, it means that an eight-bit micro can select any one of a number of boards, each containing 64K of memory. All, however, except one remain in the non-selected state unless activated at a select input point.

This could be done by addressing each board as a part peripheral, using an I/O instruction to select it perhaps by making its bi-directional bus driver chips go low impedence. Once selected, the board operates in the usual way.

Imagine 16 megabytes of memory on one eight-bit system. This technique will be available for those adopting the E78 bus standard. Further details from me.

Alan Secker,
Avant House,
9 Bridge Street,
Pinner, Middx.

● **Alan sent us an interesting cutting from a November, 1977 issue of the specialist U.S. magazine *Electronic Design*, written by the director of R & D at a California company, Extensys, which deals in bank-switched memory extensions.**

The principle is simple. The micro still addresses no more than 64KB directly but memory reference instructions go through a decode/select phase in software which identifies exactly which of several available blocks of 64KB is to be accessed.

That article mentioned two bank-switching add-ons available in the States for S-100 micros. Both are 64KB boards with bank-selection logic in PROM. IMSAI is one manufacturer; Extensys is the other. And the Extensys board is half the price, about $1,750.

As far as we know neither is available in this country but watch this space.

Accounting

AS AN accountant I read with interest your article, Payroll and the Pet. Ease of use and reliability are the most important factors when choosing any business package and I was surprised that you dismiss as minor the fact that this payroll is difficult to use, since the more cumbersome the procedures the higher the probability that errors will occur.

Also under the PAYE system it is the employer's responsibility to ensure that proper deductions have been made and he could find himself liable to the Inland Revenue for any under-deductions which occur as a result of errors.

You state that the program has been written by an accountant, as if this is a recommendation of its reliability. I would agree that any company computerising its accounting procedures should consult its accountant, but the user should not expect him to be an expert in programming. The analogy I would use is: "Would any user accept a computer system which has been passed for audit purposes by a programmer?"

The Pet is ideal as a low-cost computer for handling accounting procedures, especially now that discs will soon be available, but only if the quality of the software can match the capabilities of the machine.

Ethne McClean
Manchester.

Apple group

WE ARE hoping to set up the U.K. Apple users' group under the chairmanship of Dr. Tim Keen. It is hoped that this group will allow for the interchange of programs and information between Apple users, and the solution of any problems which may arise, both with hardware and software.

As the organising body of the users' group we hope to provide all members with a regular newsletter, probably bi-monthly, and to keep them informed of new developments.

Before the group can be organised fully, it would help us if Apple users and dealers (and the new ITT 2020 owners) would contact our office to let us know who they are; we can then send them more information and arrange a conference between all interested parties sometime in the early Summer.

Judith Fletcher
Keen Computers Ltd.,
5 The Poultry,
Nottingham.

Helpful aid

AS MANY of your readers have a Pet 2001 I suspect that they have been trying the Cars game, as shown in December, 1978 issue, Page 45, without success.

I suggest that the following lines are modified or added so that they can enjoy this fascinating game.

```
10   DIM M$ (22), QS (18), J$ (9), X (22), Y (22),
     Z (22), G (5), J (22), L (10)
230  FOR I = 1 to 5
231  READ G (I)
232  NEXT I
250  FOR I = 1 to 10
251  READ L (I)
252  NEXT I
270  FOR I = 1 to 22
271  READ J (I)
272  NEXT I
300  FOR I = 1 to 22
301  READ X (I)
302  NEXT (I)
320  FOR I = 1 to 22
321  READ Y (I)
322  NEXT I
340  FOR I = 1 to 22
341  READ Z (I)
342  NEXT I
1030 READ M$ (I)
1050 PRINT "POINT"; I; M$ (I)
```

A. Bond,
Liverpool.

Vacation work

IT WOULD be appreciated if you would do me a favour by printing the following in your Feedback column.

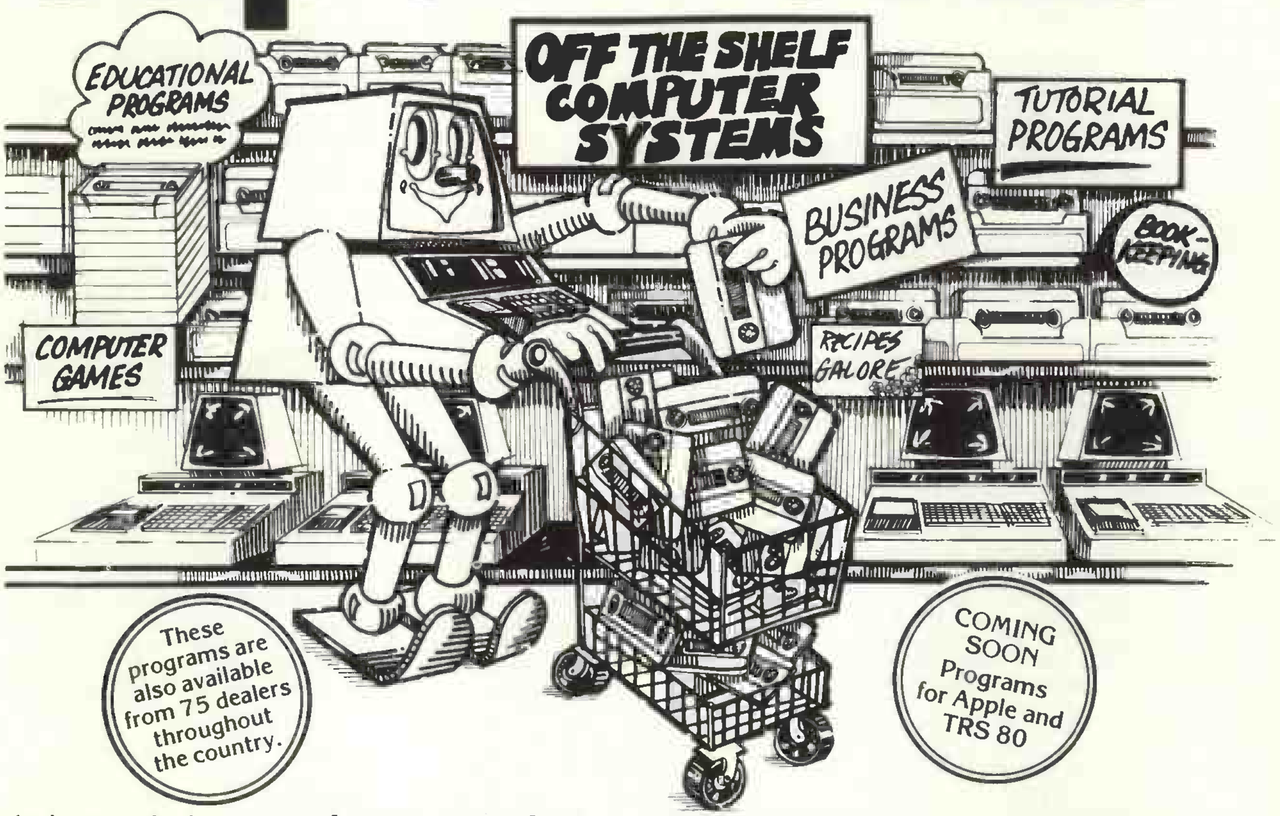
Sponsorship or vacational work opportunity is required for a first-year undergraduate student on a BSc honours degree sandwich course in electrical and electronic engineering.

The undergraduate would like to get into the hardware side of computers/microcomputers.

J. R. Bridges
7 Eltham Park Gardens,
London S.E.9.

(*continued on page 29*)

Pet program supermarket



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My name is

My PET lives at:

● **Circle No. 143**

(continued from page 27)

Musical Pet

I HAVE become more and more interested in microcomputers, especially the Pet, since reading your magazine. As I was looking through your new column on the Pet in the February issue I was wondering if the Pet could be modified to teach children and adults to play the piano, or any other musical instrument which has a keyboard.

I wondered if it is possible to link the processor to the keyboard, thus linking the computer's memory as well. In this way the computer could be programmed to recognise the different notes and display them on a VDU and thus put them in order and display the tune being made. It could be programmed also to teach. I would be grateful if you could tell me if this is feasible.

Tyrone Cooper,
Cannock, Staffs.

● **There are several ways in which the Pet can be used for musical computer applications. At the most basic level, the computer memory could be used to store note sequences; with a sound generator add-on, it could be used to play back these notes. In this way, the Pet can easily be used to create and edit musical sequences. It can, of course, also be used to generate mathematically-based sequences of notes for less conventional music.**

Alphabetic game

G Saini of 50 Whitmore Road, Birmingham B1O 0NP has an alphabetic Mastermind-type game. The system picks a random sequence of letters—you can specify how many, up to 26—and you have to guess what they are. It's neat but we are a little over-burdened with guessing games of this kind at the moment. Mr. Saini, however, is keen to get together with any owner of a graphics system in his area with a view to adding colour graphics to the program. Any takers?

Not difficult

IN Vincent Tseng's article on the Nascom-1, it gave the impression that the kit was difficult to build. I am 14 and previously had experience only in building small transistor radios and the like.

It took me a weekend to build my Nascom-1 but I did not find it difficult or tedious. I did not have any real problems with it and do not want people to be put off as it's not as difficult as it sounds.

Stuart Erskine,
Wyken,
Coventry.

Cost-effective

REGARDING Mr. Page's letter about stock control on a small business system, may I make the following comments which I hope he and others interested in this field may find of use?

Any cassette system will be very slow and cumbersome—much worse, in fact, than any manual record-card-based stock recording system. In my book this completely rules out any system using tape cassettes as the recording medium.

For a small number of items it may be possible on a 32K computer to hold up to 100 item details within memory and save them on cassette at the end of the updating session. The problem is that any sort of program fault or power failure will result in the loss of the latest data.

The only reliable choice is to use a floppy disc system. Even here many minifloppies will store only 90K per disc and do not allow multi-disc files. So even then it would be difficult to store details of 2,000 items, with, say, 128 bytes per record (250K bytes).

One of the choices which would be effective and is only just outside the £2,000 figure quoted would be to use high-density minifloppies from Micropolis attached to a 32K Sorcerer. This system would be difficult to beat on grounds of cost effectiveness.

J. M. Collier,
Keighley,
W. Yorkshire.

Freezing

WE ARE interested in a device which will freeze the digital readout from an ADDS system 70 microcomputer on to a TV monitor. The computer will output up to 25 lines of 80 alphanumeric characters on to a TV monitor. We want a memory device which will hold this image until a switch is pressed.

Do you know of any suppliers please?

J. L. Farthing,
Microact,
5-6 Vicarage Road,
Edgbaston,
Birmingham.

● **No, but perhaps our readers do.**

Far and wide

WE HAVE received a chirpy newsletter from Gonzalo Velez-Juan, who runs the Cuatro Computer Club in Caracas, Venezuela. CCC has been operating since November and if Gonzalo's two-pager is any criterion, it is a cheerfully enthusiastic outfit.

● **Enthusiasts interested in the area can reach Gonzalo and CCC at Avenue Los Pinos Edf. Airosa No. 5, La Florida, Caracas.**

In the other direction, Singapore is another place with evidence of micro enthusiasm. The Singapore Microcomputer Society held its inaugural meeting towards the end of last year and signed 100 or so members, one of whom has been writing to us complimenting *Practical Computing* for not being a U.S. home computer magazine.

You can reach the Singapore Micro Society via its president, Jack Page, at Page-Asia Associates, 279-M Selegie Complex, Singapore 7.

For engineers

I FIND your articles deal mainly with commercial applications, together with some games. It seems to me that in view of Government support for microprocessors for industry, a major growth area in computing will be in machine and process controllers, particularly those for the smaller industry.

May I suggest that you devote a small part of your space to the problems likely to face engineers trying to use analogue signals in a microcomputer for general industrial control, which often requires proportional signals.

The main problems facing new microprocessor users in this area would seem to be the "hand-shaking" technique for multiplexing analogue input and putput signals.

E. John Skenett,
Clifton, Bristol.

● **Thanks for the idea. We shall look into it.**

New approach

I LOOK forward to the program examples and I admit, the games each month. With a bit of luck, most of them are up and running by midnight on the day that *Practical Computing* arrives.

But can you please do something about the "l"s and the "i"s in the program listings. Without the aid of a strong magnifying glass I find them indistinguishable. I know we can work out the difference from the logic, but this becomes very tiresome after a time.

Best of luck with your new magazine. I find it a welcome addition to the literature. What a pleasure it is to find so many people "doing computing" simply because they like it.

Peter Russell,
Headley, Newbury.

● **We have adopted a new approach to program listing which will resolve the problem.**

Coming

I HAVE ordered a Science of Cambridge Mk 14 microprocessor. Could you please send me any tips or program routines for the Mk 14?

S. Robinson,
Markefield, Leicestershire.

● **Watch for next month's issue, when we shall be reviewing the Mk14.**

Packages

I HAVE been looking for some time for a software program suitable for incomplete records accounting but have, so far, failed to find any suitable for microcomputers. Do you have any information on the subject?

Fordhams,
54, Fleet Street,
London EC4.

● **See this issue for details of accounting packages.**

Machine state

I AM writing for help concerning a microcomputer application I have thought out but I am unable to realise because of insufficient knowledge on hardware.

The purpose served by this application is to indicate the state of a machine (phase of operation) or the activities in a factory.

I thought of doing this, using a single-line display (of about 20 illuminating characters of about 8× 4 cm in size) connected to a micro with an alphanumeric keyboard.

The role of the microcomputer is to accept strings of alphanumeric characters into variable names, store the contents of these variables in EPROM or something equivalent for this application, and output the contents of these variables at a later stage by the depression of a "print" key and the variable name on the keyboard.

The variables should be capable of containing about 20 characters and remain unaltered in memory even after the system is switched-off. The ability to re-assign values to these variables provides the freedom of applying the system to various machines.

The system should work on power supplied by commercially-available batteries and the display should be positioned easily at least three metres away from the micro-keyboard system.

I would be most grateful if you could kindly send me any information which would help me put together such a system or provide me with names of manufacturers who already produce such hardware.

G. Vamialis,
Neas Elvetias 60
Byron T.T.517
Athens, Greece

● **The application sounds simple for a microcomputer. You seem to want to call-up a series of messages, with each message related to a specific control key on the keyboard. If that is the case, you don't need a micro at all—any electronics buff should be able to hard-wire such a system for you without great difficulty.**

A microprocessor would be more appropriate if your system needed to detect the state of the machine and the time to make its own decision about what should be displaced. That will obviously require a degree of programming, since choice is involved and it will also involve sensors on the machinery itself. Either way the task will not be too difficult, and it should be possible to accomplish it at minimal expense.

Unmistakable.

APPLE II

Try a comparison test.
Look at the features of Apple II. It still has 8 I/O ports, high and low resolution graphics, a mini assembler, A/D paddles, fantastic Basic, Disks and the best documentation in the business.

Intelligent interface cards.
They're neat. The high speed serial card, printer card and communication card all have elegant documentation. There is also easy-to-use software that mean taking B.C.D. from instrumentation, connecting your favourite printer or talking to a time-sharing computer, is childs play. Apple makes things easy.

Plus:

* Say hello to Apple and let Apple talk back. Explore voice recognition, computer voice recognition and computer voice production. You can now have large vocabularies.
* Perhaps you'd like to be reminded that it is a special day or would like to chase overdue accounts. Apple clock card is simply the best. It is the most advanced on any personal computer.
* Draw graphics with the light pen.
* Make chips for your own software with the Eprom burner. Apple naturally has spare sockets for this.
* Make interfaces with the prototyping boards.
* Use Apple's incredible 'programmers aid' hardware option. More thought and care from Apple for you to use.

And there's more yet more to come from our friends at Apple. Phone Personal Computers' distributors and get to know them. They're busy, successful, highly qualified professionals and the best in the business.

Personal Computers Limited

Personal Computers Limited 194-200 Bishopsgate, London EC2M 4NR. Tel. 01-283 3391

Tim Keen, Keen Computers Ltd., Nottingham. Tel. 0602 583254
Stanton Smith, Microsolve, Edgware. Tel. 01-951 0218
Trevor Brownen, Crystal Electronics, Torquay. Tel. 0803 22699
Trevor Williams, Padmede Ltd, Odiham, Nr. Basingstoke. Tel. 02-5671 2434
Bruce Everiss, Micro Digital Ltd., Liverpool. Tel. 051-236 0707
Claude Cowan, Cambridge Computer Store. Tel. 0223 68155
George Sinclair, G.A.T.E. Microsystems, Dundee. Tel. 0382 74390
Peter McNaughton, Perthshire. Tel. 07388 8267
Robin Woods, Isher-Woods, Luton. Tel. 0582 424851
Tom Piercy, Topmark Computers, Huntingdon. Tel. 0480 212563
Steve Cooper, Creative Vision, Leeds. Tel. 0532 458444
John Page, P.I.P.S. Computer Services, Newcastle. Tel. 0632-482 359
Alan Wood, Apple Corner, London. Tel. 01-580 5304

● Circle No. 144

Midlands program exchange

WOLVERHAMPTON is opening its doors to users of small systems to promote and exchange programming experience and programs. If you would like some useful tips on software, or just to talk to people who, like you are using microcomputers to help your business, why not pay a visit?

The organisation is called the Central Program Exchange (CPE) and is completely independent of any manufacturer, being financed jointly by members' subscriptions and the Council for Educational Technology. It has a membership of 72 and holds a library of more than 200 programs in Basic, Fortran and Algol.

Membership normally is £25 per year but individual members can obtain CPE services for £10 per year. That entitles members to a catalogue, newsletter and up to 10 CPE programs as listings or paper tapes.

Details of membership are available from Dr. G. Beech, Central Program Exchange, Department of Computing and Mathematical Sciences, The Polytechnic, Wolverhampton, WV1 1LY.

Digital panel prints as added bonus

DIGITAL EQUIPMENT has announced the latest addition to the PDP-11 series, the Datasystem 150, described as a "compact table-top computer", and costing £5,625 for the basic configuration.

It uses dual-drive floppy discs, which store up to 512,000 characters, an LSI-11 central processor, the new VT100 terminal with free-standing keyboard, and a 180 cps dot matrix printer. It has memory sizes of 32K or 60K bytes, and runs under CTS-300 (Commercial Transaction System) operating software, which means it is ideal for payroll, accounts payable and receivable, general ledger and inventory in DIBOL, the Digital high-level language.

As an added bonus, Digital is offering silkscreen panel prints designed by Corita Kent, one of the most celebrated American serigraph artists. The prints are optional but if you want to brighten your office, a set of three will cost £65—one for the wall and two for the end of each cabinet.

Alternative sets of two duplicate prints from each series of designs can be bought for £49. They are for mounting on Digital low-profile system cabinets.

Above, the concept; below, the artist.

Business decisions package

A BUSINESS decisions package for programmable calculators has been developed by Texas Instruments for its TI58/59 machines.

The library, in the form of a solid state software plug-in module, contains a range of programs to make tasks involved in business decisions much easier, and it permits managers to have instant access to processes handled usually by the computer.

The library also contains several programs which can be incorporated easily in specific routines for a particular company, without the need to produce programs involving detailed analysis of certain techniques such as demand forecasting or economic ordering.

There are 11 programs in the business decisions package which cover module checking, long-term financing, debt financing, investment evaluation, project planning and budgeting, break-even analysis facility capacity, economic re-ordering and production runs re-order timing, demand forecasting, and assembly line balancing.

There is also a 96-page manual containing full information on calculations of short-term financing requirements and facility scheduling.

The library costs £32 including VAT, covering the module, program reference cards, a quick reference guide, the library manual and a wallet.

Helpful newsletter for VIP users

IN THE WILDS of Pennsylvania there's a cheaply-produced but fact-packed independent newsletter for users of RCA VIP microcomputers. It's called *The VIPER* and it is from a small publishing house which makes a habit of publishing cheap but fact-packed newsletters—Aresco Inc also produces *The PET Paper* and is planning similar operations for Apple, Sorcerer and Tandy users, among others.

So if you have a micro with 1802 or COSMAC or RCA on it somewhere, read on. The issue we have seen has 26 pages. It includes the third and final part of a text editor project on the VIP, adding program-controlled tape I/O—with plenty of useful information about playing with the relevant parts of the operating system.

There is the announcement of a VIP software library, with a LIFE game for a start—$10 for a tape documentation.

There is a neat piece of opportunism. Someone discovered that a $60 video game from Radio Shack is really an 1802 system with keypad, 512 bytes of CMOS RAM, video interface and power supply; it needs an operating system and cassette to make it work, and that is promised for future issues. You won't get a $ VIP here, by the way—Radio Shack was expected to sell out of them.

There's more. VIPER costs $25 outside the States and they will accept Visa (which means Barclaycard) or Mastercharge (Access).

We are looking at the possibility of doing a European edition; let us know what you think. Meanwhile, Aresco can be reached at PO Box 43, Audubon, PA 19407 U.S.A.

Nim game

THERE are two curious errors in the Nim game we printed in March. Both seem to have been caused somewhere along the line between computer and printer because the game ran satisfactorily when we tested it.

Here are the modifications

- add a line as follows:
  1120 PRINT "YOU WIN. DO YOU WANT ANOTHER GAME?"
- delete 1840 and add:
  1830 IF D(3) = 1 THEN 1860
- change 3490 to read:
  3490 GOTO 1120

Incidentally, credit is due to Roger Hargrave, of Crawley, who developed the original flowchart.

Reference card from Strumech

THE LATEST Strumech catalogue contains several new microprocessor-associated products, together with some very reasonable prices.

For 35p Strumech offers a 6800 reference card, packed full of invaluable information.

Two examples of new products include the Smoke Signal Broadcasting BFD disc system which now offers Strubal, a new structural Basic language, and it will shortly offer Fortran as well. SDOS, the new operating system for MSI6800 systems, utilises FD-8 and HD-8R disc systems. FD-8 and MSI 6800 can be updated to SDOS.

The 6800 reference card (please enclose SAE), and the catalogue are available from Strumech, Portland Hse., Coppice Side, Brownhills, Walsall, WS8 7EX, West Midlands.

New version

THOSE whose appetites were whetted by our extracts from the book *Computer Programs that Work* will be pleased to hear it has been re-printed with minor changes. The book, which costs £2·40, has three main sections—mathematics, science and games.

All programs are written in Basic and a paper tape version of all programs is available for £6.

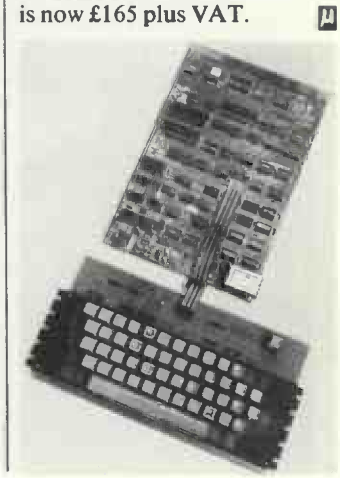
If you have difficulty obtaining a copy, write to Sigma Technical Press, 23 Dippons Mill Close, Tettenhall, Wolverhampton, WV6 8HH, West Midlands.

Sigma is also offering to publish any programs you may have for a modest sum of £25. They will help to make up similar books.

Nascom-1

OUR REVIEW of single-board computers omitted the fact that the Nascom-1 has an onboard cpu clock, a video modulator, a cassette modem (or Teletype) and 2K bytes of RAM, of which 1K is dedicated for video interface. There is also a NASBUG 1K 2708 Eprom monitor.

The Nascom-1 is manufactured by Nascom Microcomputers Ltd and is available from 21 distributors worldwide, of which Lynx Electronics is one. The price of the kit is now £165 plus VAT.



Dot matrix

HEWLETT-PACKARD has a new stand-alone dot matrix which couples a "proven display with a microprocessor-based controller to provide an easy to read display with very low power requirements and easy interfacing".

The new system, designated the HDSP-24XX Series, is claimed to reduce engineering development costs and time because the microprocessor controller is pre-programmed with routines which accept, decode and display standard ASCII data.

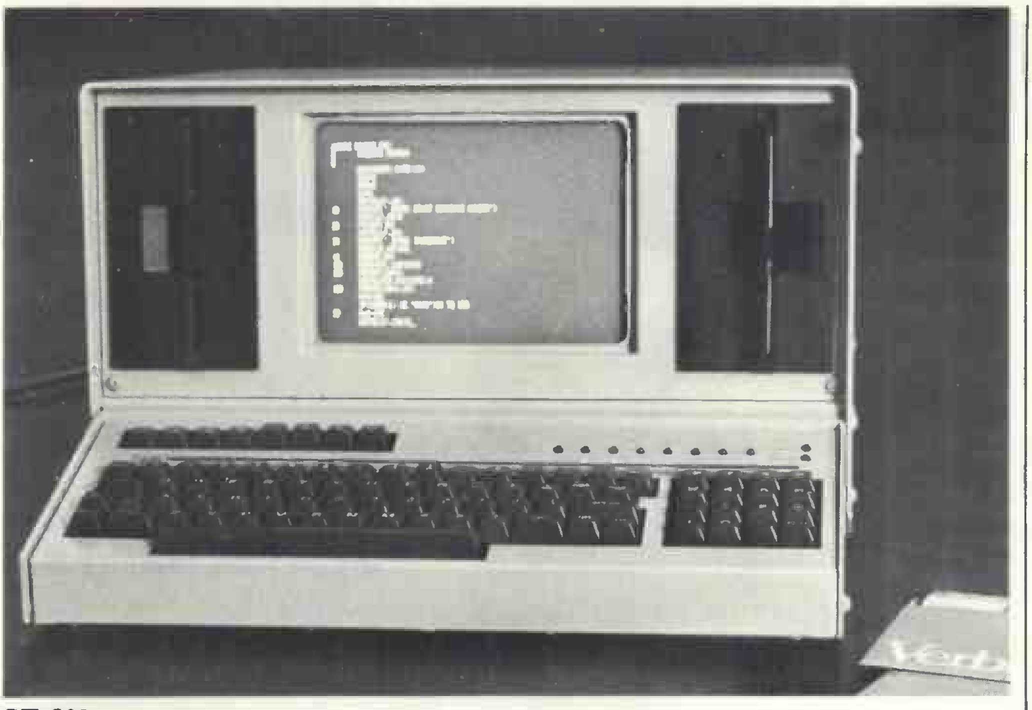
The 5 volt operation, standard low-power schottky TTL-compatible inputs and four separate display formatting modes permit easy interface to a keyboard or microprocessor based system.

The series is available now and a 32-character single-line display model costs £231·15.

Data aid

AN IMMEDIATE need for a copy of the complete Motorola Microcumputer Data Library can be satisfied by Cramer Microsystems of Sunbury-on-Thames.

The publications include most of the technical data sheets on all Motorola microprocessors, memories and associated devices, up to the latest M6081 single-chip microcomputers.



PT 208

Abacus selling new low-cost range

A NEW RANGE of low-cost, high-performance microcomputers is being sold in the U.K. by Abacus Computers for Texas Electronic Instruments.

Abacus, appointed worldwide distributor for the range in November, has already sold two systems to China. Two popular models in the range are the PT 208, which has a 9 in. CRT and twin SA400 drives. It is priced at £4,190 and has a delivery time of seven days.

The PT 212 has a 15 in. CRT and two Shugart SA800 disc drives. It sells for £4,826 and has a delivery time of between 14 and 21 days.

All the machines feature as standard a CPU with 32K RAM, expandable to 64K, 2K PROM, three parallel and three serial I/O ports, and a floppy disc controller which allows a mixture of large and small disc drives.

The TEI range will understand a variety of languages including Cobol, Fortran, Pascal, Super Basic, RPG II and APL. The machines are fully-compatible with the operating system CP/M and its full range of utility programs.

Abacus is looking for high-street dealers to market the range, so that it will be available off-the-shelf. So far, four dealers have been named—Kingston Computers, of Hull; Dams Office Equipment, of Liverpool; Shulbrook Microservices of Twickenham; and Stratheden of the Isle of Man, who will be the sole distributor there and in Ireland.

Intel users' group

AN INTEL microprocessor development system users' group has been formed in the U.K. It is entirely independent and has been formed for the benefit of users of the Intel MDS.

Membership is free but is restricted loosely to those organisations or individuals who either own, hire, use or intend to use either Intel Series-I or Series-II configurations.

No such group has existed until now, although Intel reports that it is to improve its system of distributing new product information to its MDS system users.

The group will attempt tokeep users up-to-date withnew Intel products and will provide a platform for users' software and hardware products.

The group has clarified for the benefit of new Series-II users that Intel has not released in its Series-II documentation any detailed software information relating to direct read/write operations to its floppy disc subsystem.

Intel is treating this as an oversight and assures Series-II users that the configuration is similar to the Series-I configuration in this respect, and that Series-II users wishing to read/write directly to their floppy disc subsystems should purchase the Series-I MDS DOS manual.

The users' group is keen to expand its membership and any organisation or individual wishing to join should write to 29 Chaucer Road, Bedford.

Moving fast at Gants Hill

THE Byte Shop in Gants Hill, Essex, installed a Cromemco System three, which it set up and displayed so that interested customers could see it in action. In the first few weeks of this year, it sold three systems.

Gerard Talaucher, the assistant manager, says that the system is proving to be a "very popular" line. Costing around £4,000, it is ideal for the small business systems user—see *Practical Computing*, February, 1979—but with disc drives, I/O cards and other peripherals, the cost can rise to £8,000 or more.

The system on display in the shop was sold to a school and the other two to small businesses. Talaucher attributed the interest of schools and computer bureaux to its speed and attractive cost-efficiency.

Many enquiries have been received from small businesses —for example, a manufacturer who was considering buying a Cromemco to enable closer cooperation between his accountant and stock controller.

North Star Horizon in two models

NORTH STAR looks like being one of the survivors in the personal computer market and one reason is that it started not with a computer but with a floppy disc subsystem for the S100 bus.

It was one of the first companies to supply minifloppy discs in quantity. Its disc system was supplied with a disc operating system and extended Basic and as they have now been in use for two years they are among the most reliable personal computer software available. About 10,000 of the disc systems have been sold to date.

Immediately following the floppy disc subsystem, North Star released a hardware floating point board for use with its extended Basic. It claims that this can speed execution of a Basic program by as much as a factor of 10 where extensive mathematical calculations are performed.

Logical step

Having established itself as a reliable supplier of S100 subsystems, North Star took the logical step of introducing its own complete system, the Horizon. It is available in two models, the Horizon-1 with a single minifloppy drive and the Horizon-2 with two drives. The storage capacity of each drive is 90K bytes. Double density has now been introduced in the U.K.

Horizon is an S100 bus computer. The motherboard has slots for up to 12 S100 circuit boards. The motherboard contains one or two serial I/O ports and one parallel I/O port. The processor board uses a Z80A and operates at 4MHz which is twice the speed of an 8080. The complete system is packaged very neatly and

by Martin Collins

includes a more than adequate power supply and a cooling fan.

Our review system was a Horizon-2 supplied by Equinox Computer Systems Ltd. The system had four 8K memory boards made by Industrial Micro Systems, two serial ports, one set to run at 4,800 baud and one at 300 baud, and two parallel ports, one for input and one for output.

Prices

Horizon with one disc drive, U.K. power supply, eight edge-connectors and serial port, fully assembled and tested.

16K RAM	£1,328
24K RAM	£1,483
32K RAM	£1,638

Horizon with two disc drives, U.K. power supply, eight edge-connectors and serial port, fully assembled and tested.

16K RAM	£1,668
24K RAM	£1,823
32K RAM	£1,978

Extra serial port £45; parallel port £45; hardware floating-point board £220.

Eight of the 12 slots on the motherboard were fixed with edge connectors and six of them were used, one by the processor card, one by the disc controller and four by the memory boards.

Equinox supplies the IMS memory boards because they are static and this, it claims, makes them more reliable. North Star manufactures a 16K dynamic memory board.

We tested the system using an ACT-1A VDU which has a "simple" RS232 interface requiring only pins 2, 3 and 7 to be used on a standard 25-pin connector.

Confusing advice

The Horizon manual and some additional instructions supplied by Equinox gave confusing advice on how to connect the terminal to the system. The Horizon interface is full RS232, which enables it to be used with modems. To use it with a simple terminal such as the ACT-1A, pins 4-5 and 6-8-20 should be wired together at the Horizon end of the interface cable.

The initial problem we had in wiring the system was caused by the rather scrappy documentation we received with the system. On software we had the following documents:

(continued on next page)

(continued from previous page)

North Star Disc Operating System Version 2 Release 3
North Star Basic—Version 6
North Star Monitor—Version 1
Release 4 Software Changes
Notes on system start up from Equinox

All the problems we had in wiring the system resulted from finding the most up-to-date part of the documentation. The manuals are not designed for the first-time user; the Basic manual, for example, is little more than a brief specification of the language as implemented on the system.

Since our initial evaluation we have received revised documentation for the system. This consists of two manuals:

Horizon Computer System Double Density HRZ-D
North Star System Software Manual SOFT-DOC

The first was concerned mainly with assembling a Horizon system from a kit. It provides much information about the hardware but would probably be of use only to anyone capable of or interested in locating and curing hardware faults.

