# Practical Computing

50p

December 1979
Volume 2 Issue 12

## Artificial Intelligence
## Cell Scanning

## Eurapple v. ITT 2020

## Triton Review

## Self-testing micro


# MicroCentre are the UK Cromemco experts

Sample catalogue prices:

| | |
|---|---|
| *System Two computer | 1995 |
| *System Three computer | 3293 |
| *Z-2H computer | 4998 |
| Extra 64K memory | 893 |
| 3101 visual display unit | 1147 |
| 3355 daisywheel printer | 2297 |
| HDD 11-mbytes hard disc | 4022 |
| ANSI Cobol compiler | 55 |
| ANSI Fortran IV compiler | 55 |
| 16K extended Basic | 55 |
| Word processing system | 55 |
| Database management | 55 |
| Macro relocating assembler | 55 |

Prices exclude VAT and delivery

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132 St. Stephen Street,
Edinburgh EH3 5AA.
Tel: 031-225 2022.

*Photo features Cromemco System 3 computer, 3101 VDU, and 3355 daisywheel printer.*

● Circle No. 101

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*CP/M is a trade name of Digital Research
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EFFECTIVE 1 OCTOBER 1979

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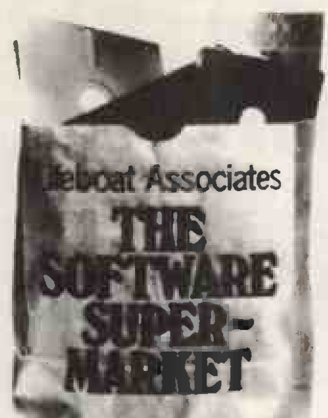


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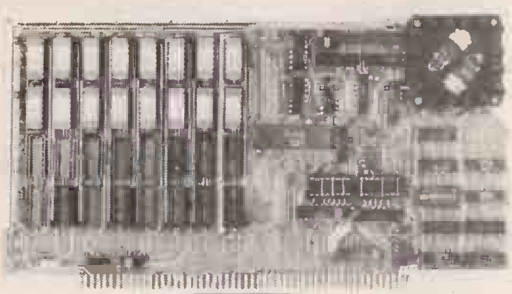
☐ All boards and Systems are supplied assembled and tested.



Central Data

## New RAM Prices.
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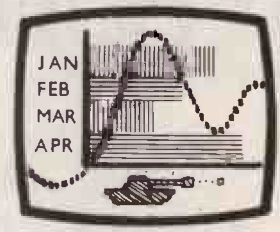


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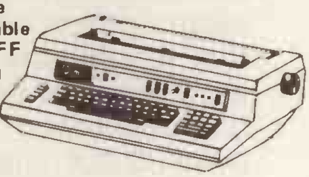

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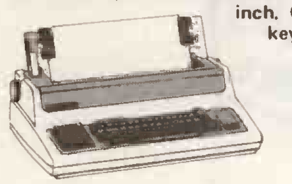

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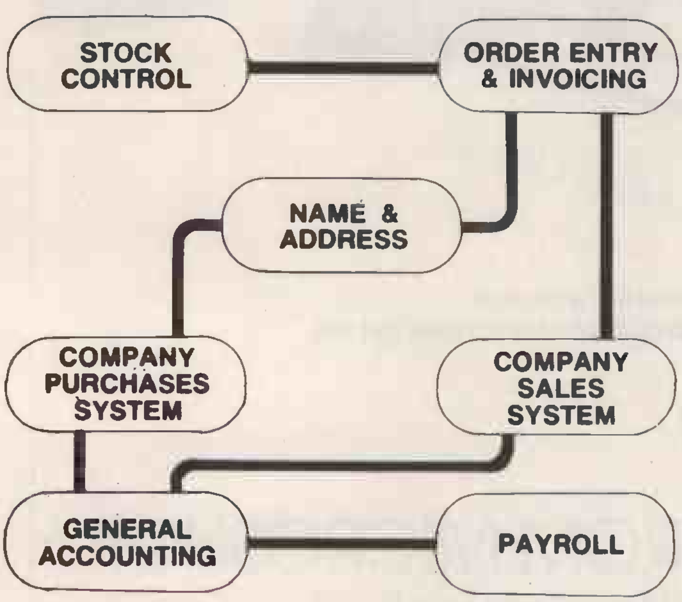


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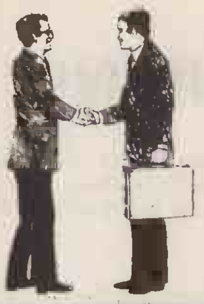

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# * News from ROSTRONICS *

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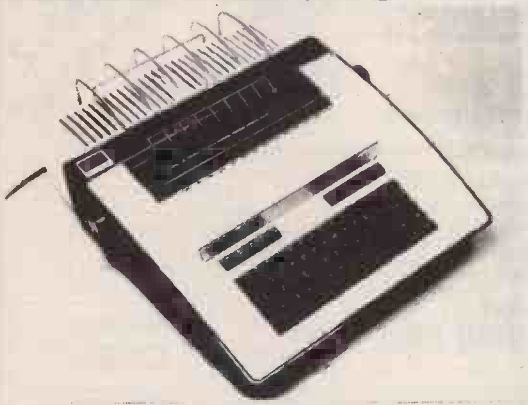

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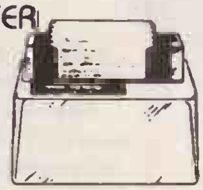

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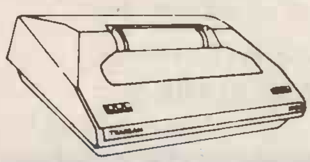

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| 7912 | 1 10 |
| 7915 | 1 10 |
| 7924 | 1 10 |
| 7905K | 1 80 |

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|---|---|
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| 7915K | 1 50 |
| 7924K | 1 80 |
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| 14DIL | 0 15 |
| 16DIL | 0 17 |
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## TRITON DOCUMENTATION

available separately as follows, prices include p & p

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| Triton manual — detailed circuit description and constructional details + user documentation on level 4.1 monitor & basic | £5.70 |
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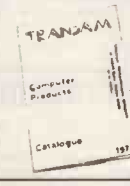

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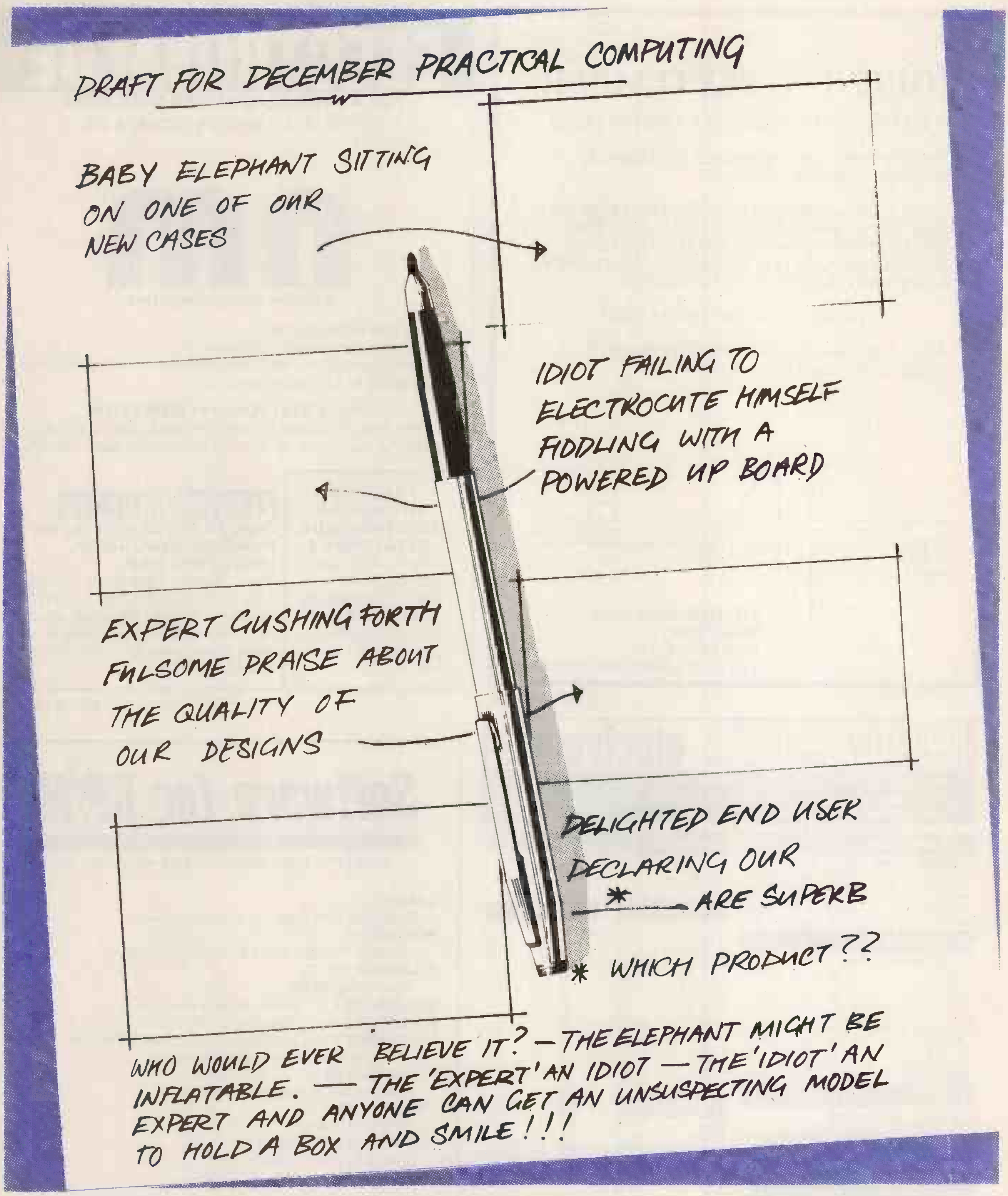




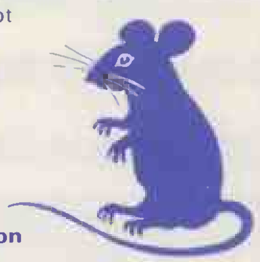

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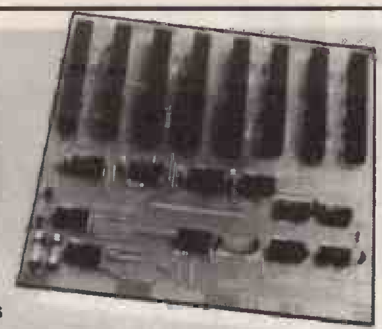

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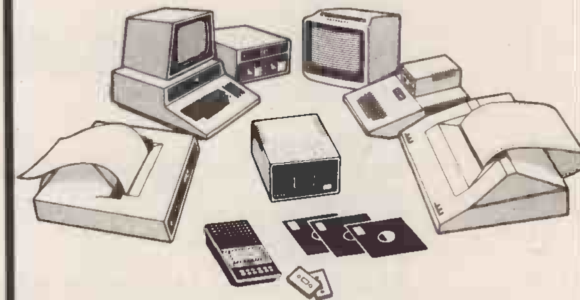

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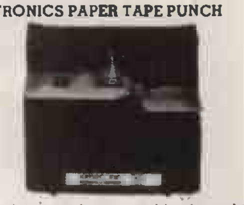

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• Circle No. 176

# A crowd of peasants with clogs

THROUGHOUT recorded time there has been no man more disliked than the inventor of new ways of doing things. Old ways might not be brilliant, citizens of the more solid kind tend to say, but they work. New ways could be disastrous. So, when the young say, "Dad, why don't we . . . ?", those citizens sigh.

For some reason this almost immutable law of nature has been suspended over the last 200 years. So frayed has it now become that people advertise themselves as 'innovative', a term which in more conservative periods would have right-thinking persons looking for six feet of stout rope and a convenient branch.

No-one has more immunity from this natural law than computer people. Although the advantages of data processing are very real in business, banking, insurance and the distributive trades, they are more advertised than perceptible to the man in the street.

So far, if anything, computers have been a nuisance. Now, the microchip revolution promises to make them a menace. The immunity the computing profession has enjoyed for 20 years from serious public criticism may well be about to end. As is foreshadowed in the title of this piece, a crowd of peasants with clogs is gathering with a glint in their collective eyes.

The first protagonists of computers could see very clearly that such machines would, potentially, abolish almost all jobs which require a modest amount of routine skill. That it has taken almost 40 years to make this foreboding come true is a testimony to the amount of skill needed for even the simplest-looking job. Now, that bastion is crumbling. Advances in software and the rapid growth of computing power on chips threaten a large number of jobs by the end of the next decade.

It is odd that people outside computing can visualise it much more clearly than those inside. If you say to the majority of computing professionals that the chip may destroy life as we know it, they smile pityingly and say that, on the contrary, the spread of automation will increase jobs.

In the short term, they are correct. It is all very much harder work than people outside can guess, but in the long term the professionals are wrong and the lay persons are right, because the effects multiply each other. If anyone who knows something of computing were asked, say, to automate an office, he would decline because he knows the vast amount of work needed on word processing, storage, communication, display.

That reaction over-states the difficulties. The new armies are converging on the office from a dozen different directions. Yearly, huge advances are made in data storage and retrieval. Advances are being made in providing digital exchanges, satellites, high-speed cables. Display devices are improving vastly. Thousands of people are at work on graphics and linguistics, on intelligent databases and printers.

All those advances are like rival guerilla bands creeping-up on an enemy strongpoint, under cover, up separate valleys from separate directions. You could stand on the ramparts of the threatened fort and see only a wisp of smoke from a camp fire on the horizon. The fullness of the threat is known to no single person because the simultaneous assaults are being made by autonomous bands who may well be almost unaware of each other's existence. Yet, one day, they will all meet at 'Fort Office' and abolish it.

The peasants quietly tilling the fields around the protective castle know that the woods are full of bandits. The bandits know only how small is their band and how far they have to go. The peasants are correct when they slip off their clogs and hold them by the heel, when they pick up rocks from the fields and look around for a target.

The campaign is not fought in one fell swoop. It has already started. One of the first bands of peasantry to take the threat seriously was the ASTMS — Association of Scientific Technical and Managerial Staffs — whose members, one might suppose, to be towards the forefront of the threat.

The union's argument is simple. The days when fears of unemployment caused by computing could be discounted have definitely vanished. The lengthy and dispassionate discussion document — Technological Change Employment and the Need for Collective Bargaining — gives many examples of employment erased by automation.

Phillips expects to have to reduce its near half-million workforce by a half in 10 years. Western Electric, the main American supplier of telephone exchanges, expects to reduce its labour from 39.000 in 1970 to 17,400 in 1980. As many as 128,000 workers in the U.S. car industry will lose their jobs by 1985. The Japanese Methodology for Unmanned Manufacture factory could use a control crew of 10 to do the work of 700. Although British industry lags behind, and perhaps just as well in many ways, examples are quoted from the insurance industry of staff savings between 30 and 70 percent.

Some industries are so mechanised already that they cannot be automated — for instance, farming. Yet there is little doubt that the ASTMS predictions of 3.8 million people unemployed in Britain by 1985 and 5.2 million by 1991 are of the right sort of magnitude.

Many of the promised benefits of the chip can only be good. The abolition of dirty, dangerous and, above all, boring work must be an advance for civilisation. The difficulty is the speed with which change happens. A generation of workers lasts 40 years. In that time an industry can disappear and another take its place without too much strain. Perhaps, if society made a determined effort, we could cope with major change over 20 years. If, by some malign miracle, all the wonders the chip promises were installed by the end of next week, the effect would be worse than World War III.

What compounds our problems is that we are competing with societies which take a much tougher line about social disruption. In some countries, if a factory automates half its workers out of a job, they are invited to leave, and if they try to return with sabots in their hands, intending to deal with the offending machinery in the time-honoured way, the army will stop them — dead, if necessary.

In Britain, we are used to a much gentler level of industrial strife. We opt almost automatically for the soft solution, for industrial inefficiency rather than para-military riot police and barbed wire in the streets.

It is one of Britain's admired assets. It is difficult to see how we can retain it while automating our production industry to compete with tougher and cheaper nations. Rather, we should adopt a higher strategy. We should tolerate a level of industrial inefficiency in our manufacture to make the transition easier, while concentrating our efforts on the crucial technology.

The American system has proved to be a great success in creating hardware. Computing power is no longer a problem; the IBM 370 on a chip is a realistic target by 1990. The problem now is software, the skill to blend that computing power with the incredibly complex traditions of politics, business, language, in living societies. There the Americans may be at a disadvantage, and the Europeans, with our older and subtler social skills, find ourselves to the fore.

There are certainly huge opportunities, particularly, one would imagine, for the kind of people who read this magazine but let us be warned by ASTMS that the peasants are gathering, watching, weighing their sabots in their hands. We must all be very careful.

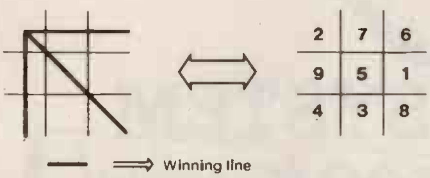
**Our Feedback columns offer readers the opportunity of bringing their computing experience and problems to the attention of others, as well as to seek our advice or to make suggestions, which we are always happy to receive. Make sure you use Feedback—it is your chance to keep in touch.**

## Magic square

MY "PROCESSOR" is a humble TI 59 calculator — I don't have a printer — and the noughts and crosses programs are beyond its capacity. About two years ago, soon after I bought the calculator, I decided to try to create a noughts and crosses program. The key to this I found in a simple mathematical model for the game. I have no way of knowing whether this is an original idea.

Thinking of the game I realised its structure and winning forms corresponded exactly to a 3 x 3 "magic" square. As shown, I chose a square using the numbers one to nine.

The winning lines all add up to 15. So I




program the calculator to search for lines adding up to 15 and to block any moves of its opponents.

So far I have programmed the calculator to play first. The first few moves are rather predictable, of course, and I have programmed it to start on the centre square — the calculator displays 5 for this. My move is made by keying-in the number corresponding to the particular square in which I wish to put my 0. I have biased the second move — for the calculator — for the corners, which you will notice are all even numbers, a property which is useful later in the program.

Although the first few moves are somewhat boring, once the game develops the calculator searches for numbers needed to make its stored moves up to the "magic" 15. If this is not possible it blocks its opponent's move. You must always be careful that the move the calculator produces has not already occurred, of course.

I won't go into all the details of my program, but using this basis I expect sophisticated programs may be produced for many types of processor.

I believe that this type of program has important lessons for those in the Artificial Intelligence field. To start, it uses patterns which are already part of the calculator logic — the numbers 1 to 9, simple addition, subtraction and comparison. The human brain, emulation of which is the goal, has its own parameters, but many of them are visual patterns which a computer cannot understand without digitisation and interpretation.

In this noughts and crosses program, I have replaced the visual pattern of a line with the numerical pattern, those numbers adding to 15.

Possibly more work should be done into defining rigidly what basic patterns the brain uses. When they are found, the search for mathematical substitutes should begin, thus enabling a machine to "think" like a human.

Although I know very little about the study of the operation of the mind, I think that the basic patterns found will be mostly visual, like the line idea in noughts and crosses. it was Einstein who said he thought in pictures and I believe it will be shown that we all do. For the human brain, the number is the abstraction for the computer, the visual must be.

**Baldur Van Lew,**
**Newtownards,**
**Co. Down.**

## Apple discs

YOU MALIGN the Apple II DOS 3.2 in your October review; there is no problem with multi-file access. The misconception is that PRINT Ð "WRITEFILENAME" should be associated with PRINT Ð "OPENFILENAME" in the program sequence. Rather, it should be placed immediately before the INPUT or PRINT statements which read or write a line or record.

It is advisable to follow the statements by PRINT DS. In this way any number of files may be referenced and interleaved with keyboard input, screen printing, hard copy printing. DOS ensures that only the logically necessary physical reads and writes are performed.

The following programe will write records consisting of single strings to files A and B. Each file is deemed to contain no more than 101 records of length 10 bytes. The keyboard input determines which file and which record each string is written to.

**John Kilpatrick,**
**Sheffield.**

```
10 D$ =  CHR$ (4)
20  PRINT D$"OPENA,L10"
30  PRINT D$"OPENB,L10"
40  REM  KEYBOARD INPUT
50  INPUT "FILE A OR B? ";F$: IF F$ < "A" OR F$ > "B" GOTO 200
60  INPUT "RECORD NO.? ";R: IF R < 0 OR R > 100 GOTO 200
70  INPUT "TEXT? ";A$: IF  LEN (A$) > 9 GOTO 200
100  PRINT D$"WRITE"F$",R"R: REM  SWITCH ON WRITE-TO-FILE & STATE RECORD N
     O.
110  PRINT A$: REM  WRITE RECORD
120  PRINT D$: REM  SWITCH OFF WRITE-TO-FILE
130  GOTO 40
200  PRINT D$"CLOSE"
```

## Happy customer

FEEDBACK is on occasions critical of suppliers. Perhaps my experience is more typical but of the kind which does not usually inspire a letter.

I ordered a Superboard II by telephone on a Friday, asking for it to be modified to 50Hz standard, fitted with modulator, and supplied with a power pack. It was delivered personally the following Wednesday and the proprietor of the firm spent some two hours checking that it worked in all modes, and fixing a fault on my cassette recorder — dirty heads. Because the company was out of stock of power packs, I have a very expensive-looking one on loan from the service department.

Having made a tape of a Starwars game for my 12-year-old, the supplier insisted that I telephoned if I had any problems. He then explained that the price had gone down since I placed my order, so the bill was less than I had anticipated.

My thanks to CTS of Littleborough, and to *Practical Computing* Shopwindow, where I saw the advertisement.

As far as the Superboard is concerned, I have found the problems in your review are almost irrelevant. I can't see why I should want to dump at less than full screen width. CTS supplies a subroutine to get round the problem anyway. I can debug happily with a few stop statements.

I'm no enthusiast for machine code when I have 8K of Basic. I am still astounded at how easy and versatile it is to use, and at the price I can not see any competition.

**John Freeman,**
**Stockport.**

## Birth problems

I AM SURPRISED that there were no comments in your October issue on John Dodridge's program (Tandy forum, September) presenting a programming solution to the "Birthday problem".

While Dodridge's program is neat and elegant, it indicates one reason why software producers are so often criticised — it produces the correct answer to the wrong problem.

This is because the problem is badly-

*(continued on page 55)*

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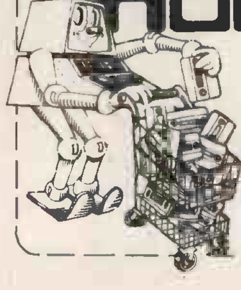

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*(continued from page 53)*

formulated. The program solves the problem for the situation where we are seeking to calculate the probability of at least two people having the same birthday — excluding the year of birth — not the probability of two people having the same birthday.

In probability theory, the word "two" means "exactly two", not "at least two". The logic of the difference between the two formulations, and its effect upon the mathematics of the problem, can be found in most standard tests on probability theory.

Additionally, the assumptions made in the solution should be made explicit. Thus, it is important to state that it is assumed that there are no seasonal fluctuations in the birth pattern. It would also have been better to use the term 'birthday' rather than "birth date". The latter is an unusual expression which implies the inclusion of the year of birth — which is specifically excluded from the problem — whereas the former more often than not excludes the year of birth.

**Clive Loveluck, Director,**
**Ulster Management Centre,**
**Co. Antrim.**

## Time to blush

THE BENEFITS I've received from my subscription to *Practical Computing* have been more tangible than enjoyable reading. Your reviews of small systems on the market are generally packed with useful information, and were a great help to me when I decided to buy a microcomputer. It was a simple matter to peruse all your back issues to decide which system suited my needs. Perhaps the way I purchased the system would interest you.

Having decided to buy a TRS-80, I found that the price in Israel of a system with Level II Basic and 16K RAM was about twice the price of the same system in England, or roughly three and a half times the price in the States. So I decided to import a system privately from the States. That is when the fun began.

Knowing next to nothing about electronics, it was an unpleasant surprise to find that I could not use the system in Israel, because of the difference in line frequencies — in Israel (as in England) the frequency is 50Hz, as opposed to 60Hz in the States. Radio Shack sells only 60Hz VDU monitors outside the States, and even buy buying a system in England and thereby paying double import duties — British and Israeli — I would still have saved several hundred dollars on the local price.

Not wanting to waste my limited budget on unnecessary taxes, I decided to buy only the keyboard in the States with Level II Basic and 4K, which cost me $450, a 16K upgrade kit for $100 — not from Radio Shack — and a UHF modulator and 220V power supply in England.

Taxes here on microcomputers were abut 50 percent, and, after all the expenses, I paid roughly half the local price. To cure the slight "video shakes" caused by using 60Hz equipment with a 50Hz TV, I intend performing either the minor surgery described in September's Tandy forum, or to buy the modification from Comp Computer Components for £7.50.

The point I am making is that contrary to what the importers would have us believe, American equipment will often run on European current with slight — often very slight — modification. So it is possible frequently to save money if you are willing to do the importing yourself. Even with the lower taxes in England, the system I bought would still cost about £100 less than the lowest price there, if imported privately.

Another point; recently I had the wonderful opportunity of some hands-on experience on three systems — Apple, Pet and TRS-80. The impression I received was that the disc drives supplied by Radio Shack worked considerably slower than those I used with the Pet, besides the fact that storage capabilities on the Radio Shack drive are nowhere near those the Pet used.

I am glad to see that there are now other drives on the market suitable for use with the TRS-80, which greatly increase storage capabilities of the latter, especially since the DOS and other necessary software — e.g., disc basic — take up over 30K, leaving you with a mere 55K of storage space on the first Radio Shack drive. With the new, better drives, that problem would seem to cease to exist. Still, it would be pleasant to have the DOS in ROM.

**R. Schreiber,**
**Jerusalem, Israel.**

## Ellipses

REFERRING to the reply to Paul Benham's letter concerning the simulation of comet orbitals on a computer screen, a slight misunderstanding seems to have arisen — Feedback, September, 1979.

Tingey makes the statement that to draw an ellipse or circle it is necessary to use Lissajous figures. That is not so. Although it is possible to use this method it would be just as effective as a visual aid to use the high-resolution graphics capabilities of many of the present micro computers, e.g. Apple II, TI 99/4, Compucolor. It is not too difficult to deduce equations of the form.

$$\binom{a \sin t}{b \cos t}$$

which can then be plotted as a graph on the screen.

The real difficulty arises when trying to simulate an orbital at the actual speed or scaled-up speed. This is certainly possible with a real-time clock and high-resolution graphics but Tingey would certainly be hard put to modulate the speed of an oscilloscope trade at the required speed.

If Benham wishes to deduce suitable equations for this, may I suggest the book *Teach Yourself Dynamics*.

Finally, for anybody interested in comparison of prices here and in the States of microcomputers, may I point out that the proposed British price of approximately £700 for the TI 99/4 is about four times the predicted price TI was to charge ($300) to $500 according to the September magazine. For anybody who might point out that this was for a different model, this U.S. price was indeed for the monitorless console as it will be sold in the U.K.

**P. J. A White,**
**Harpenden, Herts.**

## Noughts and crosses

I WAS fascinated by the article and program of Trevor Lusty on Artificial Intelligence. As I have a Pet (8K) I found a certain difficulty in getting the program to print. The following slight alteration may help others:

```
3660 PRINT L8 "(TWOspaces)"; "  " add 3710 PRINT.
```

Line 3710 'opens' the square somewhat. The idea is from Donald Alcock's *Illustrating Basic* on his page 98 when explaining the long way around 'Mat Print', which Pet does not have.

**J. Patterson,**
**Leeds.**

RE Trevor Lusty's learning programe, I found the main ideas very interesting and the presentation clear. Surely, however, lines 2340 and 3660 should read:

```
2340 LET T2 = T2 + T1*(C10   (6-ZN1)) (for pattern no. to agree with that given in text) 3660 PRINT L8 (M8];" ";
(L8 is a one dimensional array).
```

Note, also, that at least five moves must be made before a win is possible, so that using the win-testing subroutine earlier is unnecessary. Running time could be shortened by taking account of this:

```
2090 )
2930 ) IF M9 «5 THEN 2280
```

**Kieran Lundy,**
**Scarborough.**

## No sorcery

IN RESPONSE to your Editorial 'The Real World' (September), I would like to inform you of some of my experiences with an Exidy Sorcerer 32K. Firstly, I wish to state that this is an excellent machine which lines up to its title of 'computer'. I say this having had seven years' experience, programming in Basic on the Hatfield Polytechnic Digital 10.

The Sorcerer was bought with the intention of developing an interactive engineering analysis program, using graphics. This has so far been its almost sole use.

The 32K memory proved more than adequate for a program which was large, and also required many variables.

It is easy to plot graphs to the full screen resolution (512 X 240) provided only one dot is required per character location.

The Basic compiler lacks certain features found in other versions — user functions are only single variable; no print formatting; no statement to output to a printer. This results is printouts which

*(continued on page 57)*

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*(continued from page 55)*
contain all the garbage used to run programs.

The manuals supplied with the machine are adequate for a beginner but omit most useful information such as how to connect a printer. A Sorcerer Technical Manual is essential.

**C.M. Felgate,**
**Cheshunt, Herts.**

## Star-Trek veracity

NOT MUCH to do with micro-computing but we were fascinated by a paper in the Journal of the British Interplanetary Society Vol 30, pp99-104, 1977; *Detection of Starships* by D R J Viewing *et al.* The authors look at different types of starships and the chances we might have of spotting them and conclude that "No matter how awesome the starship might be in a terrestrial context, it is in its own environment — inter-stellar space — virtually invisible."

Perhaps authors of future Star-Trek programs might like to take these considerations into account?

## From Newcastle

THE NEWCASTLE Personal Computer Society sent us its newsletter — well-produced and interesting. Computer freaks in the north-east might find it worth contacting the society. If, that is, they can find someone to contact.

It seems to be a rule of small newsletters never to give a contact address or telephone number. Editor P Scargill, however, incautiously admits in one issue to the telephone number North Shields 73905.

## Computers in schools

COMPUTERS IN SCHOOLS is the new title of the journal of MUSE, the national body for co-ordinating interest in mini and micro computing in secondary education. We were delighted to receive the September issue with its new format, new publisher (Longmans) and new editor, Bryan Spielman, who writes in this issue on the rivalry between the Eurapple and the ITT.

*Computers in Schools* is available at £1.25 per issue from Charles Sweeten, the honorary secretary of MUSE, at 18 South Road, Oundle, Peterborough.

## TV challenge

HAVING WORKED as an electronic engineer in the television industry for the last 13 years, I cannot allow your article (October, 1979) on David Graham's work to go without comment.

A number of staggering generalisations were made which can only mislead. the reference to portable TV cameras and recorders presumably refers to ENG/EFP equipment which, while it certainly has a place in journalism, can in no way replace existing equipment without substantial a lowering of technical standards.

Those of us who have seen programmes originated in Italy, the U.S. and the like, using these techniques would be horrified to see this appear on U.K. TV screens. I would be the first to agree that over-manning occurs in the TV industry but that is a union problem rather than a technical one.

Computers are making significant inroads into TV studio technology, perhaps too slowly, but computer-controlled lighting grids, switching matrices and vision mixers exist and it is not the engineers who are 'knocked-out', as Graham suggests, but the production staff.

**J. Hill**

## Criticisms

THERE HAS been much at fault with every issue of *Practical Computing.* Readers may well be contemplating spending hundreds, or even thousands, of pounds on a microcomputer and might expect from such a publication informed, professional advice, and accurate, responsibly-presented reviews and information.

Unfortunately, the advice, information and reviews are not only often inaccurate but are nearly always very much out-of-date. We appreciate you are trying to keep up with a very fast-moving industry and that such a task is not easy, although the American publications seem to manage very well indeed, but there is no excuse for unreasonable and misleading reviews and unhelpful and misinformed advice.

The over-all impression is one of a publication prepared not only for amateurs but also by amateurs.

To illustrate our criticisms we could use almost any review of hardware, software or documentation which has appeared but we have chosen a recent example — the review of Robert Rogers' *The Users' Guide to North Star Basic,* which appeared in the October 1979 issue, to highlight the apparent lack of knowledge and experience on the part of your reviewers and which typifies the misleading information given to readers.

In the paragraph 'Secrets', your reviewer says ". . . how to print to an external printer in Basic (sic), a procedure which we (who?) regard as a flaw ion the North Star Basic." For the benefit of readers not familiar with North Star Basic I feel that it is very important to draw to their attention the versatility and sophitication of the North Star's implementation of the PRINT statement, a versatility and sophisication not found in the Microsoft Basic implementation.

In North Star Basic, to print to any port, the appropriate format is PRINTfi, followed by the print list, where i is a numeric expression denoting the symbolic address of the desired 1/0 port. Normally, 1 = 0 for the first serial port, or VDU, and i = 1 for the printer, or second serial port.

Thus a program may print to either the VDU or printer by changing the value of i. To ensure conformity with other Basics, PRINTfi, where i = 0, may be abbreviated to PRINT.

The North Star Basic implementation of the PRINT statement has the versatility necessary for sophisticated software. And, of course, is detailed in the North Star Basic manual.

It is also stated that ". . . data files . . . must be created and/or deleted when in DOS." This is not true. These functions have been implemented in versions of North Star Basic obtainable in this country since the end of 1978, if not earlier.

The conclusion states: "There is a lack of good North Star documentation . . .". This is also untrue. Excellent manuals have been supplied by North Star since 1978 and have been readily available in this country for about eight or nine months, thus making Rogers' book unnecessary for all except those with no computing experience.

I hope that there are drastic improvements in the quality of material appearing in *Practical Computing* in the next few months. Such improvements are urgently needed.

**Andrew Ward**
**Hotel MicroSystems Ltd**
**London, NW8**

**• It is easy to make sweeping criticisms of incompetence and difficult to refute them in detail.**

**In this case, our review of Rogers' book concerned the book, not North Star Basic. Let us assume for the moment that Rogers was wrong about the points to which Ward takes exception. Surely, if someone who has written a book about this implementation of the language can be incorrect, then the ordinary reader should be aware of difficulties which may be in store?**

**Ward says, and he probably does not mean it as a compliment, that *Practical Computing* gives the impression of being prepared 'by amateurs'. To a large extent that is true and we are not shy about it. In the flood of computing power micro have released, almost all are amateurs.**

**An amateur readershipo needs an amateur magazine. We are baffled by the same things as you; we are pleased by the same successes as you are. If the readership wished for a magazine run by omniscient professionals who never make a mistake, there are others from which to choose. They, presumbly, do not choose such a magazine because they know they would not learn much from it.**

**Ignorance is a journalist's main stock-in-trade — knowledge is his enemy. He should know very slightly more than his readers and that only because he learned it yesterday. By tomorrow he will have passed on the knowledge and all will have the same level of knowledge, or ignorance.**

**If in the process we mislead you occasionally, we are sorry. We also mislead ourselves.**

# How to make your ideas turn to money

AS THE National Research and Development Corporation celebrated its birthday, the Corporation was criticised by *New Scientist* for its lack of support for the small inventor, including those who have new ideas for microprocessor applications.

A reply by the chairman of NRDC has been circulated, stating: "Money by itself may often be of no real value to a small inventor. Someone once said that offering money to a small inventor is like giving a bottle of chilled champagne to a man dying of thirst in the Sahara Desert. In his desperation to open the bottle, our thirsty man breaks off the neck, spills half the wine, cuts himself badly and, having consumed the balance of the wine, is thirstier than ever half an hour later".

In the last seven years 6,600 applications have been received. Of those, 44 were considered worth backing.

Far better to sell an idea once and for all to IBM and sleep easy at night. Before you concede, the NRDC is offering another chance. although you had better move smartly. It is sponsoring a competition for the best invention incorporating a microprocessor.

Any product which has a "programmable microelectronic device" and which is not yet in full-scale production can win a place on a training course on how to open champagne bottles in emergencies.

More seriously though, the first prize is £10,000 if there is a working model and £2,000 if there is not. In addition to the cash prizes, NRDC will give "favourable consideration" to investing up to £500,000 in any of the winning projects, be subject to the normal terms. The closing date is December 14.

Another competition is being organised by Peterborough Development Corporation. It is called the National Microelectronics Competition.

The judges are looking for the individual or firm with the best viable idea for using a microelectronic device. The overall winner will be offered a new factory of up to 10,000 sq.ft, rent free for a year. £4,000 cash from Barclays Bank and the Industrial and Commercial Finance Corporation; working capital at preferential rates; financial management and support from Barclays; design and marketing advice; the services of a recruitment company; housing to rent or buy for every worker recruited; and immediate consideration for requests of up to £250,000 venture capital from the ICFC.

The closing date for the competition is January 31, 1980. Application forms are available from Peterborough Development Corporation, PO Box 3, Touthill Close, Peterborough, PE1 1UJ. Telephone (0733) 68931.

# Minifloppy for Pet

ACT PETSOFT has entered the hardware market with a double-density minifloppy system for the Pet. Developed by the Californian company Compu/Think, the Petsoft professional disc system will aimed at business users. It is available in two configurations which offer either 400,000 or 800,000 bytes of storage on-line. Prices start at around £800.

Although double-density floppies have a reputation for unreliability, Act Petsoft says: "We've moved one hundred units in the last month and we had no complaints."

The disc operating system is in ROM and adds line additional commands to Pet Basic. Act can supply many Petsoft programs.

The Petsoft professional disc system is available from most U.K. Pet dealers. If you have any difficulty, Act Petsoft Peripherals is based at Radcliffe House, 66-68 Hagley Road, Edgbaston, Birmingham. Telephone: 021-455 8585.

# New disc family

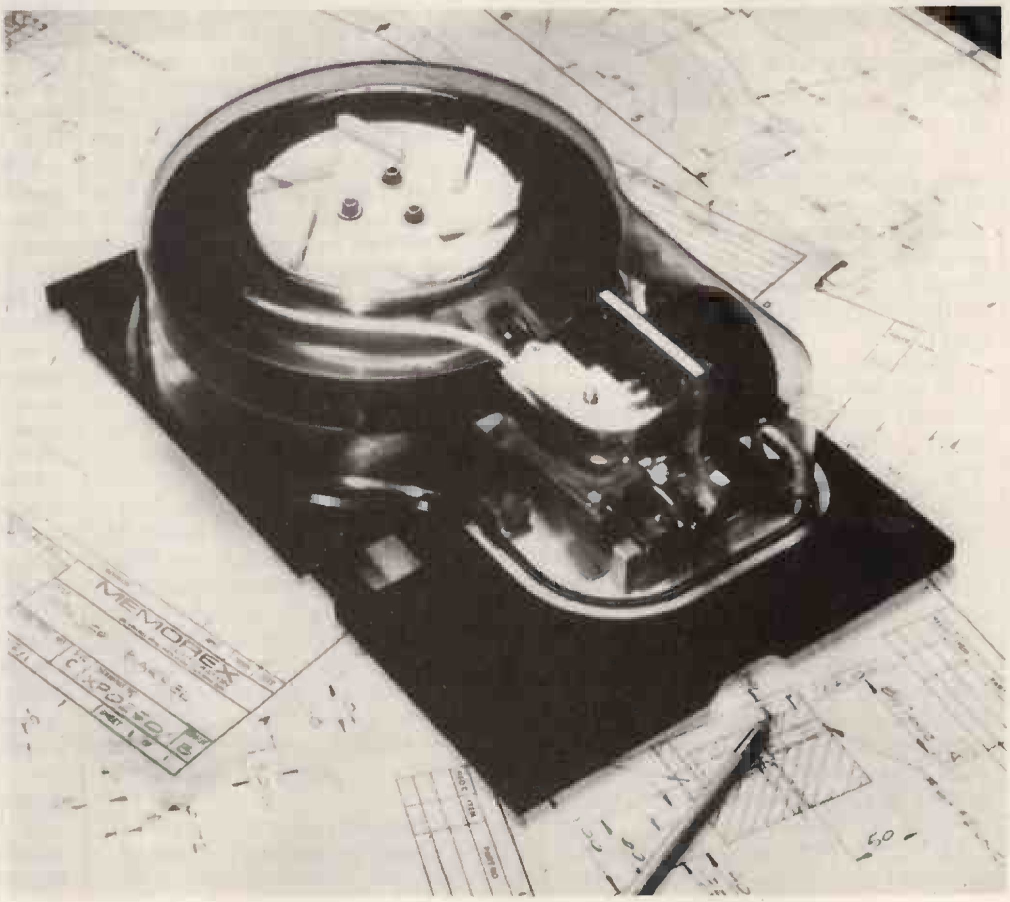
MEMOREX CORPORATION has announced the first in a planned family of 8in. rigid disc drives. They have more than seven times the capacity of the largest floppy disc drives in the same space.

Known as Model 101, the new drive features 11.7 megabytes of fixed storage capacity on two discs. It has been designed for OEMs and includes the usual advantages of 8in. disc technology, including reduced package size and less head mass.

It also has a number of new features, including a direct drive spindle motor. By incorporating the motor with the hub, Memorex engineers have managed to eliminate belts, brackets and side-loaded bearing wear.

First shipments of the 101 will not start until the first quarter of next year, when it should be available for $1,560 in quantities of at least 100 units. Memorex U.K. Ltd is on Staines (0784) 51488.

Memorex 8 in. disc drive.




Computerised clocking system developers David Wood, Richard Danbury, Michael Benjamin and Jonathan White.

## Viewdata terminal from STC

STC, the British arm of ITT, has introduced its specially-designed viewdata terminal, the Novatel. It costs at least £750 for which you have a 7in. black and white screen/terminal. Despite the price, STC predicts that it will have sold more than 1,000 of them by the end of the year.

The Novatel has been built for business use. At 14.1in. deep, by 11.9in. wide and 7.6in. high, it should fit easily on to a desk-top. There is a high-definition 7in. display and an anti-reflective screen.

One useful point is that the Novatel can be connected to a standard cassette or tape recorder and any pages accessed can be recorded and played-back without recalling the database. For message-sending, a socket is also provided for connecting a full alphanumeric keyboard.

STC is still appointing dealers. If you would like to find out more about the terminal, telephone STC on 01-368 1234.

## System to work for 'slackers'

EVERY YEAR the British Aerospace Training Department at Bristol sponsors pre-university students for short projects in which they have 14 weeks and £150 to produce a money-spinner for the company.

This year these four contestants developed a system to discover 'slackers'. They devised a "computerised attendance clocking system which could eliminate the use of clock cards and clerical recording." That means that the company knows when you arrive, and when you leave, and cuts wages accordingly.

The system, which consists of a reader and central control unit, was built for only £141. The reader units, at the left of the photograph, are supposed to replace existing time clocks. The employee has to use a pass or identification card. The reader transmits data in the form of 16-bit words to the central control unit, from where the data can be fed, once a week, to the company's mainframe computer.

The reader has a digital recording system and can operate from either mains or battery supplies. It can record starting and finishing time, for bonus calculations, and can also accommodate personnel working flexible hours. The central control units can be matched with up to 250 reader units.

## Old and new with Apple Pascal

APPLE COMPUTER INC has introduced its version of Pascal, to be known as Apple Pascal. It was written by the University of California in San Diego and is an implementation of standard Pascal.

The Apple Pascal is intended to run on the Apple II and Apple II Plus computers. The system requires 48KB of installed memory and one or more Apple II disc drives. While the system is intended primarily to use the Apple keyboard and monitor, an external CRT terminal may be used to give the full 80-character screen display.

The heart of the language system is the language card, which adds 16K to the Apple 48K of RAM. In addition, the language system includes the Autostart ROM which facilitates screen editing of Basic programs and starts your disc drive automatically when you turn on the computer.

The system includes two new PROMs for the disc interface card, which make it possible for a one-drive system to run Pascal. It also includes the Basic diskette, which allows the user to run Integer and Applesoft Basic.

## Catalogue

TRANSAM COMPONENTS has published a new computer products catalogue containing details of products and specialist services for microcomputer users in the U.K. Transam manufactures the Triton personal computer system. The catalogue is available from 12 Chapel Street, London NW1. Telephone: 01-402 8137.

## Forty-track disc capacity

IF TANDY users are still having trouble with their disc drives, they could try a new system designed and developed by Computer Instruments Ltd of Chandler's Ford, Hampshire. The disc system has been designed to interface easily with most micro and minicomputers, via a suitable controller. The unit is based on the Pertec FD200 microfloppy disc drive and is directly interface-compatible with the Shugart Model SA400. The capacity is 250K per side of double-density diskette and the device is suitable for double or single-density disc operation.

It claims a 40-track capacity which will give users 14 percent extra capacity by comparison with competitive disc drives. Transfer rate is 125/250Kbits per second.

The unit is available from Rostronics Ltd, 118 Wandsworth High Street, London SW18.

# Triton is impressive

THERE ARE many single-board computers on the market. Most of them failed to impress me but I am writing about one of the few which does. The Triton is British-designed and engineered and was launched in November, 1978.

Transam, the supplier, has not rested on U.S. laurels, however, but has introduced an expansion motherboard which will accept plug-in daughter boards to configure the computer to the user's requirements.

The Triton is based on the 8080 processor which, although not my personal favourite, has a considerable following. The design of the Triton makes it ideal for the beginner with the minimum of cash and know-how. Not only is it available as a complete kit but also as a part-kit, so that the constructor can choose which parts to buy and which to use from his existing stock.

When the constructor outgrows the initial system, it is easy to expand it, using a range of plug-in modules based on the same kit philosophy.

## Documentation

An impressive array of documentation is available. It ranges from simple construction and how-it-works notes on the plug-in cards to the mighty half-inch thick *Triton Manual*. Between those extremes are descriptions and listings of the five alternative firmware packages. Sufficient detail is given for advanced programmers to modifying vectors and pointers, making possible those clever tricks which are part of the fascination of programming. Even listings, both source and object code, of Basic are available.

The beginner need not have the feeling of being left alone. The Triton User Group Newsletter is available to provide news of new products, programming units, program listings and circuit add-ons. The issue which I read contained in its 35 pages a Tiny Basic Startrek program

**by Ron Geere**

**Editor, Independent Pet User Group Newsletter**

— one of the few computer games which appeals to me — a version of 3D noughts and crosses and a game called Time Warp. Hardware items mostly dealt with analogue interfacing and control applications.

The 116-page manual contains a detailed description of the Triton, its construction and assembly. The how-it-works sections covers the power supply, processor, memory, the peripheral interfaces and the VDU graphics. Included are ASCII/decimal/hex code tables, a table of graphic symbols and their corresponding codes and a table of control codes.

**Graham Clifton and Nigel Stride in their London West End shop. On the bench, centre, the Triton computer. The single-board with 8K of RAM is in the black portion behind the keyboard. To the left, the expansion motherboard, with, from front to rear, the trap package containing assembler and disassembler, 8K of RAM and 7K Scientific Basic in ROM. On the right, an alternative touch-sensitive keyboard by Star Devices and a TVM-10 VDU displaying the extensive monitor command set of the Triton.**

## Firmware packages

EPROMs are used for all firmware and Transam allows one to trade-in an EPROM pack and have it upgraded to another. That makes it easy to keep abreast of software improvements, as, for instance, Pascal might be preferred as an alternative to Basic.

There is a choice of five Basic firmware packs. Three of them, the L4.1, L5.1 and L6.1, represent differing levels of Basic — tiny, extended and scientific. The latter lives in nine 2708 EPROMs with a comprehensive 2K monitor and a 7K Basic which will handle numbers within the range $10^{+-127}$ to six-digit precision. To house the additional EPROMs, an 8K EPROM card and expansion motherboard is required. The smaller packs can be housed on the main pcb.

The monitors increase in versatility for a minimum of seven single-character commands in the 1K version to one of the most comprehensive monitors I have seen on this type of computer. Its single-character command set uses all the letters of the alphabet, except K and Y, to give 24 commands.

Two more packs, the L5.2 and L6.2, are the same as their .1 equivalent but designed for use with an 18MHz crystal instead of the standard 7.2MHz version to control the processor clock.

One further firmware package is available, aimed at the machine code enthusiast. It has an 8K EPROM call TRAP—Triton Resident Assembler Package. It gives nine facilities which, apart from the usual editor and two-pass assembler, includes a disassembler giving standard Intel mnemonics and the ability to create a symbol table which will put labels into listings for clarity.

Further facilities permit the setting of break points, single-stepping, trace — which displays register contents after stepping automatically through each instruction of a specified block of code — and a 10-command monitor.

## Processor unit

The single board housing the cpu is well made and clearly laid-out. The circuitry is conventional, good use being made of LSI chips appropriate to the tasks performed, with low-power Schottky devices filling-in the details.

The keyboard is a full 56-station ASCII model complete with shift-lock, escape and control keys. The VDU screen will accommodate 16 lines of 64 characters. Use of the shift and control keys should produce 64 graphic characters from the keyboard but I found some oddities. The DEL key does not delete but moves the cursor left, so one can re-type a character. To delete, say, 10 characters requires 10 such cursor lefts followed by 10 spaces.

Reset (home) cursor is given as 'CTRL \ ' and since there are two keys marked ' \ ' I found the wrong one initially. There are also two '=' keys — one produces a graphics character, the other does not.

## Interface

One criticism I have of the graphics was due to limitations arising from the VDU chip and graphic generator combination. The lower area of the dot matrix array must, by default, be the same as the top row. That imposes a restriction on the graphic symbols which can be generated.

Improvement in operation could be made by using a keyboard which was VDU-orientated in respect of cursor controls. I found it an inconvenience to press two simultaneous and unrelated keys each time.

The processor has five interfaces — keyboard port, LED port, cassette interface, TV interface and bus extension. The TV interface uses the popular Astec modulator type 1111E36. U.K. modulation standards are used to output a carrier on TV channel 36. Interlacing of lines is random; line and field frequencies are determined by the SFC 96364 VDU chip. The combination of the two devices eliminates any synchronisation problems, such as arises occasionally in the U.S.-designed equipment.

The casstte interface uses a UART which drives the Motorola MC14412VL mode to generate the crystal-derived tones for the casstte recorder. A 'mark' (1) is 1270Hz and a 'space' (0) is 1070Hz. The band rate is determined by a 555 timer circuit which has an adjustment for fine frequency-control.