Improvement

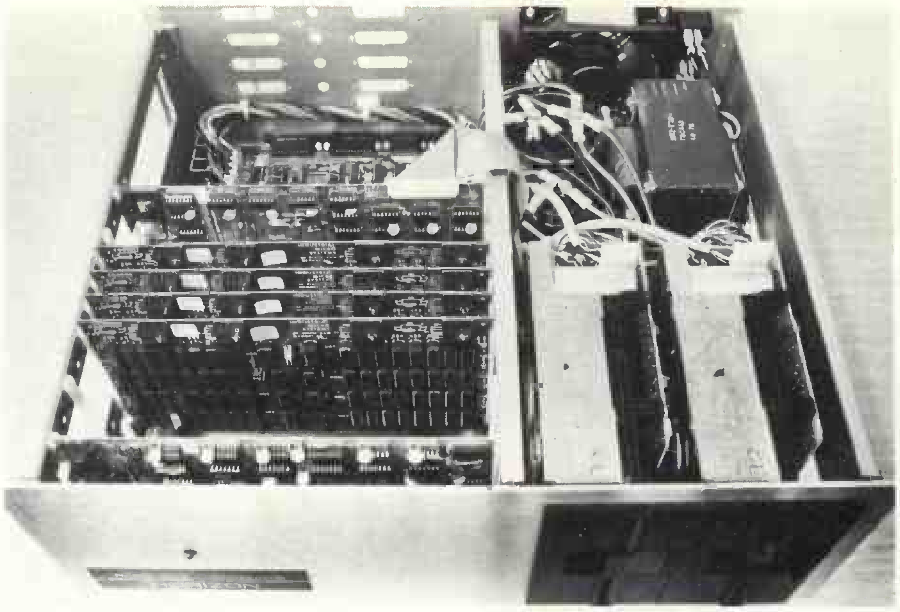
The second was a greatly-enhanced version of the software documents we received with the system. It was certainly an improvement to have all the relevant information in a single manual. The manual includes four main sections:

Getting started, which tells you what to do when the system is unpacked.

The operating system, which is concerned largely with the filing system and its associated utility programs.

The monitor, a program which allows the user to examine and amend memory locations. It may be necessary to use it for "personalising" a system, e.g., amending it to suit a particular set of terminal characteristics, but for most users it will be only of academic interest.

Basic; this forms the major part of the manual and has been written to serve both as an introduction for the novice and as a reference manual for the experienced user. At first sight it seems to meet both those requirements successfully. It also includes as an appendix a number of well-documented sample programs.



Overall, the manuals were some of the best we have seen for a micro system. They are not the easiest for use by a novice, so if you are starting from scratch you may need to read a simple introduction to computers before using these manuals.

Once we had overcome the problems in linking our VDU to the Horizon we had no further problems in getting the system up and working. There are only two external controls on the system, an on/off switch and a re-set switch.

Loading

Powering the system on or pressing the re-set switch causes the operating system to be loaded from the floppy disc. As we had no printer interfaced, the first prompt was PR to which N is input;* which is the operating system prompt, is then displayed.

The operating system is not the most sophisticated available on a micro system but it includes all the necessary basic commands for setting-up and maintaining disc files. One drawback to the system is that files must occupy physically contiguous disc space.

This has two advantages, however; the first is that the file size must be specified when the file is created and it cannot be extended subsequently. The second is that space left by a deleted file cannot be re-used until the disc has been compacted. The operating system manual supplied with the system is brief and is certainly not written for the beginner. It did, however, contain all the necessary information. It includes a section on "personalising your system" to match it to specific terminal and memory requirements.

No limit

The Basic system is entered by typing GO BASIC. The standard Basic supplied by North Star has 8-digit precision but there are versions available with 2, 4, 6, 10, 12 or 14 digits. Three versions are supplied with the system to operate in 16, 24 and 32K.

This is a good extended Basic, with all the normal features available. One unusual capability is that there is no limit on the number of dimensions which an array may have. Strings may be dimensioned up to the limit of memory and substrings may be defined either by $ (u,m) where n and m are the first and last characters or using the LEFT$, RIGHT$ and to insert commas, suppress zeroes and so on.

The file-handling allows data to be read or written sequentially or randomly. The sequential file access requires the length of any strings written to be known; there is no equivalent to the ASCII sequential format available on many Basic systems. Random access to files is done by specifying a file pointer which is a byte address within the file.

Limited expansion

North Star has designed the Horizon as a complete system and for that reason system expansion is fairly limited. There is a new version now available in the U.K. with double-density discs giving 180K bytes per drive. A third drive can be added to any system and would be housed outside the cabinet.

Any S100-compatible peripherals can be used with the system. With the double-density system, four drives are supported by one new controller.

With North Star Basic, the memory can be expanded to 56K. North Star will be releasing a PASCAL compiler shortly which will require a minimum of 48K. As an alternative to the North Star software, the system can also be supplied with the CP/M operating system which provides Cobol, Fortran and CBASIC.

Packages

Equinox is developing packages for the system in conjunction with a number of software houses. The first to be released will be an estate agents' package and a payroll package. There is a large amount of application software available for the system in the States, and Equinox is assessing a number of packages for distribution in this country. They include:

Stock Control
Plant Maintenance and Control
Medical Package
Word Processor
Incomplete Record Accounting

Although Equinox does not undertake software development for specific customers, it is able to recommend software houses with experience in program development for the Horizon.

Conclusions

- The Horizon is a well-made system with fully-proven software.
- The availability of a floating-point hardware board to work with the Basic and the fact that the system is based on the Z80A operating at 4MHz make the system suited particularly to applications requiring extensive mathematical calculations.
- Before buying a system with mini-floppy discs, you should make sure that they have sufficient storage capacity for your requirements. Even with the new double-density discs, the capacity is considerably less than a normal full-size floppy.
- The availability of the North Star Operating System and CP/M gives a wide choice of programming languages and application software.
- The revised documentation we received was of a high standard. The first-time user would require a simpler manual, perhaps one of the introduction to micro books, before understanding the manuals.

Practical Computing evaluation

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

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

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

THE NO
COMPU

ROBIN BRADBEER spent a few hours with Steve Wozniak, inventor of Apple computers, some weeks ago. Today, Apple is one of the success stories of the microcomputer business, it is rich and independent, and its problems are those of over-demand, a rather pleasant position for a company.

Two years ago Apple was two guys and an idea in a garage. If you want to tune-in to commercial success in the home computer world, read on.

The interview is in two parts. We begin with Steve's story about the birth of Apple. Next month the questions are about ideas, developments, trends and opinions.

LONG before Apple began, I was working at Hewlett-Packard, designing calculators. Round about that time in 1974, I became interested in video games. Atari and other companies were beginning to put their video games into coffee bars, bars, restaurants and similar places. So I thought I'd try to design my own version of them—I was one of those guys who was always playing around with these things as my hobby. This led on to a couple of other projects, chess displays and things like that.

That naturally led to the video terminal. There's not much more to learn to build one of those after you've built a chess display. I looked through the data books and found the appropriate shift registers. My trademark is designing small, tight circuits—this helps to solve many problems later on—by keeping all the logic very close together. I was able to design and build a very simple video terminal.

Terminal start

Of course, all this was taking place while I was still with HP—and none of it was for HP. About that time, the Altair computer had just been introduced. My video terminal was almost finished and a friend mentioned that some people locally were about to start a club for those interested.

Microprocessors I didn't know the first thing about; video terminals I did. So I became one of the founders of a club which consisted initially of 40 people sitting in a garage with the rain pouring outside.

Working on chips

We were sitting discussing microprocessors, which micro had this feature and which had that. Honestly, I just didn't know what was going on—I'd never been into this hobby world at all; what I was doing was working on calculator chips which were a totally different style of microprocessor. I felt a trifle out of it but I attended a few meetings and began to get to know what was going on.

Then I heard that Chuck Peddle was to sell micros over the counter for around $20 at an electronics trade fair. In the HP lab there were two of us really interested in this type of thing and we went there to buy ourselves some microprocessors.

Now the only micro with which I'd really had any experience up to that time was the 6800. In fact, I had designed on paper a complete system based around the 6800, but Chuck was selling the 6502.

When we went through the instruction set, found out everything it had and everything it didn't have, we were left with a question—What do you do with a computer?

I realised that Basic was the language which was becoming more and more popular, so I tried to write a Basic compiler with a few things of my own. A friend wrote an Algol program which ran on a HP2000 mini and simulated the 6502 chip, so I was able to write the guts of the Basic compiler. It eventually became our Integer Basic.

Making it work

The next step was to design a system. There was this video terminal on my desk, so I put the microprocessor on it with enough circuitry to make it work as a system. I interfaced it to some RAMs, put a ROM monitor on it and powered up the thing. It started to interact with the keyboard and I could get it to go to various memory locations; it was a very basic first-level system.

There were still a couple of bugs; for example, I forgot to clear the decimal mode on the 6502 which everyone does when they first run it. I took my compiler which was working on the simulator and loaded it in and that sat in the RAM.

Now that I had my system I had to do some more software. So I had to work out more and more of the Basic. While this was going on every few weeks the club would meet and I'd go down to show off the latest.

I got good at typing-in hex; I had no development aids, no cassette recorder, no floppy disc, no assemblers, so it was all done on paper and hand-coded.

I was pass 1, I was pass 2, I was the linking loader, I was the text editor, I was everything: I became very good at working out the op. codes in my head and putting it all down on paper.

At about that time I contracted asthma or something. This rather helped me to develop things because I couldn't sleep; I would get up in the middle of the night and work.

The friend I mentioned before had built his own system as well. My idea was the single-card system. He went for the more traditional route most people were taking, which was slot-based and bus-structured—the CPU was just one of the cards, the memory was another.

I was still making hand-wired breadboards. Then this friend of mine, Steve Jobbs, said why don't we make a few boards like this and sell them? Our original idea was to build about 50 blank boards, take them to the club, hold them up in the air and say "Is anybody interested in buying one of these boards?"

First big order

I sold my HP calculator and Steve sold his van and we used the money to hire a printed circuit artist to lay-out the boards. While we were thinking about making the first boards, Steve received a telephone call to place a $25,000 order for 50 complete computers, fully built. We were planning to sell only blank boards but these were orders for boards which were fully-stocked with the ICs.

The order was from the local Byte Shop. By arranging credit properly we were able to get all the components we needed to build the boards. Then we went and sold them on the date for which the purchase order was made out and were able to pay our creditors. It was a very neat operation. We were able to turn the whole thing around very fast, in less than a month. That put us in business—in a garage.

We decided to call the company Apple. Steve was working at a place called Apple Orchard, or something like that, in Oregon. It's a really great name—it's one of those names which sticks.

We used the garage for a year and we didn't move too many computers, about 200; but it was the name which sold, and we started advertising in the national magazines.

Fast development

Of course, all this is on the side, and I'm still working at HP. I got a formal legal release from HP to allow me to do this sort of thing.

Stores were springing-up all over the country and the Apple was a different product from the others around. It wasn't a completely finished product like the Apple 2—it was just a board with a microprocessor, 8K of memory and a video terminal.

I think we were the first people to us the 4K dynamic RAMs which were coming in at the time, so the Apple I

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used a lot less power and cost much less.

With Apple I beginning to make an impression, we needed a cassette interface. That was our second product; it was a really fast development. We couldn't do it so fast now—it took about a month.

March, 1976 was when we formed the partnership and started selling the computers. In June, I started on the Apple II, which was designed to do all the things Apple I could do, but better. I was also very interested in colour video.

It proved almost impossible to design a simple colour circuit for the Apple I, so I decided to start completely with a new system and, in fact, everything turned out cleaner. The whole thing was still built as a single stand-alone system.

I had designed a game for Atari called Breakout, so I wrote another version of it with graphics commands. It took about a day to write and a day to debug and two weeks of modifying. I couldn't believe how easy it was to write in Basic compared to assembly language.

We took this to Atlantic City in September for our first Computer Fair, PC 76.

'Beautiful'

We came across this Advent projector television and thought it would be really neat if we could try the Apple II on the colour projector TV to see what it would look like. We hooked the Apple II to this projector and threw it up on the screen and it looked just beautiful.

The guy in the booth said "I want one of those". Remember, it was still a hand-wired breadboard at that stage. That told us something. Surrounded by all the fantastic video and computer equipment, this guy wanted ours.

Things were going really well. We were coming up with high-resolution graphics and the 16K RAM was coming along. In fact, we started using 16K RAMs on the Apple I. I think we might have been the first people to sell 16K RAMs for a computer as an extension to the Apple I.

Cost-effective

The Apple II was probably the first small computer to use 16K RAMs as well. We feel we've kept up with the RAM technology all the way through, and as we were one of the few to use this technology, it worked out to be very cost-effective in the end.

The final board design for the Apple II was done around November, 1976. It appeared eventually as a product about April, 1977. We didn't have a case designed. Carl Helmers of *Byte* magazine got interested at this time. He was keen on having a small computer you could take home and plug in, rather like a piece of hi-fi equipment.

Steve Wozniak

Straight lines

We took the hand-drawn work and digitised it into the computer. The lines came out perfectly straight and the board looks better because the lines are all straight.

Meanwhile, the garage was filling with racks and test equipment and there was no way that we were going to be able to do the Apple II in there. There just weren't enough of us involved. We might have gone under; we could just not have met the demand.

News of the product had started getting out. For example, I was going to Los Angeles to demonstrate Apple I to a group there and I forgot the transformers or something like that. All I had with me was an Apple II which I could demonstrate. So I showed that. It was still in breadboard form but there were about a dozen people at that meeting and eight of them ordered Apple IIs.

We knew we had an exciting product and just knew we could sell it, so we started to look for other people.

Steve met the guy who is now our marketing manager; he worked for Intel. Then we hired another guy who was a friend of the marketing manager and he became president. He had been running a division of National Semi, where he had a lot of responsibility. His job was to keep an eye on the dollars and cents.

He's still our president. As for me, I was still working for HP until the first quarter of 1977. We hired two more engineers, including one guy from Atari who had a superb analogue background. We're now adding about 10 people a week still. We have about 110 employees now; we also place a lot of contracts outside. So there are now many people working just on Apple—the total could be nearer 200 full-time if you take the other companies into account.

More natural

We started slowly and that was a good thing. We had some really good exposure in the Press. We took on a good advertising agency—that's one of the first things we did—and the thing just took off from there.

Apple was beginning to be accepted, it was a more natural sort of product and it wasn't considered a brand new product any more—remember that at that time there were many companies coming out with really neat-looking products which might well be advertised in perhaps five issues of a magazine and then disappear.

So we finally made it to that point where our momentum was going to carry us. We knew we were going to survive unless something very drastic happened.

These pages represent an independent collection of news and views for owners of the Commodore Pet.

The principal focus is Mike Lake, of the Independent Pet Users' Group (IPUG).

If you wish to contact *Pet Corner*, write to him or send articles or ideas to us directly.

Offerings this month include items on the use of a 40-column printer, the Teletype 43, increasing competition in the supply of floppy discs, and information on how to play Pet music.

News about the Pet Users' Group

RESPONSE to the formation of the Independent Pet User's Group has been very good indeed, according to secretary Mike Lake. "Membership has almost trebled, with nearly 150 members already and growing daily. Many new members have enquired if there is anyone else in the group tackling the same problems as themselves. I hope the newsletter and the address list will put them in touch."

Printer: the PR40

TO keep up with the addressing for the group, Mike invested in an SWTP PR40 40-column printer to use with his Pet. He reports that he is "very pleased" with results so far, though he was concerned initially about its speed.

Driving the user port from Basic programs was very slow indeed and each line was taking several seconds to appear. A 256-byte machine-code routine, sitting protected in the top of the memory, has cured that and now the PR40 is delivering about 75 lines per minute.

Mike notes one or two things about this printer which are not so good, though. It is certainly in an attractive enough case, and it is complete with a plug for the Pet user port. Inside the case is a roll of 3⅞ in. paper. It has caused some problems because it is impossible to change the paper roll without loosening the 18 self-tapping screws which hold the case together. SWTP must have designed the case around a printer which had the roll of paper on it, unless no-one is expected to use more than one roll.

The problem, however, is fairly easy to cure. Two neat hacksaw cuts leave the case intact and allow access to the paper roll.

There's another problem. Where do you get 3⅞ in. paper? SWTP wants £1 per roll for it and also charges £4 for a new ribbon—five times the cost of an equivalent typewriter ribbon. Does any reader know of a source of cheap consumables?

That apart, Mike's printer has worked well. The machine code routine for driving it at full speed is available to group members at £2·50 (£5 for non-members). Incidentally, this routine can be used to drive almost any parallel printer from the user port—hardware interfaces become necessary for using the IEEE port.

The Teletype 43

WE HAVE seen several Pets with the Teletype 43. One user Mike encountered was concerned that he could not get lower-case when driving it from a program—in local mode the lower-case was fine.

To get the lower-case output from a program, you have to fudge the output data slightly.

Here is one way it can be done:

```
10  FOR A = 1 TO LEN (A$)
20  X = ASC (MID$ (A$,A,1))
30  IF X <219 AND X> 192 THEN X = X - 96
40  B$ = B$ + CHR$ (X)
50  NEXT
60  A$ = B$
70  B$ = ""
```

This converts a string (A$) containing a mixture of upper- and lower-case characters into a form suitable for the Teletype 43. If anyone can think of a better way, let us know.

This still leaves a problem with the Teletype 43. When doing program listings it appears to suppress cursor and other control characters—not even a blank is left in their place. Has anyone found a solution to this problem?

The cheapest printer yet

THE January edition of *Practical Electronics* (no relation) carries the first of two articles on building a 40-column electrostatic printer—total cost about £90. If anyone makes one, please let us know how it goes with Pet.

Floppy discs

COMPETITION to supply floppy discs for the Pet seems to be hotting-up. Commodore has demonstrated a single drive in the U.S., though it has a somewhat limited software. It is hoping to produce a dual mini-floppy system sometime before the summer. Meanwhile, we count at least three contenders here.

Midland Micronics offers the MM3. This system we have already highlighted in *Practical Computing*. It sits across the top of the Pet VDU and thus forms an integral part of the machine. This twin mini-floppy system offers 80K bytes of storage; a full 8K program can be loaded in two or three seconds. Midland Micronics had some difficulties with the software for the drives but this has been sorted out now.

The system is offered at £1,300 for the dual-drive version and £870 for a single drive.

John Chew, of Kingston Computers in Hull, tells us his company will be importing a dual-drive system from the States early this year. The price will be about £860. This again offers 80KB storage on each diskette.

Kingston Computers is to lend Mike Lake a system for evaluation, so he should be able to report on it for us.

Lotus Sound also has a dual-drive mini-floppy system and if anyone cares to get in touch the company will supply full details. We noted this one last month.

Memory

HERE is another area where competition is getting stronger. Lotus Sound now has 16KB for £298, £364 for 24K, and £425 for 32K. The prices seem to be the lowest around at the moment.

Incidentally, some people have asked why buy an extra 32K of memory when only 24K can be recognised by Basic? The extra 8K can be used for machine-code routines such as the PR40 driver and the IPUG Renumberer (see later). These routines are then protected from being over-written by Basic and can be called by the USR or SYS commands. Routines for controlling the I/O ports are particularly suitable for this area.

Be warned, though, if you are thinking of buying a floppy disc. Don't rush to buy 32KB of extra memory and expect to use it all for programs; some may be required by the floppy disc itself, any-

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thing up to 12K of mixed RAM and ROM in some cases.

IPUG Offers

FROM time to time, the group will be offering software for sale; proceeds will go to IPUG to help defray expenses.

At the moment there are two routines on offer:

- the PR40 (parallel printer) driver already mentioned;
- the IPUG Renumberer, which Mike Lake describes modestly as "the bee's knees of renumberers". It really works, and will catch THENs, GOTOs, ON.....GOTOs GOSUBs. It is in machine code and needs 962 bytes of memory to itself; it will take around four seconds to re-number a very large program. The program can then be saved or executed to test whether the re-numbered version works.

Both routines cost £2·50 to members—not bad at all. Non-members must pay £5, so with membership at £2·50 per annum, it's cheaper to join and then buy.

Word lists

ANYONE interested in word processing could do worse than taking a leaf from Microsoft's book. The list of Basic key-words is stored at locations CO92 through C18F (you will need to get round PEEK protect to look at this area—try using a disassembler) and the way it is stored is interesting.

The last character of each word has bit 7 set. This means that there is no need to store a space between words. ASCII characters normally do not have this bit set, so as soon as it is detected, you know you are on the last letter of a word. If this idea could be used when storing lists of words, a considerable saving on storage space can be made.

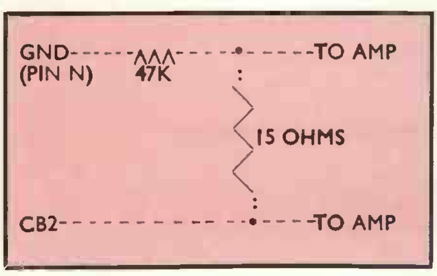
Note production

AS promised in the last article, here are full details from Mike Lake of how to make Pet play music—this is also an example of the PR40 printout:

To produce a note you must:

```
1) POKE 59467,16
2) POKE 59466,D  (SEE COLUMN D)
3) POKE 59464,C  (SEE COLUMN C)
```

To hear the note you must connect up the user port like this:



NOTE	FREQUENCY	D	C
G	3136	15	18
F#	2960	15	19
F	2794	15	20
E	2637	15	22
E•	2489	15	23
D	2359	15	25
C#	2217	15	26
C	2093	15	28
B	1976	15	30
B•	1865	15	32
A	1760	15	34
G#	1661	15	36
G	1568	15	38
F#	1480	15	40
F	1397	15	43
E	1319	15	45
E•	1245	15	48
D	1175	15	51
C#	1109	15	54
C	1047	15	58

NOTE	FREQUENCY	D	C
B	988	15	61
B•	932	15	65
A	880	15	69
G#	831	15	73
G	784	15	78
F#	740	15	82
F	698	15	87
E	659	15	93
E•	622	15	98
D	587	15	104
C#	554	15	111
C	523	15	117
B	494	15	125
B•	466	15	132
A	440	15	140
G#	415	15	148
G	392	15	157
F#	370	15	167
F	349	15	177
E	330	15	188

NOTE	FREQUENCY	D	C
E•	311	15	199
D	294	15	211
C#	277	15	223
C	262	15	237
B	247	15	251

Education

NICK GREEN of Commodore—who, as we discovered by accident at a Christmas party, shares the same *alma mater* as our managing editor—has been in touch expressing concern about the lack of educational facilities for Pet users. Some dealers have also expressed the same concern to Mike Lake and made this suggestion.

IPUG would be willing to organise a weekend course—Friday evening to Sunday afternoon—at a "good hotel" close to the M1 in Nottinghamshire. The course would have experienced tutors from the group, and the cost would be about £40 per head, including full board.

IPUG is a voluntary organisation and does not wish to make a profit; neither can it afford to set up such a course without knowing what the demand would be. If anyone is interested, get in touch with Mike as soon as possible. Numbers would have to be limited to give everyone a fair chance for hands-on experience with Pets and peripherals—they would be loaned by local dealers.

To join IPUG only costs £2·50: just drop a line (and a cheque) to:

Mike Lake, 9 Littleover Lane, Derby.

Pilot arrives

A COPY of Pilot for the Tandy arrived on our desks this month from Optronics in Twickenham, which is one of the first dealers in the U.K. to offer the language.

Pilot is one of the best languages available for writing computer-assisted instruction programs. Its facilities were described in great detail in our November, 1978 issue.

TRS-80 Pilot is Jeff Lasman's version. Programs are written as simulated dialogues in English and can be entered and executed very quickly.

There are four main functions—T to type text; A to receive an answer; M for match keyword; and J for jump. It took us about half-an-hour to master the main parts of the language. It is certainly one of the simplest ways of organising questions, conversations, riddles and general interaction with a computer we have come across.

Programs 50p

ANOTHER goodie to arrive in the U.K. is Library 100, a collection of 100 programs to run on the Tandy. The collection will be selling here for £46·95, less than 50p a program.

Bringing the collection to the U.K. is A. J. Harding of Bexhill-on-Sea, Sussex (0424) 220391. The programs are split into five categories—finance, education, graphics home and games.

We are waiting for our own preview copy but glancing through the contents list it seems that the finance section is definitely American, covering items like real estate capital investment, salvage value, and amortisation schedule. It also includes simple and compound interest and terms of loans.

The list of education programs is what one might expect—addition, subtraction, algebra and so on. There are, however, some intriguing items like inventors and inventions, authors and books, capitals and countries, and presidents and orders.

For the home there are 15 programs with interesting titles like bartender, babysitter, drunkometer, Christmas list and expense account.

Finally, on the games front there are 29 assorted games like Star Trek, quizzes, and Wheel of Fortune.

Printer interface

WE HAVE just connected a TRS 232 printer interface to link our Tandy with a Diablo printer.

We discovered the interface on a trip to the U.S. where we paid about £30 for it. It is understood that Whitehead Micro Systems of Kenilworth is planning to bring them to the U.K., although there are probably some dealers already offering them here. Doubtless they will let us know.

It is a simple task to set-up the printer interface. It works with any RS-232-compatible printer including Diablo 1620, Teletype 43 and TI Silent.

The interface is a piece of hardware about the size of a cigarette packet which you connect between the power supply and the Tandy. No tools are required. It is a simple plug-to-plug connection.

Some software on cassette is provided to handle the output formatting. That's all there is to it.

Software fix

YOU KNOW that when you touch one letter on the Tandy keyboard you sometimes get two on the screen. Well, Tandy has introduced a software fix for it.

At the moment, it is available only on disc but Tandy plans to issue a tape later. For those readers who want to jump the queue, A. J. Harding has given us a disassembled listing for the routine.

It was disassembled from a 48K machine, starting at 65481. For 16K the starting address is 32713, and for 32K it is 49097.

FFC9	AF	XOR	A
FFCA	110A00	LD	DE,00A
FFCD	CD0B00	CALL	000B
FFD0	19	ADD	HL,DE
FFD1	221640	LD	(4016),HL
FFD4	CD611B	CALL	1B61
FFD7	CF191A	JP	1A19
FFDA	21 36 40	LD	HL,4036
FFDD	010138	LD	BC, 3801
FFE0	1600	LD	D,00
FFE2	0A	LD	A, (BC)
FFE3	5F	LD	E,A
FFE4	AE	XOR	(HL)
FFE5	73	LD	(HL),E
FFE6	A3	AND	E
FFE7	2008	JR	NZ,FFF1
FFE9	14	INC	D
FFE8	2C	INC	L
FFEB	CB01	RLC	C
FFED	F2E2FF	JP	P,FFE2
FFF0	C9	RET	
FFF1	5F	LD	E,A
FFF2	C5	PUSH	BC
FFF3	01DC05	LD	BC,05DC
FFF6	CD6000	CALL	0060
FFF9	C1	POP	BC
FFFA	0A	LD	A,(BC)
FFFB	A3	AND	E
FFFC	C8	RET	Z
FFFD	C3FB03	JP	03FB

Do you have a Tandy tip? We will pay £5 for every tip printed. Send to Tandy Tips, Practical Computing, 2 Duncan Terrace, London N1 8BJ.

One of the most infuriating features of the Tandy Level II manual is that there is no index. We now remedy that with contents you can cut out and stick into your manual.

TRS-80 Level II Index

ABS	7/1	FIX	7/2	PRINT#-1	3/10
ASC	5/3	FOR..TO..STEP	4/8	PRINT	3/1
ATN	7/1			PRINT@	3/1
AUTO	2/1	FRE	5/5	RANDOM	7/3
CDBL	7/1	GOSUB	4/6	READ	3/9
CHR$	5/4	GOTO	4/5		
CINT	7/2	IF	4/12	RESET	8/2
CLEAR	2/2,4/3	INKEY$	5/5	RESTORE	3/10
CLOAD	2/2	INPUT#-1	3/10	RESUME	4/11
CLOAD?	2/2	INPUT	3/7	RETURN	4/6
CLS	8/2	INT	7/3	RIGHT$	5/7
CONT	2/3	LEFT$	5/6	RND	7/3
COS	7/2	LEN	5/6	SET	8/1
CSAVE	2/3	LET	4/4	SGN	7/4
CSNG	7/2	LIST	2/4	SIN	7/4
DATA	3/8	LLIST	10/2	SQR	7/4
DEFDBL	4/2	LOG	7/3	STOP	4/5
DEFINT	4/1	MEM	8/4	STR$	5/7
DEFSNG	4/2	MID$	5/6	STRING$	5/7
DEFSTR	4/2	NEW	2/4	SYSTEM	2/5
DELETE	2/3	NEXT	4/8	TAB	5/2
DIM	4/3,6/3	ON ERROR GOTO	4/11	TAN	7/4
EDIT	2/4	ON N GOSUB	4/7	THEN	4/13
ELSE	4/13	ON N GOTO	4/6	TROFF	2/5
END	4/4	OUT	8/4	TRON	2/5
ERL	8/2	PEEK	8/5	USING	3/3
ERR/2+1	8/3	POINT	8/2	USR	8/7
ERROR	4/10	POKE	8/5	VAL	5/8
EXP	7/2	POS	8/6	VARPTR	8/8

Reprinted from Orange County TRS-80 Users' Group Newsletter, available by donation, £10 a year from user group, 24232 Tahoe ct., Laguna Niguel CA 92677.

Helping you to choose

Buying a visual display unit (VDU) can be a daunting task. This month we look at what you can buy for less than £1,000.

THE PRINCIPAL aim of this guide is to explain the features to be found and to look for when selecting VDUs and, equally important, to prevent you having to wade through masses of manufacturers' brochures with their superlatives.

Most VDUs on the market have evolved from the ubiquitous Teletype, a hardcopy printer/keyboard terminal with a maximum operating speed of 10 characters per second.

The Teletype was a winner, selling tens of thousands of units throughout the world, but more recently applications demand higher transmission speeds and where the need for hard-copy is not so important, "glass teletypes" are coming to the fore.

Naturally, many VDUs offer more features than mere "Teletype replacement" and compatibility. They will be covered in more detail later. First, some of the more common buzzwords:

Major role

Interface: the Teletype had a major role to play here, and the development of the 20mA current loop interface was designed around it. This allows for "local" communications by direct two-wire connection over a limited distance to a computer.

The other common type of interface is the EIA RS232C (U.S. standard) or CCITT-V24 (European), both of which are supposedly identical, apart from minor variations, and therefore are used interchangeably. This allows for a signal to be fed into a modem and transmitted via telephone line, theoretically over any distance. Both are serial interfaces. Parallel interfacing is somewhat more ambitious.

ASCII: This is one of the ways of representing alphanumeric characters in binary code patterns. Seven binary digits (bits) will represent 128 patterns, each corresponding to a particular ASCII character, although most terminals use only a subset of the full character set.

Most interfaces, however, allow for 8-bit character codes, so the spare bit, the eighth bit, may be used as parity bit, which represents whether the bits in the character add up to an even or odd number against which it may be checked for accuracy at the receiving end.

The rate at which a human keys-in characters at a keyboard is somewhat erratic and therefore not synchronised with the computer's own clock; in other words transmission is asynchronous. This means that the computer has to be warned that a character is on its way by means of a start bit preceding it, and a stop bit at the end of it, or in the case of the Teletype, two stop bits to make sure.

This means that a terminal accepting transmission at 9,600 baud—used synonymously with bits-per-second—will display characters at the rate of 960 per second or thereabouts.

Display: If you are wondering why 80 characters per line is so common, it is for no other reason than that punch cards, an earlier data entry medium, have 80 columns. The number of lines ranges between 20 and 25 lines. The characters are formed in a matrix of dots which differs in dimension and format across the various models available.

If you are looking for more bells and whistles, you might like to consider the following features, most of which are designed to facilitate data entry:

Buffers: These are areas of memory which serve as a halfway house for data in transit. This is useful for block mode transmission, where a piece of data may first be checked and edited if necessary, rather than having each character transmitted immediately as it is keyed-in. In line mode, transmission takes place one line at a time.

Scrolling: This takes place as new lines are entered at the bottom of the screen, with earlier lines disappearing from the top. A scrolling memory will capture some of the lines to display them again when required, by scrolling down. The screen acts, in fact, as a "window into memory".

Alternative

An alternative means of displaying memory is page mode, where it is divided into pages rather than lines. Used with protected fields, page mode allows a programmer to set-up forms on the screen, permitting a switch from one type of data entry to another—for example, from invoicing to stores receipts, or stock enquiries.

Data entry: Other data entry aids include blinking, reverse or inverse video, half-background, and underline, either of protected fields, blank spaces for data entry, or error messages, or any combination of them.

Editing: Editing features may range from simple cursor control and addressing to complex word processing functions. The more common editing functions, however, are character insert/delete, line insert/delete, erase line/screen, and tabulation, the last of which may be used also as a data entry aid.

If you are a supplier of VDUs and we have missed you from this survey, please contact us and we will be pleased to include you in our next round-up.

Burnt Hill Electronics

THE principal advantages claimed for the BH 720 video display terminal are clear text with underline facility, graphics capability, simple cursor control and ease of maintenance.

The 12-in. CRT displays 25 lines by 80 ASCII characters in upper- and lower-case with full descenders including text underlining, blinking and inverse video, and character protection for data entry.

A graphics function is provided and the control system also provides line and page erase, addressable cursor and display of all control codes. A special function allows the cursor to be returned to the position it was in before the use of the cursor address facility.

The keyboard is capable of generating the full 128-character ASCII code and includes a standard numeric keypad. The interface has a switch-selectable transmission rate from 100 to 19,200 baud in both RS232C and 20mA current loop form. An extension provides for direct connection to a hard-copy printer.

Burnt Hill Electronics Ltd, Holder Road, Aldershot, Hampshire GU12 4RH
Tel: (0252) 313701
Price: £795.

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Cifer Systems

CIFER is a Wiltshire-based British manufacturer. Of particular interest to the hobbyist will be its Model 034 Cub, featuring a 12-in. diagonal display of 16 lines by 64 upper- and lower-case characters, keyboard with 60 keys, CCITT-V24 interface and eight transmission speeds from 50 to 1,200 bps.

The one-off end-user price is £380 and includes a 12-months' factory warranty. In addition to the standard unit which operates from the normal AC mains voltage, a 12-volt DC model is available as well as a receive-only Telex version.