The LED port, as Transam calls it, need not be used for LEDs. It could be used equally well to drive a device such as a printer. A number of spare output lines exist and would enable handshaking to be used if necessary.

## Expansion

The keyboard data and strobe lines are connected to port zero. The keyboard routines does not seem to be interrupt-driven. There are eight interrupt inputs, one of which (INT3) is labelled 'spare to keyboard' in the documentation.

The bus extension lines are buffered from the processor. Additional buffers are provided on the expansion motherboard input. The unit reviewed had a ribbon cable of about one metre long and the length appeared to present no problems.

The expansion motherboard kit has its own power supply and the 5V rail can supply up to 6A with the components supplied. The printed circuit board, as with all the circuit boards in the system, has plated-through-hole, double-sized construction to professional standards.

## Conclusions

- **The prospective buyer is advised to study the Transam computer catalogue to determine the options required and the best method of purchase.**
- **Sufficient documentation is provided to make assembly and testing a straightforward process and then, if the constructor still does not have a working unit, Transam operates a get-it-going service to purchasers of their components.**
- **If your electronics is satisfactory but the housing is a problem, Transam can supply a vacuum-formed case.**
- **It is difficult to design something to suit everyone within the constraints of price, reliability and performance. In this respect the Triton has scored remarkably well. The piece-wise availability enables one to tailor the unit to one's own requirements and not to pay for unrequired facilities.**

## Practical Computing evaluation

| | Yes/No N/A | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Ease of construction (where applicable) | | | | | ✓ | |
| Quality of documentation | | | | | | ✓ |
| Can handle 32K of memory | Y | | | | | |
| Quality of video monitor (consider resolution and screen size) | N/A | | | | | |
| Sockets for chips | Y | | | | | |
| Numeric, calculator-type pad on keyboard | N | | | | | |
| Large amount of removable memory, randomly accessible | Y | | | | | |
| Cassette tape recorder capability: Own | Y | | | | | |
| Built-in recorder | N | | | | | |
| Floppy disc capability | N | | | | | |
| Speed of instruction cycle | | | | ✓ | | |
| Ease of expansion | | | | | | ✓ |
| Lower power consumption | | | | ✓ | | |
| Assembly languages | Y | | | | | |
| Basic language | Y | | | | | |
| Other languages | N | | | | | |
| Compatibility with other systems | | | | | ✓ | |
| Appearance | N/A | | | | | |
| Portability | | | | ✓ | | |
| No. of software applications packages available | | | ✓ | | | |
| Hobby use | | | | | ✓ | |
| Business use | | | ✓ | | | |
| Educational use | | | | | ✓ | |
| Ability to add printer(s) | | | | | ✓ | |
| Ability to add discs | Y | | | | | |
| Ability to add other manufacturers' plug-in memory | | | | ✓ | | |

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

# Contrasting Euroapple with ITT 2020

**Bryan Spielman investigates one of the great micro mysteries — what is the difference between the two Apples?**

WHAT HAS the latest European Apple II, the Europlus, to offer? How different is it from the latest ITT 2020? How well do these computers perform and what can an owner expect in the way of support and reliability?

To try to answer those questions and to shed some light on what makes their special features tick, Jim Hurst of Microcontrol and I have examined them and this is a report of our findings. We are grateful to Microsense Computers Ltd and to ITT for their help and co-operation but our investigations and conclusions are our own.

Apart from the colour of the plastic case and the keyboard, the two computers look alike. The case is strong, yet light, making it more easily portable than almost any other computer of comparable capability.

The motherboard of the 2020 is manufactured by Apple but is different in design from the boards in the computers which bear the Apple name. In the ITT Basildon factory, the board receives further modification. The keyboard, too, is imported from the U.S. but the remainder of the 2020 is home-produced. Assembly and testing is by the same procedures of quality control as are used in the manufacture of other ITT products.

## Powerful and fast

The capability, under either brand name, reflects the flair which is evident in the concept of the Apple computer. The functional structure borrows from the philosophy of large computers rather than being an *ad hoc* creation stemming from the nucleus microprocessor.

They are powerful machines and, for micros, are fast. In high-resolution graphics the Apple performs faster than the ITT.

There is an elegant Integer Basic available in ROM and an extended Basic in two versions, to accommodate the two versions of high-resolution graphics employed by Apple and ITT respectively. This extended Basic, called variously APPLESOFT or PALSOFT, is excellent, apart from some minor flaws, and meets a high professional standard. It is also available in ROM.

The main manuals are produced by Apple and are literate, lucid, lively, thorough and accurate, though they could be enhanced further by the addition of more non-trivial examples. Unfortunately, some of the programming facilities described will not work on the 2020, and the ITT supplementary documentation does not cover all the amendments it should. ITT is trying to correct this but it would be more satisfactory if the price of one of its machines included an automatic after-sales information update service. There has been talk of an ITT-sponsored users' club but as yet there has been no action.

A good mini-assembler and disassembler are provided in ROM together with a pseudo machine interpreter which imitates a 16-bit processor and goes by the name of Sweet 16. There is a rich repertoire of monitor commands and a first-class software front panel. The mini-assembler and Sweet 16, however, have to be sacrificed if Applesoft or Palsoft is in ROM on the main board.

It differs from its predecessor in that it has 'Autostart' ROM. It replaces the standard system-monitor ROM and, with disc drive, enables the computer to function in turnkey mode — it can move directly into a pre-selected program by being turned on. It includes improved edit facilities and gives a less tormenting response than that to which Apple owners are accustomed on hitting RESET.

This ROM is all that distinguishes a Europlus from a plain Eurapple and an instant update is achieved by plugging it in. It works equally well in a 2020.

The ease with which one can hit reset accidentally is a notorious irritant with these machines. The RESET key is next to the RETURN key so it is almost impossible to miss. ITT is ahead of Apple in having corrected the difficulty on its latest model by linking the RESET key to the CONTROL key, making it necessary to press both simultaneously for anything to result.

## Penalty

Those are some of the good points. What about the other side of the picture? The first disappointment is in the display; that applies to both brands but there are differences. The fact that a well-known reason for having an Apple or 2020 is that it can perform in colour means that it is very likely to be used with a colour TV set. You can use a colour monitor if you wish but you would probably be better advised to spend the money on something else.

The immediate penalty is that image definition is inferior to the showing by a monochrome set. Text is fuzzy and in the case of the Apple has some annoying colour fringes. The ITT display is the better one in this respect but the Apple has a different and, in our view, more legible, character set.

There are only 40 characters per line, which is a disadvantage for many purposes, but there are 24 lines per screen page. There is no space between consecutive lines, the bottom of one abutting directly on to the top of the next, and as standard there is no lower-case. That makes text a strain to read and must be considered a major defect.

A further extremely irritating feature is that the display occupies only 60 percent of the total available screen area. Moreover, it is not centrally on the screen is the set is adjusted normally. The ITT display is slightly larger than that of the Apple, because of timing circuitry differences.

Disappointment mounts when one finds that the text is conceived in monochrome only and cannot ordinarily be mixed with graphics. Nor can graphics be mixed with text. It is possible to put four lines as a caption to a page of graphics, however, but the text is apt to be revealed in a riot of colours, whether you like it or not.

## Graphics mixtures

The low-resolution graphics give colour more or less as expected but the resolution is very low — a maximum of 48 rows of 40 points, those 'points' being fearsome rectangles. The ITT colours are very good but those of the Apple look washed-out and also create an effect of worms wriggling all over them.

The high-resolution graphics are a mixture of marvels and disasters. They are extraordinarily easy to use in programs, with some wonderful facilities which supposedly draw lines and shapes and put them anywhere, and enlarge and rotate them and are full of promise. Alas, the promise is not always fulfilled. Some of the facilities work only to a point. The ITT colours, although subject to the same disorders of unpredictability as the Apple, as purer and richer.

Since a change in U.K. distributorship earlier this year, the Apple II — the European version, the Eurapple — has been sold as standard without colour output. The price is correspondingly lower and you have to pay the difference for the special colour card as an extra. A new colour card is due from Apple soon which uses digital techniques. We have tested an advance sample and consider it to be up to that of the ITT achievement, but no better.

The geometry of the high-resolution graphics reveals a great contrast. The Apple has a plot grid of 280 × 192 while the 2020 gives 360 × 192. The extra points crammed into a horizontal line by the ITT machine give increased resolution, true, but also present problems in that the horizontal scale factor is different from the vertical one.

A rectangle made up of 40 plots horizontally by 40 plots vertically, for instance, is a square on the Apple but not on the 2020 and it distorts badly when the facility for rotating shapes is used. Neither is the Apple perfect. Certain orientations of a rotated shape are accompanied by unwanted changes in scale; but how many low-cost computers can do this kind of thing at all?

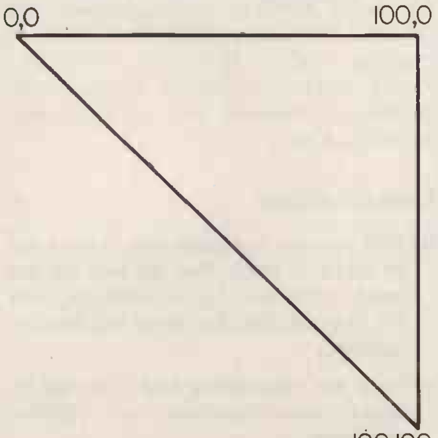
A further consequence of the differences is an incompatibility of software between the Apple and the 2020 in cases where high-resolution routines are included using machine code. The problem can be overcome by writing programs in Applesoft or Palsoft and running them with the interpreter appropriate to the machine on which they are running (irrespective of the interpreter or machine used when the program was created).

## Simple adjustments

Any such program which runs on a 2020 will run on an Apple provided X co-ordinates are kept to less than 280. A program which runs on an Apple might need a little more adjustment to run a 2020 if they happen to use any of the Applesoft commands which do not work on the ITT machine. These adjustments are usually quite simple, though. For instance, on the Apple, the instruction

```
10 HPLOT 0, 0 TO 100, 0 TO 100, 100 TO 0,0
```

will plot a right angled triangle:




With the 2020 it is necessary to use

```
10 HPLOT 0, 0 TO 100, 0: HPLOT TO 100, 100:
HPLOT TO 0,0
```

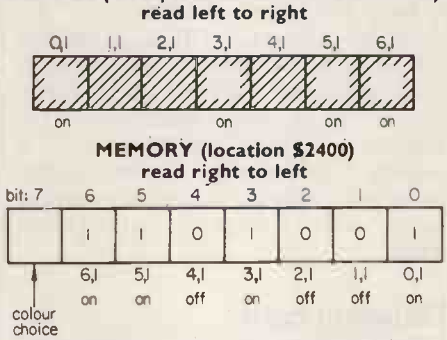
and all will be well, although the triangle won't be isosceles.

With the Apple method for high-resolution colour, the 53,760 points or picture elements, on the screen can be regarded as 7,680 sets of seven. There are 40 of those sets of seven per horizontal line. The state of every point is one set, whether it is on — i.e. glowing — or off and, if it is on, what colour it is, is encoded in one byte of memory. So if, for example, you plot any of the points with co-ordinates (0,1) to (6,1), the information — which points are on, and in what colour — is contained in location $2400 of HI-RES page 1 or $4400 of HI-RES page 2.

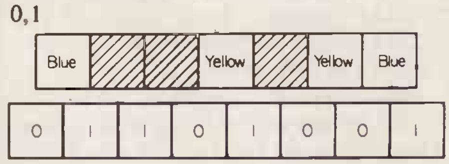
Essentially, the whole method is something of a cheat. Although you can name patches of colour to order, you cannot do the same thing with individual points. The colour of aggregates of points results from the mixing of the colours of neighbouring points. No point is ever white, for instance, but two horizontally-consecutive points, when both are on, will always appear white, because their respective colours are always complementary.

There are only two colours which any one point can possibly assume. For example, the point (0,1) can be either blue or magenta — or off, of course; but the point next to it, (1,1), can only be yellow or green, which are the respective complements of blue and magenta. I should remark that these colour names are for purposes of explanation and might not exactly describe what emerges in practice.

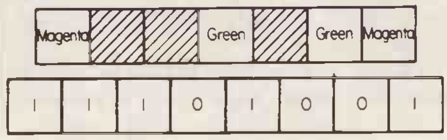
The information is encoded in memory like this:



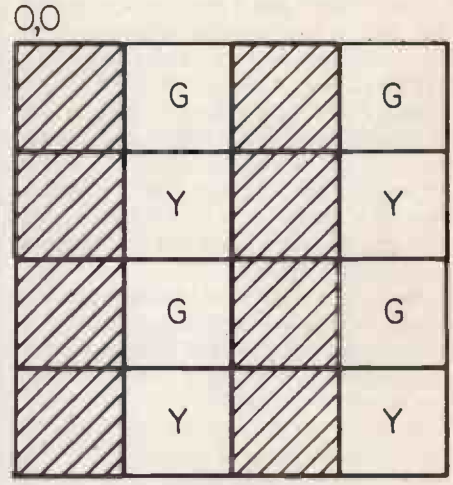

Bit 7 of the byte — bit 7 is the eighth from the right — codes the colour choice. If bit 7 is 0, the colours of the points (if on) will be blue-yellow blue-yellow-blue-yellow-blue, and if bit 7 is 1 they will be magenta-green-magenta-green-magenta-green-magenta. So, adding colour to the above diagram, we have either:



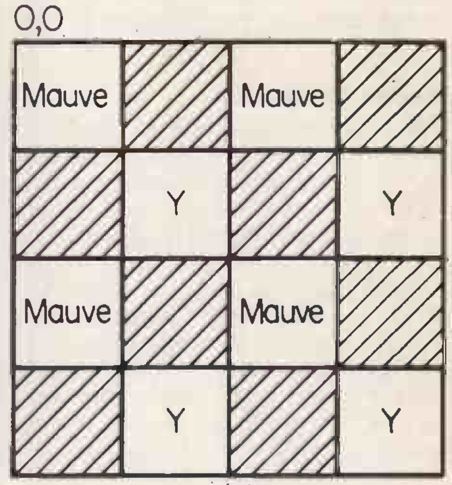

or:



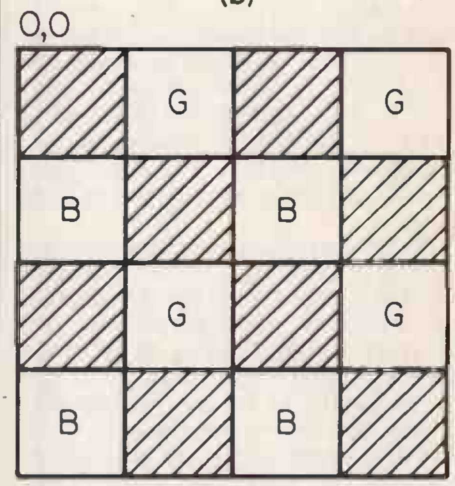

Various colour effects can be produced on lines and patches by varying the combinations. Here are some examples:




Appearance: yellow
(a)




pink
(b)




aqua
(c)

All those combinations are realisable in practice but some only by writing special routines. Using standard the standard programming provisions, you determine

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the colour by setting a parameter called HCOLOR equal to a number from 0-7.

The values 0 and 4 give black — ensure that a 0 is put into the appropriate bit corresponding to any point which is plotted; 3 and 7 give white, obtained by ensuring that a 1 is put there. Each of the remaining four values selects respectively one of the four possible colours available on a given line, the particular depending also on whether the Y co-ordinate is odd or even. Diagram (a) above corresponds to HCOLOR = 1.

Since any specified colour can be produced only at alternate points, there is a 50 percent chance that a point plotted at random will fail to appear — likewise also for an entire vertical line.

Because of the inadequacies of the colour generation effected by the circuitry which converts the output from NTSC standard to PAL, when the colours appear they might, for many purposes, equally well have been in white. The new colour card will be improved in this respect.

## Room to spare

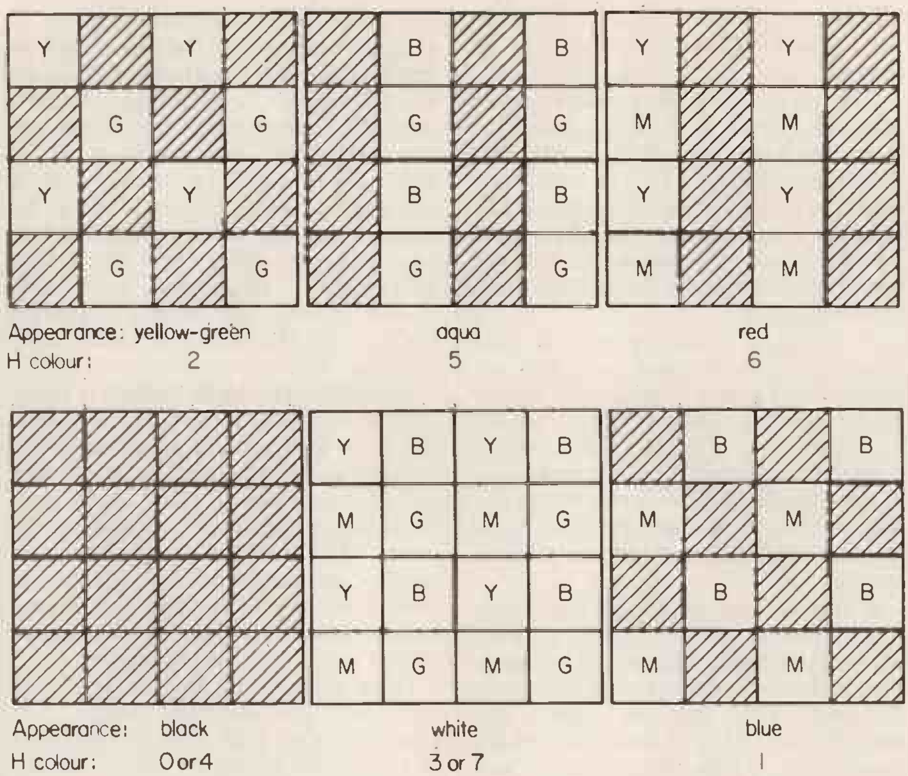
We have seen that, for the Apple, 40 bytes of memory are needed for each horizontal line of high-resolution points. So the total number of bytes needed is 192 × 40 = 7,680. Each HI-RES page of memory is 8K, that is 8192 bytes, whence there is plenty of room to spare. The 61,920 points on the ITT high-resolution display, if divided into sets of seven as with the Apple, would give more sets than there are bytes in 8K. Hence the Apple way of doing things is not directly possible.

So let us abandon the colour-choice bit and allow each point to be able to light up in only a single colour. For the effect of being able to vary colour of the output, at least for lines and patches, we will have to rely wholly on the device of varying the combination of points which are in play. It is perfectly feasible and allows us to divide the full number of points into sets of eight. But 69,120 ÷ 8 = 8,640, which is still too many to be contained in 8,192 bytes.

The ITT solution is to enlarge the bytes. Instead of having eight bits to a byte in the HI-RES memory, it has added a ninth bit. More precisely, Apple has added it. It is done by adding an extra 8K-bit RAM chip, one bit of which is adjoined to each byte of the HI-RES memory as required.

It is addressed by way of a latch, which has to be enabled before the ninth bit can be read or written to, and then has to be disabled. The extra procedures take time and contribute to the comparative slowness of the ITT. Another reason for the slowness is, of course, the need to plot more points than the Apple to cover the same horizontal distance.

To the right of the page are the respective patch patterns which are yielded by plotting all the points in a patch in conjunction with the eight possible values of HCOLOR.




Given a non-black-or-white setting of HCOLOR there is still a 50 percent chance of failure of anything appearing on the screen if you plot a single random point. Moreover, if the point lights-up, it is likely to be in an unexpected colour.

Neither Apple nor ITT is at pains to point-out the limitations of the high-resolution colour facilities. That is a pity, for provided one understands the organisation of the colour system it is possible to take account of it in programming and, without frustration, produce some very respectable, trouble-free effects.

## Different card

The Apple as sold in the U.S. generates an NTSC signal on the logic board, which can be fed directly to American TV sets and monitors. In the U.K. the signal is converted to the PAL standard by a plug-in card which is a rather second-best affair. In Europe a different card is needed to convert the signal to the SECAM standard. Early forms of the SECAM card have been even less successful that the PAL card.

Possessors of Eurapples, however, should be warned that they cannot plan improved output only by buying an NTSC monitor, because the clock crystal fitted in the European model is not of the same frequency as in machines intended for use in the States.

On the English 2020, the PAL signal is generated on the logic board in identical fashion to the way the NTSC signal is produced in the Apple. That enables the best-quality result to issue without the need for a special card. If the ITT machine had kept the high-resolution graphics in the original Apple form, I think it would have been the better one to buy on this side of the Atlantic.

With the new colour card the Apple will constitute a serious challenge to ITT.

There is an established range of ancillary products for the machines and it is being extended all the time. Most items are usable freely with either brand of computer but there is the inevitable small difference.

Languages available for the Apple/2020 include FORTH, which is reported to be very good, and a version of PILOT called APPILOT which is on disc, includes the facility for using the low-resolution graphics, and is first-rate. There is a Pascal system, including a card with impressive firmware and an extra 16K dedicated RAM.

## Conclusions

- **This account is critical and should not be taken to imply that the two are not good machines. On the contrary, they are so good that they merit this kind of scrutiny.**
- **Both are expandable and it is easy to make modifications to existing machines.**
- **Any Apple or ITT 2020 can be improved by suitable provisions from the manufacturers, if they choose, and could still have a good part to play for some time after many of their contemporaries are obsolete.**

# Corvus hard disc for Apple

THE STANDARD Apple II floppy disc system provides 110 kilobytes of storage per drive, immediately accessible to the computer. What that means, for example, to a sales ledger program, is that the Apple is limited to about 600 customers and 1,600 transactions. What is more, the speed at which the computer can print reports is often limited by the disc, and certainly it is a tedious operation to have the computer search 600 names on disc for an account number you have forgotten.

So the Apple or, indeed, any micro-computer, would be improved by using a faster disc system with a greater capacity, like the Corvus 11A hard disc system. It provides 9.5 megabytes of storage, all immediately accessible, and is claimed to be about 10 times faster than mini-floppy discs; 9.5 megabytes is sufficient to store;

- 50,000 customer names and addresses;
- 4,000 pages of poetry, report, manual;
- one-sixth of the Encyclopaedia Britannica;
- 12 hours of digitised speech;
- 1,000 Apple high-resolution graphics pictures;
- One second of colour TV signal.

The disc system we had for review was in three parts. The main unit is the drive, which is a black box 500mm by 150mm by 200mm. There is a separate power supply unit which is about half the size of the drive. Finally, there is an interface printed circuit board which plugs into a slot in the Apple in the standard way.

## Simple process

A brief instruction booklet and two warning notices were also supplied. The system was already assembled but all that appears to be necessary is to plug it together. The instructions for doing so were complete and comprehensible; the process would probably be no more difficult than installing an Apple floppy disc or printer.

Starting the drive working was equally simple. Turn the drive on at its power supply and the disc starts to rotate. It takes about 15 seconds to reach speed and the booklet warns you to wait that long before trying to use it. Unlike a minifloppy drive, this rotates all the time it is switched on, rather than only when access to date is required. When the disc is ready, type PR# 4 on the Apple keyboard and in two seconds the Corvus banner appears on the screen and the Corvus disc operating system is installed in the computer.

On an Apple Plus, the PR# 4 should be unnecessary; the drive should boot itself automatically when the Apple is turned-on.

To the user at the Apple keyboard the disc system seems much the same as the floppy disc operating system (DOS). All the usual CATALOG, DELETE, RUN, LOAD and OPEN commands are there. There is little new to learn. The only difference is that the Corvus disc is organised to look exactly like 82 floppy disc drives.

To choose among the 82 so-called volumes, you use the volume parameter on disc commands. In the normal Apple DOS, that is used to check that the correct disc has been inserted in the drive. So a

**by Mike Gardner**

Corvus disc command would look like; OPEN BOTTLE, V61, to access a file called BOTTLE on the 61st section of the disc.

The division into volumes provides almost complete compatibility with the original Apple DOS and may mean that some programs can be transferred to the Corvus disc with very small changes.

This system, however, makes spreading files over more than one volume rather awkward. That is important because if you need a 9.5MB disc you probably have files which are larger than the capacity of one floppy disc.

There is a fundamental difference between the Corvus disc and a floppy, in that the discs are not interchangeable. In fact, the Corvus disc drive is a sealed unit which may be opened only in a dust-free room. That creates a problem about the security of the data.

The speed of the disc was tested by setting the computer to search through a name and address file. It managed about 10 records per second. At that rate the program may well be limited by the Basic interpreter rather than the disc. The CATALOG, V99 command takes five seconds to traverse the disc and read the first file name of the catalogue of each of 82 volumes.

Technically, the drive consists of the IMI 7710 Winchester disc drive. To this Corvus has added a controller based on a Z-80 microprocessor with 16K of RAM, the power supply and the Apple interface. The drive is made up of two solid magnetic coated discs.

Both sides of each are used, to make four surfaces. One is used for head positioning and the other three hold data.

## Conclusions

- **The Corvus 11A disc drive offers one-hundredfold increase in storage capacity and a 10 times increase in speed over the Apple floppy disc system. It should also be more reliable.**
- **The documentation is adequate to use the disc but more help could be given, particularly with the advanced facilities available.**
- **There are potential difficulties in keeping back-up copies of the large amounts of data the disc can store.**
- **Compatibility with the Apple DOS should make for easy program conversion.**
- **Price is £3,500 for an initial unit; a second drive can be added for £2,500.**

**Corvus 10MB hard disc system. On the left, power supply; centre, the disc drive in its sealed black box; right, an ordinary Apple with mini-floppies.**

# Chip takes step forward in picture processing

**Stephen Pass describes the history and present prospects of the CLIP 4 image processing machine at University College, London.**

IN ABOUT 1952 Von Neumann, the father of the modern serial computer, first proposed a two-dimensional cellular computer. His work was the inspiration for much of the subsequent thinking on highly-parallel computers. In 1958, Unger published a work on *A computer orientated towards spatial problems.*

His theoretical machine consisted of a rectangular array of processing elements (PEs), each of which performed the same instruction from a central controller on its own data. This mode of operation is known as a single instruction, multiple data stream (SIMD).

Unger simulated a cellular array of 36 × 36 PEs, each connected to its north, east, south and west neighbours (figure 1). Memory was limited to nine registers for each PE and the possible instructions performed only simple operations. Data could be shifted left, right, up or down in the array; simple Boolean functions of a PE and its neighbouring PEs could be carried out; and there was a special "link" instruction for finding connected sets (figure 2).

In the early 1960s the first parallel computers follows. Solomon I and Solomon II were designed as fast, powerful, number-crunching machines of 32 × 32 PEs. Intended applications were numerical modelling, solving differential equations and radar data analysis. The project, however, never fulfilled its promise and only a simpler 16 × 16 array processor was built.

Solomon's designer, Daniel Slotnick, moved on to work on the ill-fated ILLIAC IV computer which was designed to be operated in SIMD or MIMD — multiple instruction, multiple data — modes. The aim was a machine performing a gigaflop — one thousand million floating-point operations per second — but the project proved too costly and only a quarter of the original design was built.

Returning to computers for image processing, ILLIAC III was conceived as a machine for the automatic analysis of bubble chamber photographs. It consisted of a 32 × 32 array which could be configured in either a square or hexagonal arrangemnet (figure 3).

The design was published in 1963 but construction was beset with problems and it never worked at all well. Had the project been completed, the performance of ILLIAC III would have considerably exceeded any contemporary machine, such as Solomon, but apparently it was destroyed by fire.

The Solomon and ILLIAC machines were very expensive and were attempting to use the most advanced technology of the sixties. Other projects, however, were pursued which implemented the logic of a cellular array in a serial, or 'slightly parallel' manner.

The first, CELLSCAN, was built in 1960. It processed a picture element (pixel) and its eight neighbours sequentially, and was intended for the analysis of white blood cells. Further

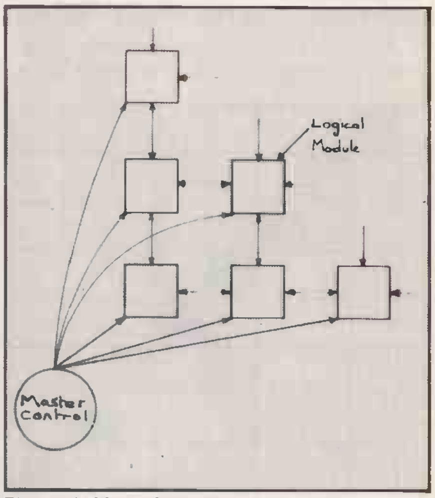



Figure 1. Unger's spatial computer.

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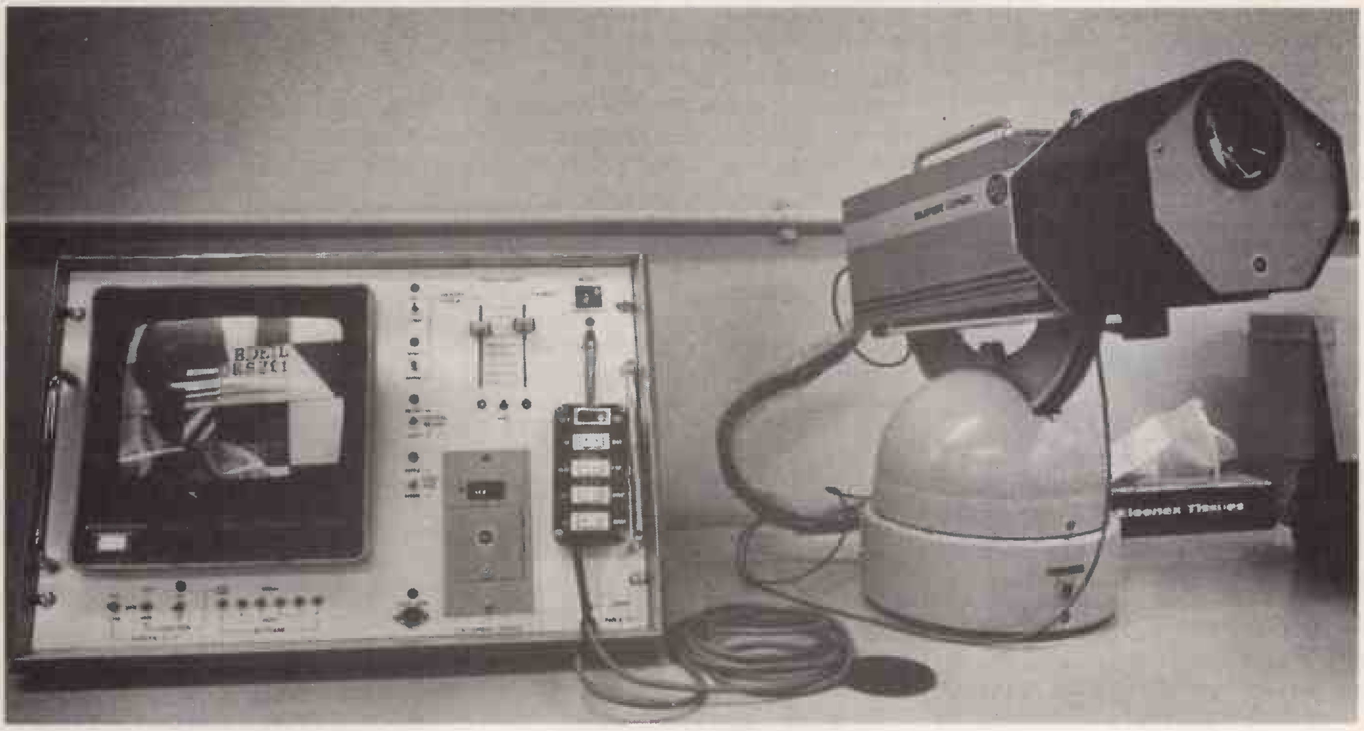
The TV camera and video mixer med CLIP experiments.



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development led to the Golay logic processor (GLOPR) which was incorporated in a commercial machine for white blood cell analysis.

That machine used the concept of "Golay surrounds" which are based on hexagonal connectivity. There are 14 combinations of the six neighbours of a given pixel, ignoring surrounds which are identical under rotation. That approach allows for the topological analysis of an image so that the type and form of a white blood cell can be found.

After GLOPR, the binary image processor (BIP) followed. It could perform Boolean operations between corresponding pixels of two images, the cross-correlation of two images over a 3 × 3 window — producing nine correlation counts — and analysis of a

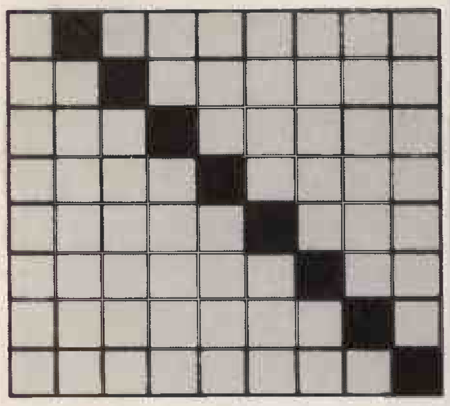

**Figure 2 (refer also to figure 3). (a) A single set of (black) connected points. The "link" instruction on Unger's machine used a special array to mark the position of vertical, horizontal and diagonal connections between adjacent points of the object.**

single image with a 2 × 2 window. BIP was again essentially a serial machine but cross-correlation was performed in a pipeline, giving a processing time of 20nS per pixel. The machine is now incorporated in a commercial system for alphanumeric data processing and storage.

The machines mentioned previously

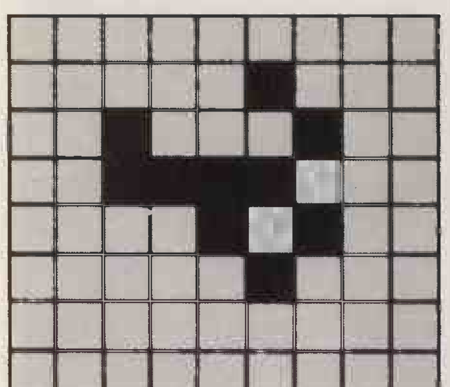

**Figure 2 (b). A paradox of 8-connectivity. Does the 8-connected line divide the array into separate regions?**

were all built in the United States. PICAP was built in Sweden. The heart of PICAP is a 3 × 3 array processor having nine shift registers, each four bits wide and 4,096 bits long. An image is processed sequentially, one 3 × 3 neighbourhood at a time.

Unlike GLOPR and BIP, PICAP has hardware to perform arithmetic operations on grey level images which are stored in the four-bit-wide shift registers. GLOPR and BIP work on binary images and will perform only bit-wise arithmetic under software direction. The PICAP system uses a serial mini-computer for controlling the parallel processor and the I/O.

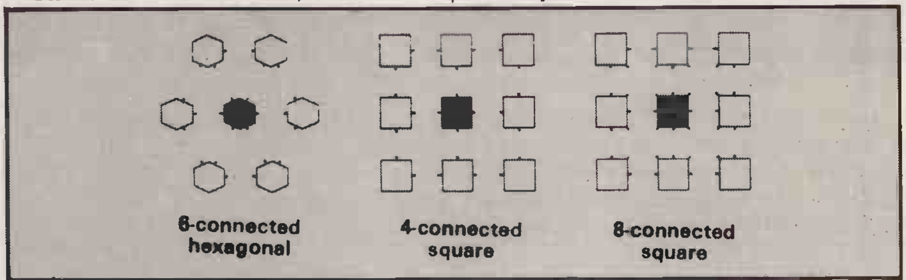


**Figure 3. Hexagonal and square connectivity.**

The previously-mentioned sequential cellular processors are considerably faster than a conventional computer. For most picture processing operations, however, all are surpassed by the CLIP — Cellular Logic Image Processor — computer, which is a truly parallel machine. The project started with the construction by M J B Duff of a special-purpose processor for the analysis of bubble chamber photographs. A more general architecture was investigated with the construction of CLIP 1 and CLIP 2 at University College, London. The design of the basic processing element was finalised and CLIP 3 was completed in 1973. The machine embodies physically the ideas proposed in the 1950s by Von Neumann and Unger. CLIP 3 is a 12 × 16 array processor operating in a SIMD mode. The basic PE is shown in figure 4.

## Binary outputs

There are two binary inputs to the Boolean processor, one of which is the logical image value — in the A register — and the other is derived from any combination of the neighbouring cells and the B register. The B register can be loaded with data from another image and can be used for two purposes.

If no neighbour inputs are allowed, the images in the A and B registers can be combined in a Boolean manner. If neighbour inputs are allowed, the contents of the B register can act as a "label" to put-out a specific object in the array of A registers — this will be explained in detail later.

The two binary outputs from the Boolean processor are independent. One is the new image value (the D output) and the other is routed to the immediate neighbours (N output). Either square or hexagonal connectivity for the array can be specified under program control.

On CLIP 3 there are only 16 bits of memory per PE so only 16 binary images can be stored. The small size of the array meant that although parallel algorithms could be investigated, real images could not be processed. CLIP 3 was constructed from SSI and MSI TTL and fitted into a 5 ft. × 20 in. × 18 in. cabinet. That meant that an array suitable for practical image processing would be very large — and expensive — if TTL were employed. The solution adopted was the commissioning of a custom-made integrated circuit. This chip will be used in CLIP 4, which will be a 96 × 96 array processor in a single 7 ft. × 20 in. 18 in. cabinet.

As an interim measure between CLIP 3 and CLIP 4, a scanned array was built, using CLIP 3 as the parallel processor. The 12 × 16 array is used in 48 positions to simulate a 96 × 96 array. The loss of speed is considerably greater than 48 times — in fact, 1,000-3,000 times — since the overheads of data shuffling are immense; but the machine is still much faster than an implementation on a minicomputer. The basic CLIP 4 cell is shown in figure 5.

## Threshold gates

The cell is little changed from that of CLIP 3. The threshold gate at the neighbour inputs is replaced by an OR gate, and a few gates and a flip-flop have been added to make it into a full-adder. The threshold gate produced a T output only when a specified minimum of neighbours produced a 'neighbour' output.

The function was little used and not considered worth implementing on the CLIP 4 chip. The provision of a full-adder in each processor speeds arithmetic processing by CLIP 4. Additionally, there is an increase in memory to 32 bits in CLIP 4.

The CLIP 4 integrated circuit is made in MOS on a chip 0.168 × 0.177 in. It contains eight processing elements. The chip design began about seven years ago and has been dogged by setbacks. The situation now looks brighter and CLIP 4 should be working shortly. For the 96 × array, 1,151 chips will be required. Each will cost about £12 because of limited production. The basic chip should be useful in building future array processors of different and larger configurations.

The CLIP 4 computer is interfaced to a PDB-11/10 minicomputer which runs the operating system. It will handle I/O assignment, image display, error traps, image transfer between CLIP and PDP peripherals, and interactive debugging. There is provision for the user to allow control to pass between the PDP-11 and CLIP so that a program can utilise serial and parallel processing.

The machines will not run concurrently. A development system has been written which allows CLIP to be programmed interactively. To the user it seems like an interpreter but it is an on-line editor and CLIP 4 assembler. There are also, of course, a standard editor, assembler and linker run by the PDP for CLIP 4 code generation.

A schematic of the overall CLIP 4 system is shown in figure 6. The basic form of image input is from a standard faster scan monochrome TV camera, but it can be taken from a VTR — analogue recording. The image is digitised into 64 levels (6 bits) in about 20mS (one TV scan) and an additional 24mS is required to input the whole grey image into the array. The basic instruction time of CLIP 4 is about 10 S and so a great many operations can be performed in the time it takes to intput an image.

For many processing applications the input time could be the limiting factor in throughput. For this reason other forms of visual input are being considered. A CCD camera can provide serial data faster than a standard TV system at up to 10 million picture points per second, compared to the 5 MHz rate used by the CLIP TV camera.

There are no systems on the market which provide a completely parallel output of picture data and, anyway, CLIP 4 could not handle a 96 × 96 data buts. The array is organised as 96 shift-registers of length 96 bits for data input and so the fastest system for CLIP 4 would be a camera providing a 96-bit-wide data stream.

CLIP is orientated specifically towards the manipulation of binary data. For the processing of grey pictures, however, arithmetic is required. The grey value of a pixel is stored as an integer with each bit in a different storage plane (figure 7). Integer addition, subtraction and multiplication have been implemented in bit plane arithmetic. Division is not feasible, since too many bits are required

Dr M J B Duff.

to achieve reasonable accuracy.

Even holding a few grey images in memory can use a considerable proportion of the storage available. Thus, judicious data manipulation is required if several images must be dealt with together.

CLIP 3 processors can act only as half-adders but additional circuitry in the CLIP 4 cell allows full-adder operation when performing bit plane arithmetic. Setting the R bit (figure 5) allows the C register to save the carry resulting from the addition of bits in the A and B registers — they are bits from the corresponding planes of two-bit plane numbers.

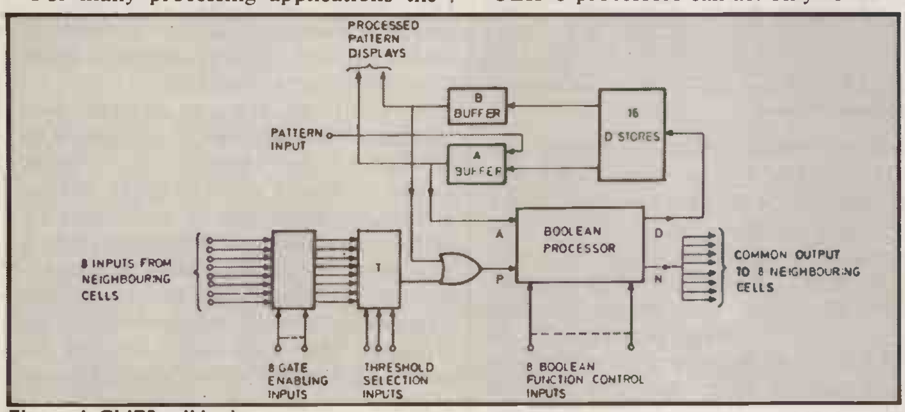


Figure 4. CLIP3 cell logic.

Setting the C control on the input gating passes the previous carry in the C register to the processor input, where it is added to the A and B registers which have been loaded with the next most significant bits of the numbers being added. The new carry is stored again in the C register and the process is reiterated to complete the addition of the two numbers.

The full-adder capability is also useful for executing sideways arithmetic on a single grey-level image. Such operations as adding and subtracting a pixel from a neighbour in a specified direction allow the implementation of a certain class of digital filters — binomial filters. They can be used for image smoothing, edge finding and enhancement.

An alternative representation of numbers is the binary column mode. Here, a single storage plane can hold 96 numbers, each of up to 96 bits. Floating point numbers can now be used and since any operation is performed on all 96 numbers at once, the time per number process is small, even though the CLIP processor handles arithmetic rather crudely.

For example, the simultaneous multiplication of 96 pairs of 16-bit integers would take about 800μ S on CLIP 4, giving an effective time of less than 10μ S per pair. For the addition of two 96 × 96 arrays of 16-bit integers (9,216 pairs) using bit plane arithmetic, the estimated processing time on CLIP 4 is about 170μ S, giving an effective time of only 18μ S per addition.

## First operations

The operation of the CLIP computer with regard to a specific image processing application will now be considered. In the automatic analysis of blood, one of the first operations is to distinguish the white and red cells. The former have nuclei while the latter do not have, and this fact can be used for separating the cells. For extracting a nucleated cell from an image containing nucleated and non-nucleated cells and various "blobs", The input

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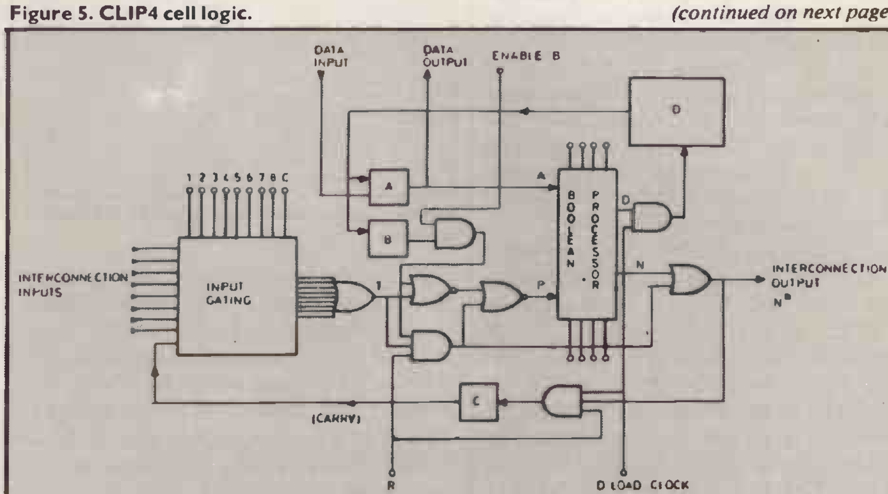


Figure 5. CLIP4 cell logic.

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image is binary; some pre-processing would be required to achieve this from a real input. The first step in the segmentation process is to extract the inner white areas of all cells. This is done by initiating a signal from the edge of the array — not visible in the figures — which is passed-on only by white pixels. The white pixels in the middle of the cells are surrounded by black and so do not receive this "propagation" signal, and so can be separated from other white pixels.

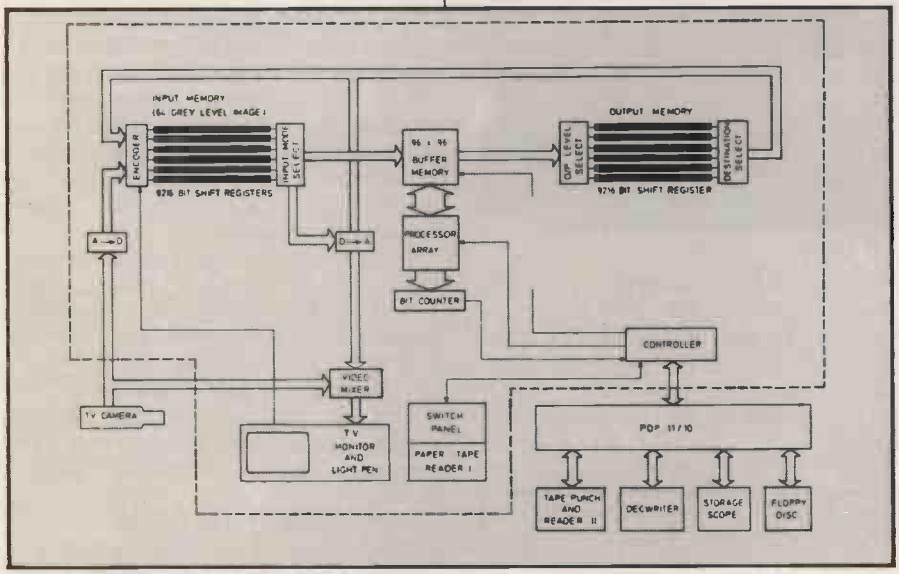


**Figure 6. Schematic of CLIP4 system and control minicomputer.**

This is an example of "global propagation" and takes 1.2µS for each pixel crossed in CLIP 4. A test on the overall array is made to discover when the process settles and the propagation signals disappear. The next instruction can then be executed.

All nuclei are than extracted, in much the same way as the inner white areas. They can now be used to extract the nucleated cells by a process known as "labelling". If the nuclei are expanded by one layer of pixels, they overlap the inner white areas of the nucleated cells. If the original image is loaded into the A register of CLIP and the expanded nuclei into the B register, propagation through white pixels can be initiated from the expanded nuclei.

Once the propagation signal reaches the cell wall it ceases and hence only the inner white areas of nucleated cells are extracted. The inner areas of nucleated cells can be expanded by one pixel layer and used as a label on the original image to extract the nucleated cells.

Of course, the algorithm can be altered easily to extract only the non-nucleated cells. The overall cell segmentation program consists of only six CLIP operations, each taking about 10µS, plus time for the propagation signal to circulate, giving an execution time of around 100µS. The same program was run on a simulation of CLIP 4 — but only a 32 × 32 array — on an IBM 360/651 mainframe and took 12 seconds to execute.

That is $10^5$ times slower than CLIP 4 but comparison of a simulation with hardware is not really fair. CLIP 4, however, is expected to be about one thousand times faster than the 360 performing picture processing operations on a 96 × 96 array. Since the instruction time for CLIP 4 is 10µS, the effective time for each pixel is 1µS, far shorter than any serial computer can manage. The TTL of CLIP 3 is five times faster than the MOS of CLIP 4 but since the array is 50 times smaller, the time per pixel operation is reduced to 10µS.

To many, image processing conjures ideas of image enhancement like that performed on space photographs by NASA. That, however, is only a very small part of the subject. The range of medical applications continues to grow. As mentioned previously, a cellular computer is now available commercially for the automatic analysis of blood smears. Automatic biopsy is also being pursued for detection of cancer and liver disease. The problems, however, are considerably greater than blood analysis, since the variation in input image is much greater. Work has also been done on the analysis of X-ray photographs, which will be very useful for mass screening.

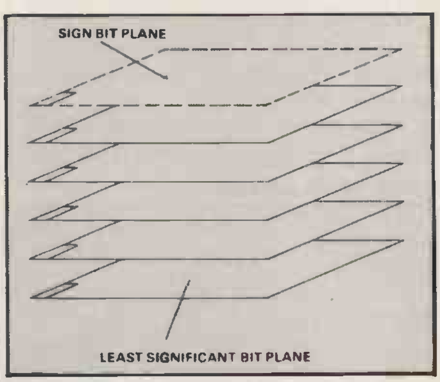


**Figure 7. Bit plane integer storage (17 shown stored).**

Fingerprint matching is an obvious candidate for an image-processing computer and it is anticipated that a commercial CLIP machine will be used eventually by the police for that purpose. Other applications for CLIP which have been investigated include lay-planning, egg inspection, texture analysis and cell analysis.