Model 127A features the full ASCII repertoire displayed as high-definition 7x12 dot matrix characters on a 24-lines by 80-character display. Standard features include direct XY cursor addressing, fixed or rolling page, printer and video output ports, separate cursor control keys, nine transmission speeds and transmission by character, line, page, or block. (£690 one-off).

Model 026 features a separate contactless keyboard, single- and double-line spacing, double-width characters plus 14 selectable character highlights and cursor addressing (£580 one-off).

Model 224A is a high-quality, page-buffered terminal featuring a separate 84-key keyboard, including numeric and control clusters. Models are available with optional text editing, protected format, tabs, customer-defined character sets and a pseudo-synchronous communications facility (£850 one-off).

Cifer Systems Ltd,
Avro Way, Bowerhill,
Melksham, Wiltshire SN12 6TP.
Tel: (0225) 704502.

Computer Workshop

THE South West Technical Products Co CT-64 visual display terminal is manufactured under licence in the U.K. at Peterborough and marketed by Computer Workshop in London.

It is not a beautiful terminal but worth thinking about at the price (£230 in kit form plus £140 for monitor). A face-lift is imminent, although the price is open to speculation.

The display consists of 16 lines of 64 characters, each formed in a 9x7 dot matrix with full descenders on upper- and lower-case ASCII characters. A switch on the front panel disables lower-case characters.

All cursor movements including home, up, erase to end of line, end of frame, cursor blinking/solid, cursor on/off, page/scroll, and page switch may be selected individually by means of user-defined control characters.

A screen-reversing feature allows field reversal around individual characters or of the whole screen for highlighting purposes. Parity and stop-bit may be jumper programmed on the serial RS232C interface.

The CT-64 is available optionally in assembled form but if you fancy your chances with the soldering iron, you ought to put aside around 15 hours to assemble from kit form.

Computer Workshop,
38 Dover Street,
Piccadilly, London W1.
Tel: (01 491-7507.

Control Data

MODEL 92452 has a 1,920-character display of 24 lines by 80 characters in page or scroll mode. Features include direct XY cursor addressing, incremental cursor positioning, clear screen, clear line, cursor home, and character/field highlighting.

The standard CCITT-V24 interface allows for transmission at speeds from 110 to 9,600 baud in full-or half-duplex and character or block mode; 20mA current loop interface is optional.

Other options include screen formatting features and numeric keypad.

Megabyte Ltd.,
Kerry House,
Kerry Street, Horsforth,
Leeds, LS18 4AW
Tel: (0532) 583608. Price: £950.

Dacoll Engineering

THE chief attraction of the Model 241 terminal is its lower-case alphabetics. It has a 96-character ASCII code using a large 12×7 dot matrix. This format allows for true descenders on lower-case characters. The 12 in. CRT has a 24-line by 80-character display.

Also standard is a numeric keypad. Apart from backspace it offers no editing facilities. Video output for a TV monitor is optional, as is 20mA current loop interface. CCITT-V24 is standard.

The 241 incorporates 1,920-character RAM with switch-selectable half- or full-duplex transmission from 100 to 4,800 baud (Price £660).

The specifications for the Model 247 are much the same as those of the 241 but the characters are formed in a 8×7 dot matrix, and 32 control codes are added to the 96-character ASCII code. Transmission rate increases to 9,600 baud (Price £890).

Dacoll Engineering Services Ltd.,
Gardners Lane, Bathgate,
West Lothian.
Tel: (0506) 56565.

Data Dynamics

THE Tele-ZIP is easily transportable, permitting a user to communicate over a telephone line to a remote computer system, using a standard television receiver or video monitor. Housed in a smart suitcase, it comprises a keyboard and integral acoustic modem. It incorporates fuly-controllable cursor and transmission from 110 to 1,200 baud.

The Tele-ZIP is connected to any standard television receiver aerial socket, using the cable supplied, or connected to a video monitor requiring a video signal at one volt peak-to-peak. (Price £550).

The ZIP-64 costs £395 and employs the 64-character subset of ASCII code—upper-case only. It presents a 16-line by 64-character display on a standard 12 in. screen. A standard CCITT-V24 interface is included for data transmission from 110 to 1,200 baud, with parity, full- or half-duplex and one or two stop bits.

Data Dynamics,
Data House, Springfield Road,
Hayes, Middx.
Tel: (01) 848-9781.

(continued on next page)

(continued from previous page)

Elbit

ELBIT Data Systems is the Israeli subsidiary of Control Data Corporation. The DS1920/11 is described as a Teletype-replacement terminal, with a 12 or 15 in. diagonal screen displaying 1,920 characters in 24 lines by 80 characters.

A 5×8 dot matrix character format is standard but an optional 7×8 dot matrix format is available for lower-case character descenders, with ASCII codes in 64-, 96- and 128-character sets.

Transmission rates are switch-selectable from 110 to 9,600 baud asynchronous with even, odd or no parity via RS232C or 20mA current loop and printer interface.

Options include editing features, blinking, field protection, tabulation, cursor control, numeric keypad, address field XY positioning, and page and scroll modes.

Elbit Data Systems Ltd,
Copthall House, St Ives Road,
Maidenhead, Berkshire.
Tel: (0628) 32312.
Price: £550.

Fungus Computer Products

THE abbreviation for metal-oxide silicon is MOS. Stretch that a little and you have Fungus Computer Products, the subsidiary of Systime, a systems house which packages Digital Equipment PDP-lls.

Model 7752 Mark I VDU features direct cursor addressing, high-character definition on a 15 in. diagonal screen, detachable keyboard and inverse video.

Characters are made up in a 7×5 dot matrix and displayed in 80 characters by 25 lines. The character set is 96 ASCII upper-and lower-case and the keyboard includes a numeric cluster.

Transmission in block or character mode is provided via the built-in CCITT V24 and 20mA current loop interface at rates from 110 to 9,600 baud. Price: £685.

The 7753 Mark II model is similar to the above, but has an additional row of special function keys.

Fungus Computer Products,
Westmorland House, Second Floor,
Teall Street Wakefield,
West Yorkshire.
Tel: (0924) 60274.
Price: £695.

GEC Telecommunications

THE Datacom 30 terminal is designed for use with the Post Office Prestel and private viewdata systems. It comprises a full alphanumeric detachable keyboard, a 12 in. monochrome display, an integral modem, automatic dialling and a security switch.

A normal keyboard layout is used with upper- and lower-case characters and Teletype symbols. Control keys give access to viewdata graphic codes.

Local data storage allows the last page of data to be displayed and retained when the connection to the viewdata centre is released, thereby reducing line costs to a minimum.

A six-address, short-code dialler gives rapid access to Prestel/viewdata centres, the Prestel numbers being programmed by the Post Office. Security is provided by means of a key-operated switch to prohibit unauthorised use.

GEC Telecommunications,
Telephone Division,
Whinbank Road, Aycliffe Industrial Estate,
Co. Durham.
Tel: (0325) 313341.
Price £600 approximately.

Geveke Electronics

TERMINALS manufactured by TEC Inc are supplied in the U.K. by Geveke Electronics.

Model 502 features a 12 in. diagonal screen of 25 lines by 80 characters formed in an 8×10 dot matrix with a character set of 126 ASCII codes in upper- and lower-case.

Numeric keypad is optional. Full cursor control, switchable inverse video and end-of-line bell are standard features. It is supplied with a standard RS232C and current loop interface for transmission speeds from 50 to 9,600 baud in full- or half-duplex mode (£720).

The Tele-TEC Model 1440/1445 features a raster scan refresh rate of 60 Hz, a 64-character ASCII code (upper-case only), 24 lines by 80 characters formed in a 5×7 dot matrix, and transmission as per Model 502, plus 10- or 11-bit characters with even, odd or no parity (£815-£959 depending on screen size).

Geveke Electronics,
RMC House, Vale Farm Road,
Woking, Surrey GU21 1UW.
Tel: (00862) 71337.

Hazeltine

THE H1400 represents the company's fifth generation of microprocessor-based video terminals, supplementing the existing H1500 range.

Hazeltine says that because of the microprocessor design, the H1400 has far fewer components, resulting in greater reliability and cooler operating temperatures than can be obtained by earlier conventional designs. All the electronics are contained on a single printed circuit card.

The H1400 features a RS232C interface, with odd, even or no parity operating at rates switch-selectable up to 9,600 baud, in full- or half-duplex mode; 64 ASCII characters are formed in a 5×7 dot matrix. Remote commands provide for screen control, such as absolute or incremental cursor address, read cursor address, read character at cursor position, and clear screen (£550).

The H1410 includes a separate numeric keypad which adds another £50 to the price.

The H1500 costs £785 and provides a 94 ASCII character set formed in a 7×10 dot matrix, dual-intensity, rates up to 19,200 baud, auxiliary output, and reverse video.

The H1510 costs £880 and adds protected fields, transmit batch/line/page of unprotected-only data, function keys, tab/back tab/auto tab, and format mode with insert and delete line keys.

Hazeltine Ltd,
Terminal House,
14 Petersham Road,
Richmond Surrey.
Tel: /01 908-3111.

Heathkit

THE Heathkit H9 is designed ideally for use with its H8 or H11 personal computers (reviewed November, 1978) but will nonetheless plug into any other system via its RS-232C (or CCITT-V24 for European) and 20mA current loop serial interfaces, or its parallel interface including standard TTL levels, 8-bits input and 8-bits output and four hand-shaking lines.

The character format is standard upper-case 5×7 dot matrix. The standard long-form display is 12 80-character lines but if you can obtain back copies of the unofficial Heathkit user magazine, one of them contains details on ROM-tweaking by which you can achieve a 24-line display.

The short-form display provides four 12-line columns of 20 characters each. The automatic line carry-over feature executes line feed and return when the line exceeds the character count of both display forms. A built-in oscillator/speaker generates an audible end-of-line warning.

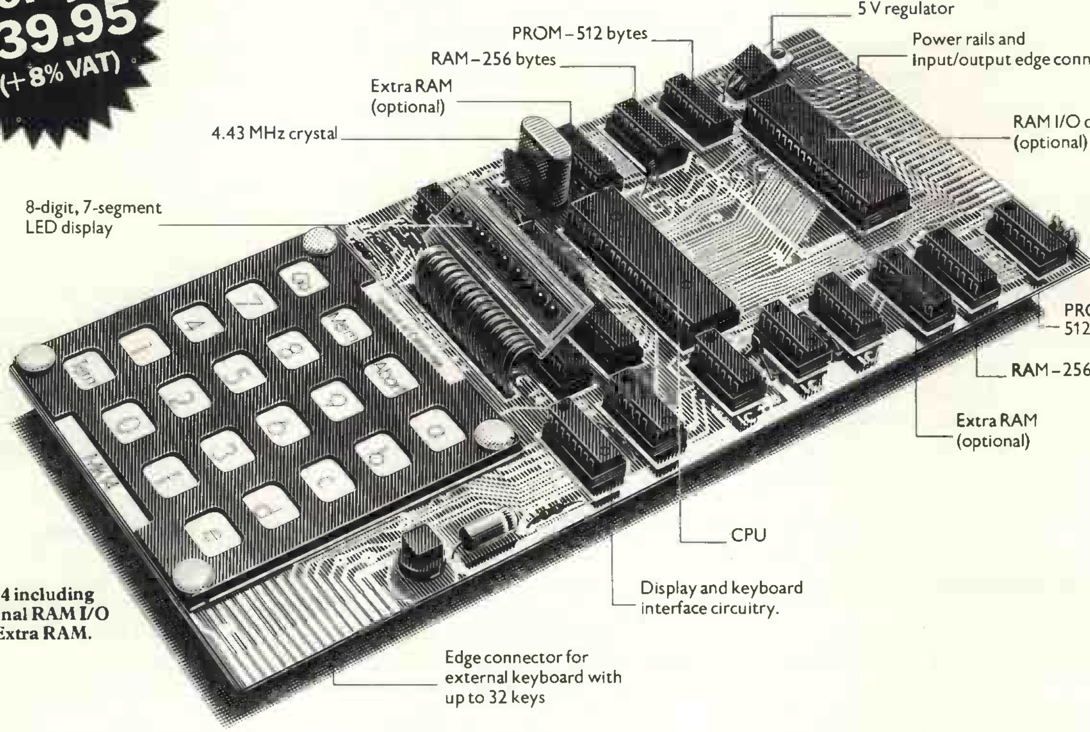
Auto-scrolling is featured in both long and short form, with new lines entered from the bottom or new columns entered from the right. This feature may be disabled with a front panel switch. Cursor control keys include up, down, left, right and home.

The erase mode permits automatic full-page erase, or erase to end of line starting at cursor position. A transmit-

(continued on page 49)

From Science of Cambridge: the new MK 14. Simplest, most advanced, most flexible microcomputer – in kit form.

only £39.95 (+8% VAT)



MK 14 including optional RAM I/O and Extra RAM.

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4. Revised monitor, to get the most from the cassette interface module. It consists of 2 replacement PROMs, pre-programmed with sub-routines for the interface, offset calculations and single step, and single-operation data entry.
5. PROM programmer and blank PROMs to set up your own pre-programmed dedicated applications.

All are available now to owners of MK 14.

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SPECIFICATIONS

●Hexadecimal keyboard ● 8-digit, 7-segment LED display ● 8 x 512 PROM, containing monitor program and interface instructions ●256 bytes of RAM ● 4 MHz crystal ● 5 V regulator ● Single 8 V power supply ● Space available for extra 256-byte RAM and 16 port I/O ● Edge connector access to all data lines and I/O ports

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Every MK 14 kit includes a Manual which deals with procedures from soldering techniques to interfacing with complex external equipment. It includes 20 sample programs including math routines (square root, etc), digital alarm clock, single-step, music box, mastermind and moon landing games, self-replication, general purpose sequencing, etc.

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Science of Cambridge Ltd,
6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Telephone: Cambridge (0223) 311488

To: Science of Cambridge Ltd, 6 Kings Parade, Cambridge, Cambs., CB2 1SN.
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Name________________

Address (please print)________________

Allow 21 days for delivery.

Science of Cambridge

● Circle No. 149

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page function allows a full page to be formatted, edited and modified, and then transmitted as a block of continuous data.

The plot mode permits graphs, curves and simple figures to be displayed. Plotting can be accomplished via the front-panel keyboard or from external inputs.

Heathkit,
233 Tottenham Court Road,
London W1P 9AE.
Tel: (01) 636-7349.
Price: £499.

Lear Siegler

BETTER-KNOWN as the Dumb Terminal, the Lear Siegler ADM-3A is one of the most popular VDUs with hobbyist systems, particularly in the U.S. where its price is really competitive. Indeed, ADM stands for American Dream Machine.

Standard features include 11 switchable transmission speeds to 19,200 bps, and switch-selectable data word formats, 9, 10 or 11 bits in length; odd, even, or no parity; one or two stop bits. The display is 12 lines by 80 characters in 5×7 dot matrix.

Upper-and lower-case characters are standard, though without true descenders. Switch-selectable 20mA or V24 interfaces are provided. Data entry is by means of scrolling, one line at a time with each new line entered, or in page mode, allowing the programmer to position the cursor at any character position on the screen, from which the operator may enter data —assuming they are different people.

Options include 24-line display, full 96-character ASCII code, numeric keypad and answer-back.

Penny & Giles Data Recorders,
Mudeford, Christchurch, Dorset.
Tel: (04252)-71511.
Price: £569.

Lyme Peripherals

THE MODEL 4002 terminal holds 4,000 characters in its memory, 1,920 of which are displayed on the 12 in. diagonal screen in a 7×12 dot matrix.

The display may be scrolled up or down, line by line or continuously by using the repeat key. Instant return to last entry position is provided by a single key depression.

Transmission speeds are switchable from 75 to 9,600 baud via the dual RS232C/20mA current loop interface. Price: £645.

The Model 4004 is a text-editing version of the former with 16 user-programmable function keys, horizontal tabs, optional printer port, two separate pages and block and character mode transmission. (Price £745).

Other features include protected areas—defined by reduced intensity—XY cursor addressing character insert/delete and cursor blinking underscore.

Lyme Peripherals Ltd.,
2 Avenue Court, Farm Avenue,
London NW2 2PT.
Tel: 01-452-0490.

Mellordata

THE ELITE 1521A is manufactured by Datamedia Corporation and supplied by Mellordata in the U.K. It features a 24-line by 80-character display using the full 128-character ASCII code, or 64-character subset for upper-case only.

Characters are formed in a 5 × 9 dot matrix on a dual-intensity display (upper-case only). Editing facilities include clear screen, page and line with full cursor control. Transmission rates are switchable between 50 and 9,600 baud via a standard RS232C or 20mA current loop interface. Delivery ex-stock.

Mellordata,
Woodgates Road,
East Bergholt, Colchester
Tel: (020629) 8181. Price £720.

Newbury Laboratories

NEWBURY LABORATORIES is an all-British manufacturer concentrating on VDUs. It owns Newbear Computing Store and is in turn owned by another all-British peripheral manufacturer, Data Recording Equipment.

Even if you are not bound to buy British you could do worse in terms of value. Prices start at £495 for Model 7000/1/2. This provides a 24 lines by 80 characters (5 × 7 dot matrix) display. Dual CCITT–V24 and 20/60mA current loop interface, hard-copy facility and video output for external monitors, and switchable half-or full-duplex mode transmission from 75 to 9,600 bps are available on the 7001/7002.

Upwards from that are Models 7006/7 starting at £695, based on the Intel 8080 with split-speed transmission, and Models 7008/9, starting at £775, featuring two-page memory (3,840 characters), full editing facilities and block transmission by line or page.

Newbury Laboratories,
King Street, Odiham,
Hampshire RG25 1NN
Tel: (025671) 2910.

Pericom

PERICOM offers a programmable microprocessor-controlled VDU based on the Motorola 6800, the Pericom 6801.

It features 32 user-definable function keys, 52 editing function keys, scrolling memory, full cursor control and block and character transmission. The screen displays 24 lines by 80 characters. V24 interface is standard with optional 20mA current loop interface.

Pericom Data Systems Ltd,
Burners Lane, Kiln Farm,
Milton Keynes, Bucks.
Tel: (0908) 564747. Price: £985.

Perkin-Elmer

PERKIN-ELMER has a new model, the Bantam Model 550. It has a display of 80 characters to its 24 lines, and its special features include full upper-and lower-case characters, complete cursor addressing, shadow numeric pad, silent operation and compact size, and a range of international character sets, including APL. The one-off price for the unit is slightly less than £600.

Perkin-Elmer Data Systems,
Terminals Division, 227 Bath Road,
Slough, Berkshire
Tel: (0753) 34511.

Pragma

memory lock allows the operator or the computer to lock a portion of the display, while retaining the ability to enter or receive data in the unlocked portion.

Features include eight levels of video and a data display of 80 characters on 24 lines, with 16 extra characters per line available for field attributes. Other

THE user-programmable MCB1 Beehive Micro Bee is a microprocessor-controlled conversational terminal operating at speeds up to 19,200 bps.

It has a self-diagnostic feature to show at a glance if the terminal is working properly. A status line displays modes of operation, error messages, and the like. A features include cursor addressing, read cursor address, invisible memory address pointer and read terminal status. (Price from £877).

Pragma Ltd,
29 High Street, Edgware,
Middlesex HA8 7UU
Tel: 01-952 8471.

Pronto Electronic Systems

MODEL 601A does not include a screen but the company says a modified domestic TV set may be used.

It is a portable unit weighing 10 lb. and costing £325. Standard features include full cursor control and built-in V24 and 20mA current loop interface.

Pronto Electronic Systems,
645 High Road, Seven Kings,
Essex IG3 8RA
Tel: 01-599 3041

(continued on page 51)

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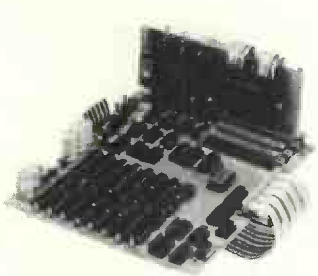

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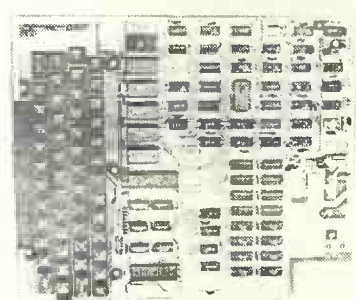

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LOTUS SOUND, 4 MORGAN ST., LONDON E3 5AB

Tel: 01-981-3993 Telex: 261426 Attn: Lotus Sound

(continued from page 49)

SEN Electronics

INFOTON terminals are marketed in the U.K. by SEN Electronics. The Infoton 100 is the latest offering in the range and is a microprocessor-controlled terminal based on the Zilog Z80, featuring a 1,920-character 12-in. diagonal screen displaying 24 lines of 80 characters formed in a 5 × 9 dot matrix, with a 25th status line from a 96-character ASCII set, plus drawing characters for graphics.

Other standard features include selectable reverse video, selectable half- or full-intensity, line insert/delete, addressable/readable cursor, and 15-key numeric cluster. Basic price is £610.

Options include PROM-progammable function keys, separately addressable RS232C printer port, block mode, protected field/erase field, insert/delete character, composite video output for monitors and true emulation for the following terminals—DEC VT52 including special keycaps, Lear Siegler ADM3A, ADDS Console 520, Hazeltine 1400/1500 and Perkin-Elmer Fox.

The Infoton is also Z80-based but is an older and completely different terminal with detachable keyboard, providing three pages of user memory.

The basic price is £875.

SEN Electronics Ltd,
5 London Street,
Chertsey, Surrey
Tel: (09328) 66744.

Soroc

THE Soroc IQ 120 offers such standard features as switch-selectable transmission rates from 75 to 19,200 bps, cursor control, RS 232C interface, standard numeric keypad, line and page erase functions and protect mode.

Options include block mode transmission, hard-copy facility with printer interface extension, lower-case characters and 1,920-character screen memory. Other options include 24 lines by 80 characters (12 lines standard) and 20mA current loop interface.

Compelec Electronics,
310 Kilburn High Road,
London NW6
Tel: (01) 636 1392. Price: £655.

Strumech Engineering

THE ACT–1 from Strumech Engineering is a video monitor-based terminal which manages a 1,024-character memory into 16 lines of 64 upper- and lower-case ASCII characters.

Output can be to the standard video monitor, or to a standard television set by means of an optional UHF modulator costing £10. Characters are formed in a 9 × 7 dot matrix with full descenders on lower-case characters.

Standard features are cursor forward/backward, scroll up/down, and bell. I/O specifications include switchable data transfer rates from 110 to 19,200 baud; even, odd, or no parity; one or two stop bits; and standard RS232C or 20mA current loop interface.

Strumech Engineering Ltd,
Portland House, Coppice Side,
Brownhills, Walsall, Staffs.
Tel: (05433) 4321.
Price: Monitor £125, terminal £260.

Technitron

TELERAY terminals manufactured by Resarch Inc are marketed inthe U. K. by Technitron Inc (U.K.).

The Teleray 3541 is a straight Teletype replacement with upper-case-only character set ASCII code. It features a display of 24 lines by 80 characters, detachable keyboard, and built-in CCITT–V24 and 20mA current loop interface (£800).

The Teleray 3741 include the same features plus user-definable function keys and 'space over data' edit functions, and upper- and lower-case ASCII code (£850).

The Teleray 3841 adds fully-addressable cursor control at £900.

Technitron Inc (U.K.),
Doman Road, Yorktown Industrial Estate,
Camberley, Surrey GU15 3DH
Tel: (0726) 26517.

Terminal Display Systems

THE ADDS Regent 100 utilises a 96-character ASCII code displayed on a 24-line by 80-character screen in 8 × 8 dot matrix. A 25th line displays the operating status of the terminal.

Transmission speeds are switch-selectable up to 9,600 baud and features include reverse video, underline, half and zero intensity, blinking, line-drawing and full cursor addressability. An RS232C or current loop interface is supplied.

Terminal Display Systems,
Hillside, Whitebirk Estate,
Blackburn, Lancs BB1 5BR
Tel: (0254) 662244.
Price: £845.

Warren Logic

THE SR100 Minitype comprises a Teletype-compatible keyboard with full ASCII capabilities. The display consists of 15 alphanumeric 16-segment LEDs utilising a 128-character ASCII subset.

The on-line mode of operation is in full duplex with a local facility. Both RS232C and 20mA current loop transmission are standard at rates from 50 to 9,600 baud. Also available is an interface for a low-cost thermal printer.

Warren Logic Ltd,
Hockley Road, Broseley,
Salop TF12 5HT
Tel: (0952) 883010.
Price: £298.

VDUs for less than £1,000

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Cifer Systems	034 Cub	£380
Cifer Systems	127A	£690
Cifer Systems	026	£580
Cifer Systems	224A	£850
Computer Workshop	SWTPC CT-64	£230 (kit form) + £140 for monitor
Control Data	92452	£950
Dacoll Engineering	241	£660
Dacoll Engineering	247	£890
Data Dynamics	Tele-ZIP	£550
Data Dynamics	ZIP 64	£395
Elbit	DSI1920	£550
Fungus Computer Products	7752	£685
Fungus Computer Products	7753	£695
GEC Telecommunications	Datacom 30	£600
Geveke Electronics	502	£720
Geveke Electronics	Tele-TEC 1440/1445	£750 £815-959
Hazeltine	H1400	£550
Hazeltine	H1410	£600
Hazeltine	H1500	£785
Hazeltine	H1510	£880
Heathkit	H9	£499
Lear Siegler	ADM-3A	£569
Lyme Peripherals	4002	£645
Lyme Peripherals	4004	£745
Mellordata	Elite 1521A	£720
Newbury Laboratories	7000/1/2	£495/£595
Newbury Laboratories	70046/7	£695
Newbury Laboratories	7008/9	£775
Pericom	6801	£985
Perkin-Elmer	550	£600
Pragma	MCB1 Beehive Micro Bee	£877
Pronto Electronic Systems	601A	£352
SEN Electronics	Infoton	£875
SEN Electronics	Infoton 100	£610
Soroc	IQ 120	£655
Strumech Engineering	ACT-1	£260
Technitron	Teleray 3541	£800
Technitron	Teleray 3741	£850
Technitron	Teleray 3841	£900
Terminal Display Systems	ADDS Regent 100	£845
Warren Logic	SR100 Minitype	£298

Note: Most companies will offer discounts for quantity orders.

Games you can play

Video Checkers

Cassette for either Tandy TRS-80 or Commodore Pet. Available from Whitehead Micro Systems, Holly House, 45A Windy Arbour, Kenilworth, Warwickshire. Price £9.95.

THIS program allows the computer to play an intelligent, legal game of draughts, using international rules. The computer is black and therefore always moves first and prompts you by displaying the message "your move" on the right-hand side of the screen. You can move by typing-in the number of the square you occupy and then the number of the square to which you want to move your piece. We tested the program on the Pet, but in the TRS-80 version, you must type a comma between the two sets of numbers.

One quirk in the program we found particularly annoying was that you must jump a piece when the computer tells you to. The game will not continue until you do as it wishes; thus you lose a certain amount of control over it. It does sometimes work the other way, however, and the computer points out an advantageous move you may have missed.

Double and triple jumps are mandatory and they are made one jump at a time. The computer will prompt you when to take your second or third jump. A king is denoted by K in the corner of the appropriate square. A game can be terminated by typing either a "BREAK" or a "STOP".

You will love this program if you have an evening to spare and you will need that, because the computer takes a long time to make up its mind where to move. An average game takes from 45 – 60 minutes to play but if your patience is strong enough, it's worth it in the end, if only to see the computer's startled "I can't believe it, you won" light up on the screen.

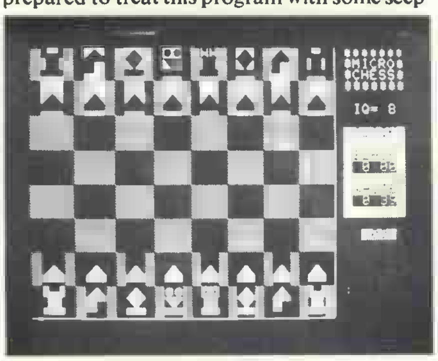
Despite this, it is an enjoyable game to play.

Microchess 2.0

Cassette for Commodore Pet. Written by Peter Jennings and available from most Pet dealers.

I HATE to admit it but I was continually beaten by the computer on its top level. So far I have won twice out of about 50 attempts.

I'm probably an average chess player yet prepared to treat this program with some scepticism – "Whoever thought I could be beaten at chess by a computer" and all that.



The program gives eight choices of "difficulty". At its most difficult the computer is thinking six moves ahead and can take some time to work out its moves.

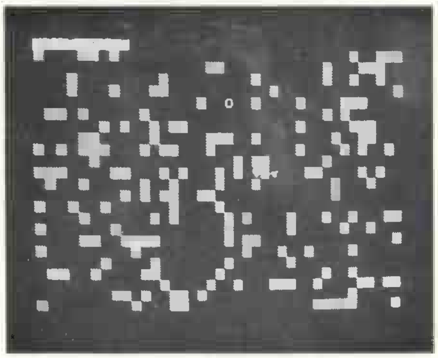
I started with Level 8 and then worked backwards until I found a level I could beat easily, then started to "climb". At the top level the computer is setting some ingenious traps and you end up kicking yourself and saying that was obvious after you walked right into it.

Still, it is great fun. I am sure it can improve your play. I know mine is better. Chess experts would doubtless find it trivial but for the average player it's great fun. Graphics are excellent. There's a time clock and you can set chess problems to solve.

Rhino, Hangman and Reaction Test

Cassette for the Commodore Pet. Available from most Pet dealers. Manufactured by Infoguide on the Compusette label. 142 Wardour Street, London W.1.

RHINO is a novel game in which you get chased all over the VDU by things which purport to be rhinos but look remarkably like pi signs.



We felt it re-created all the thrills and spills involved in the Big Hunt. Definitely a fun game.

The object is to get "home" through the random jungle which the computer prints before the start of each game, without being "whammed" by the rhino(s). They hide among the trees and you cannot see them, and they appear only when they see you.

The computer tells you how many there are on the screen before the game starts. The number is determined by how many games you win in succession. You start with one, and when you get past that, you go to two, and so on. We managed to reach 11 at once but that was our limit, so we can't really say how far you can go with the game, although the maximum is 30.

You negotiate yourself around the screen by using the Pet's number keypad. This is laid out like a calculator and you are in the centre, in effect number five. So if you want to move to the right, you press number six, and so on. You cannot move until the computer tells you to do so, and it is always your move until the rhino spots you. Once he does, he is after you very quickly and often moves three or four times in a row before it is your turn again.

An exciting game which everyone can play, from granny to the kids.

By comparison, the other two games on the cassette were fairly uninteresting. Hangman contains dozens of different words, so if that is up your street, it will keep you happy for hours. The hangman is drawn with some rapidity by the computer and you only have 10 chances to get it right before you're hanged.

Some letters occur more than once in each word but are entered only one at a time, so you may have to press a certain letter more than once before you find the solution.

After the thrills of Rhino, the Reaction Test was something of a letdown. You have to press any button on the keyboard when the word "go" appears. The time you take to press it is then entered in a table at the top of the screen, opposite the number of attempts you have had. The average is worked out and that is all there is to it.

One final word of warning. If you depress the key before the "go" signal has appeared, you are accused of cheating by the computer. Like most games, it is fun when two play but not quite so invigorating when played alone.

Air Raid

Cassette for Tandy TRS-80. Manufactured by Small System Software, PO Box 483, Newbury Park, California 91320, U.S. Available from Whitehead Micro Systems, Holly House, 45A Windy Arbour, Kenilworth, Warwickshire. Price: £9.95.

AIR RAID gave us many hours of pleasure, which probably shows what vicious creatures we are, for the game involves shooting down enemy aircraft with a ground gun and then trying to exterminate the parachutists who abandon their craft.

There are two types of craft which fly across the screen, fast and slow. You score more points for hitting the fast aircraft, and even more points for shooting down the parachutists when two planes crash. You control the ground gun by moving the Tandy cursors left or right and you shoot your missiles by pressing any key on the keyboard. Your score is added as you proceed and you have points deducted if you use too many shots.

You have 90 seconds in which to complete your game, but if you total more than 6,000 points, you go into extra time. The game speed is controlled by pressing any key from 1 to 9 before the game starts.

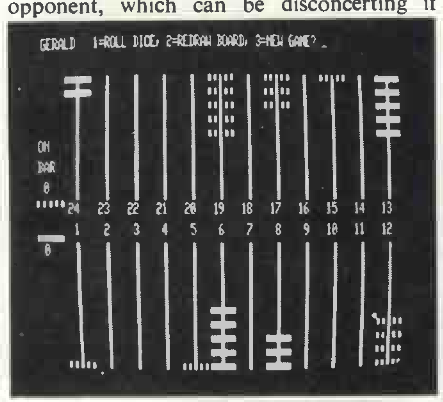
We had fun with Air Raid. The graphics are good and the type of game you play varies with the speed which you select. With the slower speed, you can control the 'bend" of shots, even though the aircraft move more slowly on to the screen.

Backgammon and Blackjack

Cassette for Tandy TRS-80. Manufactured by: Tandy Corporation. Available from Tandy Corporation, Bilston Road, Wednesbury, West Midlands. 021-556 6101.

THIS program is definitely not the best we have seen or heard about. There are no instructions with the cassette as to how it works – we had difficulty trying to get our pieces into the base. It was only by trial and error that we discovered you have to press 99 to move your piece there.

You have to play the game with a human opponent, which can be disconcerting if everyone else you know thinks backgammon is boring.



The most appealing thing about Blackjack was that you could bet as much as you liked without losing money. As compulsive gamblers, we found this a great asset.