## Minimum length

Lay-planning is the process of laying-out patterns on a width of cloth so that the minimum length is used. That is a skilled job in the tailoring industry. A program operating on the scanned CLIP array processor takes 20 minutes to fit 12 pieces, but on CLIP 4 the execution time would reduce to about one second.

Egg inspection may seem a trivial problem but is a skilled and tiring task. Humans can inspect eggs at a rate of about five per second. A machine which could replace humans would need to be fast and CLIP 4 can provide that speed. The faults an egg can exhibit can be very subtle and considerable computing is required to enhance fine cracks or to pick out the mis-shapen eggs. The amazing power of human visual discrimination is always apparent when an attempt is made to replace a human inspector.

A study of texture analysis was instigated with the hope of applying it to LANDSAT photographs. Land areas exhibit different visual textures and so land-use analysis can be performed by texture discrimination. Texture analysis is also important in the field of metallurgy. Microscope images of the crystalline structure of a metal tell much about its strength and weakness and can be processed under a texture discrimination regime.

## Real time

The cell study has involved the analysis of the movement of a single-celled amoeba. It is hoped that CLIP 4 will provide a system for real-time measurement of amoeboid movement. The problem is really one of image segmentation, important in many image-processing applications. The source images are of varied type, have very poor contrast, and the desired object is usually rather fuzzy. Completely successful segmentation of the image is proving difficult to achieve.

A version of CLIP 4 eventually will be marketed commercially and should make available to industry many areas of image processing. Its speed and price — around £40,000 — will give CLIP a place on the production line for automatic inspection, and possibly a derivative machine will provide the image analysing power for the much-mooted industrial robot.

*Acknowledgment: Appreciation to Dr M J B Duff and all members of the image processing group of University College, London.*


# Modern technology showing its hand

Nick Laurie anticipates the season of peace and goodwill by reviewing electronic games. Many of these use microprocessors and the market seems brisk. Perhaps some readers will be inspired to write their own for next year.

PREHISTORIC spinning tops and throwing balls are familiar to many archaeologists, so it should not be much of a surprise to find that today's toys reflect today's technologies, with electronic toys more and more in the limelight. It is no great surprise, either, to find that many of them are sold on the strength of their ability to shoot, bomb and zap everything from submarines to Klingons.

Even the so-called 'educational' kits are not entirely immune. The Electronikit *Ex System* is a modular electronics kit, using discrete components packaged individually with common connectors. It can build, at various levels, doorbells, radios and logic gates. It is thoroughly 'educational', yet it has to be dressed in military green in an imitation diecast package to appeal to the customer.

To prepare this article, I wrote to 10 toy manufacturers asking for details of their latest offerings and it is interesting to see that all the material could be fitted fairly easily into one of three main categories — educational, intellectual/strategic, and inevitably, war; war being a term covering all forms of guns, bombs, and combat, whether 20,000 leagues under the sea or in the remote corner of a space pirate's empire.

In agreement with a number of educationalists, I would be very suspicious of the first category. Very few toys are more educational than another; man does most of his learning through play. His ability to handle real objects, and concepts, stems directly from his play experience with toys and by this criterion all toys, from a radio-controlled helicopter to a matchbox floating down the stream, must be classed as educational.

I suppose many of the 'less acceptable' items — although still among the most popular — such as guns, 'realistic' hand grenades, war games and the like can really be distinguished from chess or bridge only on the grounds of personal taste. Then, if one were still feeling philosophical, chess, too, would have to be re-considered in the light of other aggressive games.

So, to business. There can be no doubt that electronics has arrived in the toy market in a very real way. No more of the half-hearted radio-controlled tanks which fail on Boxing Day. Now here is the infra-red-controlled tank with a microprocessor heart, as sophisticated in many ways as the real thing. Lesney's new *Super* car can respond to instructions from a calculator-style keyboard, carried by a single infra-red beam and allowing up to nine kinds of movement.

The beam decoding and motor control is carried-out by a Texas Instruments calculator chip with 2,000 bytes of ROM,

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allowing for an absolute minimum of electro-mechanical parts.

*George*, the voice-operated delivery van, has a rather smaller repertoire of instructions, but will, in response to verbal commands, move forwards or backwards, turn right or left. At the same time he is built robustly enough to withstand a fair amount of abuse. How he does it, I'll leave you to try to discover.

Also from Actiongable, and probably containing much the same electronics as George, is *Ben*, a voice-operated dog which walks, stops, barks and wags his tail in response to your claps. He is complete with an 'acoustic hammer' for those who can't whistle; there are no prizes for guessing what he does not do, no matter how much you give him to drink.

On the same fun level as George, are Electroni-Kit *Mechanimals*. Meccano-like but rather more modular, the constructions walk, hop, crawl and jump their science-fictional way across almost any surface. They are not really electronic, since their electrical involvement ends at the level of motors, but they are well worth mentioning, since they serve as superb mobile bases for robot builders.

Moving further into the field of modern electronic toys, we find the variants on pocket calculators, synthesisers and even computers. *Lil Genius* has the format of a very simple pocket calculator, dressed-up with garish printing to look like a schoolteacher and with flashing eyes which signal approval or dismay at your attempts to answer the arithmetic problems it poses.

## For music

That mini synthesiser, the *Stylophone*, is still going strong under Rolf Harris' wing with a big brother now on the market. *Compute-a-Tune* goes even further with the ability to recall your compositions, arrange them to a given tempo and add effects like echo and note mixing. A few years ago this instrument was the dream of many a rock group.

There are a number of simpler musical instruments, described variously as electronic organs or pianos, based on a simple tone generator with either electronic or manual keyboards. Many of them can provide cheap but acceptable music for the child starting on a musical career.

Then there are television games, where the field is now so big that nothing short of a full review would suffice, and even that would be hopelessly out-of-date by the time it was published. Those games are becoming more sophisticated, more adaptable and more complex every few weeks, and the ubiquitous micro is there more and more.

Toys have always been used in the imitation of the adult or 'real' world, possibly nowhere more blatantly than in the field of weaponry. From the Ideal Toy Company, *Tin Can Alley* has a beam of light from a rifle which causes a row of spring-loaded tin cans to hurl themselves around the room whenever they are 'shot'.

From Harrods there is the *Sonic Fazer Computer Gun* which, according to the literature, uses a 'computer chip' to produce sounds including 'Anti Gravity', 'Ion Transport', 'Radiate' and the even more mysterious 'Mass Invert'. To round it off the American manufacturers have included what they call an 'inter-space voice projector'.

There are variations on this theme and I would not be too surprised to see them kitted-out with infra-red sights or laser rangefinders before long.

## Serious in intent

Often disguised as military games but nevertheless much more serious in intent are the games of strategy. Into this category falls by far the largest number of games and once again there are big inroads from the electronic industry. Initially, electronics is being used for scoring purposes, often programmed to add a few special effects from time to time but still relying largely on traditional materials and schemes.

*Intercept* from Action Games is described as a 'Search and Destroy' game, with one player manipulating an attack jet through a battlefield to bomb an airbase. Sam missiles, interceptors, flashing lights and a host of whistles, bangs and flashes bring it to life.

MB Electronics offers *Computer Battleship*, another hybrid using a complex game board covered in plastic ships and pegs with a built-in computer to model the field of battle, keep track of the scores, and supply a stream of assorted sonar 'pings', missile whistles and, of course, the inevitable explosions.

The Waddington *Sonic UFO* is a strange combination of board game and bleep-emitting-UFO In which the players have to identify a position entirely on the level of sound being emitted. The same firm's *Code Name: Sector* has the participants hunting a very strong-willed submarine over a traditional board but with the addition of a complex console full of electronic strategy, scoring and sound.

Along slightly more traditional lines run various chess and backgammon players, complemented by the runaway success of the Invicta *Mastermind* — again with many copies around under different names — and the arrival of variants like *Blackjack* from Actiongable; a pocket calculator with the ability to deal hands of blackjack when not engaged in pocket calculating; and *Bridge Challenger* from Computer Games Ltd, a box of tricks which can play from one to four hands under most of the common systems, reading the specially-encoded cards as they are dealt to it. This game, incidentally, uses two microprocessors and has 168KB of ROM and 8½KB of RAM.

While on the subject of the paramilitary, it is worth mentioning that walkie-talkie sets have progressed a very long way since the days when I tied together two tin cans with a piece of string and tried to discover whether we were hearing the message over the string or through the air. The *Inter-Galactic Communicator* from Harrods may not live up fully to its name but it uses modern low-cost electronics to give the kind of clarity and power one expects from the real thing.

To my mind, realism in its most addictive form is heralded most clearly in *Master Blaster* from Spectrum. A hand-held plastic moulding contains a small display screen and a fire button, together with a three-way selector switch and various odds and ends. Periodically at a slow setting a flying saucer screams, literally, down the display and you have to select the correct track for an anti-UFO missile which you launch, with full sound effects, and which hopefully blows up the invader, again with much audio accompaniment. If you miss, you blow up.

We find that our information reaches us via electronic links. Many electronically-operated channels can produce strong emotional and psychological reactions — the doorbell, the telephone or even Orson Welles on the radio warning us of the landing of the Martians. All these and many other inputs can be simulated, synthesised or copied electronically and it seems likely that some of the toys and games of the next decade will be able to simulate them and other effects to give us a co-ordinated and very real experience — for example, the complete launch of a moon rocket from the astronaut's point of view or the flying of an aircraft or an invasion from Mars.

## Displays

Perhaps the biggest problem in the development of computerised adult toys is still the business of displays. While electronic dials, lights and sounds can and will go a long way towards creating a realistic atmosphere, the fact that many of the strategy games still rely on cardboard playing areas and much shuffling of plastic bits must be a source of annoyance to games manufacturers.

The imagination leaps to animated holograms: *Middle Earth, Dungeons and Dragons* and other fantasy games in which participation can become so realistic that it might seem real for the players. Fantasy games were quick to respond to the arrival of the personal computer, used largely to keep track of the convoluted scoring systems used in this field, but given the possibility of ever more ingenious use of ever more powerful micros, the business of boys and games may be set for a major change of direction.

# Computer paymasters have to be convinced

**Dave Hemmings of Sandbach High School shows how to put an arm-lock on computer-wary administrators.**

IF YOU are in the unfortunate position of wanting to start computing studies in your school but find it hard to convince people that it is a good idea, there are no easy answers, but what follows might provide you with some ideas.

The worst thing about a computer is that it is costly and, as anyone in any school will tell you, that is a disadvantage. Even a second-hand terminal will cost £200 and the service contract on that will probably be another £150 a year.

If you manage to wring that meagre sum from the bureaucrats you still have the cost of an acoustic coupler — to link your terminal to some remote computer; and the telephone bills — you will use telephone lines. Not least, there is the computer time to buy. Trying to justify the expenditure is, to put it mildly, difficult. If the controllers of the purse-strings know nothing about computing, you may feel like giving-up the idea and investing what you have in slide rules.

You are short of money and talking to a headmaster who has a BA in Ancient Greek history. He knows nothing about computers and hopes microprocessors will go away. What do you do? The answer is simply to make the computer do something really useful. There are two obvious options, Computer Assisted Learning and administration — see his eyes light up at that last suggestion.

Computer Assisted Learning is a process by which the computer instructs and tests individual pupils. It is limited by the accessibility of the machine and the number of terminals available — so forget it. Except perhaps as a one-off demonstration program teaching English-French translation or multiplication tables — or Ancient Greek history. It is a method of instruction which is bound to grown as the cost of computer hardware falls but at the moment it is probably not for you.

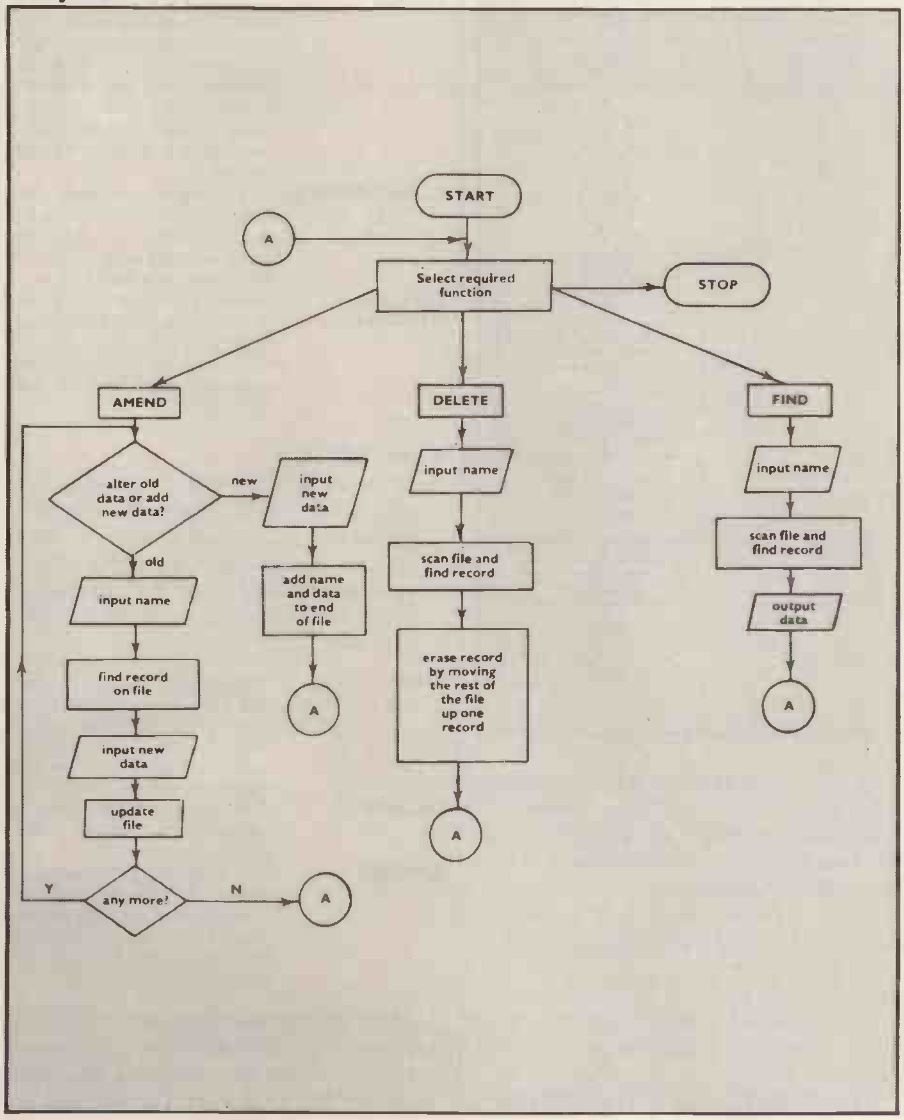
On the other hand, administration provides endless scope for the computer and is something the headmaster will understand immediately. Time tabling springs to mind as an immediate application but it presents major problems for the programmer, and even commercially-available programs cannot produce successful timetables from simple raw data. So put it aside.

The creation of a databank of facts and figures about the pupils in the school might also suggest itself.

Sandbach High School has been involved in the field of computer education for more than four years. We have an on-line terminal linked to the computer at the South Cheshire College of Further Education at Crewe. It is used extensively as a teaching facility and it is also employed as an administrative workhorse. For three years, it has handled the sorting and collating of the fourth-year option scheme and has more than earned its place, and its keep.

More recently the school has acquired its own machine, an 8080-based micro with 48K of RAM and twin floppy discs designed for the school by Real Time Computer Systems of Crewe. It meant that the system, developed originally at the college had to be re-written in Microsoft Basic for use in the school.

**SAISJHTED**




## Fast printer

Both machines are well suited to data processing use. At the college there is a 16-bit Data General Nova 2 configured with six on-lines, disc operating system, disc backing store and a fast printer.

Our machine is designed to handle a number of slave terminals but has no fast printer. It is slower than the 16-bit Nova 2 but has ample file space on the discs. The sample outputs shown are printed on an Olivetti TE300 terminal from the school micro.

Fortunately, both the Data General and Microsoft versions of Basic allow for sophisticated data processing — arrays of

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any size (almost), strings (ditto), file-handling with random access and read-or-write-only files; in short almost the perfect basis for largish data processing.

So, it you want to justify your subject or you want to make yourself useful, why not write something like our fourth-year option scheme package.

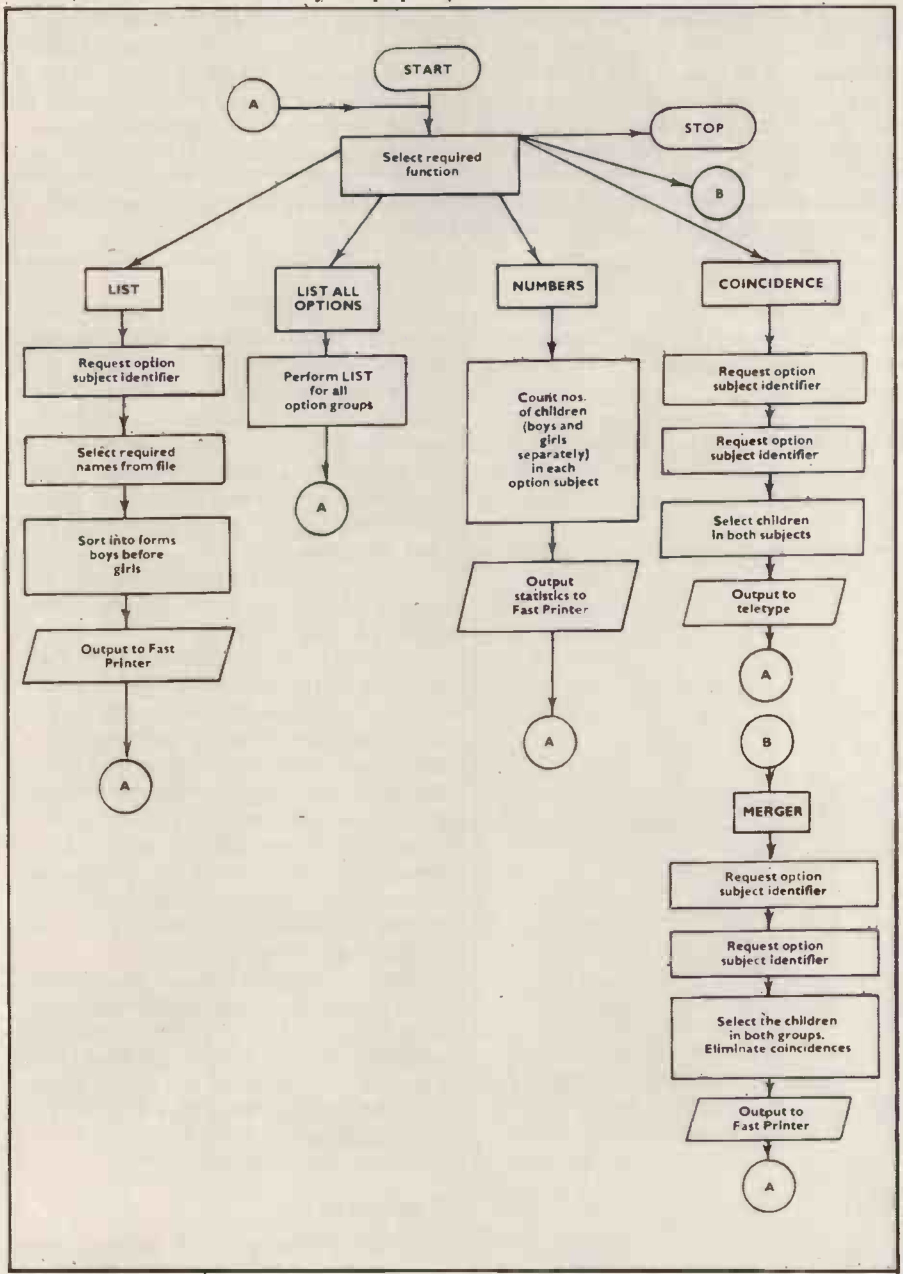
At the end of the third year pupils choose the examination subjects they will follow in their fourth and fifth years. The subjects offered can vary considerably from year to year but the system used to organise the choices remains constant.

Each child chooses five option subjects, one from each of five groups A-E. The programs allow for a maximum group size of 20 subjects. In addition, the pupil chooses a leisure option (L) and is placed in an English and a mathematics group (G and H — no choice here).

The information is recorded for use by the computer in the form of an ordered data file. Each record contains the name, sex and form of the child, followed by eight numbers denoting the option choices. A typical record might be:

J. SMITH (G) 3L, 1,4,3,4,6,2,8,4

A the girl in 3L has chosen option subjects A1, B4, C3, and so on. Another data file stores the titles for each option subject — A1 is physics, B4 is geography.




**SA1SJHMP6L**

So much for the raw data. The suite of programs described is designed to process the data for use within the school. There are four main programs:

| | |
|---|---|
| SA1SJHMP6L: | produces listings of pupils in each option subject, along with numerical statistics. |
| SA1SJHTED: | allows the data file to be altered, appended or shortened. |
| SA1SJHSORT: | sorts the data file alphabetically. |
| SA1SJHLIST: | lists the data file. |

The incredible program names are an administrative requirement of the computer system.

SA1SJHMP6L and SA1SJHTED are described in some detail. SA1SJHSORT is a classical bubble sort; although fairly slow in sorting a completely disordered file, it is extremely fast in sorting a partially-ordered file. It is used whenever new data is added to the file.

SA1SJHLIST produces a listing of the (ordered) data file. A copy is kept in the school office; if any child needs to be found within the school, the list can be used to locate his or her classroom by comparison with the master timetable.

- **SA1SJHMP6L**

  This program is concerned with the organisation and collation of the data file. During operation, the user is asked for certain command keywords:

| | |
|---|---|
| **LIST:** | The program allows the user to type-in the option group and number of any option subject — for example, "D4". An alphabetically-ordered listing by forms, boys before girls, is then made on the printer. |
| **NUMBERS:** | The program scans the data file, counting the numbers of children in each option subject. Results are obtained for total numbers and for numbers of boys and of girls. |
| **MERGE:** | The program requests the identifiers of any number of option subjects and merges the groups to produce an ordered listing within which coincidences have been eliminated — useful where a subject occurs in two option groups. |
| **COINCIDENCE:** | The program requests the identifiers for two option subjects. It then searches for pupils who appear in both and prints-out an ordered list. |
| **LIST ALL OPTIONS:** | The program prints-out automatically the contents of each option subject from A1 to H20. It is a repeated and automatic application of the LIST facility. |

- **SA1SJHTED**

  With children leaving or entering the school or, worse, altering their option choices, it is necessary to have some system to edit the data file. This program, acting on the following command keywords, performs this function:

| | |
|---|---|
| **FIND:** | The program requests a name and then scans the data file looking for that name. When located, the name and all associated option choices are output to the terminal. |
| **DELETE:** | The program requests a name, scans the file, and deletes the record. |
| **AMEND:** | The program again requests a name and finds it; the user types-in new data to substitute for the old. It may also be used to add new names to the end of the data file. |

Those are the main programs within the package. Other programs are, of course, necessary. There are programs to create the data files, to append the files and to produce copies of the files.

In addition, there is one program which has proved particularly useful — SA1SJHPPLS. At the beginning of the fourth year all fourth-year form teachers are issued with a printout from this program. It produces a listing of all option choices for each pupil organised by form. So the form teacher of form 4R, for instance, knows which options each of the children in his class should be following.

The most recent addition to the package is a program which prints-out individual timetables for each child. The master timetable is built into the program, which accesses the data files to produce the output.

The usefulness of the programs detailed must be self-evident. They have been used extensively and their superiorty over any manual system of data processing is obvious. Information is available more quickly and it is presented well and more of it is available. For example, a program has been written to identify the relative popularity of all combinations of three subjects chosen from five, a task which takes the computer minutes but would require many man-hours of human processing.

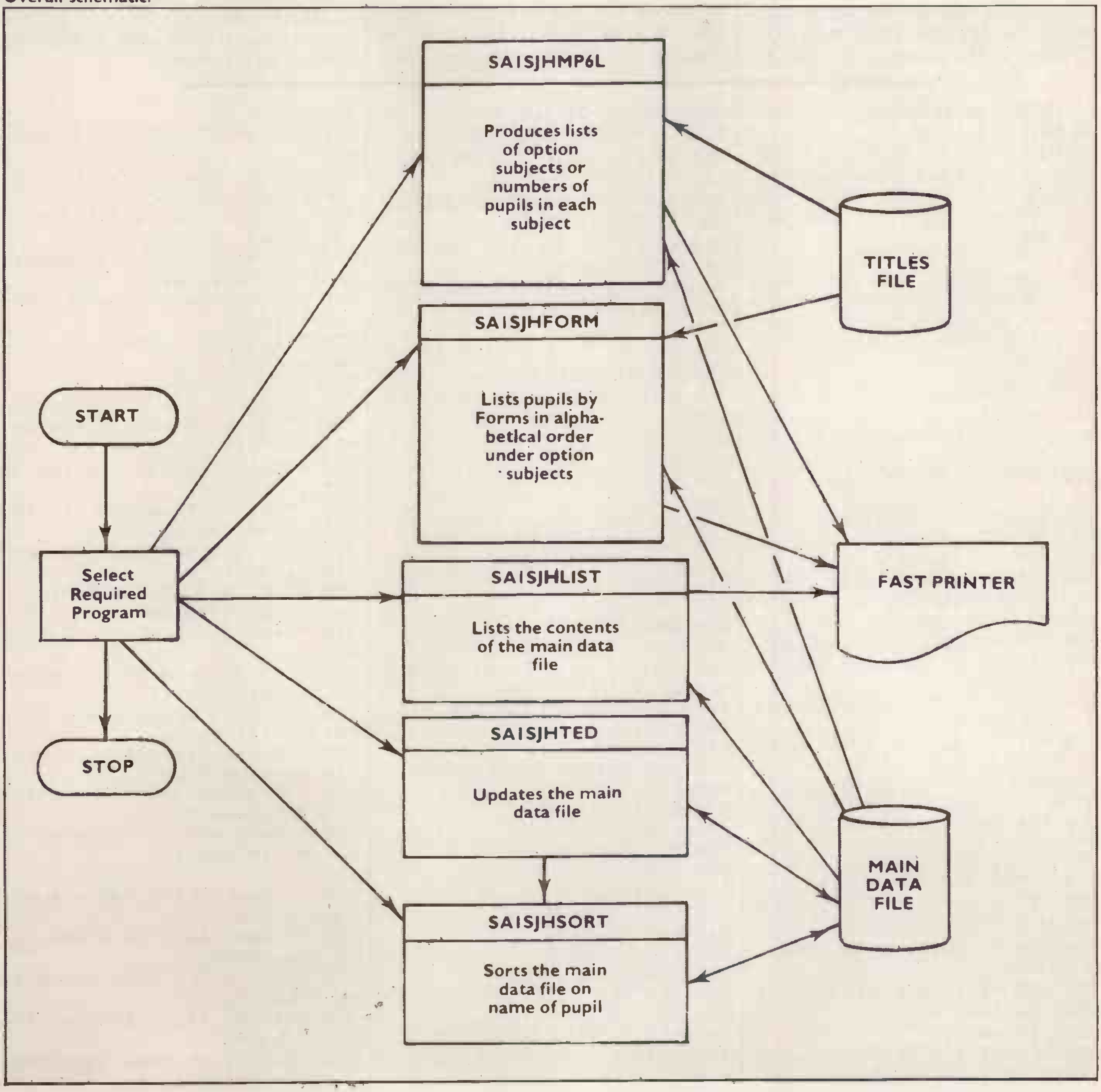
Although the Sandbach programs undoubtedly saves a great deal of time in the construction of lists and statistics, they also make great demands in terms of data preparation. Someone has to type-in all the names and option choices and all the data has to be checked before it can be used. The data has to be prepared only once, though, and it can be achieved in a reasonable time, perhaps an hour and a half for 200 names.

A word of warning. Anyone who decides to write any kind of administrative package must be prepared to spend a good deal of time programming and debugging. The exercise is probably not cost-effective for those whose programming skills are only slightly better than those of the children.

Having decided to use the machine in this way, however, be prepared for an avalanche of requests for additional facilities and even a computer thrust on you by a classicist tired of data processing by hand.

Finally, my thanks to those who have helped to make these systems operational, especially Don Grimsditch and Dave Pugh at SCCFE for allowing me to use their computer — and miles of paper.

**Overall schematic.**



# Startraders can keep you busy for six hours

**STARTRADERS may not be the biggest game in the world but it is certainly the longest we have published. It concerns the economies of starships trading betwen primitive and developed solar systems.**

**Deal in software, uranium and other goods of a futuristic character. Copes with two to 12 players. Allow at least six hours for a game; if you have to stop, there is a subroutine to save the variables for the next session.**

The program is in two parts: *Trades* sets up the game; *Sedrat* runs it. *Trades* needs 7.4KB, *Sedrat* 17.5KB in Research Machines Extended Disc Basic.

To adapt the program to other machines, the main problem will probably be with lines like 3290: 'OPEN # 10, "O", "TRDV"'. This opens a disc file for output ("O"), called 'TRDV' and henceforth identified to the computer as Channel 10. So, line 3300: 'MAT WRITE # 10, S . . . etc' stores the values of the matrices S, T . . . in the file TRDV to be read back by *Sedrat*. To adapt the program to languages without that command, one would have to read each variable from each matrix with a FOR loop and then store it in a sequential file, and vice versa.

The last line of *Trades* is 'LOADGO SEDRAT' which will load and run the second program of the game. Failing that, you can do it manually.

```
10 REM Q.J. North.
20 REM Brighton.
30 REM This is the first part of a two-part program. This part sets up the game. 'LOADGO "SEDRAT"' starts the second part.
40 REM The file 'TRDV' contains the values for the game.
50 REM USES 7,379 Bytes  (Cor!! in'it cleva!)
60 CLEAR 1000
70 ERASE"TRDV"
80 GOSUB 3240
90 DIM S(12,15),T(12,12),T$(12),B(3,12)
100 'COM W,D9,K9,X9,D1,X1,P9,T9,S9,Y9,H
110 'COM Y1,R9,G9,Q,M(6,3),C(6,3)
120 DIM M(6,3),C(6,3)
130 DIM N$(12)
140 'COM S1,T1,R
150 DIM P(6),Q(6),G(6)
160 'COM H3,H4
170 REM STAR TRADERS
180 REM *GAME SET UP MODULE*
190 REM S IS THE STAR SYSTEM INFO ARRAY
200 REM T IS THE TRADING SHIP INFO ARRAY
210 REM T$ IS THE TRADING SHIP NAME STRING
220 REM M AND C DETERMINE A STAR'S PRODUCTIVITY/MONTH
230 REM PROD/MO.=S(7,J)*M(I,R1)+C(I,R1)
240 REM WHER J IS THE STAR ID #,I THE MERCHANDISE #,
250 REM AND R1 IS THE DEVELOPMENT CLASS OF THE STAR
260 REM B CONTAINS THE BANK ACCOUNTS
270 REM A$ IS THE STANDARD INPUT BUFFER
280 DIM A$(6)
290 REM R9 IS THE SPEED OF A SHIP IN LIGHT-YEARS PER DAY
300 REM D9 IS THE MINIMUM DISTANCE ALLOWED BETWEEN STARS
310 REM Q IS THE PROBABILITY OF A DELAY
320 REM K9 IS THE MAX NUMBER OF BIDDING ROUNDS
330 REM W IS THE MAX WEIGHT OF A TRADING SHIP
340 REM X9 CONTROLS THE PROFIT MARGIN; HIGH X9 LIMITS THE %
350 REM G9 IS THE STELLAR DEVELOPMENT INCREMENT 1<=G9<=5
360 REM R=1 IF THIS IS A RESTART
370 R9=2/7
380 D9=15
390 S9=8
400 X3=2
410 Q=.1
420 GOSUB 2990
430 K9=3
440 W=30
450 X9=36
460 G9=1.25
470 R=0
480 REM D1 IS THE DAY OF THIS YEAR (1<=D1<=360)
490 REM Y1 IS THIS YEAR
500 D1=1
510 Y1=2070
520 REM SET UP ECONEMETRICS MODEL
530 RESTORE 2950
540 FOR XX=1TO6
550 FOR YY=1TO3
560 READM(XX,YY)
570 NEXT YY
580 NEXT XX
590 FOR XX=1TO6
600 FOR YY=1TO3
610 READ C(XX,YY)
620 NEXT YY
630 NEXT XX
640 REM **BLOCK #1
650 ?"Instructions:(Type Y or N)";
660 INPUT A$
670 IF A$="N" THEN GOTO 1000
680 ?
690 ?"The date is Jan 1,2070 and interstellar"
700 ?"flight has existed for 70 years. There"
710 ?"are several star systems that have been"
720 ?"colonized. Some are only frontier "
730 ?"systems, others are older and more"
740 ?"developed.
750 ?
760 ?" Each of you is the captain of two"
770 ?"interstellar trading ships. You will"
780 ?"travel from star system to star system,"
790 ?"buying and selling merchandise. If you"
800 ?"drive a good bargain you can make large"
810 ?"profits."
820 ?
830 ?" As time goes on, each star system will"
840 ?"slowly grow, and it's needs will change"
850 ?"A star system that now is selling much"
860 ?"uranium and raw metals cheaply may not"
870 ?"have enough for export in a few years."
880 ?
890 ?" Your ships can travel about two"
900 ?"lightyears in a week and can carry"
910 ?"up to "W" tons of cargo. Only class"
920 ?"I and class II star systems have "
930 ?"banks on them. They pay 5% interest and"
```

```
940 ?"any money you deposit
on one planet is"
950 ?"avaliable on another--
Provided there"
960 ?"is a local bank."
970 ?
980 ?" frontier systems, oth
ers are older and more devel
oped."
990 REM ***BLOCK #2
1000 ?"Have all the players
played before (Y or N)";
1010 INPUT A$
1020 ?
1030 IF A$="Y" THEN GOTO 105
0
1040 GOTO 1170
1050 ?"Set up your own game"
;
1060 INPUT A$
1070 ?
1080 IF A$="Y" THEN GOTO 117
0
1090 ?"Is this a restart";
1100 INPUT A$
1110 IF A$="Y" THEN GOTO 118
0
1120 ?"How many players";
1130 INPUT P9
1140 IF P9>=2 AND P9<=12 THE
N GOTO 1830
1150 ?"2 To 12 Can play"
1160 GOTO 1120
1170 GOTO 1310
1180 ?"Filename";
1190 INPUT A$
1200 REM (Open old file 'A$'
)
1210 REM FOR I=1 TO 12
1220 REM (Input from old fil
e:T$(I),N$(I)
1230 REM NEXT I
1240 REM (Input from old fil
e:
1250 REM W,D9,K9,X9,D1,V1,P9
,T9,S9,Y9,T1,S1,H3,H4,H )
1260 REM (MAT READ From old
file:
1270 REM S,T,B,P,C,M,Q,G )
1280 R=1
1290 REM (Close old file)
1300 GOTO 3280
1310 ?"How many players";
1320 INPUT P9
1330 ?
1340 IF P9>=2 AND P9<=12 THE
N GOTO 1370
1350 ?"2 To 12 can play"
1360 GOTO 1310
1370 ?"How many ships per pl
ayer";
1380 INPUT X
1390 ?
1400 IF X<1 THEN  GOTO 1370
1410 T9=P9*X
1420 X3=X
1430 IF T9<=12 THEN GOTO 147
0
1440 ?"I can't keep track of
 more than 12 ships"
1450 ?P9;" Players times";X;
" ships makes";T9
1460 GOTO 1370
1470 ?"How many star systems
";
1480 INPUT S9
1490 ?
1500 IF S9>=4 AND S9<=13 THE
N 1530
1510 ?"From 4 to 13 stars"
1520 GOTO 1470
1530 ?"Enter the length of g
ame in years";
1540 INPUT X
1550 ?
1560 IF X>=1 AND INT(X)=X TH
EN 1590
1570 ?"Choose a positive int
eger"
1580 GOTO 1540
1590 Y9=Y1+X
1600 ?"What's the max tonnag
e (Usually 30)";
1610 INPUT W
1620 ?
1630 IF W<25 THEN GOTO 1600
1640 ?"What's the minimum di
stance between stars (Usuall
y 15)";
1650 INPUT D9
1660 ?
1670 IF D9<=25 AND D9>=10 TH
EN GOTO 1700
1680 ?"Min spacing 10, max 2
5"
1690 GOTO 1640
1700 ?"How many bids or offe
rs (Usually 3)";
1710 INPUT K9
1720 ?
1730 IF K9<1 THEN GOTO 1700
1740 ?"Set the profit margin
 (1,2,3,4 or 5)..."
1750 ?"The higher the number
, the lower the"
1760 ?"profit %...Usually se
t to 2"
1770 ?"Your number";
1780 INPUT X9
1790 ?
1800 ?"WOW!...This will take
 a while!"
1810 X9=18*FNM(ABS(X9),5)
1820 REM ***BLOCK #4.1
1830 S(11,1)=0:S(12,1)=0
1840 T9=P9*X3
1850 S(7,1)=15
1860 REM ***BLOCK 4.2
1870 H=1
1880 S1=2
1890 GOSUB 2460
1900 S1=3
1910 GOSUB 2460
1920 S1=4
1930 GOSUB 2550
1940 FOR S1=5 TO S9
1950  ONS1-3*INT((S1-1)/3) G
OSUB 2460,2550,2600
1960 NEXT S1
1970 REM ***BLOCK#4.3
1980 FOR S1=1 TO S9
1990 FOR J=1 TO 6
2000 S(J,S1)=0
2010 NEXT J
2020 IF S1>1 THEN GOTO 2050
2030 I=1
2040 GOTO 2090
2050 I=4*INT(14*RND(10))+5
2060 FOR J=2 TO S1-1
2070 IF I=S(8,J) THEN GOTO 2
050
2080 NEXT J
2090 S(8,S1)=I
2100 S(9,S1)=270
2110 S(10,S1)=Y1-1
2120 NEXT S1
2130 GOSUB 3150
2140 REM *** BLOCK #4.4
2150 T1=1
2160 ?
2170 ?
2180 ?"Captains,name your sh
ips (Up to 6 letters/blanks/
numbers)"
2190 FOR I = 1 TO T9/P9
2200 ?
2210 FOR P1=1 TO P9
2220 T(1,T1)=0:T(2,T1)=0:T(6
,T1)=0
2230 T(3,T1)=15
2240 T(4,T1)=10:T(5,T1)=10
2250 T(7,T1)=25
2260 T(8,T1)=1
2270 T(9,T1)=D1
2280 T(10,T1)=Y1
2290 T(11,T1)=5000
2300 T(12,T1)=0
2310 ?TAB(5);N$(P1);" What d
o you christen your ship #";
I;
2320 INPUT T$(T1)
2330 T1=T1+1
2340 NEXT P1
2350 NEXT I
2360 REM *** BLOCK #4.5
2370 FOR B1 =1 TO P9
2380 B(1,B1)=0
2390 B(2,B1)=D1
2400 B(3,B1)=Y1
2410 NEXT B1
2420 'CHAIN"TRADES"
2430 GOTO 3290
2440 REM *** GOSUBS FOLLOW *
**
2450 REM <FRONTIER>
2460 X=(RND(10)-.5)*100
2470 Y=50 *RND(10)
2480 IF(ABS(X)<25) AND (Y<25
)THEN GOTO2460
2490 F=1
2500 GOSUB2730
2510 IF F=0 THEN 2460
2520 S(7,S1)=0
2530 RETURN
2540 REM *** <UNDERDEVELOPED
>
2550 E=100
2560 GOSUB 2650
2570 S(7,S1)=5
2580 RETURN
2590 REM *** <DEVELOPED>
2600 E=50
2610 GOSUB 2650
2620 S(7,S1)=10
2630 RETURN
2640 REM *** <GENERATE CO-OR
DS>
2650 X=(RND(10)-.5)*E
2660 Y=RND(10)*E/2
2670 F=1
2680 GOSUB 2730
2690 IF F=0 THEN 2650
2700 RETURN
2710 REM ***<TEST STAR CO-OR
DS>
2720 REM FIRST CONVERT CO-OR
DS TO NEXT HALF BOARD
```

*(continued on next page)*

*(continued from previous page)*

```
2730 ON H GOTO 2840,2800,2780,2740
2740 Z=X
2750 X=-Y
2760 Y=Z
2770 GOTO2840
2780 Y=-Y
2790 GOTO2840
2800 Z=X
2810 X=Y
2820 Y=Z
2830 REM SECOND,TEST PROXIMITY
2840 FOR J=1 TO S1-1
2850 IF SQR((X-S(11,J))↑2+(Y-S(12,J))↑2)>=D9 THEN 2880
2860 F=0
2870 RETURN
2880 NEXT J
2890 REM FINALLY,ENTER CO-ORDS AND INCREMENT HALF-BOARD CTR
2900 S(11,S1)=INT(X)
2910 S(12,S1)=INT(Y)
2920 H=1+(H<=3)*H
2930 RETURN
2940 REM ***DATA FOR ECONOMETRIC MODEL FOLLOWS ***
2950 REM MODEL #1
2960 DATA -.1,-.2,-.1,0,-.1,-.1,0,.1,.1,-.1,.1,0,.1,.2,.1,.1,-.1,0
2970 DATA 1,1.5,.5,.75,.75,.75,-.75,-.75,-.75,-.5,-1.5,.5,-1,-1.5
2980 DATA -.5,.5,1.5,-.5
2990 FOR XX=0 TO 12
3000 FOR YY=0 TO 12
3010 T(XX,YY)=0
3020 NEXT YY
3030 NEXT XX
3040 FOR XX=0TO3
3050 FOR YY=0TO12
3060 B(XX,YY)=0
3070 NEXT YY
3080 NEXT XX
3090 FOR XX=0TO12
3100 FOR YY=0TO15
3110 S(XX,YY)=0
3120 NEXT YY
3130 NEXT XX
3140 RETURN
3150 ?
3160 ?TAB(5);"Now identify yourselves"
3170 ?
3180 FOR I=1 TO P9
3190 ?"  Captain ";I;
3200 INPUT N$(I)
3210 NEXT I
3220 RETURN
3230 END
3240 DEF FNM(X,Y)
3250 IF X<Y THEN FNRETURN Y
3260 FNEND X
3270 RETURN
3280 ERASE"TRDV"
3290 OPEN #10,"O","TRDV"
3300 MAT WRITE #10,S,T,B,M,C,P,Q,G
3310 FOR I=1 TO 12
3320 PRINT #10,T$(I),N$(I)
3330 NEXT I
3340 WRITE #10,W,D9,K9,X9,D1,X1,P9,T9,S9,Y9,H,Y1,R9,G9,Q,S1,T1,R,H3,H4
3350 CLOSE #10
3360 LOADGO"SEDRAT"
```

SEDRAT

```
10 '*** <?#2 Is output to the printer> ***
20 '*** <Zis is da secunt pardt.> ***
30 '*** <USES 17.445K!! SHOCK HORROR> ***
40 '***
50 '*** <Q.J.North,> ***
60 '*** <92 Hanover st.> ***
70 '*** <Brighton.> ***
80 '***
90 CLEAR 5000,1
100 GOSUB 7930
110 DIM S(12,15),T(12,12),T$(12),B(3,12)
120 ZZ$="     UR     MET      HE     MED     SOFT    GEMS"
130 DIM M(6,3),C(6,3)
140 DIM O$(12)
150 DIM P(6),Q(6),G(6)
160 GOSUB 7280
170 '*** <STAR TRADERS> ***
180 '** <MAIN MODULE> **
190 '** <SET UP CALENDER AND STAR SYSTEM NAMES> **
200 C$="JANFEBMARAPRMAYJUNJULAUGSEPOCTNOVDEC"
210 S$="SOL PROXHELLCENTJINXKZINDUMEMOTEYORKBOYDIVANREEFLOOK"
220 S$=S$+"KRISFATE"
230 '** <S IS THE STAR SYSTEM INFO ARRAY> **
240 '** <T IS THE TRADING SHIP ARRAY> **
250 '** <T$ IS THE TRADING SHIP NAME STRING> **
260 '** <P CONTAINS THE FAIR PRICES ON THE LOCAL PLANET> **
270 '** <Q HAS THE FIXED PRICES> **
280 '** <B HAS THE BANK ACCOUNTS> **
290 RESTORE 330
300 FOR XX=1 TO 6
310 READ Q(XX)
320 NEXT XX
330 DATA 5000,3500,4000,4500,3000,3000
340 N$="     UR    MET     HE    MED   SOFT   GEMS"
350 '** <FNZ COMPUTES THE PRICE WINDOW THROUGH WHICH A> **
360 '** <BID IS ACCEPTABLE FOR FURTHER HAGGLING> **
370 DEF FNZ(X)=(FNY(X)*.5-(NOT FNY(X))*X)/(2*ABS(S(I1,S1)))/K1
380 DEF FNY(X)=-(X>=ABS(S(I1,S1)))
390 '** <R9 IS THE SPEED OF A SHIP IN LIGHTYEARS PER DAY> **
400 '** <D9 IS THE MINIMUM DISTANCE BETWEEN STARS> **
410 '** <Q IS THE PROBABILITY OF A DELAY> **
420 '** <K9 IS THE MAX NUMBER OF BIDDING ROUNDS> **
430 '** <W IS THE MAX WEIGHT OFA TRADING SHIP'S CARGO> **
440 '** <X9 CONTROLS THE PROFIT MARGIN> **
450 '** <G9 IS THE STELLER DEVELOPMENT # INCREMENT> **
460 '**
470 '*** <BLOCK #5> ***
480 '**
490 I=BRK(0)
500 IF R=1 THEN 530
510 H3=1:H4=1
520 GOTO 730
530 GOSUB 5380
540 GOSUB 6550
550 FOR T2=1 TO T9
560 IF T2=T1 THEN 650
570 L=(T2-1)*6+1
580 S3=T(8,T2)
590 IF S3=0 THEN 650
600 S4=S(8,S3)
610 M7=INT((T(9,T2)-1)/30)
620 L7=3*M7+1
630 L8=T(9,T2)-30*M7
640 ?T$(T2);" is enroute to ";MID$(S$,S4,4);" ETA at ";MID$(C$,L7,3);" ";L8;",";T(10,T2)
650 NEXT T2
660 S3=T(8,T1)
670 IF S3<>0 THEN 690
680 T1=1:T2=1:S3=1
690 S4=S(8,S3)
700 L=(T1-1)*6+1
710 ?" and ";T$(T1);" is about to leave ";MID$(S$,S4,4)
720 GOTO 2850
730 GOSUB 6550
740 GOSUB 4550
750 S1=1:T1=1:L1=1
760 ?
770 ?"All ships start at Sol"
780 ?"Advice; visit the class III and IV"
790 ?"systems...Sol and the class II stars"
800 ?"produce a lot of HE,MED and SOFT, which"
810 ?"the poorer star systems (Class III and"
820 ?"IV)need. Also,the poor stars produce"
830 ?"the raw goods:UR,MET,GEMS that you can"
840 ?"bring back to Sol and the class II"
850 ?"systems in trade."
860 ?
870 ?"Study the map and current price charts"
880 ?"carefully...Class I and II stars make"
890 ?"excellent trading partners with class"
900 ?"III or IV stars."
910 FOR I1=1 TO T9/P9
920 FOR P1=1 TO P9
930 ?
940 S7=(P1-1)*6+1
950 ?O$(P1);", which star wi
```

```
11 ";T$(T1);" travel to";
960 GOSUB 3740
970 L1=L1+6
980 T1=T1+1
990 NEXT P1
1000 NEXT I1
1010 '**
1020 '*** (BLOCK #6) ***
1030 '**
1040 D=T(9,1)
1050 Y=T(10,1)
1060 T1=1
1070 FOR I=2 TO T9
1080 IF T(10,I)<Y THEN 1120
1090 IF T(10,I)>Y THEN 1150
1100 IF T(9,I)>D THEN 1150
1110 IF T(9,I)=D AND RND(10)
>.5 THEN 1150
1120 D=T(9,I)
1130 Y=T(10,I)
1140 T1=I
1150 NEXT I
1160 IF Y1=Y THEN 1370
1170 D1=1
1180 Y1=Y
1190 T2=T1
1200 GOSUB 4550
1210 IF Y1<>2071 THEN 1280
1220 GOSUB 6140
1230 ?"The last year of this
 game is ";Y9;
1240 ?"but if you want to qu
it before then"
1250 ?"you can type 'SAVE' a
s your next port"
1260 ?"of call...This will w
rite to a file so"
1270 ?"you can continue late
r."
1280 T1=T2
1290 IF Y1<Y9 THEN 1370
1300 GOSUB 6140
1310 GOSUB 5100
1320 ?"End of game"
1330 ?"New game";
1340 INPUT A$
1350 IF A$="N" THEN 7240
1360 LOADGO"TRADES"
1370 D1=D
1380 M=INT((D1-1)/30)
1390 L=3*M+1
1400 ?
1410 ?
1420 ?"*****************"
1430 ?"* ";MID$(C$,L,3);D1-3
0*M;",";Y1
1440 H3=L
1450 H4=D1-30*M
1460 L=(T1-1)*6+1
1470 S1=T(8,T1)
1480 M=S(8,S1)
1490 ?"* ";T$(T1);" has land
ed on ";MID$(S$,M,4)
1500 ON T(12,T1)+1 GOTO 1680
,1640,1620,1510
1510 IF TIM(4)>3 THEN 1680
1520 T(11,T1)=INT(T(11,T1)/2
)
1530 T(1,T1)=INT(T(1,T1)*(1-
.3*RND(10)))
1540 T(2,T1)=INT(T(2,T1)*(1-
.3*RND(10)))
1550 T(3,T1)=INT(T(3,T1)*(1-
.5*RND(10)))
1560 T(4,T1)=INT(T(4,T1)*(1-
.5*RND(10)))
1570 T(5,T1)=INT(T(5,T1)*(1-
.5*RND(10)))
1580 T(6,T1)=INT(T(6,T1)*RND
(10))
1590 T(7,T1)=T(1,T1)+T(2,T1)
+T(3,T1)+T(4,T1)
1600 ?"3 Weeks late....Pirat
e attack midvoyage"
1610 GOTO 1680
1620 ?"2 Weeks late....'We g
ot lost.Sorry'"
1630 GOTO 1680
1640 ?"1 Week late.....'Comp
uter's mistake'"
1650 '**
1660 '*** (PRINT CARGO STATU
S FOR CURRENT SHIP) ***
1670 '**
1680 ?#2
1690 ?#2,"$ on board";N$;"
net wt"
1700 PRINT#2, USING 1710, T(
11,T1),T(1,T1),T(2,T1),T(3,T
1),T(4,T1),T(5,T1),T(6,T1),T
(7,T1)
1710 ! #######       ##     ##
    ##    ##    ###    ###    #
##
1720 ?#2:?#2
1730 IF QQ=1 THEN RETURN
1740 '**
1750 '*** (BLOCK #7) ***
1760 '**
1770 GOSUB 5400
1780 ?
1790 ?"We are buying:"
1800 J1=1
1810 FOR I1=1 TO 6
1820 IF S(I1,S1)>=0 OR T(I1,
T1)<.5 THEN 2160
1830 ?TAB(5);MID$(N$,J1,6);"
 We need ";-INT(S(I1,S1));"
units.";
1840 ?"How many are you sell
ing";
1850 GOSUB 6070
1860 IF X=0 THEN 2160
1870 IF X<=T(I1,T1) THEN 191
0
1880 ?TAB(5);"You only have
";T(I1,T1);" units in your h
old"
1890 ?TAB(5);
1900 GOTO 1840
1910 IF X<=2*-INT(S(I1,S1))T
HEN 1940
1920 X=2*-INT(S(I1,S1))
1930 ?TAB(5);"We'll bid on "
;X;" units."
1940 FOR K1=1 TO K9
1950 IF K1<>FNM(K9,2) THEN 1
980
1960 ?TAB(5);"Our final offe
r:";
1970 GOTO 2000
1980 ?"We offer ";
1990 Y2=(L1+1)*10/3
2000 ?100*INT(9E-03*P(I1)*X+
.5);" What do you bid";
2010 INPUT Y
2020 IF Y>P(I1)*X/10 AND Y<P
(I1)*X*10 THEN 2050
2030 ?TAB(5);"Watch your typ
ing...Try again"
2040 GOTO 1980
2050 IF Y<=P(I1)*X THEN 2110
2060 IF Y>(1+FNZ(X))*P(I1)*X
 THEN 2090
2070 P(I1)=.8*P(I1)+.2*Y/X
2080 NEXT K1
2090 ?TAB(5);"We'll pass thi
s one"
2100 GOTO 2160
2110 ?TAB(5);"We'll buy!"
2120 T(I1,T1)=T(I1,T1)-X
2130 T(7,T1)=T(7,T1)+X*(I1<5
)
2140 T(11,T1)=T(11,T1)+Y
2150 S(I1,S1)=S(I1,S1)+X
2160 J1=J1+6
2170 NEXT I1
2180 ?
2190 '**
2200 '*** (BLOCK #8) ***
2210 '**
2220 ?:?"**********":?
2230 QQ=1
2240 GOSUB 1660
2250 QQ=0
2260 ?"We are selling:"
2270 J1=1
2280 FOR I1=1 TO 6
2290 IF G(I1)<=0 OR S(I1,S1)
<1 THEN 2750
2300 IF I1<=4 AND T(7,T1)>=W
 THEN 2750
2310 ?TAB(5);MID$(N$,J1,6);"
 up to ";INT(S(I1,S1));" uni
ts.";
2320 ?"How many are you buyi
ng";
2330 GOSUB 6070
2340 IF X=0 THEN 2750
2350 IF I1>4 OR X+T(7,T1)<=W
 THEN 2410
2360 ?TAB(5);" You have ";T(
7,T1);" tons aboard,so ";X;
2370 ?" tons puts you over"
2380 ?TAB(5);"the ";W;" ton
limit."
2390 ?TAB(5);
2400 GOTO 2320
2410 IF X<=S(I1,S1) THEN 245
0
2420 ?TAB(5);"We only have "
;INT(S(I1,S1));" units"
2430 ?TAB(5);
2440 GOTO 2320
2450 FOR K1=1 TO K9
2460 IF K1<>FNM(K9 , 2) THEN
 2490
2470 ? TAB(5);"Our final off
er:";
2480 GOTO 2500
2490 ?TAB(5);"We want about
";
2500 ?100*INT(.011*P(I1)*X+.
5);
2510 ?"Your offer";
2520 INPUT Y
2530 IF Y>P(I1)*X/10 AND Y<P
(I1)*X*10 THEN 2560
2540 ?TAB(5);"Watch your typ
ing...Try again"
2550 GOTO 2490
2560 IF Y>=P(I1)*X THEN 2620
2570 IF Y<(1-FNZ(X))*P(I1)*X
 THEN 2600
```