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Computerising accounts

WE CONTINUE our series on business applications systems and software for micros by looking at accounting packages. Specifically, packages to handle sales accounting, purchase accounting, general and nominal ledgers, priced at anything from £12 to £950 for software, and from £950 to £6,500 for complete systems.

ACCOUNTING is the principle and technique used in establishing, maintaining and analysing the records of the financial transactions of a business. Debiting and crediting accounts in your business follow 10 simple rules:

Assets:	debit to record INCREASE credit to record decrease
Liabilities:	debit to record decrease credit to record INCREASE
Capital:	debit to record decrease credit to record INCREASE
Expenses:	debit to record INCREASE credit to record decrease
Revenue:	debit to record decrease credit to record INCREASE

Any transaction, broken into its simplest parts, will adhere to those rules.

Sales accounting

Sales accounting probably performs the most important function in a businessman's operation, other than the actual sales. Sales accounting tells him what he has sold, for how much, often to whom and when. It records the transactions of sales, the lifeblood of his business.

The sales ledger—sometimes called "debtors ledger" and, in American-influenced accounting systems, "accounts receivable"—contains the accounts of individuals or companies owing money to your business, because you have extended credit of some kind i.e., the transaction was not made directly for cash over the counter.

The accounts may be divided alphabetically, geographically, or in some other way convenient to your business. Analysis of the sales ledger usually takes the form of "aged debt analysis"—you see who owes you what after one month, two months, and over three months, and start chasing the "over three months".

Two other ways of accounting for debtors is balance forward—payments are made against the total account regardless of the kind of item(s) purchased, like a Barclaycard statement—or open item debtors, where payment is made against individual items, either the oldest purchase or some other classification.

Using those debts owed to you to raise immediate cash is done by financing your accounts receivable, called "factoring", with someone who will lend you money against the account collection at some future date.

Purchase accounting

In a way this is less pressing to a businessman than sales accounting because he owes the money to someone else. Nonetheless, to retain goodwill, obtain good credit terms, and retain good credit ratings, the businessman pays close attention to when, from whom he buys, and how much he pays. So, purchase accounting is the reverse, in a sense, of sales accounting but without (almost) all the fuss of analysis or ageing or carry-forwards, and so on. Purchase ledgers are sometimes called "creditors ledger" and, again, in American parlance, "accounts payable".

General ledger

To clear some confusion—and perhaps create more—a general ledger, sometimes called an "impersonal ledger", contains those transactions which are the businessman's dealings in property and items

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of expenditure—like land, buildings, rent, wages, insurance.

The place of the general ledger can sometimes be taken by a nominal ledger (containing the nominal accounts, i.e., rent, wages, insurance, and the like) and a private ledger (containing the assets of the business and confidential matters, such as profit and loss accounts, and balance sheet.

So what is in the marketplace to help you, the businessman, get the most from your debtors and service your creditors conveniently?

Accounts suite

Micro Software Systems, Grays, Essex.

SOFTWARE is priced at £850, when supplied with a hardware system by Micro Software, or £950 on its own. Since Micro Software claims to be able to supply "the best of the machines now on the market", the total cost of a system can be from about £2,500 upwards. It is a disc-based system comprising six programs.

1. Entry—a simple security entry system requiring a password for access.
2. Menu—listing the suite's programs.
3. Invoicing—with this you can enter details of either sales or purchase invoices to the corresponding ledger.
4. Receipt—the details of money received—either a cash or credit sale—are entered here.
5. Payment—payment details are entered here but information about payments due or outstanding invoices can be called-up.
6. Reports—only one entry is required and the system will perform the double entries and collate the information into the following:
   a) Bank or cash book—opening balance, debit, credit, closing balance.
   b) VAT—incoming and outgoing.
   c) Sales ledger.
   d) Purchase ledger.
   e) Nominal ledger—with breakdown into expense and cost areas, with history files if required.
   f) Audit trail.
   g) List of all unpaid invoices (sales or purchase).
   h) Trial balance and profit-and-loss account up to year-end.

Error-correction facilities either at input time or later are provided throughout the suite.

On a medium-sized system—say in the £3,500 to £5,000 range—about 1,000 entries per month could be handled. If more are required, a disc-filing system could be employed using a new disc for every period.

The accounts suite covers a wide range of facilities and its 'minimum entries' philosophy means less hassle and fewer errors. A company with sales in the £1–£2 million region could usefully employ it as a basic system.

Accounts receivable

A J Harding, Bexhill-on-Sea, East Sussex.

RUNNING on a Tandy TRS-80, this Level 2 software is £19·95—a Level 2 Tandy costs about £900. The system performs three sales ledger functions:

1. Initialisation, i.e. filling-up your file.
2. Maintenance—essentially this is posting payments and error-correction.
3. Analysis—it performs two kinds:
   a) List of delinquent accounts.
   b) Ageing report.

You can hold up to 200 records per cassette. You can have more cassettes but each cassette is a separate totality.

There are two minor drawbacks to this software which we are sure will have been corrected. The currency signs are in dollars, not sterling—the software is imported from the U.S.—and the instructions for processing from one function to the next are unclear, which can be amended by written instruction or augmenting the instructions on the tape.

Accountancy package

Compucorp Ltd, Wembley, Middlesex.

ALTHOUGH no specific limitations are indicated in the specifications we received, they indicate that double floppy disc storage is required, so about 800 to 1,500 records can be assumed held.

On-line enquiries of the files are available but the software caters for hard-copy status reports; that means you will require a printer and an audit trial printer—like on a printing calculator. The whole system, hardware Compucor 610 and 625 Series) and software, costs about £5,000 and up.

The system uses the 'question-and-answer' technique for guiding a user through succeeding steps.

The heart of posting entries to the sales, purchase, or nominal ledgers is the unposted transactions file through which all entries pass. By using a 'posting key'—there are 15—the entry is identified and the computer then updates the correct ledger using that identification code.

A 'by-value' sales analysis can be performed using the analysis code keys in the transaction records. Extensive cash book routines keep current balances of cash-in-hand, bank balances (multiple accounts), and cash floats.

In all, there are 40 programs in the package dealing with accountancy. Additional jobs, like payroll and invoicing, can be integrated into the system. It is a comprehensive and useful system for the business with sales in the area of £2–£5 million a year.

Video-purchase and Video-debt

Video Software, Kinver, Stourbridge, West Midlands.

THIS GROUP supplies software which is machine-independent and operates with disc-based systems. VIDEO-PURCHASE costs around £300 and VIDEO-DEBT about £300, both dependent on features required—together they will be £600.

VIDEO-PURCHASE is the purchase ledger software. It has direct keyboard entry and each transaction can be supplemented by detailed analysis lines for purchase analysis or the nominal ledger. Enquiries can give details of individual ledger accounts, including individual outstanding transactions and creditors. Outputs include open-item or balance-forward statements, purchase analysis, and so on. Options include cheque-printing, bank lists, credit transfers.

VIDEO-DEBT is the sales ledger software. It, too, has direct keyboard entry with four categories of debits and of credits and each category can be 'simple' or 'compound'.

Like VIDEO-PURCHASE, enquiries on individual accounts or on an aged debtor list can be made. Output includes statements printed as open-item or balance forward. A useful addition to VIDEO-PURCHASE and VIDEO-DEBT on your system would be VIDEO-BOSS. It provides a link with all other VIDEO systems and supplies those required sales and purchases analyses, e.g., sales by area/customer, purchases by industry/supplier, and so on.

Horizon Business System

Equinox Computer Systems Ltd, London, EC1.

EQUINOX supplies the Horizon micro for anywhere between £1,000 and £2,500, depending on RAM size and discs. The Horizon Business System—a Horizon with 32K, disc, monitor, and software—will cost around £4,000. The system provides management control of sales, purchase and general ledgers, payroll, and stock accounting. It uses the 'question-and-answer' technique to guide the user.

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The sales ledger program can handle 200 accounts with a total of 900 invoices; the purchase ledger program has about the same capacity. The sales ledger program holds the customers' balances as aged accounts so that 30-60; and 90-day ageing is readily available. Facilities for additions, deletions and corrections are provided.

The purchase ledger program has all you need to operate a purchase ledger, including a cheque file which produces cheques corresponding to totals in the invoice file.

The general ledger program provides a double-entry ledger of all transactions in a given month. Up to 1,100 items can be handled on each disc. Among several facilities it provides editing of files, balances the cheque file, and provides a balance sheet and profit-and-loss statement.

Purchase ledger system and debtor ledger system

Microsolve Computer Services Ltd, Edgware, Middlesex.

THE PURCHASE ledger software costs £400 and debtor ledger software £500. A complete purchase ledger system costs about £3,400 (excluding VAT). For this, you have the software and a 48K Apple II, two floppies, a matrix printer, and monitor. The system is standard open-item ledger and guides the user through without previous computer knowledge.

The system performs the following functions.

1. Maintains suppliers' account file.
2. Maintains invoice file.
3. Processes credit notes and journal transfers.
4. Processes cash payments.
5. Produces remittance advices.
6. Prints invoices due for payment.

Maximum capacity of the purchase ledger system is 750 suppliers' accounts, 3,400 invoices and 2,500 payments and adjustments.

The debtor ledger system has an invoicing program as an integral part. Like the purchase ledger system, a complete package runs on the Apple II and costs £3,500.

The system performs the following functions:

1. Maintains a customer accounts file.
2. Maintains a products file.
3. Formats and produces invoices automatically.
4. Processes payments made by customers.
5. Produces an aged analysis of debtors.
6. Enquiries can be made as to the state of a particular account balance.

Maximum capacity is 750 customer accounts, 2,000 products, 3,400 invoices, and 2,500 payments and adjustments.

Purchase ledger and Sales ledger

Wilcox Computers Ltd, Wrexham Clywd.

THE WILCOX Series II, on which these accounting packages run, is based on a Z80 with 16K RAM, VDU, printer (140 cps), and two floppy discs with 1·2 Mbytes of storage. Series II costs £7,600 plus VAT. The purchase ledger software is £800 and sales ledger is £600.

Invoice details are keyed into the purchase ledger system. When an invoice is paid a cheque or a credit transfer slip is produced, together with a remittance advice. The system will also accept credit notes, cash received and journal voucher entries and, retains a record of each transaction. Purchase ledger operates as an open item debtors system. For audit purposes, an audit trial is printed-out each day.

The sales ledger also uses the open-item technique. Details of all uncleared items, including the original invoice and any subsequent transactions affecting that invoice, such as credit notes, cash and journal entries, are held on file.

The main inputs to the sales ledger package are the original invoice details and details of any subsequent cash received from customers. The main outputs are customer statements of account and an internally-used printout of the accounts. An audit trial is also provided, as are on-line enquiries. Age analysis and credit limit reports are provided.

General ledger—Hustler 1

Petsoft, Newbury, Berkshire.

THIS very general 'general ledger' package sells for £12 and runs on an 8K Pet (about £700). The program holds up to 100 data lines (entries into accounts) with an 8K memory and about 340 with an additional 8K. When the maximum capacity is reached, another block of memories can be started on new tapes—provision is made to carry-over the totals figures to the new records, so giving continuity.

The account chequebook and bank records are the basis for the system. Each entry is coded into any of eight types of deposits, any of 27 expense accounts, or any of three non-expense withdrawal accounts.

The program operates in three modes:

1. displays all withdrawals made, all deposits made, accumulated totals.
2. all entries with a user-requested code number are displayed line-by-line, and totalled.
3. calculates and displays, in turn, the detailed entries made for each deposit account, expense account, and non-expense withdrawal account, and totals for each account type.

The software should appeal to very small businesses. The introduction of disc storage to Pet micros will increase its attractiveness.

Bondain Book-keeper

Sumlock Bondain Ltd, London, EC1.

THIS SYSTEM is presented as a complete unit comprising a 32K Adler TA-20, two discs—providing 360K bytes and integral to the system—a VDU, and 150 cps matrix printer. With the standard software, which provides the book-keeping function, the system sells for £6,500.

The standard software consists of four packages:

1. Integrated invoicing and sales ledger suite.
2. Purchase and nominal ledger suite.
3. Payroll suite.
4. Separate stock control suite.

The cost of a standard "package" is from £350 per program, which includes initial installation and training.

Nominal ledger

Computer Mart Ltd, Norwich.

TO WORK on the Imsai 8080, the nominal ledger costs £700. It consists of six modules:

1. Set-up programs.
2. Expense codes.
3. Budgets.
4. Last year's history.
5. Daily processing.
6. Reports—include nominal listing, trial balances, profit and-loss accounts, balance sheet, account apportioning, and profit-and-loss and balance sheet histories.

Incomplete record accounting

Padmede, Odiham, Hants.

IT RUNS on a 48K Apple II with VDU, printer, and cassette for about £3,700. With disc instead of cassette, it costs about £4,000. The cassette version can hold about 1,300 records; the disc version about 5,000.

This system is aimed at the accountant, with two objectives—to produce periodically, usually quarterly or annually, statements of accounts for the client; and

(continued on page 61)

(*continued from page* 59)
to satisfy the taxman's requirements.

It is a "menu"-type system, hand-holding the user through eight options:

1. Enquiry by client name.
2. Input (from keyboard).
3. Input (from cassette tape).
4. List or amend records.
5. Save data on tape.
6. Listout on printer.
7. Profit/loss and trial balance.
8. Enter account code descriptions—in this system, the account codes are numeric, viz, 100–499 are for profit-and-loss sheet items and 500–999 are balance sheet items.

The documentation provided is good and includes a profusion of account code descriptions—the user, of course, can name his own but, in the majority of cases, the ones shown will suffice. A prime feature of the system is that the user can key-in data directly from a bank statement—after all, the bank has done much of the sorting and accounting already—thus eliminating extraneous source documentation.

Incomplete record system

Verwood Systems, West Haddon, Northamptonshire.

ANOTHER ENTRY to the incomplete record accounting system stakes. This one runs on an SWTP 6800 with 32K RAM, a floppy disc, VDU, and a Centronics printer, all of which costs about £3,600. The software is priced at £50 when bought with the hardware.

From one entry, a transaction is reported on all the accounts to which it applies. Validation and error-correction are done on-line before transactions are posted.

The system depends on an input batch-type code to control the posting—24 are given, up to 99 can be named. A nominal account code then allows the proper slot in the nominal ledger to be accessed and a double entry made. For example, the batch type could be "10"—sales ledger invoices and credit notes—and the nominal account code could be between 100-199—sales accounts, say, sales branch No. 1, 110.

The eight kinds of reports include profit-and-loss accounts, balance sheet, sales ledger purchase ledger, cash books, VAT analysis, nominal ledger trial balance, and sales ledger statements.

COMAC (computerised accounting)

Microcomputers Etc, Ltd, Camberley, Surrey.

THIS SYSTEM written in Basic is designed for a 48K Tandy TRS-80 with two disc drives, a VDU, and a printer (Centronics) and sells for around £1,700. Microcomputers Etc Ltd also sells the software alone for £250.

It will handle about 1,000 transactions per month and up to 14 branches—or departments or cost centres or profit centres.

The system guides the user with a "menu", and there are six options:

1. Input.
2. Process—this option processes the input in double entries, carries forward the previous period totals and accumulates.
3. PLBAL—an acronym for the trial profit and loss and balance sheet calculations. This is for one branch. The next option,
4. GROUP PLBAL summarises all the branches totals into the corporate totals.

5. and 6. Two editing options.

An interesting feature of COMAC is the use of alphabetic mnemonics for account codes; thus ADV is advertising expense, CAR is automobile expense, and so on. They are chosen by the user.

NAME	PROGRAMS	SUPPLIER	AVAILABLE	MACHINE	PRICE (£)
Accounts Suite	Sales Ledger Purchase Ledger Nominal Ledger	Micro Software Systems, Grays, Essex	Now	—	950 (software only)
Accounts Receivable	Sales Ledger	A J Harding Bexhill-on-Sea, Sussex	Now	TRS-80	19·95 (software only)
Accountancy Package	Sales Ledger Purchase Ledger Nominal Ledger	Compucorp, Wembley, Mdx.	Now	Compucorp 610 and 625	about 5,000
VIDEO-PURCHASE; VIDEO-DEBT	Purchase Ledger Sales Ledger	Video Software, Stourbridge, West Midlands	Now	Machine Independent	300 300 (software only)
Horizon Business System	Sales Ledger Purchase Ledger General Ledger	Equinox Computer Systems Ltd, London EC1	Now	Horizon	about 4,000
Purchase Ledger/ Debtor Ledger System	Purchase Ledger Sales Ledger	Microsolve Computer Services Ltd, Edgware Middx.	Now	Apple II	about 3,400 (400 for purchase ledger s/w only, 500 for sales ledger s/w only)
Purchase Ledger and Sales Ledger	Purchase and Sales Ledger accounting	Wilcox Computers Ltd, Wrexham, Clwyd	Now		£7,600 (plus VAT) Purchase ledger £800 Sales ledger £600
General Ledger–Hustler I	General Ledger	Petsoft, Newbury, Berks.	Now	PET	about 700 (12 software only)
Bondain Bookkeeper	Sales Ledger Purchase Ledger Nominal Ledger	Sumlock Bondain, London EC1	Now	Adler TA-20	6,500 (350 per package; software only)
Nominal Ledger	Nominal Ledger	Computer Mart Ltd, Norwich	Now	Imsai 8080	700 (software only)
Incomplete Record Accounting	Incomplete Record Acctg to Trial Balance	Padmede, Odiham, Hants.	Now	Apple II	3,700 (cassette) 4,000 (disc)
Incomplete Record System	Incomplete Record Accounting	Verwood Systems, West Haddon, Northamptonshire.	Now		£3,600 hardware; software £50 when purchased with hardware.
COMAC	Incomplete Record Acctg to Trial Balance	Microcomputers Etc, Ltd, Camberley, Surrey	Now	TRS-80	1,700

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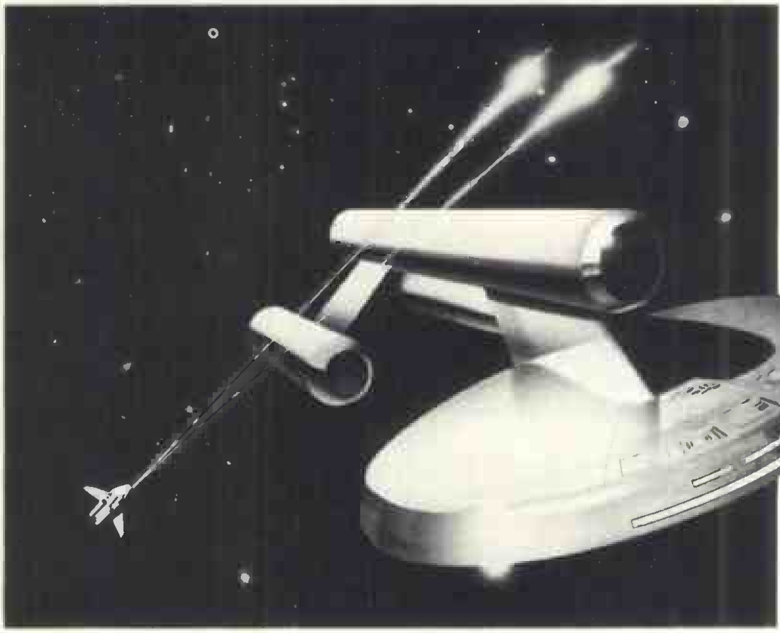
● **Circle No. 161**

Star Trek is a classical computer game, which may see a resurgence in popularity now that the series is being re-run on BBC 1. This version was written to give as many features as possible within the constraints of a 16K memory and an 11K BASIC. It is *Practical Computing* tested.

Star Trek



THE object of Star Trek is to destroy all the Klingon ships within 15 stardates. The galaxy is divided into 64 quadrants, with each quadrant split into 64 sections. Both are eight-by-eight grids. The galaxy is initialised with 75 stars, seven Klingons and two starbases placed randomly throughout the 64 quadrants.

A quadrant is initialised each time it is entered by the Enterprise by having the stars, Klingons or starbases assigned randomly to sectors. A sector can be occupied by only one object at a time.

You, as Captain Kirk, control 500 units of energy—for motion, phasers and defence screens—and three photon torpedoes. The two starbases are available to replenish your supplies. Each time the Enterprise enters a quadrant, any Klingon ships in the quadrant are given 100 units of energy.

You may change the computer readout, move the Enterprise or fire either a photon torpedo or your phasers at any time. If you are in a quadrant occupied by a Klingon, he will fire on you and move each time you enter the quadrant, manoeuvre, or fire at him.

The Enterprise is, of course, well-supplied with computer power to control your weapons and defensive screens, to scan your galactic neighbourhood and to display a composite image of prior scans. Unfortunately, you have limited display capabilities and can see only your status (Figure 1) and either a short-range scan, a long-range scan or the galactic composite at any one time. This display will be updated after each manoeuvre or attack.

Commands

Six Commands are available to you:

Fire phasers. The Enterprise and the Klingon ships are armed with these pure-energy weapons. Phaser fire is countered effectively by deflector screens but each hit depletes the energy reserves of the target ship. This effect is inversely proportional to the distance between ships. You may fire as much of your remaining energy as you wish.

Fire photon torpedo. The on-board computer aims automatically at the Klingon ship and will not hit a star or starbase. Evasive action by the Klingon is more effective at longer ranges.

Move the Enterprise. The computer requests the motion vector. This is to be given in sectors horizontally and vertically. A negative entry will yield motion to the left or down.

Display short-range sensor scan. The

by Ronald Subler

objects in the quadrant you occupy are displayed with the following symbols:

< • >	=	Enterprise
+ + +	=	Klingon
< ! >	=	Starbase
*	=	Star.

Display long-range sensor scan. The objects in the eight quadrants adjacent to the one you occupy are displayed in the form KBS, where:

K	=	Klingons
B	=	Starbases
S	=	Stars.

Display known galaxy. The objects in all prior long-range scans are displayed in the form KBS.

Special conditions

Moving the Enterprise consumes one unit of energy for each sector moved both horizontally and vertically. An additional 25 units and one stardate are consumed for any move which requires changing quadrants.

Docking replenishes your supplies to three photon torpedoes and 500 units of energy. This is accomplished by moving the Enterprise to one of the four sectors immediately adjacent to a starbase. You lose when a move puts you outside the galaxy; a move causes you to collide with a Klingon, starbase or star; you use up 15 stardates; or your remaining energy goes to zero.

Program

The Star Trek program contains an executive routine and three levels of subroutines. The calling sequence, shown in Figure 2, is based on the subroutine list in Figure 3.

After deleting all comments, there are only a few bytes of memory left when running Star Trek. You may find that the REMARK statements of Figure 4 will help in understanding the program in Figure 5.

I have used the PEEK and POKE facilities to minimise storage requirements for the galaxy and quadrant maps. They are encoded and stored sequentially above the program. They are addressed relative to variables Q and S, respectively. The encoded value of a quadrant is increased by 40 when it is first scanned so that it

(continued on next page)

(continued from previous page)

will be included in the map of the known galaxy.

Customising

Five parameters are available to extend or shorten the game:

Variable	Line	Effect
B1	440	Sets the number of starbases.
E1	1330	Sets the maximum energy level of the Enterprise.
K1	480	Sets the number of Klingon ships.
K7	490	Sets the initial energy level of Klingon ships.
T	560	Sets the time limit of each game.

Adapting to other systems

This version of Star Trek was written in Polymorphic Systems A00 Basic to run on a 16K Poly-88 TM microcomputer. I have used four features which are likely to be different in other Basics:

The PRINT command can be reduced to "!" on the Poly-88.

PRINT USING is not implemented in Poly A00 Basic. Instead, the width of an integer output field is controlled with "%nI", where n is the field width.

The PLOT statement in line 400 moves the cursor to line X, column Y.

Printing the value CHR$.(12) clears the screen and places the cursor on the top line.

Figure 1 – SAMPLE CONSOLE DISPLAY

Basic status information is constantly displayed at the right side of the screen.

STARDATE:		3263
CONDITION:		RED
QUADRANT		6 , 6
SECTOR		6 , 6
STATUS —	REMAINING:	
KLINGONS	=	7
STARDATES	=	15
STARBASES	=	2
TORPEDOES	=	3
ENERGY	=	500
COMMAND?		

Figure 3 – SUBROUTINE LIST

100–350	Executive routine
360–380	Pause subroutine
390–810	Initialise
820–960	Phaser
970–1040	Photon torpedo
1050–1410	Move Enterprise (may go to 3540)
1420–1570	Short-range scan
1580–1890	Long-range scan
1900–2110	Display map of scanned galaxy
2120–2140	Save current quadrant counts
2150–2170	Restore current quadrant counts
2180–2510	Initialise new quadrant (second entry at 2390)
2520–2550	Blank quadrant or galaxy
2560–2630	Poke values into quadrant or galaxy
2640–2730	Decode Enterprise address and distance to Klingon
2740–2790	Convert quadrant code to S, K, B code
2800–2840	Print borders
2850–2870	Check Enterprise energy (may go to 3540)
2880–2970	Display "BOOM" (may STOP)
2980–3300	Display console
3310–3530	Klingon fire
3540–3560	Display loss
3570–3590	Display sensor scan title

Figure 4 – REMARK STATEMENTS

These have been omitted from the program listing so that the program will fit in 5,600 bytes.

REMARK STATEMENTS – 1

```
10   REM – STAR TREK – 16K POLY-88
80   REM – EXECUTIVE ROUTINE
90   REM – DO INITIALISE
105  REM – DO CONSOLE DISPLAY
145  REM – RESTORE COMMAND IF DISPLAY
151  REM
152  REM – DECODE COMMAND
153  REM 1 = FIRE PHASER
154  REM 2 = FIRE PHOTON TORPEDO
155  REM 3 = MOVE ENTERPRISE
156  REM 4 = SHORT-RANGE SCAN
157  REM 5 = LONG-RANGE SCAN
158  REM 6 = DISPLAY KNOWN GALAXY
159  REM

162  REM
164  REM – DO FIRE PHASER
166  REM   RETURN IF NO KLINGON IN SECTOR

185  REM   SET UP PRIOR DISPLAY, PAUSE, GO TO DECODE

212  REM
214  REM – – DO FIRE TORPEDO
216  REM   RETURN IF NO KLINGON IN SECTOR
```

REMARK STATEMENTS – 2

```
235  REM   SET UP PRIOR DISPLAY, PAUSE, GO TO DECODE

262  REM
264  REM – – DO MOVE ENTERPRISE

275  REM   SET UP PRIOR DISPLAY, GO TO DECODE

293  REM
297  REM – – DO SHORT RANGE SCAN

313  REM
317  REM – – DO LONG RANGE SCAN

333  REM
337  REM – – DO DISPLAY KNOWN GALAXY

353  REM
357  REM – – PAUSE SUBROUTINE

383  REM
387  REM – – FUNCTION POSITION TO CURSOR/BLANK

422  REM
425  REM – – INITIALISE SUBROUTINE
427  REM

615  REM   BLANK QUADRANTS

635  REM   INITIALISE STARS

675  REM   INITIALISE STARBASES
```

REMARK STATEMENTS – 3

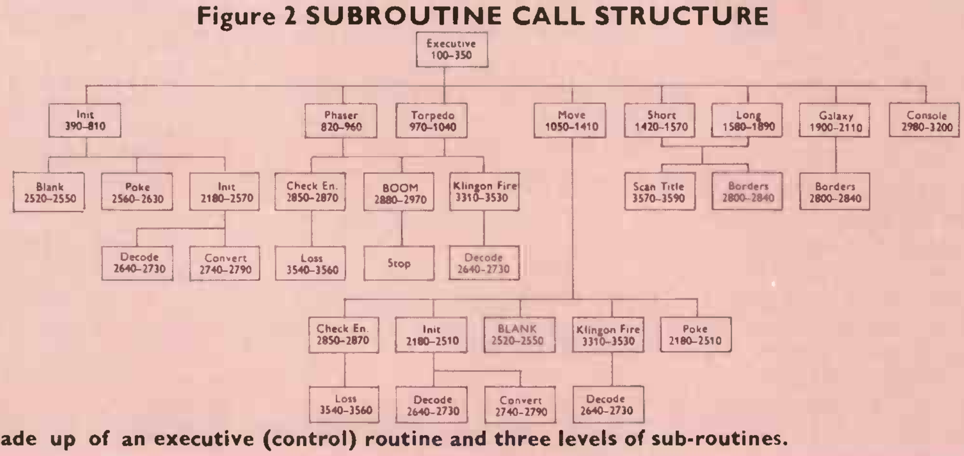
```
715  REM   INITIALISE KLINGONS

755  REM   INITIALISE STAR TREK

795  REM   DO ESTABLISH CURRENT QUADRANT

812  REM

814  REM – – FIRE PHASER SUBROUTINE

816  REM

855  REM   CHECK THAT ENTERPRISE HAS SUFFICIENT ENERGY
865  REM   CHECK WHETHER KLINGON DESTROYED

885  REM   KLINGON DESTROYED

905  REM   DO KLINGON FIRE

922  REM

924  REM – – FIRE PHOTON TORPEDO SUBROUTINE

926  REM

928  REM   CHECK WHETHER TORPEDOES REMAINING

965  REM   FIRE TORPEDO

985  REM   HIT

1005 REM   MISS – – KLINGON FIRES
```

REMARK STATEMENTS – 4

```
1042 REM
1044 REM – – ENTERPRISE MOVE SUBROUTINE
1046 REM

1095 REM   ESTABLISH NEW ENTERPRISE POSITION, ENERGY

1115 REM   CHECK WHETHER STILL IN GALAXY

1155 REM   HAS QUADRANT CHANGED?

1165 REM   NEW QUADRANT

1185 REM   ESTABLISH STARS, STARBASES, KLINGONS

1195 REM   GET DISTANCE TO KLINGON

1205 REM   TIME-UP?

1255 REM   MOVE ENTERPRISE IN SECTOR, CHECK ENERGY
1285 REM   CHECK FOR DOCKING AT STARBASE
1305 REM   DOCKED. RESUPPLY ENTERPRISE, REMOVE STARBASE

1395 REM   DO KLINGON FIRE

1412 REM
1414 REM – – SHORT-RANGE SENSOR SCAN SUB-ROUTINE
1416 REM
1418 REM   DISPLAY TITLE
```

(continued on next page)

Figure 2 SUBROUTINE CALL STRUCTURE



Star Trek is made up of an executive (control) routine and three levels of sub-routines.

(continued from previous page)

REMARK STATEMENTS – 5

1445 REM DISPLAY TOP BORDER

1475 REM LOOP TO DISPLAY ROWS OF QUADRANT

1485 REM LOOP TO DISPLAY COLUMNS OF A ROW

1505 REM PRINT LEFT BORDER

1515 REM PRINT OBJECT

1535 REM PRINT RIGHT BORDER

1555 REM DISPLAY BOTTOM BORDER

1572 REM
1574 REM – – LONG RANGE SENSOR SCAN SUBROUTINE
1576 REM
1578 REM DISPLAY TITLE

1615 REM SAVE COUNT OF STARBASES AND KLINGONS IN SECTOR

1625 REM LOOP TO DISPLAY 3 ROWS OF QUADRANTS

1635 REM SET E TO 1 IF QUADRANTS ARE OUT OF GALAXY

1665 REM DISPLAY ROW BORDER

1685 REM DISPLAY COLUMN BORDER

1705 REM LOOP TO DISPLAY 3 COLUMNS OF A ROW

REMARK STATEMENTS – 6

1715 REM SET B TO 1 IF QUADRANT IS OUT OF GALAXY

1765 REM PRINT BLANK IF QUADRANT IS OUT OF GALAXY

1785 REM PRINT QUADRANT CONTENTS AND ADD SCANNED CODE

1855 REM DISPLAY BOTTOM BORDER

1875 REM RESTORE COUNT OF STARBASES AND KLINGONS IN SECTOR

1892 REM
1894 REM – – DISPLAY OF KNOWN GALAXY SUBROUTINE
1896 REM
1898 REM DISPLAY TITLE

1925 REM DISPLAY TOP BORDER

1965 REM SAVE COUNT OF STARBASES AND KLINGONS IN SECTOR

1975 REM LOOP TO DISPLAY ROWS OF GALAXY

1985 REM PRINT ROW NUMBER

1995 REM LOOP TO DISPLAY COLUMNS IN A ROW

2005 REM PRINT COLUMN-ROW IF IT HAS BEEN PREVIOUSLY SCANNED

2055 REM PRINT ROW NUMBER

2075 REM DISPLAY BOTTOM BORDER

REMARK STATEMENTS – 7

2095 REM RESTORE COUNT OF STARBASES AND KLINGONS IN SECTOR

2112 REM
2114 REM SUBROUTINE TO SAVE COUNT OF STARBASES AND KLINGONS
2116 REM

2142 REM
2144 REM SUBROUTINE TO RESTORE COUNT OF STARBASES AND KLINGONS
2146 REM

2172 REM
2174 REM SUBROUTINE TO SET-UP QUADRANT WHEN ENTERED
2176 REM
2178 REM BLANK QUADRANT

2195 REM FIND HOW MANY STARS, STARBASES, KLINGONS

2215 REM CODE AS SCANNED

2225 REM POSITION STARS

2265 REM POSITION KLINGON

2305 REM DECODE KLINGON POSITION

2335 REM POSITION STARBASE

2375 REM DECODE STARBASE POSITION

2395 REM POSITION ENTERPRISE AND CHECK FOR COLLISION

REMARK STATEMENTS – 8

2512 REM
2514 SUBROUTINE TO BLANK QUADRANT OR GALAXY
2516 REM

2552 REM
2554 REM SUBROUTINE FOR RANDOMLY PLACING OBJECTS
2556 REM

2632 REM
2634 REM SUBROUTINE TO DECIDE ENTERPRISE POSITION AND DISTANCE
2636 REM TO KLINGON

2732 REM
2734 REM SUBROUTINE TO DECODE QUADRANT CODE INTO
2736 REM COUNT OF STARS, KLINGONS, STARBASES
2738 REM

2792 REM
2794 REM GENERAL SUBROUTINE TO PRINT BORDERS
2796 REM

2842 REM
2844 REM SUBROUTINE TO CHECK ENTERPRISE ENERGY LEVEL
2846 REM

2872 REM
2874 REM SUBROUTINE TO ELIMINATE DESTROYED KLINGON
2876 REM

REMARK STATEMENTS – 9

2972 REM

2974 REM SUBROUTINE TO DISPLAY STATUS CONSOLE AT
2976 REM RIGHT OF SCREEN
2978 REM

3302 REM
3304 REM SUBROUTINE FOR FIRE AND MOVE BY KLINGON
3306 REM
3308 REM KLINGON FIRES 20% OF AVAILABLE ENERGY

3315 REM KLINGON ENERGY REDUCED FOR MOVE AND FIRING

3335 REM REDUCE ENTERPRISE ENERGY

3375 REM MOVE KLINGON UP TO 2 COLUMNS

3435 REM MOVE KLINGON UP TO 2 ROWS

3532 REM
3534 REM END-OF-GAME; LOSS
3536 REM

3562 REM
3564 REM SUBROUTINE TO PRINT SENSOR SCAN TITLE
3566 REM

```
>LIST
100 GOSUB 390
110 GOSUB 2980
120 INPUT "COMMAND?",C
130 IF C<1 THEN 110
140 IF C>6 THEN 110
150 IF C>3 THEN M=C
160 ON C GOTO 170,
      220,270,300,320,340
170 IF K2=0 THEN120
180 GOSUB 820
190 C=M
200 GOSUB 360
210 GOTO 160
220 IF K2=0 THEN 120
230 GOSUB 930
240 C=M
250 GOSUB 360
260 GOTO 160
270 GOSUB 1050
280 C=M
290 GOTO 160
300 GOSUB 1420
310 GOTO 110
320 GOSUB 1580
330 GOTO 110
340 GOSUB 1900
350 GOTO 110
360 Z=TIME(0)
370 Z=TIME(1)
380 IF Z<T8*T9
      THEN 370 ELSE RETURN
390 DEF FNZ(X,Y)
400 PLOT Y*2,(X-1)*3,2
410 RETURNX
420 FNEND
430 DIM D$(15)
440 B1=2
450 D$="     * >!<+++<*>"
460B9=10
470 E=51
480 K1=7
490 K7=100
500 K9=20
510 M=4
520Q=24176
530S=24240
540 S1=75
550 S9=1
560 T=15
570 T8=4
580 T9=50
590 W=35
600 B=RND(TIME(0)/65536)
610 !CHR$(12)
620 B=Q
630 GOSUB 2520
640 N=S1
650 V=S9
660 L=10
670 GOSUB 2560
680 N=B1
690 V=B9
700 L=20
710 GOSUB 2560
720 N=K1
730 V=K9
740 L=40
750 GOSUB 2560
760 E1=500
770 E2=3
780 E0=INT(4096*RND(0))
790 GOSUB 2640
800 GOSUB 2180
810 RETURN
820 Z=FNZ(2,W)
830 INPUT "FIRE?",C
840 IF C<1 THEN RETURN
850 E1=E1-C
860 GOSUB 2850
870 K5=K5-C/R
880 IF K5>0 THEN 910
890 GOSUB 2880
900 RETURN
910 GOSUB 3310
920 RETURN
930 IF E2>0 THEN 970
940 Z=FNZ(2,W)
950 !"NO MORE TORPEDOES",
960 RETURN
970 E2=E2-1
980 IF R>15*RND(0) THEN 1010
990 GOSUB 2880
1000 RETURN
1010 Z=FNZ(2,W)
1020 !"YOU MISSED!",
1030 GOSUB 3310
1040 RETURN
1050 Z=FNZ(2,W)
1060 INPUT "VECTOR? ",X,Y
1070 S1=S0
1080 Q1=Q0
1090 E0=E0+X+64*Y
1100 GOSUB 2640
```

(continued on page 67)

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(continud from page 65)

```
1110 E1=E1-ABS(X)-ABS(Y)
1120 IF X0<0 THEN 1240
1130 IF X0>63 THEN 1240
1140 IF Y0<0 THEN 1240
1150 IF Y0>63 THEN 1240
1160 IF Q0=Q1 THEN 1260
1170 E1=E1-25
1180 T=T-1
1190 GOSUB 2180
1200 GOSUB 2640
1210 IF T>0 THEN 1280
1220 C$="TIME"
1230 GOTO 3540
1240 C$="GALAXY"
1250 GOTO 3540
1260 POKE S+S1,0
1270 GOSUB 2390
1280 GOSUB 2850
1290 IF B2=0 THEN 1400
1300 IF ABS(X6-X2)+ABS
      (Y6-Y2)<>1 THEN 1400
1310 Z=FNZ(2,W)
1320 !"-DOCKED-"
1330 E1=500
1340 E2=3
1350 B1=B1-1
1360 B2=0
1370 POKE Q+Q0,PEEK(Q+Q0)-10
1380 POKE S+X6+8*Y6,0
1390 GOTO 1410
1400 IF K2>0 THEN GOSUB 3310
1410 RETURN
1420 C$="SHORT"
1430 !CHR$(12)
1440 GOSUB 3570
1450 C$="+---"
1460 N=8
1470 GOSUB 2800
1480 FOR Y=7 TO 0 STEP -1
1490 FOR X=0 TO 7
1500 P=3*PEEK(S+X+8*Y)+1
1510 IF X=0 THEN !"!", ELSE !" ",
1520 !D$(P,P+2),
1530 NEXT X
1540 !"!"
1550 NEXT Y
1560 GOSUB 2800
1570 RETURN
1580 C$="LONG"
1590 !CHR$(12)
1600 GOSUB 3570
1610 N=3
1620 GOSUB 2120
1630 FOR Y=Y1+1 TO Y1-1 STEP -1
1640 Z=0
1650 IF Y<0 THEN Z=1
1660 IF Y>7 THEN Z=1
1670 C$="+------"
1680 GOSUB 2800
1690 C$="!      "
1700 GOSUB 2800
1710 FOR X=X1-1 TO X1+1
1720B=0
1730IFX<0THENB=1
1740IFX>7THENB=1
1750IFZ<>0THEN1770
1760IFB=0THEN1790
1770 !C$,
1780 GOTO 1830
1790 Q9=X+8*Y
1800 GOSUB 2740
1810 POKE Q+Q9,C9+40
1820 !"!",K2,B2,S2,
1830 NEXT X
1840 !"!"
1850 NEXT Y
1860 C$="+------"
1870 GOSUB 2800
1880 GOSUB 2150
1890 RETURN
1900 !CHR$(12)
1910 !TAB(20),"GALACTIC MAP"
1920 !
1930 !"-",
```

```
1940 C$=" ---"
1950 N=8
1960 GOSUB 2800
1970 GOSUB 2120
1980 FOR Y=7 TO 0 STEP -1
1990 !%1I,Y,
2000 FOR X=0 TO 7
2010 Q9=X+8*Y
2020 GOSUB 2740
2030 P=PEEK(Q+Q9)
2040IFP>39THEN!%2I,K2,%1I,
      B2,%1I,S2,ELSE!"    ",
2050 NEXT X
2060 !%1I,Y
2070 NEXT Y
2080 !"-",
2090 GOSUB 2800
2100 GOSUB 2150
2110 RETURN
2120 B8=B2
2130 K8=K2
2140 RETURN
2150 B2=B8
2160 K2=K8
2170 RETURN
2180 B=S
2190 GOSUB 2520
2200 Q9=Q0
2210 GOSUB 2740
2220 POKE Q+Q9,C9+40
2230 N=S2
2240 V=1
2250 L=2
2260 GOSUB 2560
2270 N=K2
2280 V=3
2290 L=4
2300 GOSUB 2560
2310 K5=K7
2320 Y5=INT(I/8)
2330 X5=I-8*Y5
2340 N=B2
2350 V=2
2360 L=3
2370 GOSUB 2560
2380 Y6=INT(I/8)
2390 X6=I-8*Y6
2400 P=PEEK(S+S0)
2410 POKE S+S0,4
2420 IF P=0 THEN RETURN
2430 IF P=4 THEN RETURN
2440 Z=FNZ(2,0)
2450 !"*** COLLISION WITH A ",
2460 IF P=1 THEN !"STAR",
2470 IF P=2 THEN !"STARBASE",
2480 IF P=3 THEN !"KLINGON",
2490 !" ***"
2500 IF P=3 THEN K1=K1-1
2510 STOP
2520 FOR K=0 TO 63
2530 POKE B+K,0
2540 NEXT K
2550 RETURN
2560 IF N=0 THEN RETURN
2570 FOR K=1 TO N
2580 I=INT(64*RND(0))
2590 P=PEEK(B+I)
2600 IF P+V>=L THEN 2580
2610 POKE B+I,P+V
2620 NEXT K
2630 RETURN
2640 Y0=INT(E0/64)
2650 X0=E0-64*Y0
2660 Y1=INT(Y0/8)
2670 X1=INT(X0/8)
2680 Y2=Y0-8*Y1
2690 X2=X0-8*X1
2700 Q0=X1+8*Y1
2710 S0=X2+8*Y2
2720 R=ABS(X5-X2)+ABS(Y5-Y2)
2730 RETURN
2740 C9=PEEK(Q+Q9)
2750 IF C9>39 THEN C9=C9-40
2760 S2=C9-10*INT(C9/10)
```

```
2770 K2=INT(C9/20)
2780 B2=INT((C9-S2-20*K2)/10)
2790 RETURN
2800 FOR J=1 TO N
2810 !C$,
2820 NEXT J
2830 !C$(1,1)
2840 RETURN
2850 IF E1>0 THEN RETURN
2860 C$="ENERGY"
2870 GOTO 3540
2880 Z=FNZ(2,35)
2890 !"***BOOM***"
2900 K1=K1-1
2910 K2=K2-1
2920 POKE Q+Q0,PEEK(Q+Q0)-20
2930 POKE S+X5+8*Y5,0
2940 IF K1>0 THEN RETURN
2950 Z=FNZ(2,0)
2960 !"MISSION ACCOMPLISHED"
2970 STOP
2980 IF K2=0 THEN C$="GREEN"
      ELSE C$="  RED"
2990 Z=FNZ(15,W)
3000 !"STARDATE:  ",3278-T,
3010 Z=FNZ(15,E)
3020 Z=FNZ(14,W)
3030 !"CONDITION: ",C$,
3040 Z=FNZ(14,E)
3050 Z=FNZ(13,W)
3060 !"QUADRANT ",X1," , ",Y1,
3070 Z=FNZ(13,E)
3080 Z=FNZ(12,W)
3090 !"SECTOR   ",X2," , ",Y2,
3100 Z=FNZ(12,E)
3110 Z=FNZ(10,W)
3120 !"STATUS - REMAINING:",
3130 Z=FNZ(10,54)
3140 Z=FNZ(9,W)
3150 !"KLINGONS =",%6I,K1,
3160 Z=FNZ(9,E)
3170 Z=FNZ(8,W)
3180 !"STARDATES=",%6I,T,
3190 Z=FNZ(8,E)
3200 Z=FNZ(7,W)
3210!"STARBASES=",%6I,B1,
3220 Z=FNZ(7,E)
3230 Z=FNZ(6,W)
3240 !"TORPEDOES=",%6I,E2,
3250 Z=FNZ(6,E)
3260 Z=FNZ(5,W)
3270 !"ENERGY    =",%6I,INT(E1),
3280 Z=FNZ(5,E)
3290 Z=FNZ(3,W)
3300 RETURN
3310B=K5/5
3320K5=K5-B-4
3330IFK5<0THENK5=.1
3340E1=E1-B/R
3350Z=FNZ(2,0)
3360POKES+X5+8*Y5,0
3370 !B/R," UNITS OF
        PHASER DAMAGE"
3380 B=X5+INT(5*RND(0)-2)
3400 IFB<0THEN3380
3410 IFB>7THEN3380
3420 IFPEEK(S+B+8*Y5)<>0THEN3380
3430X5=B
3440 B=INT(5*RND(0)-2)+Y5
3460IFB<0THEN3440
3470IFB>7THEN3440
3480IFPEEK(S+X5+8*B)<>0THEN3440
3490Y5=B
3500POKES+X5+8*Y5,3
3510GOSUB2640
3520GOSUB2850
3530RETURN
3540 !"-- OUT OF ",C$," --"
3550 !"YOU LEFT",K1," KLINGONS"
3560 STOP
3570 !C$," RANGE SENSOR SCAN"
3580 !
3590 RETURN
>?=
```

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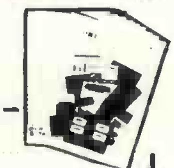

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CHAPTER 4

CHAINS

CHAINS ILLUSTRATE THE USEFULNESS OF SUBSCRIPTS. THE MANIPULATION OF CHAINS IS CALLED *LIST PROCESSING*.

THE SIMPLEST KIND OF CHAIN IS ILLUSTRATED BELOW. IT HAS A *HEAD* IN THE FORM OF A SIMPLE VARIABLE, H. THIS STORES A *POINTER* POINTING TO THE FIRST ROW OF INFORMATION SOMEWHERE IN ARRAY A(,) ⇔ POINTING ALSO TO A *LINK* CONTAINING ANOTHER POINTER POINTING TO THE *NEXT* ROW OF INFORMATION IN A(,). THE LAST LINK IN THE CHAIN CONTAINS A *ZERO* SAYING "END OF CHAIN".

H = 2 (HEAD OF CHAIN)

L(1)	20
L(2)	3
L(3)	4
L(4)	6
L(5)	37
L(6)	0

LAST LINK → L(6)

	1)	2)	3)
A(1,	6·3	-1	123
A(2,	4·7	0	246
A(3,	20·0	0	468
A(4,	16·2	0	821
A(5,	19·0	-1	333
A(6,	33·0	0	900

THE FOLLOWING PIECE OF PROGRAM WOULD PRINT INFORMATION IN A(,) ORGANISED BY THE CHAIN WITH HEAD H ⇔ HOWEVER LONG THE CHAIN.

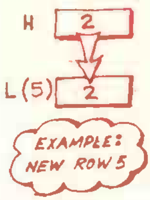
```
155 LET R = H
160 IF R=0 THEN 180
165 PRINT A(R,1); A(R,2); A(R,3)
170 LET R= L(R)      <- PICK UP NEXT LINK
175 GO TO 160
180 END

RUN

 4.7  0  246
 20  0  468
 16.2  0  821
 33  0  900
```

THE CLEAREST WAY TO DRAW A CHAIN IS TO HOLD THE HEAD IN ONE HAND, THE LAST LINK IN THE OTHER, AND PULL TIGHT. THE CHAIN ILLUSTRATED ABOVE NOW LOOKS LIKE THIS:

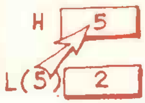
H [2] → L(2) [3] → L(3) [4] → L(4) [6] → L(6) [0]

WE USE THIS MODEL TO EXPLAIN SOME OPERATIONS ON CHAINS.

A NEW ROW OF A(,) MAY BE LINKED INTO THE CHAIN LIKE THIS:

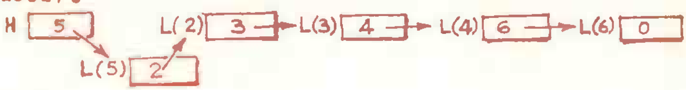


COPY THE CONTENTS OF THE HEAD INTO THE NEW LINK:



COPY THE NEW LINK'S SUBSCRIPT INTO THE HEAD (THUS MAKING THE HEAD POINT TO THE NEW LINK).

RESULT:



THE FOLLOWING SUBROUTINE LINKS ROW N INTO A CHAIN STORED IN VECTOR L( ) AND HEAD IN VARIABLE H:

```
100  REM  LINK ROW N TO CHAIN L( ) HEAD H
110  LET  L(N) = H
120  LET  H = N
130  RETURN
```

SO LINKING ROW 5 TO THE CHAIN (PICTURED ABOVE) CAN BE DONE VERY SIMPLY LIKE THIS:

```
1055  LET  N=5
1060  GO SUB  100
1065
```

AND CREATING A NEW CHAIN TO LINK, SAY, THE FIRST 10 ROWS LIKE THIS:

```
2125  LET  H=0          BEGIN WITH EMPTY CHAIN
2130  FOR  N = 1 TO 10
2135  GO SUB  100
2140  NEXT  N
```

NOTICE THE *LAST* ROW TO BE LINKED TO A CHAIN IN THIS WAY IS THE *FIRST* TO BE PRINTED BY THE ROUTINE OPPOSITE. THUS THE MECHANISM MAY BE USED TO ORGANIZE A *STACK* OF THE KIND DESCRIBED ON PAGE 54. TAKING AN ELEMENT FROM THE TOP OF THE STACK MAY BE DONE LIKE THIS:

```
3260  LET  R = H        REMEMBER THE ROW OF THE ELEMENT
3265  LET  H = L(H)     DISCARD TOP LINK
```

CHAPTER 4

CHAINS (CONTINUED)

IT MAKES FOR TIDIER PROGRAMS TO STORE HEADS OF CHAINS IN THE SAME VECTOR AS THE LINKS. THIS WASTES A FEW STORAGE LOCATIONS (AS SHOWN BELOW) BUT YOU MAY REGAIN THE SPACE BY OFFSETTING THE CHAIN FROM ITS INFORMATION AT THE EXPENSE OF MORE COMPLICATED SUBSCRIPTS IF YOU WISH.

MORE THAN ONE CHAIN CAN EXIST IN THE SAME VECTOR AS LONG AS THE ROWS BEING LINKED ARE MUTUALLY EXCLUSIVE (*i.e.* NO LINK CAN BE IN MORE THAN ONE CHAIN). THE SUBROUTINE BELOW LINKS WOMEN INTO ONE CHAIN AND MEN INTO ANOTHER. THE HEADS OF BOTH CHAINS ARE AT THE TOP OF THE VECTOR STORING BOTH CHAINS.

L(1)	0 ← HEAD OF FEMALES		WASTED		WASTED
L(2)	0 ← HEAD OF MALES				
L(3)		S$(3)	FEMALE	N$(3)	ROSE
L(4)		S$(4)	MALE	N$(4)	ALGERNON
L(5)		S$(5)	MALE	N$(5)	CLARENCE
L(6)		S$(6)	FEMALE	N$(6)	VIOLET
L(7)		S$(7)	MALE	N$(7)	CECIL
L(8)		S$(8)	MALE	N$(8)	CUTHBERT

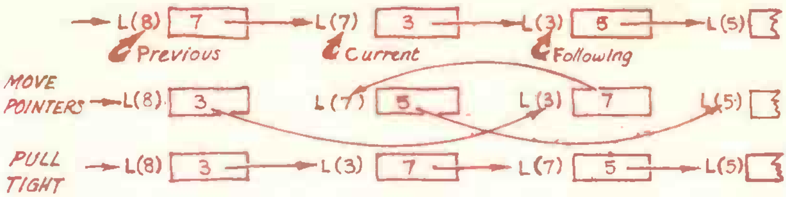
```
1000 REM LINK INTERTWINED CHAINS; N PEOPLE
1010 LET L(1)=0
1020 LET L(2)=0
1030 FOR I = 3 TO N+2
1040 LET Q=1
1050 IF S$(I) = "FEMALE" THEN 1070
1060 LET Q=2
1070 LET L(I) = L(Q)
1080 LET L(Q) = I
1090 NEXT I
1100 RETURN
```

NOT RIGOROUSLY CHECKED: ANYONE NOT DECLARED FEMALE IS TREATED AS MALE

IN THE SORTING PROGRAM ON PAGE 66 WE EXCHANGED ITEMS OF DATA. WITH CHAINED LISTS, HOWEVER, IT IS ONLY NECESSARY TO EXCHANGE *LINKS* WHEN SORTING. CONSIDER THIS SHORT LENGTH OF CHAIN:

→ L(8) [7] → L(7) [3] → L(3) [5] → L(5) [

TO *EFFECTIVELY* SWOP ROWS 7 & 3 OF THE ARRAY ASSOCIATED WITH THIS CHAIN YOU NEED ONLY SHUNT THREE POINTERS AROUND THE LINKS AS ILLUSTRATED OPPOSITE.



THE SUBROUTINE BELOW USES THE SAME LOGIC AS THE PROGRAM ON PAGE 67 THE *RIPPLE* SORT BUT WHENEVER IT HAS TO SWOP ROWS IT MOVES POINTERS IN THE MANNER ILLUSTRATED ABOVE. THE LOGIC FOR THIS IS ON LINES 2100 TO 2130, WHERE:

P IS A SUBSCRIPT FOR THE *PREVIOUS* LINK,
C IS A SUBSCRIPT FOR THE *CURRENT* LINK,
F IS A SUBSCRIPT FOR THE *FOLLOWING* LINK,

ALL AS SHOWN IN THE PICTURE ABOVE. AFTER A SWOP, C IS NO LONGER THE CURRENT SUBSCRIPT; IT IS ALTERED AT LINE 2140.

```
2000  REM   RIPPLE SORT. CHAIN L( ); HEAD L(Z);
2005  REM   NUMBER OF ROWS N(Z); COLUMN K OF A(,).
2010  FOR   S = 1  TO  N(Z)-1
2020  LET   M = 0
2030  LET   C = Z            HEAD OF CHAIN IS L(Z)
2040  FOR   I = 1  TO  N(Z)-S
2050  LET   P = C            NEW "PREVIOUS" = OLD "CURRENT"
2060  LET   C = L(C)         CLIMB DOWN TO NEXT LINK
2070  LET   F = L(C)         LOOK AHEAD TO FOLLOWING LINK
2080  IF    A(C,K) <= A(F,K) THEN 2150
                             SORT ON THE Kth COLUMN OF A(,)
                             DON'T SWOP
2090  LET   M = 1
2100  LET   X = L(P)
2110  LET   L(P) = L(C)      SEE PICTURE ABOVE
2120  LET   L(C) = L(F)
2130  LET   L(F) = X
2140  LET   C = F
2150  NEXT  I
2160  IF    M = 0  THEN  2180
2170  NEXT  S                EARLY EXIT
2180  RETURN
```

OTHER DIFFERENCES FROM THE PROGRAM ON PAGE 67 ARE NOT CONCERNED WITH THE LOGIC OF SORTING. THE ROUTINE ABOVE CAN USE *ANY* CHAIN STORED IN L( ) BEING TOLD A VALUE OF Z: THE HEAD OF THE REQUIRED CHAIN IS THEN L(Z) AND THE NUMBER OF ITEMS IS IN N(Z). FURTHERMORE THE ROUTINE ABOVE CAN SORT *ANY* COLUMN OF ARRAY A(,) BEING TOLD THE NUMBER OF THAT COLUMN IN K.

BREAKDOWNS

AN *EXAMPLE* USING THE SIMPLE LIST PROCESSING TECHNIQUES JUST DESCRIBED.

THE TYPICAL "MANAGEMENT REPORTING" PROGRAM DEALS WITH "POPULATIONS BROKEN DOWN BY AGE, RELIGION AND SEX". THE FOLLOWING PROGRAM IS A GHASTLY PARODY OF THE REAL THING BUT SERVES TO ILLUSTRATE A FEW OF THE TECHNIQUES AT THE HEART OF BUSINESS DATA PROCESSING. THE PROGRAM SORTS DIFFERENT COLUMNS OF NUMBERS. IT IS LEFT AS AN EXERCISE FOR THE READER TO EXTEND THE PROGRAM TO SORT NAMES ALPHABETICALLY (SEE PAGE 41 ON THIS).

THIS PROGRAM CALLS THE TWO SUBROUTINES GIVEN ON THE PREVIOUS DOUBLE PAGE. TO USE THE PROGRAM YOU TYPE THE NAME, SEX, DEPARTMENT NUMBER, AGE & SALARY OF EACH MEMBER OF STAFF OF A DEPARTMENT STORE. THE PROGRAM THEN PRINTS THREE MANAGEMENT REPORTS EACH OF WHICH DEALS SEPARATELY WITH THE SEXES. THE FIRST REPORT TABULATES THE INPUT DATA ORDERED BY DEPARTMENT NUMBER, THE SECOND ORDERED BY AGE OF EMPLOYEE, THE THIRD BY SALARY. IN ALL THREE REPORTS THE "ORDERING" COLUMN IS KEPT NEXT TO THE COLUMN OF NAMES.

AN IMPORTANT THING TO NOTICE ABOUT THIS PROGRAM IS THAT THE ORIGINAL INPUT DATA ARE NEVER MOVED. ORGANIZATION IS BY SHUNTING POINTERS ABOUT IN A SINGLE LIST OF POINTERS.

```
10 PRINT "DEPARTMENT STORE:  STAFF ANALYSIS"
20 DIM N(2), L$(100), N$(100), M$(100), S$(100), A(100,3), T$(2), R$(3)
30 DATA "FEMALE", "MALE", "DEPARTMENT", "AGE", "SALARY"
40 READ T$(1), T$(2), R$(1), R$(2), R$(3)
50 DEF FNC(Y)=Y-3*INT(Y/4)
60 REM FNC CYCLES 1,2,3,1,2 AS Y GOES 1 TO 5
70 PRINT "HOW MANY STAFF "
80 INPUT N                          NUMBER OF STAFF
90 PRINT "FIRSTNAME,LASTNAME,  SEX,  DEPT.,  AGE, SALARY"
100 LET N(2)=0
110 FOR I = 3 TO N+2
120 INPUT N$(I), M$(I), S$(I), A(I,1), A(I,2), A(I,3)
130 IF S$(I) = T$(1) THEN 150
140 LET N(2)=N(2)+1                 COUNT THE NUMBER OF MEN
150 NEXT I
160 LET N(1)= N - N(2)              NUMBER OF WOMEN
170 REM INPUT COMPLETE
```

```
180 REM    BEGIN ANALYSIS
190 GO SUB  1000
200 FOR  K = 1  TO  3
210 PRINT
220 PRINT "REPORT"; K; "ORDERED BY "; R$(K)
230 PRINT
240   FOR  Z = 1  TO  2
250   GO SUB  2000
260   PRINT
270   PRINT  T$(Z); " STAFF"
280   PRINT  "NAME" , , R$(K),  R$( FNC(K+1) ),  R$(  FNC(K+2) )
290   LET  R=L(Z)
300      IF  R = 0  THEN  340
310      PRINT  N$(R),  M$(R),  A(R,K),  A(R, FNC(K+1)),  A(R, FNC(K+2) )
320      LET  R=L(R)
330      GO TO  300
340   NEXT  Z
350 NEXT  K
360 GO TO 9999
```

CREATE TWO CHAINS; FEMALE & MALE

CYCLE 3 COLUMNS OF A(,) TO GIVE 3 REPORTS

SPACE

CYCLE WOMEN THEN MEN

SORT ON COLUMN K OF A(,)

SPACE

HEAD OF CHAIN

NEXT LINK

DON'T FALL THROUGH SUBROUTINES

INSERT SUBROUTINES 1000 & 2000 HERE

```
9999 END

RUN

DEPARTMENT STORE:  STAFF ANALYSIS
HOW MANY STAFF
? 6
FIRSTNAME,LASTNAME,     SEX,     DEPT.,     AGE,   SALARY
? ROSE STAGG    FEMALE            6         21      2800
? ALGERNON SWEET    MALE      6          23         3750
? CLARENCE PETTY     MALE         7           22      3750
? VIOLET BUCK     FEMALE          6      66       2000
? CECIL WILTING     MALE          7      18          4000
? CUTHBERT MACQUEEN  MALE            5      70     6000

REPORT 1 ORDERED BY DEPARTMENT

FEMALE STAFF
NAME                           DEPARTMENT     AGE           SALARY
VIOLET        BUCK              6             66             2000
ROSE          STAGG             6             21             2800
 MALE  STAFF
 NAME                          DEPARTMENT     AGE           SALARY
CUTHBERT      MACQUEEN          5             70             6000
ALGERNON      SWEET             6             23             3750
CECIL         WILTING           7             18             4000
CLARENCE      PETTY             7             22             3750

REPORT 2 ORDERED BY AGE
```

THIS BECOMES THE FIRST COLUMN HEADING IN REPORT 2

DITTO: REPORT 3

etc. etc.

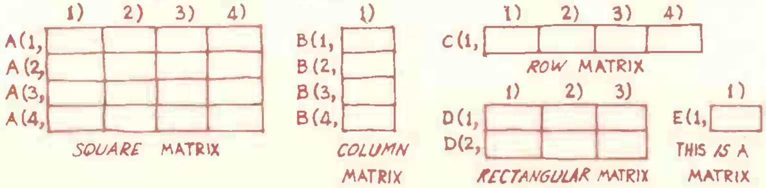
5

MATRICES

DON'T RUN AWAY — YOU DON'T HAVE TO KNOW MATRIX ALGEBRA TO FIND "MAT" STATEMENTS USEFUL.

IN *BASIC* A MATRIX IS SIMPLY A RECTANGULAR ARRAY OF SUBSCRIPTED VARIABLES:

```
10 DIM A(4,4), B(4,1), C(1,4), D(2,3), E(1,1)
```



AND THERE ARE ABOUT 12 "MAT" STATEMENTS IN MOST *BASICS* WITH WHICH YOU CAN *MANIPULATE* SUCH ARRAYS.

BUT WATCH OUT FOR THE FOLLOWING:

SOME *BASICS* ALLOW "MAT" STATEMENTS TO BE USED ON *ONE*-DIMENSIONAL ARRAYS BUT OTHERS DON'T. SO ALWAYS MAKE *TWO*-DIMENSIONAL ARRAYS WHEN YOU INTEND TO USE "MAT" STATEMENTS — EVEN WHEN ONE OF THE DIMENSIONS IS UNITY (AS IN B(,), C(,) & E(,) ABOVE).

DON'T OMIT "DIM" STATEMENTS FOR ARRAYS EVEN THOUGH MOST *BASICS* ALLOW SUCH OMISSION WHEN DIMENSIONS ARE 10 OR LESS (SEE PAGE 62).

SOME *BASICS* ALLOW SUBSCRIPTS OF ZERO, BUT IN SPITE OF THIS THEIR "MAT" STATEMENTS **IGNORE** THE ZEROth ROW & ZEROth COLUMN (THUS SUPPORTING THE EXHORTATION ON PAGE 63 NEVER TO USE ZERO SUBSCRIPTS). JUST IN CASE YOUR VERSION *DOES* ALLOW ZERO SUBSCRIPTS — AND YOU CAN'T BE CERTAIN FROM ITS USER'S MANUAL WHETHER "MAT" STATEMENTS FOLLOW SUIT — RUN THIS LITTLE PROGRAM. IF IT SHOULD PRINT 1 RATHER THAN 0 THEN PROBABLY ALL YOUR "MAT" STATEMENTS TAKE ACCOUNT OF THE ZEROth ROW & COLUMN — AN UNUSUAL *BASIC* SYSTEM.

```
10 DIM A(1,1)
20 LET A(0,0)=0
30 MAT A=CON
40 PRINT A(0,0)
50 END
RUN
 0
```

GOOD!

matrix, *mā'triks*, or *mat'riks*, *n.*(math.) a rectangular array of quantities or symbols: *pl* ma'trices (*-tris-ēz*, or *iz*) [L *mātrix,icis*, a breeding animal, later, the womb — *mater*, mother]

MATRIX INSTRUCTIONS BEGIN WITH THE WORD "MAT". TWELVE OF THEM ARE LISTED BELOW AND DESCRIBED ON SUCCEEDING PAGES. TERMS LIKE "TRANSPOSITION", "MATRIX MULTIPLICATION", AND "INVERSION" ARE EXPLAINED SO THAT THOSE WHO HAVE NEVER MET MATRIX ALGEBRA MAY UNDERSTAND AND USE THE ASSOCIATED INSTRUCTIONS.

		PAGE
MAT A = B	FOR MAKING ARRAY A(,) THE SAME AS B(,).	78
MAT A = B ± C	FOR MAKING ELEMENTS OF ARRAY A(,) THE SUM OR DIFFERENCE OF CORRESPONDING ELEMENTS OF B(,) AND C(,).	80
MAT A = (N) * B	FOR MAKING ELEMENTS OF ARRAY A(,) "N" TIMES CORRESPONDING ELEMENTS OF B(,) WHERE "N" IS A NUMBER ⇄ NOT A MATRIX.	82
MAT A = TRN(B)	FOR MAKING THE *ROWS* OF ARRAY A(,) THE SAME AS THE *COLUMNS* OF ARRAY B(,).	84
MAT A = ZER	FOR MAKING ALL ELEMENTS OF ARRAY A(,) ZERO.	86
MAT A = CON	FOR MAKING ALL ELEMENTS OF ARRAY A(,) UNITY.	87
MAT A = IDN	FOR MAKING *SQUARE* ARRAY A(,) INTO AN *IDENTITY* MATRIX ⇄ 1'S ON THE DIAGONAL AND 0'S OFF THE DIAGONAL.	87
MAT R = A * B	FOR MAKING ARRAY R(,) THE MATRIX PRODUCT OF A(,) AND B(,) BY MATRIX MULTIPLICATION.	88
MAT A = INV(B)	FOR MAKING ARRAY A(,) THE INVERSE OF THE MATRIX IN *SQUARE* ARRAY B(,).	92
MAT READ A, B, C	FOR READING COMPLETE ARRAYS FROM "DATA" STATEMENTS.	94
MAT INPUT A, B, C	FOR DEMANDING COMPLETE ARRAYS FROM A SOURCE OUTSIDE THE PROGRAM.	96
MAT PRINT A, B, C	FOR PRINTING COMPLETE ARRAYS.	98

ANY LETTERS IN ALL THESE 'MAT' INSTRUCTIONS NOT JUST A, B, C

FOR EVERY "MAT" INSTRUCTION THIS BOOK GIVES A CORRESPONDING ROUTINE IN ELEMENTARY *BASIC* USING NESTED LOOPS. IN ANY NEST OF LOOPS THE VARIABLE CONTROLLING THE INNERMOST LOOP VARIES FASTEST. IF *BASIC* STORES ARRAYS BY COLUMNS THEN IT IS MOST EFFICIENT TO MAKE THE *ROW* SUBSCRIPT VARY FASTEST; CONVERSELY IF *BASIC* STORES ARRAYS BY ROWS THEN IT IS BETTER TO MAKE THE *COLUMN* SUBSCRIPT VARY FASTEST. IT HAPPENS THAT SOME *BASICS* STORE ARRAYS BY COLUMNS; OTHERS BY ROWS; SO DON'T LOOK FOR SIGNIFICANCE IN THE CHOICE OF ROW & COLUMN SUBSCRIPTS IN THIS BOOK.