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2580 P(I1)=.8*P(I1)+.2*Y/X
2590 NEXT K1
2600 ?TAB(5);"That's too low"
2610 GOTO 2750
2620 IF Y<=T(11,T1) THEN 2700
2630 T(12,T1)=0
2640 ?TAB(5);"You bid $";Y;"But you have only $";T(11,T1)
2650 GOSUB 5930
2660 IF S(7,S1)<10 OR T(11,T1)+B(1,B1)<Y THEN 2600
2670 ?TAB(5);
2680 GOSUB 5570
2690 IF Y>T(11,T1) THEN 2600
2700 ?TAB(5);"Sold!"
2710 T(I1,T1)=T(I1,T1)+X
2720 T(7,T1)=T(7,T1)-X*(I1<5)
2730 S(I1,S1)=S(I1,S1)-X
2740 T(11,T1)=T(11,T1)-Y
2750 J1=J1+6
2760 NEXT I1
2770 '**
2780 '*** <BLOCK #9> ***
2790 '**
2800 GOSUB 5930
2810 IF S(7,S1)<10 OR T(11,T1)+B(1,B1)=0 THEN 2850
2820 ?
2830 GOSUB 5570
2840 ?
2850 ?"You are on ";MID$(S$,M,4)
2860 ?"What is your next port of call";
2870 S(7,S1)=S(7,S1)+.02+RND(10)/25
2880 GOSUB 3740
2890 '**
2900 '*** <BLOCK #10.1> ***
2910 '**
2920 J=0
2930 FOR I=1 TO 6
2940 IF S(I,S1)>=0 THEN 2970
2950 IF S(I,S1)<G(I) THEN 3120
2960 J=J+1
2970 NEXT I
2980 IF J>1 THEN 3120
2990 '**
3000 '*** <BLOCK #10.2> ***
3010 '**
3020 S(7,S1)=S(7,S1)+G9
3030 G0=S(7,S1)
3040 IF G0<>5 AND G0<>10 AND G0<>15 THEN 3120
3050 GOSUB 6210
3060 GOSUB 6140
3070 ?#2,"Star system ";S$(S(8,S1),S(8,S1)+3);" is now a class";
3080 ?#2,D$;" system"
3090 '**
3100 '*** <BLOCK #10.3> ***
3110 '**
3120 IF S9=15 THEN 1040
3130 J=0
3140 FOR I=1 TO S9
3150 J=J+S(7,I)
3160 NEXT I
3170 ?#2,"Developmental status of Galaxy is ";J/S9
3180 IF (J/S9)<7 THEN 1040
3190 '** <A NEW STAR IS BORN> **      * PING!
3200 S1=S9+1:S9=S9+1
3210 GOSUB 6330
3220 GOSUB 3380
3230 S(9,S1)=D1
3240 S(10,S1)=Y1
3250 FOR J=1 TO 6
3260 S(J,S1)=0
3270 NEXT J
3280 GOSUB 6140
3290 ?#2,"A new star system has been discovered!"
3300 ?#2,"It is a class IV"
3310 ?#2,"And it's name is ";S$(S(8,S1),S(8,S1)+3)
3320 GOSUB 6550
3330 GOTO 1040
3340 ** <GOSUBS FOLLOW> **
3350 '**
3360 *** <FRONTIER> ***
3370 '**
3380 X=(RND(10)-.5)*100
3390 Y=50*RND(10)
3400 IF (ABS(X)<25)AND(Y<25) THEN 3380
3410 F=1
3420 GOSUB 3500
3430 IF F=0 THEN 3380
3440 S(7,S1)=0
3450 RETURN
3460 '**
3470 '*** <TEST STAR CO-ORDS> ***
3480 '**
3490 '** <FIRST,CONVERT CO-ORDS TO NEXT HALF-BOARD> **
3500 GOTO H OF 3210,3170,3150,3110
3510 Z=X
3520 X=-Y
3530 Y=Z
3540 GOTO 3610
3550 Y=-Y
3560 GOTO 3610
3570 Z=X
3580 X=Y
3590 Y=Z
3600 ** <SECOND,TEST PROXIMITY> **
3610 FOR J=1 TO S1-1
3620 IF SQR((X-S(11,J))↑2+(Y-S(12,J))↑2)>=D9 THEN 3650
3630 F=0
3640 RETURN
3650 NEXT J
3660 '** <FINALLY,ENTER CO-ORDS AND INCREMENT HALF-BOARD COUNTER> **
3670 S(11,S1)=INT(X)
3680 S(12,S1)=INT(Y)
3690 H=1+(H<=3)*H
3700 RETURN
3710 '**
3720 '*** <NEXT ETA> ***
3730 '**
3740 INPUT A$
3750 FOR I=1 TO S9
3760 J=S(8,I)
3770 IF LEFT$(A$,4)=MID$(S$,J,4)THEN 4180
3780 NEXT I
3790 IF A$<>"TRAVEL" THEN 3910
3800 FOR S7=1 TO T9
3810 IF S7=T1 THEN 3890
3820 S3=T(8,S7)
3830 S4=S(8,S3)
3840 L=(S7-1)*6+1
3850 M7=INT((T(9,S7)-1)/30)
3860 L7=3*M7+1
3870 L8=T(9,S7)-30*M7
3880 ?T$(S7);" is enroute to ";MID$(S$,S4,4);" ETA at ";MID$(C$,L7,3);" ";L8;",";T(10,T1)
3890 NEXT S7
3900 GOTO 4160
3910 '
3920 IF A$<>"STATUS" THEN 3950
3930 GOSUB 5110
3940 GOTO 4160
3950 IF A$<>"PRICES" THEN 3980
3960 GOSUB 4870
3970 GOTO 4160
3980 IF A$<>"ETA" THEN 4010
3990 GOSUB 6930
4000 GOTO 4160
4010 IF A$<>"SAVE" THEN 4030
4020 GOSUB 6430
4030 IF A$="STOP" THEN 6530
4040 IF A$<>"MAP" THEN 4090
4050 S2=S1
4060 GOSUB 6550
4070 S1=S2
4080 GOTO 4160
4090 IF A$<>"CARGO" THEN 4120
4100 GOSUB 6890
4110 GOTO 4160
4120 IF A$<>"REPORT" THEN 4150
4130 GOSUB  4530
4140 GOTO 4160
4150 ?A$;" is not a star name in this game"
4160 ?"Next star";
4170 GOTO 3740
4180 T(8,T1)=I
4190 IF I<>S1 THEN 4220
4200 ?"Choose a different star system to visit."
4210 GOTO 4160
4220 D2=SQR((S(11,S1)-S(11,I))↑2+(S(12,S1)-S(12,I))↑2)/R9
4230 D2=INT(D2)
4240 IF RND(10)>(Q/2) THEN 4340
4260 ON I GOTO 4310,4290,4270
4270 ?"Ship does not pass inspection";
4280 GOTO 4320
4290 ?"Crewmen demand vacation";
4300 GOTO 4320
4310 ?"Local holiday soon";
4320 ?"...";I;" week delay."
4330 D2=D2+7*I
4340 T(9,T1)=T(9,T1)+D2
4350 IF T(9,T1)<=360 THEN 4380
4360 T(9,T1)=T(9,T1)-360
4370 T(10,T1)=T(10,T1)+1
4380 M=INT((T(9,T1)-1)/30)
```

```
4390 L=3*M+1
4400 ?"The ETA at ";MID$(S$,
J,4);" is ";MID$(C$,L,3);" "
;T(9,T1)-30*M;",";T(10,T1)
4410 '**
4420 '*** <UPDATE ETA PLUS R
ANDOM DELAY FACTOR (0,1,2 OR
 3 WEEKS)> ***
4430 '**
4440 I=(INT(RND(10)*7)+1)*(-
(RND(10)>(Q/2)))
4450 IF I>3 THEN 4440
4460 T(9,T1)=T(9,T1)+7*I
4470 IF T(9,T1)<=360 THEN 45
00
4480 T(9,T1)=T(9,T1)-360
4490 T(10,T1)=T(10,T1)+1
4500 T(12,T1)=I
4510 RETURN
4520 '**
4530 '*** <REPORT> ***
4540 '**
4550 GOSUB 6140
4560 ?#2,TAB(10);MID$(C$,H3,
3);" ";H4;",";Y1;TAB(35);"YE
ARLY REPORT #";Y1-2069
4570 ?#2
4580 ?#2
4590 IF Y1<=2070 THEN 4630
4600 GOSUB 4870
4610 GOSUB 5100
4620 RETURN
4630 ?#2,"Star system classe
s:"
4640 ?#2,"      I  Cosmopolit
an"
4650 ?#2,"     II  Developed"
4660 ?#2,"    III  Underdevel
oped"
4670 ?#2,"     IV  Frontier"
4680 ?#2
4690 ?#2
4700 ?#2,"Merchandise:"
4710 ?#2,"  UR    Uranium"
4720 ?#2,"  MET   Metals"
4730 ?#2,"  HE    Heavy Equi
pment"
4740 ?#2," MED   Medicine"
4750 ?#2," SOFT  Computer S
oftware"
4760 ?#2," GEMS  Star Gems"
4770 ?#2
4780 ?
4790 ?"Each trading ship can
 carry max";W
4800 ?"tons cargo."
4810 ?"Star Gems and Compute
r Software, which"
4820 ?"aren't sold by the to
n,don't count."
4830 ?
4840 ?
4850 GOSUB 4870
4860 RETURN
4870 ?#2,TAB(20);"Current pr
ices"
4880 ?#2
4890 ?#2
4900 ?#2,"Name class";ZZ$
4910 ?#2
4920 S3=S1
4930 FOR S1=1 TO S9
4940 GOSUB 5400
4950 FOR I=1 TO 6
4960 P(I)=SGN(S(I,S1))*P(I)
4970 NEXT I
4980 GOSUB 6210
4990 PRINT#2, MID$(S$,S(8,S1
),4);
5000 PRINT#2,D$;
5010 PRINT#2,USING 5020, P(1
),P(2),P(3),P(4),P(5),P(6)
5020 !    #####  #####  #####
  #####  #####  #####
5030 IF S1/2<>INT(S1/2) THEN
 5050
5040 ?#2
5050 NEXT S1
5060 S1=S3
5070 ?#2
5080 ?#2,"('+'Means selling
and '-' means buying)"
5090 RETURN
5100 ?
5110 ?
5120 ?TAB(22);"CAPTAINS"
5130 ?
5140 ?
5150 ?#2,"CAPTAIN          $ O
N SHIPS   $ IN BANK     CARG
OES       TOTALS"
5160 ?#2,"-------------------
------------------------------
-----------------"
5170 FOR B1=1 TO P9
5180 GOSUB 6020
5190 NEXT B1
5200 FOR P1=1 TO P9
5210 ?
5220 M1=0:M2=0
5230 FOR I1=0 TO T9/P9-1
5240 M1=M1+T(11,P9*I1+P1)
5250 FOR K=1 TO 6
5260 M2=M2+T(K,P9*I1+P1)*Q(K
)
5270 NEXT K
5280 NEXT I1
5290 S7=(P1-1)*6+1
5300 M3=M2+M1+B(1,P1)
5310 ?#2,O$(P1)
5320 PRINT#2,USING 5330 ,M1,
B(1,P1),M2,M3'USING 4820
5330 !                  #####
##       #######       #######
    ########
5340 NEXT P1
5350 ?#2:?#2:?#2
5360 RETURN
5370 '**
5380 '*** <PRICES> ***
5390 '**
5400 R1=1-(S(7,S1)>=5)-(S(7,
S1)>=10)
5410 D2=12*(Y1-S(10,S1))+(D1
-S(9,S1))/30
5420 FOR I=1 TO 6
5430 G(I)=(1+S(7,S1)/15)*(M(
I,R1)*S(7,S1)+C(I,R1))
5440 IF ABS(G(I))>.01 THEN 5
470
5450 P(I)=0
5460 GOTO 5500
5470 S(I,S1)=SGN(G(I))*FNM(A
BS(G(I)*12) , ABS(S(I,S1)+D2
*G(I)))
5480 P(I)=Q(I)*(1-SGN(S(I,S1
))*ABS(S(I,S1)/(G(I)*X9)))
5490 P(I)=100*INT(P(I)/100+.
5)
5500 NEXT I
5510 S(9,S1)=D1
5520 S(10,S1)=Y1
5530 RETURN
5540 '**
5550 '*** <BANK CALL> ***
5560 '**
5570 ?"Do you wish to visit
the local bank";
5580 INPUT A$
5590 IF A$="Y" THEN 5610
5600 RETURN
5610 GOSUB 5930
5620 GOSUB 6020
5630 ?TAB(5);"You have $";B(
1,B1);" in the bank"
5640 ?TAB(5);"And $";T(11,T1
);" on your ship"
5650 IF B(1,B1)=0 THEN 5810
5660 ?TAB(10);"How much do y
ou wish to withdraw";
5670 INPUT Z
5680 ?
5690 ?TAB(10);"You have just
 withdrawn $";Z
5700 ?TAB(10);"Are you sure
about this";
5710 INPUT X0$
5720 ?
5730 IF X0$="N" THEN 5660
5740 IF Z<=B(1,B1) THEN 5770
5750 ?TAB(5);"Too much; ";
5760 GOTO 5660
5770 IF Z<=0 THEN 5810
5780 B(1,B1)=B(1,B1)-Z
5790 T(11,T1)=T(11,T1)+Z
5800 RETURN
5810 ?TAB(5);"How much do yo
u wish to deposit";
5820 INPUT Z
5830 IF Z>=0 THEN 5860
5840 ?TAB(5);"You can't depo
sit a negative number"
5850 GOTO 5810
5860 IF Z<=T(11,T1) THEN 589
0
5870 ?TAB(5);"You have $";T(
11,T1);" on your ship"
5880 GOTO 5810
5890 T(11,T1)=T(11,T1)-Z
5900 B(1,B1)=B(1,B1)+Z
5910 RETURN
5920 '** <B1> **
5930 B1=T1
5940 FOR I=1 TO S9/P9
5950 IF B1<=P9 THEN 5980
5960 B1=B1-P9
5970 NEXT I
5980 RETURN
5990 '**
6000 '*** <BANK UPDATE> ***
6010 '**
6020 B(1,B1)=B(1,B1)*(1+.05*
(Y1-B(3,B1)+(D1-B(2,B1))/360
))
6030 B(2,B1)=D1
6040 B(3,B1)=Y1
6050 RETURN
6060 '** <INPUT> **
6070 INPUT X
6080 IF INT(X)=X AND X>=0 TH
EN 6120
6090 ?TAB(5);"Type a '0' if
you want to pass this one"
6100 ?TAB(5);"But no negativ
```

*(continued on next page)*

*(continued from previous page)*

```
es or decimals"
6110 GOTO 6070
6120 RETURN
6130 '** <GA> **
6140 ?#2
6150 ?#2,
6160 ?#2, TAB(15),"***GENERA
L ANNOUNCEMENT***"
6170 ?#2,
6180 ?#2,
6190 RETURN
6200 '** <D$> **
6210 ON S(7,S1)/5+1 GOTO 628
0,6260,6240,6220
6220 D$="    I"
6230 RETURN
6240 D$="   II"
6250 RETURN
6260 D$="  III"
6270 RETURN
6280 D$="   IV"
6290 RETURN
6300 '**
6310 '*** <STAR NAME> ***
6320 '**
6330 IF S1>1 THEN 6360
6340 I=1
6350 GOTO 6400
6360 I=4*INT(14*RND(10))+5
6370 FOR J=2 TO S1-1
6380 IF I=S(8,J) THEN 6360
6390 NEXT J
6400 S(8,S1)=I
6410 RETURN
6420 '**
6430 '*** <SAVE GAME ON FILE
> ***
6440 '**
6450 ?"Filename";
6460 INPUT B$
6470 REM (Open file 'B$')
6480 REM FOR I=1 TO 12
6490 REM (Write to file:T$(I
),O$(I) )
6500 REM NEXT I
6510 REM (Write to file:W,D9
,K9,X9,D1,Y1,P9,T9,S9,Y9,T1,
S1,H3,H4,H )
6520 REM (MAT WRITE to file:
S,T,B,P,C,M,Q,G
6530 END
6540 '**
6550 '*** <PRINT STAR MAP> *
**
6560 '**
6570 ?#2:?#2:?#2
6580 ?#2,TAB(22);"STAR MAP"
6590 ?#2,TAB(20);"***********
**"
6600 ?#2
6610 FOR L1=15 TO -15 STEP-1
6620 IF L1<>0 THEN 6650
6630 L$="1-----1-----1-----1---
-1-----*SOL-1-----1-----1-----1-
---1     "
6640 GOTO 6700
6650 L$="