CHAPTER 5

MAT A = B

THIS INSTRUCTION MAKES A COPY OF A COMPLETE ARRAY.

```
10 DIM A(3,4), B(3,4), C(2,3)
```

	1)	2)	3)	4)
A(1,				
A(2,				
A(3,				

	1)	2)	3)	4)
B(1,	5	-9.6	2.5	7.51
B(2,	6.3	0	1	2.34
B(3,	7.2	3.7	-1	8.86

	1)	2)	3)
C(1,	235	198	137
C(2,	642	856	705

SUPPOSE YOU WANT ARRAY A(,) TO CONTAIN THE VALUES NOW CONTAINED IN ARRAY B(,). YOU CAN ACHIEVE THIS FAIRLY SIMPLY BY COPYING FROM B(,) TO A(,) ELEMENT BY ELEMENT LIKE THIS:

```
200 FOR C = 1 TO 4        <- CYCLE COLUMNS
210 FOR R = 1 TO 3        <- CYCLE ROWS
220 LET A(R,C) = B(R,C)
230 NEXT R
240 NEXT C
```

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

```
100 MAT A = B
```

NOTICE THAT A & B ON LINE 100 HAVE NOTHING WHATEVER TO DO WITH SIMPLE VARIABLES A & B. THE WORD "MAT" TELLS *BASIC* YOU MEAN *ARRAYS* A(,) & B(,).

WITH THE ARRAYS PICTURED ABOVE IT WOULD BE A MISTAKE TO HAVE LINE 110 AS SHOWN BELOW; B(,) IS TOO BIG TO FIT INSIDE C(,). BUT LINE 120 *IS* ALLOWED. IT HAS THE EFFECT OF *ALTERING* THE DIMENSIONS OF B(,) TO 2 ROWS AND 3 COLUMNS:

2 & 3 ARE NOW ITS **CURRENT DIMENSIONS**

```
110 MAT C = B
120 MAT B = C
```

WHICH MAY BE ADJUSTED LATER BY OTHER "MAT" INSTRUCTIONS PROVIDED THAT THEY NEVER EXCEED THOSE IN ITS ORIGINAL "DIM" STATEMENT.

SHRINKS

	1)	2)	3)	
B(1,	235	198	137	
B(2,	642	856	705	

B(2,4) NO LONGER EXISTS

RE-DIMENSIONING

THIS APPLIES TO NEARLY ALL THE "MAT" INSTRUCTIONS.

AFTER LINE 120 OPPOSITE, ARRAY B(,) IS *RE-DIMENSIONED* TO BE THE SAME AS ARRAY C(,). IT WOULD NOW BE WRONG TO HAVE:

```
130   LET   B(2,4) = 13
```

BECAUSE B(2,4) HAS CEASED TO EXIST. IN SPITE OF THIS SOME *BASICS* WOULD FAIL TO REPORT AN ERROR AND WOULD DO SOMETHING WITH UNPREDICTABLE RESULTS — THE 13 APPEARING PHANTOM-LIKE IN SOME OTHER LOCATION.

IT IS STILL ALLOWABLE TO HAVE:

```
140   MAT   B = A
```

EVEN THOUGH A(,) STILL HAS 3 ROWS & 4 COLUMNS WHEREAS B(,) CURRENTLY HAS ONLY 2 ROWS & 3 COLUMNS. A "MAT" INSTRUCTION (UNLIKE THE ORDINARY "LET" INSTRUCTION) RE-DIMENSIONS B(,) GIVING IT CURRENT DIMENSIONS OF 3 ROWS & 4 COLUMNS *ONCE AGAIN*.

IN GENERAL *BASIC* RE-DIMENSIONS AN ARRAY ON THE LEFT OF THE EQUALS SIGN ACCORDING TO CURRENT DIMENSIONS OF ARRAYS ON THE RIGHT *AS LONG AS THE ORIGINAL SIZE GIVEN IN THE "DIM" STATEMENT IS NOT EXCEEDED*. (THAT IS WHY LINE 110 OPPOSITE IS WRONG BUT 140 ABOVE IS CORRECT.)

THERE IS, HOWEVER, A COMPLICATION: MOST *BASICS* SEEM TO INTERPRET "*ORIGINAL SIZE*" AS MEANING THE TOTAL NUMBER OF ELEMENTS IN THE ORIGINAL ARRAY; THUS IF P(1,16) APPEARED IN THE "DIM" STATEMENT, P(,) COULD BECOME, THROUGH RE-DIMENSIONING, A SQUARE ARRAY OF FOUR ROWS AND FOUR COLUMNS. THIS IS NOT NICE. IT IS BETTER AND SAFER TO CONSIDER EACH DIMENSION AS AN INDIVIDUAL LIMIT OF RE-DIMENSIONING — THUS P(1,16) IN THE ORIGINAL "DIM" STATEMENT MAY ATTAIN ANY NUMBER OF COLUMNS UP TO 16, BUT NEVER MORE THAN ONE ROW. IF YOU *PLAN* TO HAVE P(,) CHANGE FROM ONE ROW OF 16 ELEMENTS TO FOUR ROWS OF 4 ELEMENTS THEN YOU SHOULD DECLARE P(4,16) IN THE "DIM" STATEMENT.

How would your school like to own its computer? From where do you get the money? Well, if you are in London, Derek Esterson is giving it away.

DEREK ESTERSON works for the Inner London Education Authority. He is Britain's first local education officer with responsibility for computing—and he has money to give away.

First, the background. The arrival of the microprocessor has made it feasible for schools to own their own computer. There are now 10 schools out of 192 in ILEA with a micro. Not very good, you might say.

True, there are 135 schools on-line to

by Carol Gourlay

a Systime 6000 at the City of London Polytechnic, and there are some 80 terminals linked to a Hewlett-Packard computer from various colleges of further education. but that's not the same as having your own computer.

So ILEA decided to make available some £65,000 from central funds to equip schools and colleges with computing power. That's the good news.

Colleges received £50,000 of this, which leaves £15,000 for 192 schools. You cannot buy much computing power for £78. Moreover, any school wanting a micro has to raise half the cost.

In case you think you can buy any computer you like, think again. ILEA has decided to standardise on the Research Machines 380-Z. There are two exceptions —one school has an Apple and one a M6800.

The most attractive feature of the Research Machines equipment for Esterson —and some of the teachers who have had an opportunity to review the system—is its high-resolution colour graphics capability. Most schools in the area are equipped with colour TV monitors—the legacy of an educational TV network which proved too expensive to run—which can be used in conjunction with the micros.

Another point in favour of the 380-Z is that it can be enhanced easily. Esterson also likes to deal with a U.K. company because it means quicker response time and easier administration.

Not surprisingly, most schools want the largest machine, which costs £1,250. Already, Esterson has received 45 requests and he predicts that "within a year, most schools are likely to want to jump on the bandwagon".

As the £65,000 is a one-off grant, many schools will be disappointed unless more

He's away

money is made available, and only 15 requests can be granted now.

That's the bad news. The point is that if enough schools lobby Esterson, then there is surely a good case for providing more money, particularly now that the Government is spending millions of pounds (£250 million at last count) to encourage use of the micro.

With that in mind, ILEA has a somewhat unusual method of funding the purchase of extra equipment for schools. It allows schools and colleges greater freedom with the allocation of their finances than educational bureaucracy usually permits.

If a school does not spend all the money earmarked for one purpose, it can put the surplus towards the purchase of equipment it could not otherwise afford—a minibus, for example, or a computer.

In particular, Esterson explains that schools often find themselves with excess cash if a teacher resigns midway through

giving money

Derek Esterson

the year; the school is then free to spend what would have been the teacher's salary. Over a year, the surplus can be as much as £15,000. All the 45 schools which have requested help from ILEA intend to provide their share of the cost in this way.

It is not just buying a computer which is a problem. The biggest obstacle to the development of computing in schools is the lack of qualified people. Esterson, whose official title is Staff Inspector for Science, Engineering and Computing, says: "People are proving hardest to get, and we need people who are not only experienced in the classroom, but who can write their own software as well and produce backing material".

Coherent base

He pointed out that in a school it is often the maths teacher who has responsibility for computing; it seems the myth persists that computers are to do with sums and numbers. Funnily enough this parallels the situation prevalent in business computing, where the computer is often the responsibility of the accountant or the financial director. Neither the maths teacher nor the accountant is necessarily more competent than others to manage a computer system.

Esterson reckons it is important to maintain a rigid separation between electronics and computing, a point with which we definitely agree. Although proud of electronics teaching in his area—"We have some extraordinarily gifted teachers"—Esterson feels it is wrong for a school to feel that it can get dependable computing from a kit assembled by the electronics department.

In his opinion, the only sensible way to tackle the problem of insufficient instructed staff is on a nation-wide basis. He feels it is time to break with the good old British tradition of not having national training programmes, to establish what he calls "a coherent base for the teaching of computing."

The fact that there is little pre-service training in computers for teachers means that it is difficult to make any substantial advance in the number of qualified staff. It is the responsibility of the Department of Education and Science, Esterson believes, to encourage pre-service training, by setting-up and financing national guidelines.

In-service training

Some authorities offer their teachers in-service training in computing; not all of them offer such training free. Esterson runs in-service courses for teachers. They fall into three categories—courses which cover the GCE and CSE syllabuses, programming courses, and computer appreciation courses to show teachers how they can use computers in the teaching of their particular subjects. They are advertised once a term and are generally over-subscribed.

Esterson reckons that computers in schools will prove to be "an extraordinarily powerful aid" in the teaching of many topics in different subjects. In fact, he feels that this may prove to be the most important impact computers will have on education.

"There is", he says, "a great disaffection towards learning in general, among school kids and among adults. The problem is getting people to want education."

Computers help to provoke people to learn; that is why ILEA micros and terminals are for use in all subjects—the aim is computer literacy, not computer science.

Literacy aim

Computer literacy is what Esterson wants to see achieved in schools. "The aim is not to turn out lots of little programmers," he declares with something of the evangelist in his voice, "but to achieve a wide understanding of the impact computers will have and to encourage an easy familiarity with them—the kids have to come to terms with the enormous economic and social changes which will occur."

He wants youngsters to be aware of the effect computers will have on their future employment and the issue of privacy which surrounds computerisation, to protect their own position.

Above all, the aim is to get people to accept computers as enriching life and not as something alien. "Computers are entering our whole culture; we want people to take advantage of them, not to be latter-day Luddites," he says.

As for the future, Esterson predicts that the next step will be computers in primary schools. He welcomes this development: "We would like to see that every child gets some element of computing from as early as possible."

When you are looking for something different

WHEN you've landed your 137th lunar module on a simulated moon, played your last game of noughts and crosses against a computer which always draws, and you are tired of trying to find a good reason to computerise the stubs in your chequebook, is there anything left to do?

Anything really different, I mean? It seems that virtually all the programs around are variations on a few worn-out themes. Remember when you were fed up, as a child, with those board games which had cars, monsters, spaceships, pirates or whatever, but were really all based on moving round silly counters on a stupid board by shaking a dice? Doesn't it seem, sometimes, a little like that now? Was all that money for your micro really worth it?

In what—three years?—you will be able to buy a pocket computer as opposed to calculator. In six years, they will be in Woolworths. You'll have a computer, a small, built-in colour graphics screen, sound, plenty of memory, speech synthesis and recognition, and so on. In one hand.

If things go the way that they have been doing, a normal day's activity for one of these delights will be to play a few trivial games, or sing God Save the Queen in any key while drawing a picture of Snoopy in 16 wonderful colours. That is to say, it will be like using a Formula 1 racing car to deliver the milk.

Relationship

So here is a somewhat discursive attempt to air a few ideas which seem important. I want to look at some areas where the beginnings of something different may be seen. In particular, I want to write about computers, art and people.

It seems to me that somehow—I think I know how, and it's ultimately a political reason, but I need a pint or two before I really get going—we are being pushed into a view of the relationship between people and personal computers as being a *mechanistic* one.

In 1829, Thomas Carlyle wrote:

"Not the external and physical alone is now managed by machinery, but the internal and spiritual also. . .*not for internal perfection, but for external combinations and arrangements. . .for Mechanism of one sort or another do they struggle.*" (my italics.)

If you ask most people what they think of if you say "computer", it's likely to be something to do with gas-bills, or "miraclechips" in some consumer product.

Think, though, if computers had emerged in the late 1960s instead of the '40s, they would more likely be associated with light shows or advertising graphics.

Computers work on logic, not numbers. We think, or have been led to believe, that they can deal only with the quantitative aspects of the world, not the qualitative; that you can say "28·3" to a computer, but not "nice" or "fairly small".

That is nonsense. A computer can "understand" a value judgment as much, or as little, as it can a number. Techniques exist to handle qualitative data. Of course, the computer might appreciate only a concept by association with other concepts.

by Brian Smith

At the British Computer Society fair, there were graph plotters plotting, the Police National Computer naming and remembering, and a model railway being controlled. There was a show of computer art, nearly all of it pictures of numbers.

There were also drawings by children of My Friendly Robot. One, with images of a machine and the world, had the robot saying "I rule the world", while the world said "I rule the robot".

"Solve this equation" is a well-defined problem. "Build me a pleasant house" is an ill-defined problem, with no single solution everyone would agree was correct. Life, need it be said, is an ill-defined problem.

So are there less mechanistic things we could be doing? Could computer art, for example, relate a little more to real life, whatever that is? Could it, even, help us to appreciate what that is?

Weird and wonderful

I think so. There are a number of approaches. I am the happy owner of a Research Machines 380-Z. On Mondays, Tuesdays and Wednesdays I pull it through the snow on a luggage trolley, then by a mixture of buses, tubes and trains, to various art colleges.

There, painters, graphic design persons, sculptors, poets and others do weird and wonderful things with it. Sometimes you wouldn't know it, because they prevent the computer displaying anything at all; they know what's going on inside, and they'll tell you, and that's the artwork.

Sideways thinking is rampant. We put photo-sensitive resistances on to the television screen with sticky tape, then flash little squares of light on and off underneath, to make sounds from a small oscillator. They want to make programs to respond to peoples' presence.

Forthcoming projects include an intelligent program talking to people who visit London's Design Centre. The program will be created by design students at Chelsea School of Art.

Research Machines is introducing high-resolution colour graphics later in the year and the painters are already salivating.

Most important, however, instead of using the computer to make, or help make art, a few people have started to see "the computer plus what people do with it in the world" as art. They somehow use the computer, and their growing skills with it, to increase their understanding of the context of computers. Because they are supposed to be "creative and all that", they communicate their perceptions as art.

Ideas of progress

Those perceptions, since they are about the general-purpose machines we call computers, and not just any old machine, have implications for the rest of the things and processes in the world. And that to me, is what art is about, and what computers can be about, instead of number-crunchers.

The foregoing might help us, art and computing in general—little by little, I mean—but still leaves us with the problem of what the pocket computer will do in a few years. I mentioned that there were techniques for dealing with qualities rather than quantities.

A couple of names; Fuzzy set theory and Q-analysis. The former copes, as its name implies, with impreciseness. The latter deals in a topological—surface features—way with, for instance, the aesthetics of buildings.

While the techniques need a little searching for, we have access already to programs dealing with psychology, artificial intelligence and so on. There could be many more of them if, our demand stimulated the supply.

To re-state some of the foregoing thoughts more simply. We should beware of generating a kind of "spurious creativity" variety which takes us no further forward.

Unless we can become aware of an idea of progress in what we are doing with computers, we shall have the machines, the context, the public lack of awareness and the mystification we shall deserve.

CHIPS WITH SOME THINGS

by Michael Burlington

LIKE many women, Janet Gross Nicklaus raised her family and went back to work. Before marriage, she was a data prep supervisor with ICL; now she's a school meals supervisor with Cheshire County Education Authority.

That means organising up to 2,000 meals per week at a school a few miles from her home in Congleton. She has two main responsibilities—to maintain, or better still exceed, a minimum protein content in her school dinners, and to keep the average cost per meal as close as possible to a figure set in advance by the Education Authority.

Until last September, Janet worked at a distinct disadvantage; she learned whether or not she was within her nutritional and economic guidelines only some two months after her meals had been cooked and eaten.

Daily 'fix'

That was because all the relevant data had to be processed by the central staff at Chester. The effect of the delay was obvious, particularly to Janet. She never had the information when she could use it most.

Now all is changed. Mike Nicklaus, Janet's husband, is a different kind of refugee from ICL. When offered a move to far-off Reading, he elected instead to be made redundant and become a freelance entertainer.

He also invested in a Commodore Pet to continue his daily computing 'fix'. Janet watched it winking at her across the room and began playing with it.

At the same time, she was speculating whether there might not be some application to speed the procedure at work and give her the information she wanted at the time when it would be most useful.

Janet is now at pains to point out that her early experience with computers at ICL had not equipped her to achieve this, but however little her understanding, she was at least familar with computers and she was certainly not intimidated by them. So it is not too surprising that it occurred to her a small computer could be of direct use in her present job.

Mike taught her the rudiments of Basic and she wrote her School Meals' Statistics Program on her own. The relevant data was assembled either from her own files or from a fascinated, and co-operative, central office in Chester. The programming took about five hours over a weekend; with Mike's assistance, debugging took another half-hour. Overall planning took them between three and four hours during a two-week period.

The data comprises Janet's stock sheets which show the amount used, cost, and protein value for around 150 meal ingredients. Cost updates are done on a weekly basis. The entire file is read into memory from tape for processing, of course; the record data is packed to save on space.

The processing is negligible. As Janet puts it: "The main programming effort was in formatting the input and the output".

A run has each item referenced on the screen, with the user invited to enter AMOUNT and COST. When all data for the ingredients has been entered, the program asks for the total number of meals. The totals and averages are then calculated and displayed.

It's an unspectacular but neat program, exactly the kind of thing that a small computer is good at doing. Janet's next plan, to write a menu planning program, is on ice, waiting for Mike to buy a floppy disc to increase the Pet storage capacity beyond the confines of cassette.

Satisfaction

Apart from providing a useful tool in her work, the statistics program gave Janet considerable personal satisfaction. As Mike was devising all manner of applications for the Pet, Janet became impatient to try her hand at it. It was as much a question of devising a useful and original application as of developing sufficient technical expertise. After all, the latter was on hand whenever she wanted it.

Well before devising the school meals program, Janet was tinkering usefully with the Pet. Even without Mike's guidance and skill, she would eventually have had some application up and running. On one occasion, she was keying-in a game and for several hours watched 'Syntax error' flash insistently on the screen—a common enough experience among first-time users.

Eventually she cracked the mistake and corrected it. That frustration and subsequent elation is, according to Janet, the sort of satisfaction the computer enthusiast is seeking.

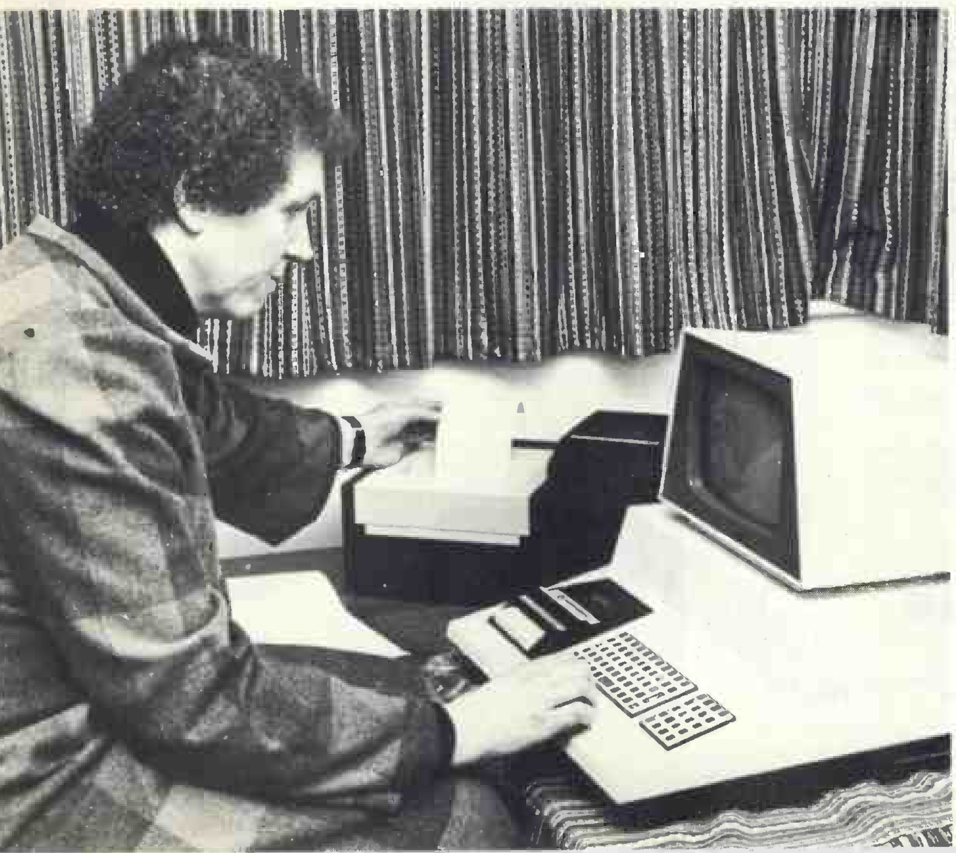
House rules

Mike attributes much of Janet's success with the statistics program to the simplicity of Basic, and especially to Pet's own sequence of teaching Basic. Neither was enthusiastic about other Pet documentation.

How easy Basic can be to learn and use is emphasised by the two Nicklaus daughters, Josephine, aged 11, and Caroline, a year older. Needless to say with Janet and Mike so absorbed in the Pet, the children became curious. Now, after some minimal instruction, they are both capable of playing many of the games Mike has devised.

With all four using the system, house rules have evolved—like no cups of coffee in the bedroom when the Pet is switched on, and no game-playing for the girls until they have checked any homework on it.

Janet Gross Nicklaus



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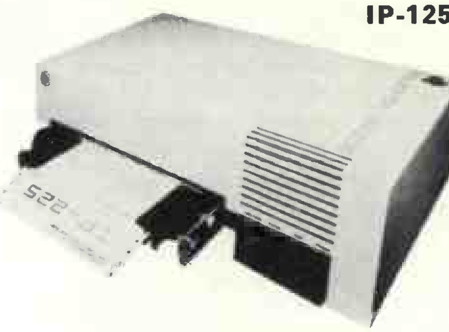

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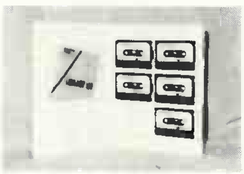

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April

3-5 **Computermarket,** Bloomsbury Centre Hotel, London WC1. Exhibition for computer buffs reaches London after two weeks travelling round the country. All types of equipment on show. Free. For further details contact Couchmead Ltd, 46 New Cavendish Street, London, W1. Telephone: 01-437 4187.

3-12 **Course in computer appreciation for businessmen and learning Basic.** Venue: Northern Software Consultants Ltd, 15 Cross Street, Manchester. This software company decided to hold a series of courses for businessmen and those interested in grasping the rudiments of Basic. On April 9 there is a one-day course for businessmen and from April 10–12 a three-day course for those wanting to learn Basic. That costs £150 plus VAT and the one-day course is £50 plus VAT. Only 20 people are accepted for each course but if you are late for this one, there are others from May 8–11 and June 11–14.

May

4-6 **Southern Microcomputer Industry Show.** Venue: Expo Hall, Exposition Park, Orlando, Florida. If you have always fancied a trip to sunny Florida, this could be your ideal opportunity to mix business with pleasure. All the latest U.S. technology will be on display. Contact Bud Felsburg, Felsburg Associates, Inc, PO Box 735, Bowie, MD 20715.

8-10 **Compec Europe Exhibition,** Brussels. Similar type of exhibition to Compec but with a European flavour. Contact Iliffe Promotions Ltd, Dorset House, Stamford Street, London SE1 for further details.

12 **Personal Computer World.** Venue: West Centre Hotel, 47 Lillie Road, London SW6. Seminar/Mini Exhibition. More information from POW Exhibitions, 62A Westbourne Grove, London W1.

15-17 **Micro/Expo 79.** Venue: Paris. Promises to be one of the leading microcomputer and personal computing exhibitions in Europe. The themes will be personal computing, new products and industrial applications. Organiser: Sybex Europe, 313 Rue Lecourbe, 75015 Paris, France. Tel: (1) 828 2502.

June

19-21 **International Microcomputers, Minicomputers & Microprocessors 79.** Venue: Geneva. Five thousand visitors from all over the world descended on Geneva for the corresponding show last year. Attracts many top European computer companies. Organisers: Kiver Communications, Surbiton, Surrey. Tel: 01-390 0281.

28-30 **The Great British Electronics Bazaar.** An electronics bazaar on tables laid in street market fashion. Aimed at the amateur, hobbyist and small professional buyer. *Practical Computing* plus many other computer firms will be there. Venue: Alexandra Palace, London. Organisers: Evan Steadman Communications Group, Saffron Walden. (0799) 22612.

July

5-7 **Microcomputer Show.** Last year it was called the Do-it-Yourself Computer Show. Now it has been expanded and moved to a new venue, the Bloomsbury Centre Hotel. We have a particular affection for this show as we launched *Practical Computing* there last year. In addition to many exhibitors, there are also three days of conferences. Thursday concentrates on *Micros in Light Industry*; Friday is devoted to *Personal Computers in Business*, and Saturday to *Personal Computers in the Home*. Speakers include Portia Isaacson, Adam Osbourne, John Coll and Guy Kewney. Highly recommended. Come and see us on our stand. Organisers; Online Computers, Uxbridge. Tel: (0895) 39362

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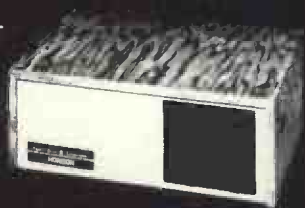

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Five-decade meter built from TTL

by NICK HAMPSHIRE

SOME YEARS ago I built a five-decade frequency meter from TTL, with a 'Nixie' neon tube display. It contains about 25 TTL devices, a crystal-controlled oscillator, a 5V power-supply line for the logic and a 180V line for the neon tubes.

Months of effort went into designing and testing the circuits, printed circuit layouts, etching, drilling and soldering. An aluminium box had to be bought, cut and painted, and the front panel labelled before being varnished.

Since then, this creation has seen much reliable service, except that occasionally it requires a sharp thump to clear a faulty connection on one of the display boards.

In frequency meter mode, each input cycle adds one to a count stored in five decade counter chips (SN7490). Every second, or one-tenth of a second, or 10 seconds, the total count is transferred from the 7490 counters into five four-bit latches (SN7475).

Immediately after this the five counters are re-set to zero and the count restarts. In any particular one-second 'slot' the display shows the number of cycles in the previous one-second slot. After each time-slot the display is updated. Resolution is therefore plus or minus one cycle.

With a one-tenth of a second time slot the display is updated more often but the resolution falls to plus or minus 10 cycles. The highest frequency which may be displayed is just short of one megahertz. Should the counter be set to accumulate over a 10-second period, the resolution rises to plus or minus one-tenth of a cycle.

Six other divide-by 10 counters divide a 100KHz crystal-controlled oscillator frequency to provide a range of time-slot periods. A rotary switch is used to select the desired range.

Commercially-available frequency meters range in price from about £75. It is possible, however, to use the Kim-1 microprocessor board to simulate most of the logic for such an instrument. The seven segment LED displays will be the visible output. The user timer on the P10 will generate the time-slot signal—after all, it is crystal-controlled.

SCANS, the monitor display routine, continually displays the six Binary Coded Decimal digits stored in DISP ($F9, $FA and $FB). DISP therefore replaces the latch chips in my TTL version. Three further locations TALLY ($06, $07 and $08) act as the counters, keeping a tally of the number of input cycles per time-slot.

The program breaks into three sections. From the label G01 to where the interrupts are enabled (CLI) the counter and display locations are cleared, the user ports are set up and TIME is loaded with the number of millisecond P10 timer delays per time-slot.

Only two instructions form the main program loop. One calls the subroutine SCANS and the next jumps back to the label MAIN to repeat this operation continually.

Interrupts

It would appear that the program will display only the initial contents of DISP. Since these locations are set to zero the display would be '000000'. Were it not for the interrupt capability of the M6502 processor this would be the case. The third part of the program is the interrupt handler and polling routine.

When an interrupt occurs a number of things happen. After execution of the instruction being performed has been completed, the main program is suspended temporarily. The current value of the program counter, the contents of the A-register and the processor condition codes are all saved by being pushed on to the stack.

Next the program counter is loaded with the address of the code to be performed after an interrupt. This address ($0051 in this program) is stored in the Kim-1 in locations $17FE and $17FF. Code starting at this address is then executed normally until a return from interrupt instruction is encountered (RTI).

At this point the current contents of the program counter are discarded and replaced by those saved previously on the stack. The A-register and condition codes are also restored. Processing then continues from the next instruction of the main program, the interrupt having been 'serviced'.

An interrupt may be made to occur

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only if the 'interrupt flag' in the condition codes register is cleared (with CLI). It occurs when the IRQ line on the processor is forced to a low state, less than 0·4 V. As it would be undesirable for an interrupt to interrupt the processor during a call to the interrupt handler, this IRQ facility is disabled between the call and its RTI; therefore only one interrupt may be serviced at once.

This simple situation is satisfactory so long as there is only one source of interrupts in the set-up—for instance, if only the incoming pulses are interrupt-driven.

In fact, there are two sources of interrupts in the current program. One is generated internally, from the P10 timer section. The timer is set-up to cause an interrupt every 1,024 microseconds, by loading C1024E with one. After that time has elapsed the program jumps, under interrupt control, to INTVEC. By checking if the top bit of location SR is set, we can tell if it was indeed the timer or another source; these are dealt with at INPUTV.

If it was the timer, then a 16-bit increment by one is performed on locations COUNT and COUNT+1. At the same time the contents of COUNT and COUNT+1 are compared to the contents of TIME and TIME+1.

Sampling

TIME and TIME+1 contain the number of 1,024-microsecond time units which comprise the desired sample time-slot for the frequency meter. They are set up at G01, G02 and G03 with the relevant values stored previously in TENTH, ONE and TEN.

While the contents of the COUNT locations are not equal to those in the TIME locations, and RTI is executed immediately. When COUNT shows finally, that TIME time units have passed, locations COUNT and COUNT+1 are cleared ready to count the next time slot.

The three TALLY locations are transferred to the three DISP so that the number of input pulses in the last time-slot is displayed by SCANS in the next. These TALLY locations are also cleared ready to keep tally of the number of incoming cycles in the next time-slot.

If it was not a timer interrupt then it was caused by the falling edge of an incoming pulse. The code for these starts at INPUTV. For each incoming pulse one is added to the three TALLY locations.

By first setting the decimal adjust mode on the M6502 with an SED instruction, adding one to a location no longer causes that location to count in 256 binary steps. Instead, the eight-bit byte is treated as two separate four-bit BCD digits. Therefore there are 99 steps between 'zero-zero' and 'nine-nine'.

A half carry between these two digits as well as the normal full carry mean that a 24-bit increment in BCD is as easy as in binary. Should the contents of the TALLY locations overflow—greater than 999999—then PAO is set. Since this situation must not occur with the current parameters it should be interpreted as an error, not as an extra digit(s) overflow. It will be cleared at the begining of the next time-slot by INTVEC.

Finally, in INPUTV there is a call to subroutine CLR74, which clears the external interrupts flag provided by the small circuit used in conjunction with the program (Figure 1). Unfortunately it is

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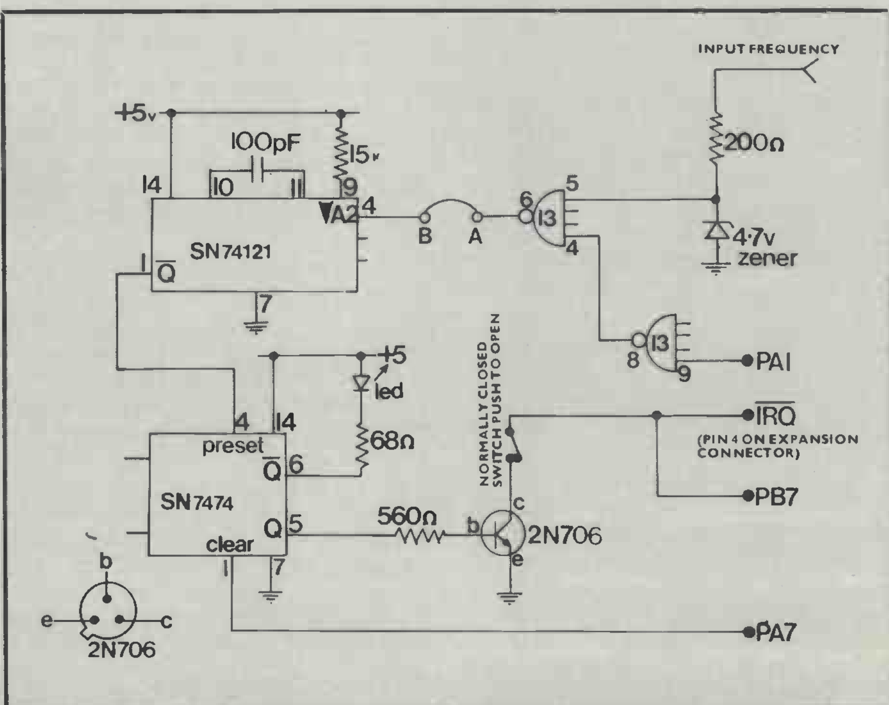

Figure 1. All un-numbered pins are un-connected.

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not enough to square-off the input waveform to be TTL-compatible and feed this directly into the IRQ line to cause the interrupt.

As there is no fixed mark: space ratio, it means that the IRQ line is held low for an undefined period. Should IRQ still be low after the RTI is performed, the processor would jump back immediately into the interrupt handler and count the same pulse again.

Nor is it possible to use a monostable directly to contract the pulse so that it is always shorter than the time taken by the interrupt handler. If we did this and the pulse occurred while the program was servicing a timer-generated interrupt, it would ignore that pulse altogether, since the interrupt mask is set while the program is in the handler.

Precise squaring

Instead, an SN7474 D-type flip-flop latch is used to 'remember' the interrupt until it is serviced. Each cycle of the waveform is squared and made TTL-compatible by a SN7413 dual four-input NAND schmitt gate. The schmitt effect is particularly useful in this application as it provides a degree of hysteresis. The input voltage must rise above a threshold (1·62V) before the output falls—it is an inverting device.

Moreover, before the output rises again the input must fall below a second, rather lower, threshold (0·83V). This causes precise squaring of the input waveform under most conditions.

This TTL waveform is inverted again by the second 7413 gate and each falling edge triggers a one-microsecond monostable (SN74121). The Q output of this device is fed to the PRESET input of the latch, causing its output to go high. While the latch Q output is high the 2N706 transistor conducts, pulling the IRQ line low and hence initiating the interrupt routines.

This transistor remains conducting until a call is made to CLR74, inside INPUTV. This subroutine feeds a logic zero to the CLEAR input of the latch. There is a similar circuit integrated into the P10 for the timer-interrupt device.

If the program is started at G01 ($000F), the TIME locations are loaded with the number of 1,024-microsecond units required to tally the input pulses for one-tenth of a second.

One would expect that 97·66 units would be closest to the required value. Yet 94 ($5E) gives the most accurate reading. This discrepancy is due to the timer causing an interrupt after exactly 1,024 microseconds, but not starting the next time unit until one is again loaded into C1024E—the half-dozen or so instructions between IRQ being pulled low and the timer being re-set being the difference.

GO2 ($001A) loads $3AF for a one-second integrating time-slot and GO3 ($0025) for a 10-second slot ($24FE). By adjusting these values while comparing them to the readings given by the TTL meter, the reading given by the program should be accurate to within about 0·5 percent.

Continuous display

By modifying these values slightly it may be possible to 'tweak' the accuracy further. Uncertainty about the last digit is unavoidable with this technique and it will usually alternate with the digit higher or lower with each successive sample.

Once started, this program runs giving a continuous display of the input frequency, though remember to apply the appropriate scaling factors if GO1 or GO3 are used. Unfortunately, due to the way SCANS is coded, the interrupts tend to cause some 'scatter' of the display segments. This gets worse as the input frequency, and hence the interrupt rate, rises. Below about 2KHz the effect is noticeable; up to 4KHz the display is still readable.

By the time the input frequency reaches 6KHz the display is unreadable; above about 10KHZ we are expecting the processor to spend more time in the interrupt handler than it can execute anyway and the effects are most interesting.

To lose this 'scatter'—segments flickering on which should be off—SCANS could be re-written using a different timing technique. Alternatively, the program could be changed to count the input waveform-generated interrupts while the program in a tight loop counted the elapsed time, then to display the results for about half a second with all the interrupts disabled (SEI). Some commercial frequency meters use this mode of operation.

Pre-scaling

The LED on the notQ output of the latch glows while the IRQ line is being held low due to an input pulse; the brighter it glows the higher the frequency. Sometimes, when the Kim-1 is re-set, the latch remains on 4 if the re-set happened while the 7474 was set. This situation upsets the program re-start.

Should the program fail to re-start, with this LED lit, a quick press on the normally-closed switch on the 2N706 transistor collector will release the IRQ line and the program will continue normally.

Since we are limited to an input frequency of one or two kilohertz, some method of pre-scaling higher frequencies to this range is required.

Figure 2 shows how an SN7490 decade-counter chip may be inserted between points A and B in figure 1 to divide the incoming frequency by 10. Any number of 7490s may be cascaded as shown to provide division by 100, or indeed any power of 10. These TTL pre-scalers are useful

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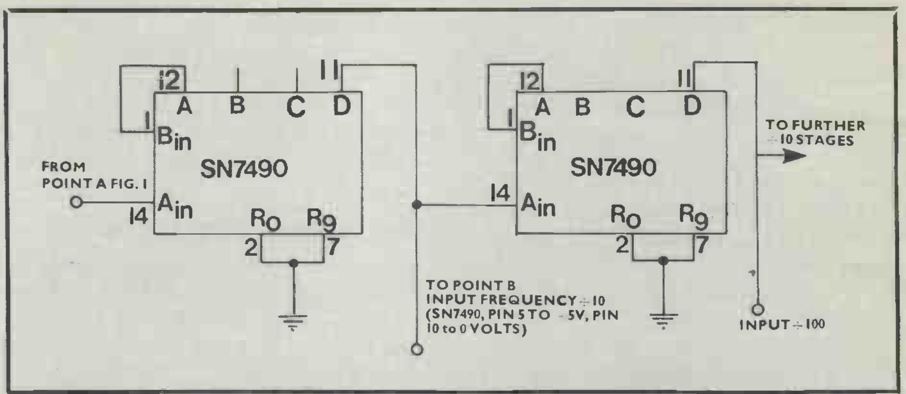

Figure 2. Frequency meter pre-scaler, each SN7490 divides by a further power of 10.

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only up to about 15MHz, although pre-scalers are available working up to many hundreds of megahertz.

By powering the Kim-1 from a car battery and taking the input from the vehicle contact-breakers, it could be used as a car tachometer. Were TIME to be loaded at the start of the program with 282, the engine RPM/100 would be displayed every 0·3 of a second—for a four-cylinder, four-stroke engine.

For a six-cylinder engine, TIME would be loaded with 188, giving the RPM every 0·2 of a second. Load 141 for an eight-cylinder every 0·15 seconds, and 94 for twelve cylinders every one-tenth of a second.

These figures are calculations—including the corrections—and may need tweaking in practice. Remember that the back e.m.f. from an ignition coil can be substantial and that contact bounce could upset the reading. Some electronic ignition systems dispense with the contacts and these would be ideal.

A 4·7V zener diode and a resistor would provide some protection to the SN7413 and microprocessor card. The schmitt gate is damaged easily if the input strays outside the zero-to-5V range.

In tricky situations a voltage comparator, such as the LM311, would offer greater input sensitivity and electrical robustness. The output of such a component would still be fed into the 7413. While the input frequency is fed into one of the inputs, possibly through a capacitor to provide some DC de-coupling, a fixed reference voltage is applied to the other input.

```
                        ;
                        ;FREQUENCY METER PROGRAM FOR KIM-1
                        ;
                        ;SYSTEM LOCATIONS
                        SCANS   =$1F1F
                        C1024E  =$170F
                        SR      =$1707
                        DA      =$1700
                        DDA     =$1701
                        DB      =$1702
                        DDB     =$1703
                        DISP    =$00F9
0000      5E 00         TENTH   .WORD $5E
0002      AF 03         ONE     .WORD $3AF
0004      FE 24         TEN     .WORD $24FE
0006                    TALLY   *=*+3
0009                    COUNT   *=*+2
000B                    TIME    *=*+2
000D                    FLAG    *=*+1
000E                    XSTORE  *=*+1
                        ;COUNT OVER A ONE TENTH, ONE OR
                        ;A TEN SECOND PERIOD. STARTING AT
                        ;GO1, GO2 OR GO3.
000F  A5  01            GO1     LDA TENTH+1
0011  85  0C                    STA TIME+1
0013  A5  00                    LDA TENTH
0015  85  0B                    STA TIME
0017  4C  2D 00                 JMP START
001A  A5  03            GO2     LDA ONE+1
001C  85  0C                    STA TIME+1
001E  A5  02                    LDA ONE
0020  85  0B                    STA TIME

0022  4C  2D 00                 JMP START
0025  A5  05            GO3     LDA TEN+1
0027  85  0C                    STA TIME+1
0029  A5  04                    LDA TEN
002B  85  0B                    STA TIME
                        ;SETUP PA0-7 AS OUTPUT, PB0-7 AS
                        ;INPUT, CONNECT PB7 TO IRQ.
                        ;SET SN7474 IS HIGH
```

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```
                        ;SET ALL TIMER,COUNT AND DISPLAY
                        ;LOCATIONS TO ZERO.
                        ;START TIMER
002D  A9  FF            START   LDA #$FF
002F  8D  01 17                 STA DDA
0032  A9  00                    LDA #0
0034  8D  00 17                 STA DA
0037  8D  03 17                 STA DDB
003A  20  0E 01                 JSR ZERO
003D  20  00 01                 JSR CLR74
0040  A9  01                    LDA #1
0042  8D  0F 17                 STA C1024E
0045  A9  00                    LDA #0
0047  8D  00 17                 STA DA
                        ;ENABLE INTERRUPTS
004A  58                        CLI
                        ;CONTINUALLY DISPLAY FREQUENCY
                        ;AS A BACKGROUND PROCESS
004B  20  1F 1F         MAIN    JSR SCANS
004E  4C  4B 00                 JMP MAIN
                        ;
                        ;INTERRUPT HANDLER
                        ;
                        ;1) FOR THE TIMER
                        ;
0051  AD  07 17         INTVEC  LDA SR
0054  10  3F                    BPL INPUTV
                        ;RESTART TIMER
0056  A9  01                    LDA #1
0058  8D  0F 17                 STA C1024E
                        ;ADD ONE TO COUNT AND COMPARE
                        ;WITH TIME.
005B  A5  09                    LDA COUNT
005D  18                        CLC
005E  69  01                    ADC #1
0060  85  09                    STA COUNT
0062  A5  0A                    LDA COUNT+1
0064  69  00                    ADC #0
0066  85  0A                    STA COUNT+1
0068  C5  0C                    CMP TIME+1
006A  F0  01                    BEQ Q1
006C  40                        RTI
006D  A5  09            Q1      LDA COUNT
006F  C5  0B                    CMP TIME
0071  F0  01                    BEQ Q2
0073  40                        RTI
                        ;TIME-UP TRANSFER TALLY TO DISP
0074  A5  06            Q2      LDA TALLY
0076  85  F9                    STA DISP
0078  A5  07                    LDA TALLY+1
007A  85  FA                    STA DISP+1
007C  A5  08                    LDA TALLY+2
007E  85  FB                    STA DISP+2
                        ;RESET TALLY AND COUNT TO ZERO
0080  A9  00                    LDA #0
0082  85  06                    STA TALLY
0084  85  07                    STA TALLY+1
0086  85  08                    STA TALLY+2
0088  85  09                    STA COUNT
008A  85  0A                    STA COUNT+1
                        ;CLEAR OVERFLOW INDICATION ON
                        ;PA0
008C  AD  00 17                 LDA DA
008F  29  FE                    AND #%11111110
0091  8D  00 17                 STA DA
                        ;RETURN FROM INTERRUPT
0094  40                        RTI
                        ;
                        ;2) FOR THE INPUT FREQUENCY
                        ;
                        ;ADD ONE TO TALLY
0095  F8                INPUTV  SED
0096  A5  06                    LDA TALLY
0098  18                        CLC
0099  69  01                    ADC #1
009B  85  06                    STA TALLY
009D  A5  07                    LDA TALLY+1
009F  69  00                    ADC #0
00A1  85  07                    STA TALLY+1
00A3  A5  08                    LDA TALLY+2
00A5  69  00                    ADC #0
00A7  85  08                    STA TALLY+2
00A9  90  08                    BCC Q3
                        ;IF CARRY FROM 999999 THEN
                        ;SET PA0 TO INDICATE OVERFLOW
00AB  AD  00 17                 LDA DA
00AE  09  01                    ORA #%00000001
00B0  8D  00 17                 STA DA
                        ;RELEASE IRQ LINE BEFORE RETURN
00B3  20  00 01         Q3      JSR CLR74
00B6  40                        RTI
```

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```
                            ;
 00B7                                *=$100
                            ;SUBROUTINE TO RELEASE IRQ
                            ;BY CLEARING SN7474 LATCH
 0100  AD  00 17            CLR74    LDA DA
 0103  29  7F                        AND #%01111111
 0105  8D  00 17                     STA DA
 0108  09  80                        ORA #%10000000
 010A  8D  00 17                     STA DA
 010D  60                            RTS
                            ;
                            ;SUBROUTINE TO ZERO ALL
                            ;COUNT AND DISPLAY LOCATIONS
 010E  A9  00               ZERO     LDA #0
 0110  85  09                        STA COUNT
 0112  85  0A                        STA COUNT+1
 0114  85  06                        STA TALLY
 0116  85  08                        STA TALLY+2
 0118  85  07                        STA TALLY+1
 011A  85  FA                        STA DISP+1
 011C  85  FB                        STA DISP+2
 011E  85  F9                        STA DISP
 0120  60                            RTS
                            ;LOAD INTERRUPT VECTOR WITH
                            ;HANDLER ADDRESS
 0121                                *=$17FE
 17FE      51 00            IRQ      .WORD INTVEC
                            ;
 1800
 SECOND PASS FINISHED O.K.
 SYMBOL TABLE
        29
 SCANS   1F1F   C1024E  170F
 SR      1707   DA      1700    DDA     1701
 DB      1702   DDB     1703    DISP    00F9
 TENTH   0000   ONE     0002    TEN     0004
 TALLY   0006   COUNT   0009    TIME    000B
 FLAG    000D   XSTORE  000E    GO1     000F
 GO2     001A   GO3     0025    START   002D
 MAIN    004B   INTVEC  0051    Q1      006D
 Q2      0074   INPUTV  0095    Q3      00B3
 CLR74   0100   ZERO    010E    IRQ     17FE
 END OF ASSEMBLY
```

Due to circumstances beyond our control, this article could not be included in last month's issue. We apologise to our readers who may have been inconvenienced as a result.

Using Kim-1 to aid motor control

HALF the fun of owning a microprocessor such as the 6502-based Kim-1 is being able to control things. The user should not be constrained to use only the hexidecimal keypad and the seven-segment displays. Think of the potential when you can switch electric motors on and off, set their direction and select a suitable speed, and make light bulbs glow, flash and glimmer.

The circuits required are simplicity personified. Further, the basic design can be uprated by changing a few component valves and types. Any small DC load can be switched. Apart from motors and lamps, they will activate relays and solenoids, thereby widening the scope for control of much heavier electrical loads.

This could be your chance to computerise that model train set or racing car layout. Not only can the speed and direction of the engine or vehicle be varied, but also the points and lights can change automatically, allowing some complex manoeuvres.

In the home

Perhaps you might consider tackling something about the home. Curtains which close automatically at dusk, as the lights switch on, and then open at dawn would act as practice before moving to more serious ventures, such as the central heating, or converting the washing machine controller to the magic of microprocessors.

You could be the first person in your street to use last year's Christmas present to make the lights on next year's tree wink

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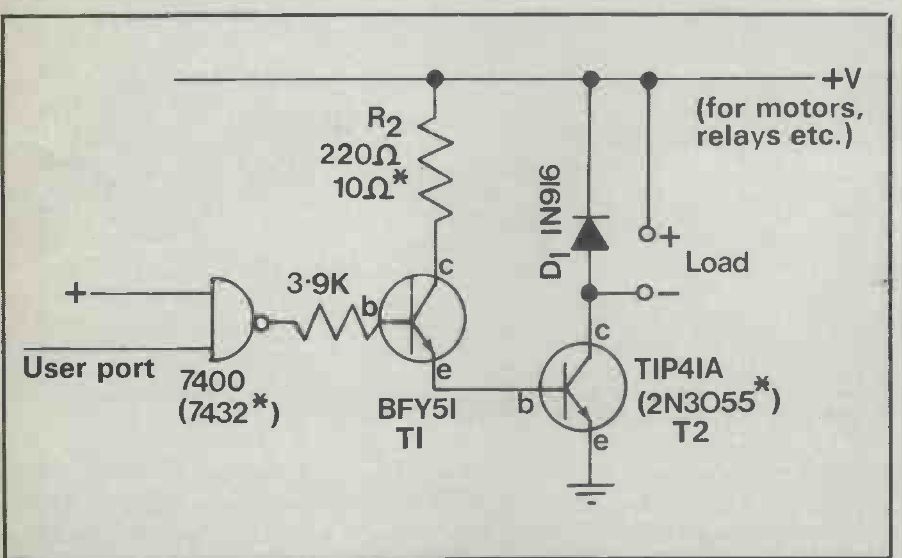

Figure 1. Basic transistor switch (*see text).

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in a most perplexing fashion. With a little time and ingenuity, mind-blowing gyrations of disco lights could be achieved.

As with past Kim projects, the body of the code in our sample programs is written as a handful of subroutines. They are then available for you to incorporate into your programs, as well as being demonstrated in a number of test programs.

They may do what you want in themselves but in any case they allow you to experiment with the circuits as soon as the program is keyed-in. At the heart of the code are eight subroutines (ON1, OFF1, ON2, OFF2, ON3, OFF3, ON4 and OFF4) which may be called to set selectively or clear any of the first four bits of the user port PAO-PA3.

Figure 1 shows the basic circuits configuration for switching small DC loads, ones which range from six to about 25 volts, with current consumptions generally less than a few amps. When the output of the inverting gate G1 rises, the emitter of T1 rises to about the same voltage as its base. Current then flows through the current-limiting resistor R2 and T1 into the base of T2.

While the base of T2 is held more than 0·8 volt above its emitter, the device will conduct. Current may then flow through the load. When the output of G1 falls to a logic zero level, the emitter of T1 also drops to a low voltage level and so T2 ceases to conduct.

Low current gain

The power transistor specified, a TIP41A, has a serious disadvantage. It has a low current gain. This means that if it is to pass a large current through its load, T1 must in turn supply a smaller, but still high, current into its base. R2 is placed in the circuit to prevent excessive current flowing through T1.

On the first prototype breadboard of this circuit a rather low value of R2 was tried first. T1 is expected to drop the load line drive voltage down to about +3 volts. With a low resistance load drawing through a high current, a correspondingly high current flowed in T1—which got hot and shimmered slightly blue. Then I touched the transistor can with my finger to see if it really was hot—and it was.

Heat problem

I threw the burnt-out device into the bin, selected a higher value for R2 and tried again. The moral of this story is not to use the TIP41A to drive loads of more than one amp.

A 2N3055 power transistor has a much higher current gain and R2 can be reduced to as low as 10 ohms without endangering T1. Currents up to many amps may then be switched. The output transistor T2 should not become hot. Either it is not conducting at all, in which case no current flows and power dissipation is zero, or it is conducting with only a small potential drop across its emitter and collector.

Protection

In that case the power dissipated by T2 is less than one watt for each amp flowing through the load. Diode D1 is included in the circuit to protect the other components from back emf spikes often produced by inductive loads, such as motors, relays and solenoids.

Four identical circuits were built-up on a single printed circuit board for the prototype. This is convenient, as each TTL 7400 package contains four gates. By using an inverter for G1, the load is switched on only if the gate input is low (Active Low). This way seem illogical at first; there is, however, a good reason.

When the microprocessor is re-set all the user port lines are set to be inputs. They then appear as a logic '1' to the inputs of TTL gates are still connected. If

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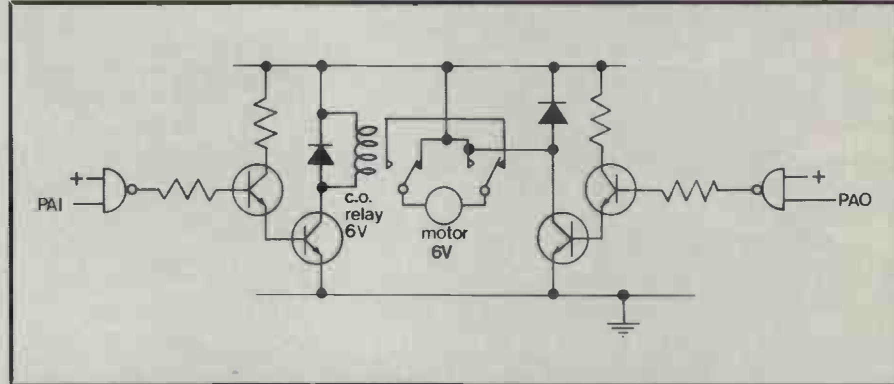

Figure 2. Reversible motor control for SPEEDR.

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the gate was non-inverting, every time the microprocessor was re-set all the transistor switches would conduct. In a different application, the quad two input OR gate 7432 package, with the second input grounded, acts as a non-inverting buffer. Further, it has the same pin layout as the 7400 (0'NAND' high = 1 and 1'NAND' high = 0 whereas 0'OR' low = 0 and 1'OR' = low 1).

Figure 2 shows how two identical circuits as shown in figure 1 may be used to turn a DC motor on and off, as well as reverse its direction. The motor connections are swapped over as the double-pole relay is energised. The subroutines starting at $0100 are written to switch a device attached to the first four-user port lines PA0-PA3.

As a simple demonstration they are incorporated into the program SWITCH at $0004. First subroutine INIT is called to set-up PIO A as outputs and PIO B as inputs. The program then cycles round, reading the keypad with the monitor routine GETKEY.

Four channels

Keys along the bottom of the pad will be used to switch on any of the four channels, i.e., set the relevant user port line low. This is done by testing for each of the keys in turn and calling ON1, ON2, ON3 or ON4 when GETKEY returns 0, 1, 2 or 3. The next row of keys 4, 5, 6, 7 call the corresponding OFF routines, setting the user port line high and turning off the transistor switch.

Each of the four ON subroutines works by loading the current contents of the user port data register, which reflects the logic values on the wires, into the A-register. By ANDing any individual bit with a '1' it remains unchanged. By ANDing it with a '0' that bit is set to zero.

In each of the four cases only one bit is zeroed before this new value is placed back in the data register DA. Irrespective of their previous values, the zeroed bit turns on the transistor switch; all the others are totally unaffected.

With each of the OFF routines only that bit which is ORed with a '1' is set to a logic high, switching off that channel. All the others ORed with a '0' remain unaffected. Referring to figure 2, with the circuits connected to the user ports shown, pressing key 0 will switch on the motor, key 4 will switch it off. Key 1 will set it forwards and key 5 into reverse.

Varying speed

When the circuits are used to drive small DC motors it is often useful to vary their speed. As these circuits act only as ordinary switches, either on and applying full voltage, or off and applying none across the windings, some form of pulse-width modulation is called for.

Here the motor is alternately switched on for a period and then switched off for a time. The ratio of on to off determines the speed of rotation. Due to various electrical, magnetic and mechanical inertias in the motor, these pulses are smoothed-out. If the pulse frequencies are chosen carefully, this gives the appearance of the motors being powered from a variable DC source.

While testing the software, various small permanent magnet motors of the type readily available from radio-control and modelling shops were tried. One particular make with bolt-on epicyclic gearboxes is particularly versatile.

Wide range

The gearboxes are manufactured from grey plastic and are flat. They can be bolted on to the output shaft of the motor, and are 'stackable' thereby offering a very wide range of reductions. They are available in a range of sizes, voltages and currents.

At least one of the medium-sized six-volt units is sold as a 'curtain cord motor', supplied with the correct gearing for the task. Also available for these motors is an electrical and wireless interference suppressor—in effect, a few capacitors and ferrite beads to control any arcing at the commutator, although they hardly seem to need it.

On the other hand some of the cheaper motors produce so much electrical 'hash' that they upset the microprocessor circuits. The yellow Meccano 3–12 volt motors, with the six-speed gearboxes, are

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guilty of this, so much so that as soon as the test one was started the Kim-1 promptly re-set itself.

Mains-powered equipment could be catered for with the routines by the use of triacs and opto-isolators (*Practical Computing*, October, 1978), or by commercially-available 'solid state relays'.

Figure 3 shows two forms of proportional control using on/off switching. 3a, as produced by the program MSR ($005A) shows the kind of control available with a fixed ON pulse-length and a variable OFF delay between these pulses.

DELAY is a subroutine taking two parameters. One, in the A-register, determines the number of 64-microsecond delays which will occur. The Y-register is loaded with the number of times this should happen. With the default settings (loading LONG into A and 1 into Y) the ON pulse is set to about 4·48 milliseconds, 70*64, which on most motors appears as a very short click, not unlike a stepping motor, with the shaft turning a very small amount.

Precise motions

Then the motor will be switched off and the DELAY routine called again. This time the A-register is loaded with the contents of SHORT (22), the basic delay is then 1·4 milliseconds. The Y-register is loaded with the contents of location SPEED ($0000). Therefore the smallest mark:space ratio is about 4·48:1·4 and the greatest 4·48:360·4.

When SPEED has been loaded with zero, this is tested for separately and the motor is never switched off full speed. This technique offers a wide dynamic range of speed control. If the ON period is short compared to the inertia of the motor, very precise motions may be made. The values for LONG and SHORT given here are only a rough guide; their optimum values will depend on the motors you use.

Figure 3b shows the effect of SPEEDR ($0079). In this example the 'time' from A to B is divided into 10 time slots. The number of slots the motor will be on is read from the keypad; for the remainder of the 10 it will be off. The program therefore loads the A-register with GETKEY.

Added bonus

As an added bonus, it will check to see if '$F', and set PA1 (the relay) off for 'forwards', and for '$B' to set PA1 for 'backwards'. If it is neither, it jumps to the subroutine ratio ($0156).

Whey a key greater than 9 is pressed, the motor is switched off and the routine returns directly. If the key '0' is pressed the Y-register is loaded with 10 and a delay for the full A to B 'time' is effected (about 14 milliseconds) with the motor OFF, before returning. For any key between 1 and 9 the keypad value is loaded into the Y-register and that many time slots are delayed with the motor on.

After the delay the keypad value is subtracted from 10 and the remaining time slots are delayed with the motor off. In any case the motor is switched off before the return, so any delay introduced by calling GETKEY reduces the total

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Fig. (3a)

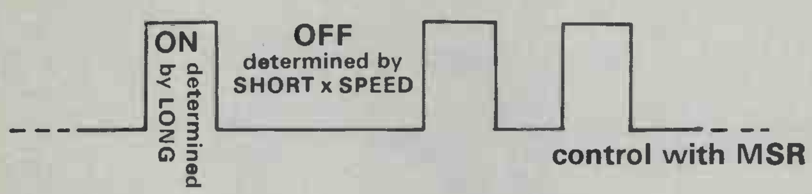
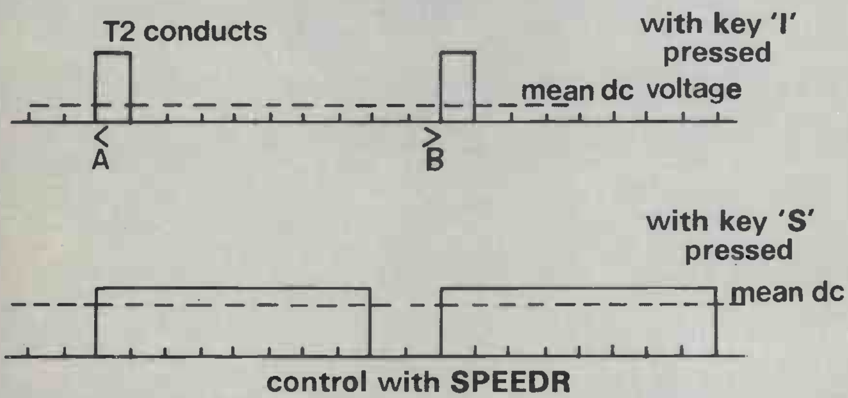


Fig. (3b)



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possible ON time to somewhat less than 100 percent.

The values used for DELAY in this program have been carefully chosen to provide a 'smooth' DC average value. If the time slots are much longer the motor—or at least those types tested—seemed to 'judder'. If the time slots were much shorter, the pulses were of such a frequency as to be readily audible and the motor 'whines'.

Also try this program with a light bulb in place of the motor. The different keys show clearly their effect as varying brightness. A 12 volt 12 watt one as used in car indicators works well.

One problem with small DC motors is the ease with which the speed changes according to such factors as loading and the supply voltage, possibly as batteries run down. One can never, therefore, guarantee that one pulse from a program like MSR will move the output shaft X degrees from one time to the next. So if such a technique was used to control a robot moved by these motors, 100 pulses might move it one foot the first time, but only 11½ in. the next.

If the delay between the pulses is reduced, the motor has a chance to 'build-up speed' and in this case might travel 15 in. for 100 pulses. As an example of how this problem may be combatted, figure 4 shows a gray code disc. The four concentric rings show a special binary code in which only one bit changes between adjacent segments. They are marked in the table.

Figure 5 shows a light-emitting diode/phototransistor pair which could shine through a transparent disc with opaque gray code markings. The advantage of such an encoding system is obvious when you consider what would happen with a disc coded with straight binary.

As the disc went from 0000 to 1111 it is possible that, due to the optical readers being slightly off axis with the shaft, or all four not being read at exactly the same time, that some of the cells would still read zero while others now read one, leading to a totally spurious result.

CONVG ($01A1) is a subroutine which converts a gray code into ordinary binary, which could then be used to determine the exact shaft rotation and speed. Gray codes and code discs are available in many resolutions, typically 6-bit (5·625 degree) and 10 bit (0·352 degree) working on exactly the same principle. The program

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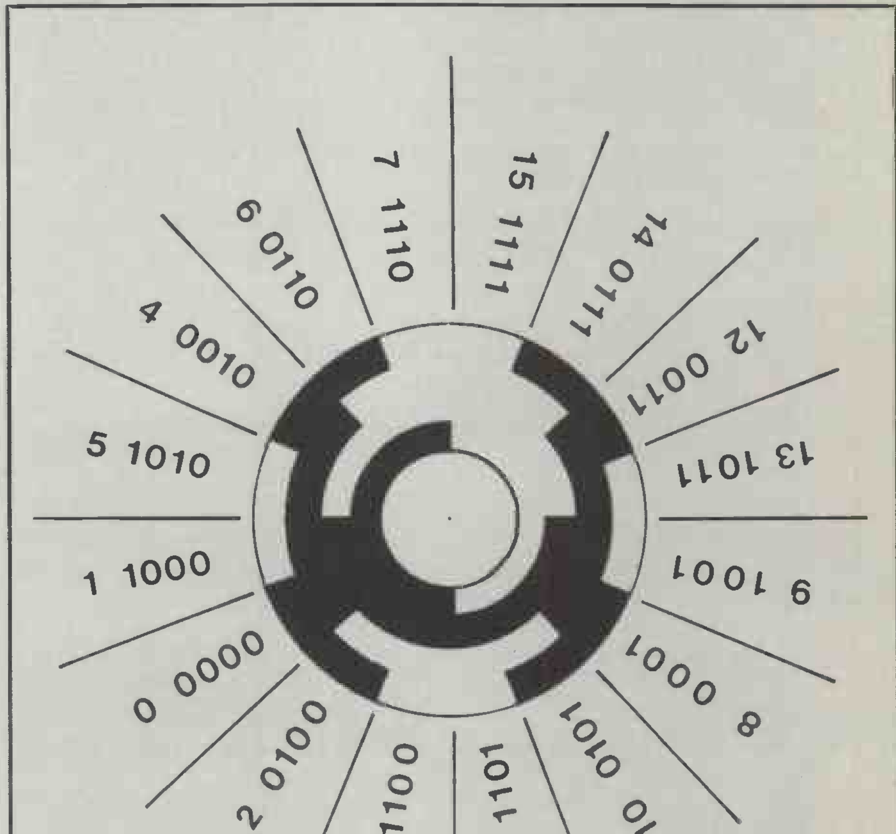
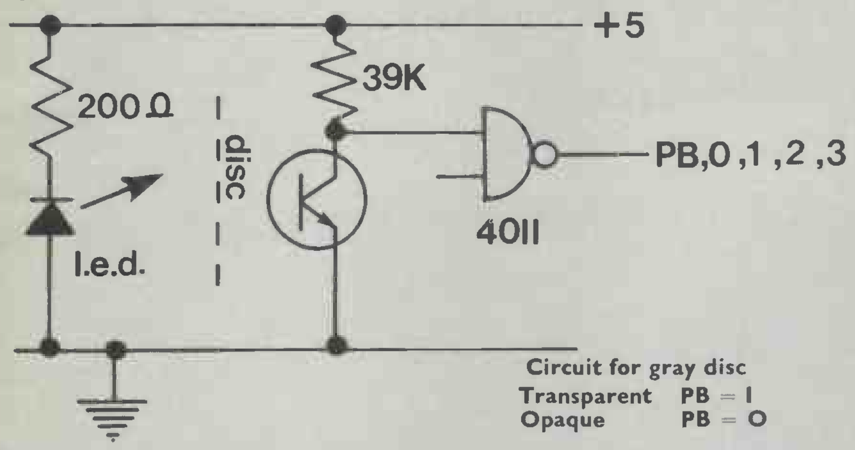


Figure 4. Excess 3-gray code shaft encoder 4-bit.

Fig. 5



Circuit for gray disc
Transparent PB = 1
Opaque PB = 0

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GRAYT ($009D) displays the gray value from bit PB0 to PB3 on the left-most hex display as a binary '0' to 'F' digit.

Obviously many things can now be tackled by modifying these subroutines to suit your own needs, or indeed using them as they are. On second thoughts, perhaps you should leave modifying the washing machine to the experts. Think how much hot water it could deposit on your floor if a spurious (and malignant) electrical spike re-set the processor.

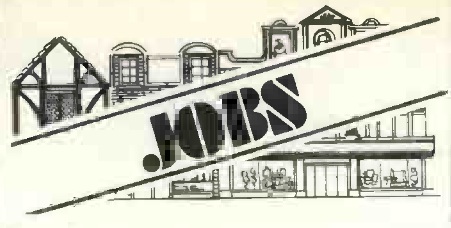
```
      *
0 0 0 0
        *
0 0 0 1
  *
0 1 0 1
        *
0 1 0 0
      *
0 1 1 0
        *
0 1 1 1
*
1 1 1 1
        *
1 1 1 0
      *
1 1 0 0
        *
1 1 0 1
  *
1 0 0 1
        *
1 0 0 0
      *
1 0 1 0
        *
1 0 1 1
*
0 0 1 1
        *
0 0 1 0
      *
```

Four-bit gray code. Notice how only one bit changes between adjacent numbers.

```
                        ;
                        ; SYSTEM LOCATIONS
                        ;
                        DA      =$1700
                        DDA     =$1701
                        DB      =$1702
                        DDB     =$1703
                        SCANS   =$1F1F
                        DISP    =$F9
                        GETKEY  =$1F6A
                        C64D    =$1706
                        SR      =$1707
                        ;VARIABLES
0000                    SPEED   *=*+1
0001       16           SHORT   .BYTE 22
0002       46           LONG    .BYTE 70
0003                    XTP     *=*+1
                        ;PROGRAM TO SWITCH ANY OF THE
                        ;CHANNELS ON OR OFF.
                        ;
                        ;0=CHANNEL 1 ON
                        ;4=CHANNEL 1 OFF
                        ;1=CHANNEL 2 ON
                        ;5=CHANNEL 2 OFF
                        ;2=CHANNEL 3 ON
                        ;6=CHANNEL 3 OFF
                        ;3=CHANNEL 4 ON
                        ;7=CHANNEL 4 OFF
                        ;
0004  20   48 01        SWITCH  JSR INIT
0007  20   6A 1F        NEXTK   JSR GETKEY
000A  C9   00                   CMP #0
000C  D0   06                   BNE G1
000E  20   00 01                JSR ON1
0011  4C   07 00                JMP NEXTK
0014  C9   04           G1      CMP #4
0016  D0   06                   BNE G2
0018  20   09 01                JSR OFF1
001B  4C   07 00                JMP NEXTK
001E  C9   01           G2      CMP #1
0020  D0   06                   BNE G3
0022  20   12 01                JSR ON2
0025  4C   07 00                JMP NEXTK
0028  C9   05           G3      CMP #5
002A  D0   06                   BNE G4
002C  20   1B 01                JSR OFF2
002F  4C   07 00                JMP NEXTK
0032  C9   02           G4      CMP #2
0034  D0   06                   BNE G5
0036  20   24 01                JSR ON3
0039  4C   07 00                JMP NEXTK
003C  C9   06           G5      CMP #6
003E  D0   06                   BNE G6
0040  20   2D 01                JSR OFF3
0043  4C   07 00                JMP NEXTK
0046  C9   03           G6      CMP #3
0048  D0   06                   BNE G7
004A  20   36 01                JSR ON4
004D  4C   07 00                JMP NEXTK
0050  C9   07           G7      CMP #7
0052  D0   B3                   BNE NEXTK
0054  20   3F 01                JSR OFF4
0057  4C   07 00                JMP NEXTK
                        ;
                        ;PROGRAM TO SHOW PULSE MOTOR
                        ;CONTROL. LOCATION 'SPEED'
                        ;CONTAINS NUMBER OF TIME SLOTS
                        ;BETWEEN MOTOR-ON PULSES.
                        ;SPEED=0 MEANS FULL ON
005A  20   48 01        MSR     JSR INIT
005D  20   00 01        MSR1    JSR ON1
0060  A5   02                   LDA LONG
0062  A0   01                   LDY #1

0064  20   8C 01                JSR DELAY
0067  A5   00                   LDA SPEED
0069  C9   00                   CMP #0
006B  F0   F0                   BEQ MSR1
006D  A8                        TAY
006E  20   09 01                JSR OFF1
```

(continued on next page)



(continued from previous page)

```
0071  A5  01             LDA SHORT
0073  20  8C 01          JSR DELAY
0076  4C  5D 00          JMP MSR1
                 ;
                 ;PROGRAM TO DEMONSTRATE PULSE
                 ;WIDTH MODULATION CONTROL OF
                 ;D.C. MOTOR SPEED CONTROL.
                 ;USE KEY-PAD TO SELECT SPEED;
                 ;0 IS OFF, 9 IS FULL SPEED,
                 ;INCREASING SPEED FROM 1 TO 8
                 ;B- SET RELAY ON (PA1)
                 ;F- TURN RELAY OFF
                 ;ANY OTHER - NO EFFECT
0079  20  48 01  SPEEDR  JSR INIT
007C  20  6A 1F  SPEED1  JSR GETKEY
007F  C9  15             CMP #$15
0081  B0  F9             BCS SPEED1
0083  C9  0B             CMP #$B REVERSE
0085  D0  06             BNE S1
0087  20  12 01          JSR ON2
008A  4C  7C 00          JMP SPEED1
008D  C9  0F     S1      CMP #$F FORWARD
008F  D0  06             BNE S2
0091  20  1B 01          JSR OFF2
0094  4C  7C 00          JMP SPEED1
0097  20  56 01  S2      JSR RATIO
009A  4C  7C 00          JMP SPEED1
                 ;
                 ;PROGRAM TO DECODE GRAY
                 ;DISC, RESULT IN DISPLAY
                 ;L.S.D.
009D  20  48 01  GRAYT   JSR INIT
00A0  20  A1 01  GRAYT1  JSR CONVG
00A3  20  1F 1F          JSR SCANS
00A6  4C  A0 00          JMP GRAYT1
                 ;
00A9                     *=$100
                 ;SUBROUTINES USED BY PROGRAMS
                 ;TURNS CHANNEL 1 ON
0100  AD  00 17  ON1     LDA DA
0103  29  FE             AND #%11111110
0105  8D  00 17          STA DA
0108  60                 RTS
                 ;TURNS CHANNEL 1 OFF
0109  AD  00 17  OFF1    LDA DA
010C  09  01             ORA #%00000001
010E  8D  00 17          STA DA
0111  60                 RTS
                 ;TURNS CHANNEL 2 ON
0112  AD  00 17  ON2     LDA DA
0115  29  FD             AND #%11111101
0117  8D  00 17          STA DA
011A  60                 RTS
                 ;TURNS CHANNEL 2 OFF
011B  AD  00 17  OFF2    LDA DA
011E  09  02             ORA #%00000010
0120  8D  00 17          STA DA
0123  60                 RTS
                 ;TURNS CHANNEL 3 ON

0124  AD  00 17  ON3     LDA DA
0127  29  FB             AND #%11111011
0129  8D  00 17          STA DA
012C  60                 RTS
                 ;TURNS CHANNEL 3 OFF
012D  AD  00 17  OFF3    LDA DA
0130  09  04             ORA #%00000100
0132  8D  00 17          STA DA
0135  60                 RTS
                 ;TURNS CHANNEL 4 ON
0136  AD  00 17  ON4     LDA DA
0139  29  F7             AND #%11110111
013B  8D  00 17          STA DA
013E  60                 RTS
                 ;TURN CHANNEL 4 OFF
013F  AD  00 17  OFF4    LDA DA
0142  09  08             ORA #%00001000
0144  8D  00 17          STA DA
0147  60                 RTS
                 ;
                 ;INITIALISE OUTPUT PORTS
                 ;A - OUT, B - IN.
0148  A9  FF     INIT    LDA #$FF
014A  8D  01 17          STA DDA
014D  8D  00 17          STA DA
0150  A9  00             LDA #0
0152  8D  03 17          STA DDB
0155  60                 RTS
                 ;DELAYS 10 TIME UNITS.
                 ;CHANNEL 1 ON FOR THE
                 ;NUMBER OF UNITS INDICATED
                 ;IN THE A-REG, OFF FOR THE
                 ;REMAINING. IF A>9 THEN
                 ;CHANNEL OFF & RETURN
0156  85  03     RATIO   STA XTP
0158  C9  0A     RATIO1  CMP #10
015A  90  04             BCC R1
015C  20  09 01          JSR OFF1
015F  60                 RTS
0160  C9  00     R1      CMP #0
0162  D0  0B             BNE R2
0164  20  09 01          JSR OFF1
0167  A0  0A             LDY #10
0169  A5  01             LDA SHORT
016B  20  8C 01          JSR DELAY
016E  60                 RTS
016F  20  00 01  R2      JSR ON1
0172  A4  03             LDY XTP
0174  A5  01             LDA SHORT
0176  20  8C 01          JSR DELAY
0179  20  09 01          JSR OFF1
017C  A9  0A             LDA #10
017E  38                 SEC
017F  E5  03             SBC XTP
0181  C9  00             CMP #0
0183  F0  06             BEQ RETN
0185  A8                 TAY
0186  A5  01             LDA SHORT
0188  20  8C 01          JSR DELAY
018B  60         RETN    RTS
                 ;SUBROUTINE TO DELAY Y-REG
                 ;TIME UNITS
018C  8D  A0 01  DELAY   STA TIME
018F  AD  A0 01  DELAY1  LDA TIME
0192  8D  06 17          STA C64D

0195  2C  07 17  D1      BIT SR
0198  10  FB             BPL D1
019A  88                 DEY
019B  C0  00             CPY #0
019D  D0  F0             BNE DELAY1
019F  60                 RTS
01A0             TIME    *=*+1

                 ;SUBROUTINE TO DECODE GRAY
                 ;CODE DISC TO CONSECUTIVE
                 ;BINARY 0TOF IN DISP+2
01A1  AD  02 17  CONVG   LDA DB
01A4  29  0F             AND #%00001111
01A6  AA                 TAX
01A7  BD  AD 01          LDA ZCODE,X
01AA  85  FB             STA DISP+2
01AC  60                 RTS
01AD      00     ZCODE   .BYTE 0,1,15,14,3,2
01AE      01
01AF      0F
01B0      0E
01B1      03
01B2      02
01B3      04             .BYTE 4,5,11,10,12
01B4      05
01B5      0B
01B6      0A
01B7      0C
01B8      0D             .BYTE 13,8,9,7,6
01B9      08
01BA      09
01BB      07
01BC      06
01BD
SECOND PASS FINISHED O.K.
SYMBOL TABLE
      50
DA       1700   DDA      1701
DB       1702   DDB      1703   SCANS    1F1F
DISP     00F9   GETKEY   1F6A   C64D     1706
SR       1707   SPEED    0000   SHORT    0001
LONG     0002   XTP      0003   SWITCH   0004
NEXTK    0007   G1       0014   G2       001E
G3       0028   G4       0032   G5       003C
G6       0046   G7       0050   MSR      005A
MSR1     005D   SPEEDR   0079   SPEED1   007C
S1       008D   S2       0097   GRAYT    009D
GRAYT1   00A0   ON1      0100   OFF1     0109
ON2      0112   OFF2     011B   ON3      0124
OFF3     012D   ON4      0136   OFF4     013F
INIT     0148   RATIO    0156   RATIO1   0158
R1       0160   R2       016F   RETN     018B
DELAY    018C   DELAY1   018F   D1       0195
TIME     01A0   CONVG    01A1   ZCODE    01AD
END OF ASSEMBLY

22.25.53-
```

Expansion boards from GEC

GEC SEMICONDUCTORS has announced a wide range of iSBC expansion boards for use with the new Intel 86/12 single-board computer, which will replace four standard minicomputer boards in a typical OEM system at about half the cost.

The boards include RAMs up to 64K bytes, ROMs up to 64K bytes, battery-powered RAM boards, PROM programmer boards, mini and standard disc controllers, video graphics, a range of analogue I/O boards, CRT/keyboard controller boards, relay output boards, isolated input boards, communications controllers and hard disc controllers.

The iSBC 86/12 uses the 8086 16-bit CPU which is designed to support high-level languages. It has a comprehensive instruction set, including multiply and divide in binary, BCD or ASCII. On-board memory includes 32K bytes of dual-port read/write memory and sockets for up to 16K bytes of ROM.

The dual-port feature allows the read/write memory to be accessed by both the 8086 CPU and any other bus master which shares the Multibus with the iSBC 86/12. Using the expansion cards, the memory can be increased to one megabyte.

Programmable parallel I/O on the boards extends to 24 lines, which can be configured as the application demands. Sockets are available to accommodate standard line drivers and receivers.

COMPANY	SYSTEM	APPLICATION	PRICE RANGE
AIRAMCO LTD 30 Witches Linn, Ardrossan, Ayrshire KA22 8BR 0294 65530	**SDS 100.** Single unit containing 32K memory (expandable to 64K); up to 8K PROM; twin double-sided floppy disc drives of 500K bytes each; serial and parallel RS232 interfacing; keyboard; 12 in. video display; power supplies; SD monitor program: line printer available.	Software: 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 available.	From £3,750 (basic machine) £890 (printer) £4,500 combined
CALDERBROOK TECHNICAL SERVICES (CTS) 1 Higher Calderbrook Littleborough, Lancs 0706 79332	**Ohio Superboard II** (computer on a board), Min. size: 6502 processor. 8K BASIC in ROM; 2K monitor in ROM; 4K RAM; Cassette I/F; full keyboard; 32 × 32 video I/F; controller for two floppies.	8K BASIC in ROM; Assembler/Editor; Games, personal, maths tutors, and business programs. American system aimed at hobbyist/small business.	£275–1,100
	Challenger II 4P (professional portable), similar to Superboard but supplied as two separate boards with open slots for expansion.	Similar to Superboard. Aimed at small business, education, research.	£595–1,500
	Challenger II 8P (personal computer), similar to 4P but expandable to include 2 × 8 floppies, multiple line printers, 74 MB hard disc, multiple terminals.	Similar to 4P but larger business/commercial programs. Aimed at small business with requirement for large storage and multiple users. Also education and research.	£800–7,500
COMART PO Box 2, St Neots, Cambridgeshire 0480 215005	**Microbox,** Min. size: Chassis with three sockets. Max. size: Chassis with six sockets.	Aimed mainly at OEM industrial users and perhaps the serious hobbyist. Manufactured in Britain by Comart, it will take Cromemco, North Star and other processors and software.	£70–£195
	Cromemco System Two, Min size: Processor alone with six sockets in kit form. Max size: 21 sockets; 512K of memory; up to three mini-diskettes of 90K bytes each.	Software: Extended Basic; Fortran IV; Cobol; Macro-assembler; Word-processing, DBMS. American system suggested for systems development.	£395 to around £5,000
	Dynabyte, Memory board for any S100 bus system. Available in 16-32K units.		£275–695
	Cromemco System Three, Min size: 32K memory; terminal and printer interface; dual 250K-byte IBM-compatible floppy discs. Max size: 128K memory; two–three terminals.	Software: Same as System Two. Suitable for a wide range of commercial and scientific applications. Theoretical maximum of 512K of memory.	£4,174–£10,000-plus
	Horizon, Min size: 16K memory; serial interface; one mini-diskette drive with 90K bytes; power supply. Max size: 48K memory; three diskettes; hardware floating point board.	Software: Extended Basic; disc operating system; monitor; access to CP/M range. Manufactured by North Star Computers of the U.S. Aimed at educational and small business users.	£995–£3,500
	SOL 20/16, Min size: 16K memory; integral keyboard and monitor; serial and parallel interface; cassette unit. Max size: 64K memory; up to 1MB disc capacity.	Software: Extended Basic; Fortran; Focal; Assembler; Editor; Games. Another American system from Processor Technology Corp aimed at the small business and education markets.	£1,785–£5,000-plus
COMMODORE SYSTEMS DIVISION London NW1 01-388 5702	**PET,** Single unit containing screen, tape cassette and keyboard. Memory is expandable from 8–32K.	Software: Basic; Games; Business packages. The British subsidiary of Commodore Systems of the U.S. sells Pet for home, educational and small business applications.	From £695
	Kim 1, Min size: Processor (6502 chip); small calculator-type keyboard; LED six-digit display; built-in interfaces for audio-cassette and Teletype; 1K RAM; 2K ROM. Max size: Can add: Kim 4 motherboard; Kim 3B 8K RAM (up to 64K); Kim 5 resident assembler.	Software: None available yet, but it has three good manuals. An American import which gives Pet-type capabilities with a maximum configuration. For the hobbyist but used mainly as an evaluation board for the 6502 chip. There are two dealers, GR Electronics and J Marshall, which offer further facilities.	£129–£600 (+VAT)
COMP Computer Components 14 Station Road, New Barnet, Herts. 01-441 2922	**EXIDY Sorcerer** based on Z-80. Typical size: 12K ROM, 32K RAM; cartridge and cassette I/F; 79-key keyboard; 256 character set (128 graphics symbols); 12 in video monitor; expandable with Micropolis floppy discs.	Software: standard Basic Assembler and Editor Fortran and Cobol; word processor; games and other pre-packaged programs.	From £950
COMPELEC 14/15 Berners Street, London W1 01-580 6296	**Altair System 1300,** Min size: 32K memory; dual minifloppy discs, 71K bytes each formatted; serial Interface. Max size: 64K memory; 4 serial ports.	Software: Basic (single and multi-user); Fortran; Cobol. The hardware for the Altair systems is from Pertec in the States, but the software is Anglo-Dutch.	£3,000–£5,500

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COMPANY	SYSTEM	APPLICATIONS	PRICE RANGE
COMPELEC (continued)	**Altair System 70,** Min size: 33K memory; dual floppy discs, 300K bytes each. Max size: 64K memory; provision for up to 8 VDUs.	Software: Single and multi-user Basic; Fortran; Cobol; APL. Aimed exclusively at business applications; packages are available for general and sales and purchase ledger, payroll, word processing, stock control, estate agency, hotel or small airline reservations, transport management and freight costing. A point-of-sale package will soon be ready.	£4,500 to £10,000-plus
	Altair System 300, Typical size: 64K memory; 10MB disc drive; turnkey processor; VDU; Qume daisywheel printer and disc unit.	Software: Single-user Basic; Fortran; Cobol. The same packages as for the System 70 are available for this top-end-of-the-market, business-orientated system. Compelec has its own office in Birmingham, but a full distributor network is being set up.	£10,000-plus
COMPUTERBITS LTD 40 Vincent Street, Yeovil, Somerset 0935 26522	**System 8,** Typical size: 64K memory; 1MB disc storage; serial I/O port for VDU; parallel port to printer; CP/M operating system.	Software: Basic; Pascal; Fortran. This British-manufactured microcomputer system is almost exclusively for business applications.	£3,000–£5,000
COMPUTER MART LTD 38 St Faiths Lane, Norwich. 0603 615089	**VDP-80,** Typical size: Single desk-top unit housing a 12 in. display, dual standard floppy disc drive, processor, power units, cooling system and fully-programmable keyboard containing 62 alphanumeric, 12 numeric and 12 cursor controls in separate keypads. Normally sold with 32K memory and 1.2M bytes of disc storage but may be expanded.	Software: Included in the price is a sophisticated operating system with Commercial Basic. A range of commercial application packages is available, including word processing if required.	£9,500
COMPUTER WORKSHOP 38 Dover Street, London W1 01-491 7507	**System 1,** Typical size: 40K memory; dual 8 in. floppy discs, total storage capacity 1·2MB; Ricoh daisywheel printer. **System 2,** Typical size: 24K memory; dual minifloppy discs of 80K bytes each; Centronics 779 dot matrix printer; VDU. **System 3,** 12K memory; cassette interface; 40-column dot matrix printer.	Software: Range of Editors, Assemblers, Basics and Games; Information retrieval package. These systems were designed and built in Peterborough and are suitable for educational, small business users and perhaps the more serious hobbyist. There is a large number of dealers around the country.	System 1—£5,000-plus; System 2—around £3,000; System 3—from £1,350
EQUINOX COMPUTER SYSTEMS LTD 32–35 Featherstone Street, London EC1Y 8QX 01-253 3781/9837	**Horizon,** Min size: 16K memory; Z80A processor; single minifloppy disc drive (180KB). Max size: 56K memory, four minifloppy disc drives (180KB), any acceptable S100 peripheral boards.	Software: Standard—Basic Interpreter (includes random and sequential access), disc operating system and monitor; Options—Basic Compiler, Fortran, Cobol, and Pilot. The system is suitable for commercial, educational and scientific applications. Application software for general commercial users.	£1,000–around £2,500
	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.	Software: Basic, Lisp, Pascal, Macro Assembler, Text Editor and Processor. All software is bundled. The system is a multi-user, multi-tasking, time-sharing system for 2–12 users. Application software is available for general commercial users.	£5,000–£40,000-plus
MICRONICS 1 Station Road, Twickenham, Middlesex 01-892 7044	**Micros,** Typical size: 1K monitor; 47-key solid state keyboard; interfaces for video, cassette, printer and UHF TV; serial I/Os; dual parallel I/O ports; 2K RAM; power supply.	Software: Extended Basic; Pascal. A British-designed and manufactured system which is being enhanced rapidly. Already available are a 40-column impact printer using plain paper, at £360; what is claimed to be the cheapest data terminal around—a system with an acoustic coupler and VDU for £1,020. Prospective applications: small businesses, process controllers and hobbyists.	From £400, assembled
NASCOM MICROCOMPUTERS 92 Broad Street, Chesham, Buckinghamshire 02405 75151	**Nascom 1,** Min size: CPU; 2K memory parallel I/O; serial data interface; 1K monitor in EPROM. Max size: CPU; 64K memory; up to 16 parallel I/O ports.	Software: Mostly games, but a maths package is on its way. The British-manufactured system started as a hobbyists' package but has found an increasing number of industrial users. Printer and minifloppy interfaces are in preparation. There are about two dozen dealers around the country.	From £165 plus VAT
NEWBEAR COMPUTING STORE 7 Bone Lane, Newbury, Berkshire and 2 Gatley Road, Cheadle, Cheshire 0635 49223	**Sym 1,** Size: 6502 chip and keypad, with memory available in 4K blocks to 64K.	Software: Any Kim software. An American system meant to be the foundation for very small business and hobbyist users.	From £200
	7768, Size: CPU board; 4K memory; cassette and VDU interfaces.	Software: Range of Basics and Games. A British-manufactured system for hobbyists. Expandable to 64K memory, it is available only in kit form.	
	Cromemco Z2, Min size: Z2 chassis: power supply; motherboard; CPU; fan; sockets; byte saver board; 16K memory. Max size: 48–64K memory; dual 8 in. floppy discs.	Software: Basic, Fortran; Assembler; macro assembler. For small business and educational applications. These systems are also supplied to more than a dozen dealers. Same basic system as Comart.	£1,375 to £4,000

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THE NEW HORIZON

The microcomputer for those who need more than the minimum. The right processor for business, scientific and educational use. Proven applications include Games • Educational • Word Processing • Invoicing • Stock Control • Sales Ledger • Purchase Ledger • Mailing • Scientific.

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Powerful Basic including sequential and random access disc files • formatted output • strings • line editor • machine language CALL • many other facilities. Optional additional software (under CP/M operating system) includes BASIC compiler, FORTRAN and COBOL.

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

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32-35 Featherstone Street,
London EC1Y 8QX.
Tel: 01-253 3781/9837.

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

LONDON
Eurocalc Ltd., 55/56 High Holborn, London. W.C.1. (Tel: 01-405-3113).
Lion House Microcomputers, 227 Tottenham Ct. Road, London. W.1. (Tel: 01-580-7383).
Sumlock Bondain Ltd., 15 Clerkenwell Close, London, EC1R 0AA. (Tel: 01-2532447).

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

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

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

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

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

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

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

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

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

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

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

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32-35 FEATHERSTONE STREET
LONDON EC1Y 8QX
01-253 3781/9837

● Circle No. 220

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COMPANY	SYSTEM	APPLICATIONS	PRICE RANGE
PERSONAL COMPUTERS LTD 194 Bishopsgate, London EC2 01-283 3391	**Apple II,** Min size: 16K memory; 8K ROM; keyboard; monitors; mini-assembler: colourgraphics; Powell card; RF modulator; Games; paddles and speaker; 4 demo cassettes. Max size: Expandable to 48K memory, and floppy discs and printers are now available.	Software: Basic; Assembler; Games; Business packages. An American system regarded as suitable for any kind of applications. There are 15 dealers throughout the country and maintenance contracts are offered.	£1,000–£2,000
RAIR 30–32 Neal Street, London WC2 01-836 4663	**RAIR Black Box,** Min size: 32K memory; dual minifloppy discs, 80K bytes each; two programmable serial I/O interfaces. Max size: 64K memory; 8 serial interfaces; 1MB disc storage (or 10MB hard disc); range of peripherals.	Software: Advanced Basic interpreter, Fortran IV compiler; Cobol compiler. Described by the makers as the only 'sensible' British-designed and manufactured microcomputer, its uses are small business and educational applications and in distributed processing networks. Hardware distributors are being signed and agreements made with software houses to add software. It is not for the hobbyists. A warranty and U.K.-wide on-site maintenance is given.	£2,300–£8,000
RESEARCH MACHINES LTD PO Box 75, 209 Cowley Road, Oxford 0865 49793	**Research Machines 380Z,** Min size: 4K memory; 380Z processor; keyboard. Max size: 48K memory. **280Z,** 4K board plus connecting cables, £398. 32K board—identical in performance to the 380Z: £722.	Software: Basic Interpreter; 12K Basic; Assembler. A British system using CP/M software; delivery times are about 6 weeks at the moment. A minifloppy disc system is on trial. Sintel is the sole distributor.	From £830
SCIENCE OF CAMBRIDGE 6 Kings Parade, Cambridge 0223 312919	**MK 14,** Min size: 8060 SC/MP; ½K user memory; ½K PROM with monitor program; Hex keyboard and 8-digit, seven-segment display; interface circuitry; 5v regulator on board. To this can be added: ½K RAM (£3·60); 16 I/O chip (£7·80); cassette interface kit (£5·95); cassette interface and replacement monitor (£7·95); PROM programmer (£9·95).	Software: None 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. Half of sales are to hobbyists, half to engineers.	Basic price is £39·95. All prices are exclusive of VAT
STRUMECH ENGINEERING ELECTRONICS DIVISION (SEED) Portland Place, Coppice Side, Brownhills, Walsall, Staffordshire 05433 4321	**MSI 6800,** Min size: 6K memory; Act I terminal (keyboard); cassette interface. Max size: Three disc systems are offered: Minifloppy disc system with triple drives of 80 bytes each and 32K memory. Large floppy system with dual 312K-byte capacity disc and 32K of memory. Hard disc system with 10MB, five fixed, five removable, and 56K.	Software: Basic interpreter and compiler; super editor assembler; text processor on small disc system. This is an American-designed system which is being manufactured increasingly in U.K. A SEED survey of its sales showed 60% of the customers were educational establishments, a further 10% research institutes, 10% hobbyists and the rest commercial companies. A distributor network is being set up.	Basic system is £1,100 (£815 as kit); Minidisc—£2,500; large floppy disc £3,200; hard disc £8,000-plus
TANDY CORPORATION Bilston Road, Wednesbury, West Midlands 021-556 6101	**TRS-80,** Min size: Level 1 4K memory; video monitor; cassette; power supply. Max size: Level 2 16K memory; line printer, floppy disc system.	Software: Basic; some business packages. An American system from the 200-outlet Tandy chain—The Level 1 is aimed at the hobbyist and education market and Level 2 at small business applications.	Level 1—£499; Level 2—£2,434
U-MICROCOMPUTERS PO Box, 24, Northwich, Cheshire 0606 75627	**Challenger 1.** Min. size: 4K RAM, 8K Basic in ROM, keyboard, video and cassette I/F. Max size: 32K memory, printers, voice I/O, dual mini floppies, modem. Based on Ohio Superboard II.	Fast Basic in ROM with wide range of business, personal, games and educational software on cassette or mini-disc.	From £300. Single mini-floppy system about £1,400.
	Challenger 2. Min-size: (C2–4P) 4K RAM, 8K Basic in ROM, two slots for expansion (C2–8P has six slots for expansion). Max size: 36K RAM, mini-floppies, full-size floppies, hard disc (74MB), printers.	Similar to Challenger 1.	From £700.
	Challenger 3, Min. size: 32K RAM, dual mini-floppies, triple processor architecture (6502A, Z-80, 6800). Max size: 768K RAM, 74MB hard disc, multiple terminals, printers.	Can run virtually all 6502, 6800, 8080 and Z-80 code. With CP/M, languages Basic, Fortran, Cobol can be run. Full business software packages available including word processing and database management. Multi-programming available.	From £3,550 (C3 OEM) to £10,000 plus (C3 B with 74MB disc).

We are anxious to keep the guide as up-to-date as possible. If you manufacture or import a computer, and you are not included, contact the Editor on 01-207 3111.

A PRACTICAL GLOSSARY

Continuing the terminological gamut from G to H

Graphics

Any output which is not alphanumeric; more specifically, the term refers to pictorial symbols and representation built from them. There's much to be said for using graphics as much as you can, largely on the 'picture being worth a thousand words' principle. That applies as much to the design of a screenful of information (try arranging information as organised blocks of copy to make it more meaningful) as it does to creating charts and pictures (lunar lander games gain from the inclusion of a lunar module about to hit the surface; seeing a string of changing figures labelled 'height' simply isn't the same).

Many personal computers have graphics built in, and for others there are several option boards which provide graphics, especially if you have a micro using the S100 bus.

Hard-copy output in graph form can be done by some printers—it looks a bit jerky if you're doing curves, though, because the print-head cannot move in fine enough increments. A graph *plotter* can do those really small movements, and they tend to use ink-filled pens to draw a continuous line; the printers tend to do it as a string of dots. Plotters aren't cheap, however, though there is at least one U.S. plotter below the $1,000 mark. Can't you do without graphical hard-copy?

Half-duplex

Refers to a communications link in which data may travel in both directions along the connected line, but not at the same time. See *full duplex* for an equally interesting definition using slightly different words.

You'll probably encounter the full-or half-duplex question only as a user of a computer terminal, and generally you don't have much say in the matter—your terminal will probably have a switch marked FULL/HALF or FDX/HDX and if it isn't set appropriately you won't be able to talk to the computer.

Halt

An instruction or internally-generated condition which switches the computer out of the 'run' mode in which it was executing a program. The computer dosen't lose its place, though—it HALTS, remembering which line of the program is due to be executed next.

HALT is used usually in program development; you can set the computer cleverly to detect mistakes, for instance, and cause it to suspend operation temporarily to allow you to do something about it. The HALT state frequently gives the user the chance to set and re-set internal conditions from the keyboard, so that when you re-start the program it continues executing but with slightly altered conditions.

Handler

A device (or peripheral) handler is alternatively called a *driver*: it's a bit of a program (usually a bit of the *operating system*, in fact) which communicates with and generally controls one of your system's peripherals. The handler for the keyboard, for instance, will detect what you mean when you depress a particular key; and it will pass on that information to the central processor for some action.

Handshake

What you get from writing too many glossary definitions too quickly. Alternatively, it's a term which refers to communication between two parts of a system, typically a terminal and the central processor. It means that the receiving end is confirming that it has, in fact, received something. It's a pleasantly graphic term, isn't it? Still, it is a bit heavy; you can now forget it.

Hard copy

Hard copy is computer output on paper, printing or graphics. You may hear the term 'hard-copy printer': that is tautology, since all printers, of course, produce hard copy. It is called 'hard' to indicate a degree of tangibility; 'soft copy' is what appears on a VDU screen.

Hard-sectored

Data is stored on disc in *tracks*, concentric rings around the spindle. So if you know which track a piece of data is on, you have to get the read/head on to that track and read around it until you reach the data; you don't have to read the whole disc looking for it.

Sectoring speeds the process even more. Discs are also organised into *sectors*, which are wedges rather like slices of cake. So each track is split effectively into a number of sectors; and if you can identify the location of data by track *and* sector, the read/write head can be directed to the start of the sector on the particular track, and it doesn't have to read round the whole track looking for the data.

Tracks are fixed on the disc by the factory. On some disc systems sectors are, too; the start of a sector is actually defined by a hole punched in the disc surface. That's hard-sectoring.

Hardware

Hardware is the physical side of computing, the equipment and physical components. Software is the paperwork, the programs, even the idea involved in programming. The third element is *data*, operated upon by software within hardware.

We've said this before but the dividing line starts to blur if you do not make a distinction between programs and media. So here's your starter for ten—is a programmed read-only memory software or hardware? How about a floppy disc? The PROM is an IC chip, so it's hardware. In practice, it might be more useful to think of it as software. Some people have tried to call hardware-implementation programs 'middleware'.

The semantics are not really worth bothering about too much, so long as you know what you mean when you use the terms.

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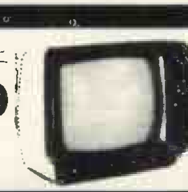

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