                    "
6660 IF ABS(L1)/3=INT(ABS(L1
)/3) THEN 6690
6670 L$=LEFT$(L$,25)+"1"+RIG
HT$(L$,LEN(L$)-26)
6680 GOTO 6700
6690 L$=LEFT$(L$,25)+"-"+RIG
HT$(L$,LEN(L$)-26)
6700 Y=L1*10/3
6710 Y0=(L1+1)*10/3
6720 S3=S1
6730 FOR S1=2 TO S9
6740 IF S(12,S1)>=Y0 OR S(12
,S1)<Y THEN 6800
6750 X1=INT(26+S(11,S1)/2)
6760 MID$(L$,X1,10)="*    (
  )"
6770 MID$(L$,X1+1,4)=MID$(S$
,S(8,S1),4)
6780 GOSUB6200
6790 MID$(L$,X1+6,3)=MID$(D$
,3,3)
6800 NEXTS1
6810 S1=S3
6820 REM
6830 ?#2,L$
6840 NEXT L1
6850 ?#2
6860 ?#2,"The map is 100 lig
ht-years by 100 light-years"
6870 ?#2,"so the cross lines
 mark ten light-year distanc
es"
6880 RETURN
6890 ?#2
6900 ?#2,"$ on board";N$;"
nett weight"
6910 ?#2,USING 1710,T(11,T1)
,T(1,T1),T(2,T1),T(3,T1),T(4
,T1),T(5,T1),T(6,T1),T(7,T1)
'USING 1540
6920 RETURN
6930 S3=T(8,T1)
6940 Z$=""
6950 FOR I = 1 TO S9
6960 S4=S(8,I)
6970 IF S3=I THEN 7010
6980 Z$=Z$+MID$(S$,S4,4)
6990 Z$=Z$+"   "
7000 S4=S4+4
7010 NEXT I
7020 ?Z$
7030 Z$=""
7040 ?
7050 FOR I =1 TO S9
7060 IF S3=I THEN7200
7070 D2=SQR((S(11,S3)-S(11,I
))↑2+(S(12,S3)-S(12,I))↑2)/R
9
7080 D2=D2*(1+T(7,T1)*(T(7,T
1)>W*.5)/W)
7090 D2=INT(D2)
7100 D7=T(9,T1)+D2
7110 IF D7<=360 THEN 7130
7120 D7=D7-360
7130 M=INT((D7-1)/30)
7140 L=3*M+1
7150 Z$=Z$+MID$(C$,L,3)
7160 Z$=Z$+STR$(D7-30*M)
7170 IF D7-30*M >10 THEN 719
0
7180 Z$=Z$+" "
7190 Z$=Z$+" "
7200 NEXT I
7210 ?Z$
7220 ?
7230 RETURN
7240 END
7250 '**
7260 '*** <READ GAME FROM DI
SC (TRDV) > ***
7270 '**
7280 OPEN#10,"I","TRDV"
7290 FOR I=0 TO 12
7300 FOR J=0 TO 15
7310 INPUT#10,S(I,J)
7320 NEXT J
7330 NEXT I
7340 FOR I=0 TO 12
7350 FOR J=0 TO 12
7360 INPUT#10,T(I,J)
7370 NEXT J
7380 NEXT I
7390 FOR I=0 TO 3
7400 FOR J=0 TO 12
7410 INPUT #10,B(I,J)
7420 NEXT J
7430 NEXT I
7440 FOR I=0 TO 6
7450 FOR J=0 TO 3
7460 INPUT#10,M(I,J)
7470 NEXT J
7480 NEXT I
7490 FOR I=0 TO 6
7500 FOR J=0 TO 3
7510 INPUT#10,C(I,J)
7520 NEXT J
7530 NEXT I
7540 FOR I=0 TO 12
7550 INPUT#10,T$(I)
7560 NEXT I
7570 FOR I=0 TO 12
7580 INPUT#10,O$(I)
7590 NEXT I
7600 FOR I=0 TO 6
7610 INPUT#10,P(I)
7620 NEXT I
7630 FOR I=0 TO 6
7640 INPUT#10,Q(I)
7650 NEXT I
7660 FOR I=0 TO 6
7670 INPUT #10,G(I)
7680 NEXT I
7690 INPUT#10,W
7700 INPUT#10,D9
7710 INPUT#10,K9
7720 INPUT#10,X9
7730 INPUT#10,D1
7740 INPUT#10,X1
7750 INPUT#10,P9
7760 INPUT#10,T9
7770 INPUT#10,S9
7780 INPUT#10,Y9
7790 INPUT#10,H
7800 INPUT#10,Y1
7810 INPUT#10,R9
7820 INPUT#10,G9
7830 INPUT#10,Q
7840 INPUT#10,S1
7850 INPUT#10,T1
7860 INPUT#10,R
7870 INPUT#10,H3
7880 INPUT#10,H4
7890 INPUT#10,XX$
7900 ?XX$
7910 CLOSE#10
7920 RETURN
7930 DEF FNM(X,Y)
7940 IF X>Y THEN FNRETURN Y
7950 FNEND X
7960 RETURN
7970 DEF FNM(X,Y)
7980 IF X>Y THEN FNRETURN Y
7990 FNEND X
8000 RETURN
8010 '**** <PHEW!> ****
```

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| Feature / Printer | Integral Data 440 | Tally 1200 | Lear Siegler 300 | Texas Instruments 810 | Centronics 779-2 |
|---|---|---|---|---|---|
| 96-character ASCII set, upper and lower case | YES | OPTION | YES | OPTION | NO |
| Software-selectable character sizes | YES | NO | NO | OPTION | NO |
| Throughput, lines per minute @ 10 char./line / @ 132 char./line | 275<br>42 | 100<br>40 | Data not available | 440<br>64 | 130<br>21 |
| Parallel and RS-232 serial interfaces standard | YES | NO | NO | NO | NO |
| CRT screen buffer | OPTION | NO | OPTION | NO | NO |
| Footprint (W x D = sq. ft.) | 1.37 | 3.45 | 3.18 | 3.58 | 2.44 |
| Weight (lbs.) | 20 | 64 | 50 | 55 | 45 |
| Forms length control | YES | OPTION | YES | OPTION | NO |
| Full dot plotting graphics | OPTION | NO | NO | NO | NO |
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Comparison data from manufacturers' current literature for 60 Hz operation.

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# Where those traps lurk for the unwary

**We reviewed the Science of Cambridge MK-14 kit in our May issue. It is popular and inexpensive but it is not without its quirks, as Guy Inchbald reports.**

IF YOU haven't built your MK14 yet, stop. Buy a load of IC sockets — you will need them. If you've built your machine but it doesn't work, check your soldering again; about 90 percent of faults are due to duff soldering. A jeweller's eyeglass is very useful for checking joints. Look for solder which has not wetted the conductors properly, and for 'whiskers' of solder shorting two adjacent conductors together.

Most of the rest of the faults are due to wrongly-inserted components. Check that ICs are the correct way round — on the MK14 they should all have their pin 1 code at the top — the same way round as the keyboard. An IC may be the proper way round but have one pin folded up under it. Again, a thorough check with the eyeglass is worth the trouble.

If you've used sockets so that your ICs are unlikely to have suffered heat-death, the problem may be in the power supply. Have you checked the fuse?

Drawing current from a supply causes its voltage to drop, so a nominally sufficient supply may drop below the required 7V under load, especially if it has to cope with extra RAM, a cassette interface, and other add-ons. The ripple from mains power supplies also worsens under load and can appear as keyboard bounce. Cure is a larger smoothing capacitor — C2 on the circuit board. If you buy a bigger one, make sure the nominal voltage is at least 10V and connect it in the correct way.

Over-heating of the on-board regulator IC 19 causes it to cut out. Switch off quickly and let it cool for a temporary respite. The problem may be excessive current drain; it is rated at 500 mA, so any peripherals should have their own regulator, though you should get away with the cassette interface. Alternatively, it may be an over-enthusiastic power supply, for which the cure is a heatsink — rule of thumb; if it's too hot to touch, it's too small — and/or a resistor between power supply and regulator. Should the instruction book leave you baffled, try 4.7 ohm rated at least at 1.5 W. If necessary, add more of them nose-to-tail. A heatsink is a good idea in any case, since the cooler any component the longer it will last.

If you use batteries, for example, as a portable power source, it is still worth putting in C2. It provides a small reservoir of current in case of momentary power loss and also eliminates the risk of HF instability, which can affect regulation.

To round-off the subject of hardware, what can one do about the keyboard? When keyed-in entries start producing garbage on a previously well-behaved machine, the most likely culprit is the rubber sheet sticking to the PCB. Temporary relief can be gained by turning-over the sheet or making a paper spacer to aid the transparent one. If you haven't yet started building your kit, don't peel the spacer from its backing. A new keyboard, however, is almost essential. A set of push-keys will cost £5, but old pocket calculators provide an excellent alternative. The 16-way edge connector is satisfactory for the job.

## Numbers game

The newcomer to machine-code programming often finds negative numbers and complements confusing. Even the revised instructions supplied by Science of Cambridge leave something to be desired. Perversely, perhaps, I shall start with binary addition — and by the way, section 7 of the instruction book is incorrect; the third rule of addition is '1+1=0 with carry', like adding 5+5 in decimal.

When large numbers are added, they can overflow available storage and leave behind a number smaller than either original. Take this four-bit addition:

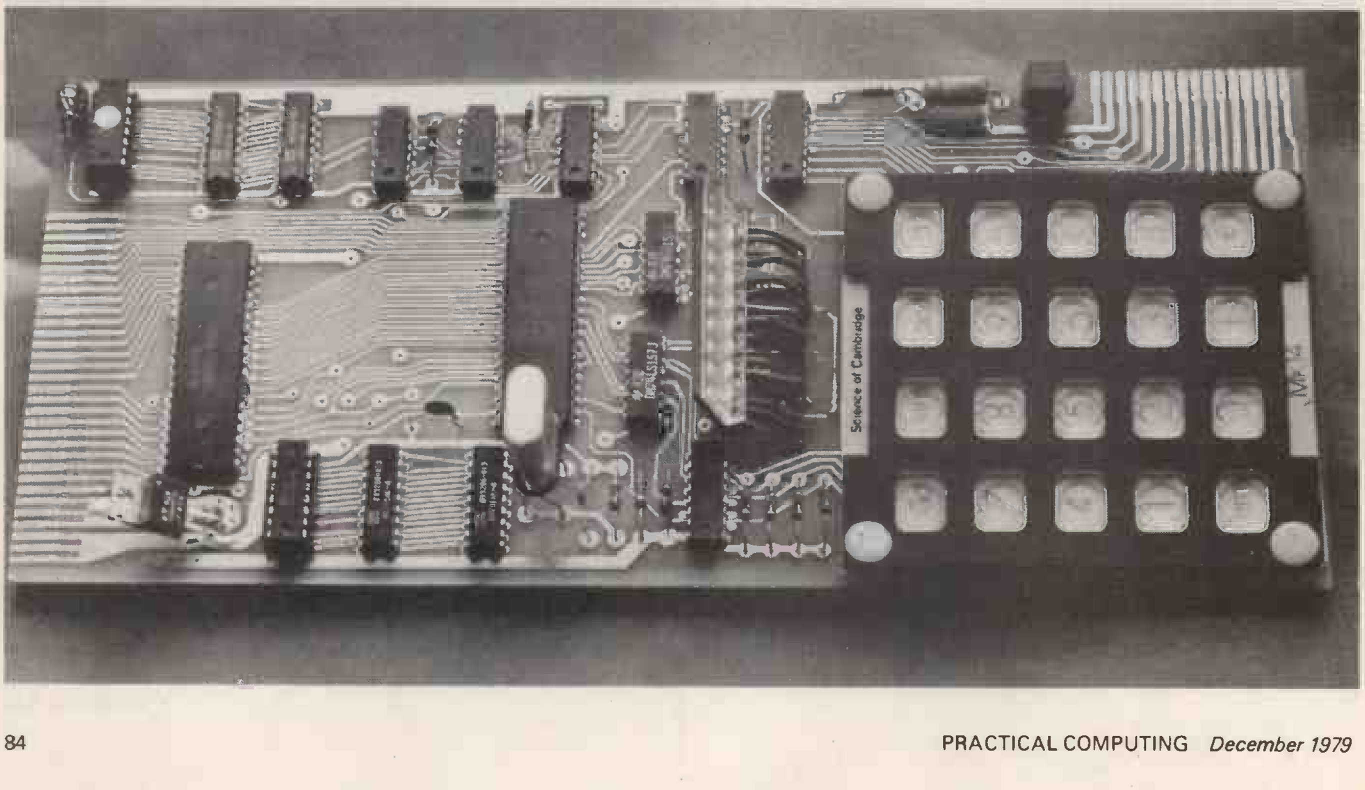
```
    1010
+   1001
=(1)0011
```

In decimal it would appear as 10+9=3, which is patently incorrect. 10-7=3 would be more like it:

```
   1010
-  0111
=  0011
```

Computers cannot store plus and minus signs, only 0s and 1s, so storing negative

*(continued on page 87)*



*(continued from page 84)*
numbers is a problem, but if every negative number has a positive equivalent which gives the same result, that can be used instead.

The problem, then, is to convert the number into its equivalent. In the example, -0111 is equivalent to +1001. Either number can be converted into the other by changing its 0s for 1s, and vice versa, and adding 1; so 0111 first becomes 1000 which is called its one s complement. Adding 1 gives 1001 which is called its twos complement. Similarly 1001 becomes 0110; and adding 1 gives 0111.

The SC/MP CAD — complement and add — instruction performs the task, with the extra 1 to make the twos complement coming from the CY/L (carry/link) bit of the status register. This is why it is usual to precede a CAD instruction by SCC (set CY/L).

Hex digits complement each other in pairs:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| F | E | D | C | B | A | 9 | 8 |

The complement of 1B is E4, its two complement is E5.

The various adding instructions affect the DY/L and OV (overflow) bits as follows:

| | |
|---|---|
| ADD, ADI, ADE | Carry from most significant bit (MSB) of result sets CY/L, which is otherwise cleared. If sign of result differs from that of both numbers OV is set; otherwise it is cleared. |
| DAD and the like | Carry from most significant digit sets CY/L, otherwise cleared. If sign differs from both numbers OV is set; otherwise it is cleared. |
| CAD and the like | Carry from MSB sets CY/L, otherwise cleared. If sign of result is same as EA but opposite to AC, CY/L is set; otherwise it is cleared. |

Note that the most significant bit contains the sign -0 for negative numbers and 0, 1 for positive numbers.

The memory reference and jump instructions of the SC/MP assume that address displacements are in twos complement form. All numbers with the MSB (bit 8) set to 1 are assumed to be negative. So bit 8 is used as a sign indicator, leaving only seven bits to give the actual size. Which is why maximum displacement is 127, or $2^7$ -1, or Hex 7F.

## Relative addressing

There are two more traps lurking for the unwary. In relative addressing, memory reference instructions count from the second byte of the instruction. So instruction COE6 at location OF30 means 'LD from OF31-1A = OF17'.

Jump instructions increment the PC again after jumping, so displacements are calculated from the following instruction. Thus 90E6 at location OF30 means 'JMP to OF32-1A = OF18'. Similarly with indexed addressing, memory reference instructions count from the indexed address and jump instructions from the next one.

Logic functions appear very strange to many of us. The computer compares the same bit from each of two numbers — in AC and EA — and sets that bit in the result according to a table of values called a truth table, invented by philosophers. Here are the tables for the SC/MP:

| AC | EA | AND | OR | XOR |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 1 | 1 | 0 |

For example, 11010011 OR 00011001 becomes 110110110, XOR is short for exclusive-OR, the other two are self-explanatory. Logic functions do not affect CY/L or OV.

When writing programs, it is essential to use clear and profuse annotations with suitable remarks for future reference. If you don't believe me, try unravelling the instruction book programs.
instruction book.

It is also worthwhile drawing a neat flow chart of the finished program for the same reason. As a useful side-effect, it also impresses other people, such as job interviewers.

It is a good idea to leave plenty of odd gaps full of NOPs in a new program. The thing is unlikely to work first time and you will have to insert the odd extra instruction. Having a gap handy saves re-locating the latter part of the program and re-calculating all those address displacements.

## Debugging aid

Another aid to debugging is the use of XPPC 3 to stop your program in mid-flight and display the next byte. You can then look at registers and the like. Return to where you left off, hit GO, and the program continues.

Some of you may have tried the 'Message' program from the official guidebook, which I found somewhat agricultural. Here is a more comprehensive version; it allows text up to 128 characters to be entered forwards, and caters for spaces. No characters need repeating. In addition, any part of a larger text may be displayed.

To run, enter text address in OF12 and OF13 with length in OF14. If length is entered as OO, the program will substitute contents of the location immediately before the text, a useful feature if your memory is no better than mine.

The eight segments of each display digit are coded as in figure 2, so the text code for A is 01111110, or 7E.

```
MK14
SC/MP
RUNNING TEXT
RELOCATABLE

DATA
OF12  TAH
  13  TAL
  14  TL

ENTRY
SET POINTERS ETC
OF15  COFC          LD    TAH    set P2 to text
                                 adr. (T O)
  17  36            XPAH  2
  18  COFA          LD    TAL
  1A  32            XPAL  2
  1B  C40D          LDI   13     set P1 to
                                 display adr.
  1D  35            XPAH  1
  1E  C400          LDI   0
  20  31            XPAL  1
  21  COF2          LD    TL     if TL = 0, set
                                 to T-1
  23  9C04          JNZ   WST
  25  C2FF          LD    T-1(2)
  27  C8EC          ST    TL
  29  C4FF          LDI   -1     set window to
                                 adr. (T-1)
  2B  C83D          ST    WPOS
MAIN LOOP STARTS HERE
OF2D  A83B  MOVE    ILD   WPOS   move window
                                 to right
```

```
MK14/10
  2F  08            NOP
  30  03            SCL          test for
                                 window
                                 overrun
  31  F8E2          CAD   TL
  33  9C04          JNZ   DSET
  35  C400          LDI   0      reset window
                                 to adr. (T O)
  37  C831          ST    WPOS

ENTER DELAY LOOP FOR WINDOW DISP
OF39  C420  DSET    LDI   32     set delay count
                                 1
  3B  C82E          ST    DC1
  3D  C406  DL1     LDI   06     set delay count
                                 2
  3F  C82B          ST    DC2

DISPLAY WINDOW
OF41  C408  DL2     LDI   08     set display seg
                                 to 1 over
  43  C816          ST    DSEG
  45  C023          LD    WPOS   set window seg
  47  C810          ST    WSEG
  49  B810  SEG     DLD   DSEG   Next segs
  4B  A80C          ILD   WSEG
  4D  08            NOP
  4E  03            SCL          test for seg
                                 overrun
  4F  F8C4          CAD   TL
  51  9C04          JNZ   DISP
  53  C400          LDI   O      reset window
                                 seg
  55  C802          ST    WSEG
  57  C2    DISP    LD    (2)    display
                                 segment
  58  xx    WSEG
```

```
MK14/11
  59  C9            ST    (1)
  5A  xx    DSEG
  5B  COFE          LD    DSEG   all segs
                                 displayed?
  5D  9CEA          JNZ   SEG    if not, loop
                                 back

DELAY LOOP COUNT & RETURN
  5F  B80B          DLD   DC2
  61  9CDE          JNZ   DL2
  63  B806          DLD   DC1
  65  9DC6          JNZ   DL1

EXIT DELAY LOOP
RETURN TO MOVE WINDOW
  67  90C4          JMP   MOVE
DATA VARIABLES
  69  WPOS
  6A  DC1
  6B  DC2
END
```

**Exidy Sorcerer users seem to be neglected, partly because we seldom receive manuscripts, but here is a collection to compensate.**

# How to use those graphics capabilities

**Ralph Turvey looks into Sorcerer graphics.**

THE TWO MANUALS with Sorcerer, *A Guided Tour of Personal Computing* and *A Short Tour of Basic,* leave a few things unexplained. At least for those Sorcerer owners who are new to computing, it requires detective work and experimentation to find some of the capabilities of the machine. This is particularly true of the graphics, so here is an explanation which should save a good deal of effort for those owners who have not yet worked out how to use them.

## Printing and Poking

There are three ways of making a particular character, let us say a Z, appear in a chosen position on the screen. For the first two, the cursor has to be in that chosen position. They are:

```
PRINT "Z"
PRINT CHR$(90)
POKE -3500,90
```

It saves trouble to enter the first two as ?"Z" or ?CHR$(90); 90 is the ASCII character code for Z. Appendix G of the Basic manual gives the complete list of standard charaters. We shall reach the non-standard Sorcerer graphics characters in a moment. The -3500 is a memory address in the part of the memory containing the display screen space. Since there are 64 characters on a line and 30 lines, there are $64 \times 30 = 1,920$ such addresses. They run from -3968 through -2049, corresponding to the top left and the bottom right positions on the screen. So POKE -3968,43 will put a + in the top left position.

## Ready-made characters

The Sorcerer also has 64 ready-made graphics characters, which one can print by using the appropriate key with the SHIFT LOCK and GRAPHIC keys depressed. Some, but not all, of those characters are marked on the keys. The complete set of them is shown at the bottom of page 23 of the Personal Computing manual.

Since neither manual indicates the character codes for those characters, you can have the machine tell you what they are by using the following program:

```
10 FOR J = 127 TO 187 STEP 4
20 FOR K = 1 TO 4
30 PRINT "CHR$"; J+K ;" = CHR$(J+K);" ";
40 NEXT K
50 PRINT : PRINT
60 NEXT J
```

It enables you to see most of the 64 at once. Now it is clear why POKE -2049,153 will put a heart at the bottom right of the screen. POKE -2049,32 will remove it, since 032 is the ASCII code for a blank space.

Returning to the 128 ASCII character codes, 000 to 032 are for giving instructions to Teletype machines and are of no use if your Sorcerer is hooked to a video display. There are two important

*(continued on next page)*

# Useful tips for Basic functions

THERE ARE no instructions on using the USR(X) function. In the Basic interpreter is a section which places a CALL instruction in memory location 0103 HEX, to use the USR function you must first enter the address of the subroutine into locations 0104H (Low order) and 0105H (HIGH ORDER). This should be done with a poke command before the call, i.e.

```
10 POKE 260,16
20 POKE 261,00
```

This means your routine starts at 0010H. Now you can insert your USR call anywhere in the program like below.

```
200 A = USR(0)
```

A is a dummy variable and its value will be altered.

0 is a dummy argument.

Any letters can be used instead of A & O.

To return to Basic, a C9H should be inserted at the end of your SUBROUTINE. Peek and Poke can be used to pass information to or from the main program to or from the subroutine. 0000H to 00FFH are not used by basic or by the Monitor, so may be used for your subroutine.

Remember Poke addresses must be the decimal equivalent of the Hex addresses.

## Cursor control

| CONTROL | NON DELETE | DELETE |
|---|---|---|
| HOME | CHR$ (17) | CHR$ (12) |
| LEFT | CHR$ (1) | CHR$ (8) |
| RIGHT | CHR$ (19) | CHR$ (32) or SPC (X) |
| UP | CHR$ (23) | |
| DOWN | CHR$ (10) or CHR$ (26) | |
| LEFT (beginning of line) | CHR$ | |

See pages 65-66 of *Guided Tour* and following. The Sorcerer keyboard is software scanned. It is arranged into 16 banks of FIVE keys. The bank is selected by sending a number between 0 and 15 to Port No: FE. The key pressed is returned on bit 0 to 4 of input Port No: FE. Care must be taken to force bits 5 to 7 to a zero value to obtain a number in response to a key pressed. The keys are shown below.

BITS 0 - 4 of FE are normally LEVEL ONE and go low only if a key of the selected bank is pressed.

Numbers obtained with bits 5-7 RESET To Ø

NO KEY PRESSED = 31
KEY IN ROW 1 = 30
2 = 29
3 = 27
4 = 23
5 = 15

PROGRAM TO SCAN THE "0 — 9" & "=" & "." keys on the number pad.

## Basic part

```
10 POKE 260, 16: POKE 261, ØØ
```

| BANK | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | STOP | CLEAR | X | C | F | B | M | R | , | / | \ | - | + | Ø | . | not |
| 2 | GRAPHIC | REPEAT | Z | D | R | V | N | I | L | . | @ | RETURN | X | 1 | 2 | used |
| 3 | CTRL | SPACE | A | S | E | G | H | J | O | ; | ] | LINE FEED | ÷ | 4 | 5 | |
| 4 | SHIFT LOCK | SKIP | Q | W | 4 | T | Y | U | 9 | P | [ | ^ | -. | 8 | 6 | = |
| 5 | SHIFT | (SEL) | 1 | 2 | 3 | 5 | 6 | 7 | 8 | Ø | : | - | NOT USED | 7 | 9 | 3 |

*(continued from previous page)*

exceptions — 012 and 017. The instruction PRINT CHR$(12) clears the screen, moving the cursor back to the top left, while PRINT CHR$(17) does this without clearing the screen.

## Screen co-ordinates

The screen can be thought of in terms of X and Y co-ordinates running horizontally from X=1 to X=64 and vertically from X=1 to Y=30. To find the address for any pair of co-ordinate values, use the formula:

address = -4033 + Y*64 + X

Thus for the bottom right of the screen, where Y=30 and X=64, the address -2049 = -4033 + 30*64 + 64. If we take any position on the screen, say -2500, the positions to the right and left of it will be 1 greater and 1 smaller, while the positions immediately above it and below it will be 64 less (-2564) and 64 greater (-2436). Similarly, the position below it to the right will be 65 greater. Thus the program:

```
10 PRINT CHR$(12)
20 FOR J = -3998 TO -3348 STEP 65
30 POKE J,42
40 NEXT
```

will yield a sloping line of asterisks, first clearing the screen. Try it again with steps of 66 (flatter slope), 64 (vertical) and 63 (slopping down to the left).

It should now be clear how the following subroutine generates a rectangle W characters wide and H high, with its upper left corner at position X,Y. Values of these four variables have to be input first.

```
1000 PRINT CHR$(12)
1010 A = -4033 + Y*64 + X
1020 FOR J = A TO A+W : POKE J,186 : NEXT
1030 FOR J=A+W+64 TO A+W+(H-1)*64 STEP 64 :
     POKE J,183 : NEXT
1040 FOR J=A+W+H*64 TO A+H*64 STEP-1 : POKE
     J,179 : NEXT
1050 FOR J=A+(H-1)*64 TO A+64 STEP-64 : POKE
     J,182  NEXT
1060 RETURN
```

Note that since characters are taller than they are wide, W has to be about 1.4 times H in order to produce a square square.

## DIY characters

Printing the 64 characters 192 through 255 gives a set of meaningless blurs. They can be replaced with characters of your own design by storing the correct pattern of dots in the proper part of the memory.

Characters are made up of eight rows of eight dots, with each dot being either turned on or off, i.e. a 1 or a 0, and each row stored in one memory address. Thus a hollow square is:

```
11111111
10000001
10000001
10000001
10000001
10000001
10000001
11111111
```

Each line is a binary number but when using Basic one has to turn it into a decimal number to store it. The first and last rows are:

128 + 64 + 32 + 16 + 8 + 4 + 2 + 1

i.e. 255. The six rows in between are : 128 + 1 = 129.

The memory addresses for storing your own graphic characters are the 8 × 4 addresses -152 through -1. The first eight of the store character 192, the next eight (-504 through -497) store character 193, and so on.

It is then easy to make character 192 a hollow square. Simply use the following to poke in the eight rows:

```
10 POKE -512,225
?0 FOR J= -511 TO -506 : POKE J,129 : NEXT
30 POKE -505,255
```

The instruction PRINT CHR$(192) will then display a hollow square. One can create other charaters by drawing an 8 by 8 pattern of 1s and 0s and converting each line into a decimal number. For example:

10101010
is 1×128 + 0×64 + 1×32 + 0×16 + 1×8 + 0×4 + 1×2 + 0 = 170.

All the poking described has been into display screen space or graphic character space in the memory but other parts of the memory can also be poked into. If you put in crazy numbers for Y and X, for example, the square-drawing subroutine will poke into parts of memory other than display screen space or graphic character space, sometimes with odd results, such as wrecking the program listing.

Each of the ready-made characters, like the do-it-yourself ones, occupies eight memories addresses. Character number × is in the eight addresses starting with -2048

*(continued on next page)*

```
20  A = USR (0)
30  B = PEER (0): C = PEEK (1): D = PEEK (2)
40  IF B = 31 and C = 31 and D = 31 then 20
50  IF B = 30 then
60  ETC
```

10 — tells the Sorcerer where the subroutine is
20 GO TO SUBROUTINE
30 TRANSFER RESULTS TO VARIABLE
40 OPTIONAL IF YOU WANT TO LOOP UNTIL A VALID KEY IS PRESSED
60 START MANIPULATING RESULTS i.e. DEPENDING ON NO'S IN B, C or D will alter where you jump in a program

Both this and the following can be used like the GET $ command on the Pet. Return does not need to be pressed and it can be used in real-time programs like "STOMP".

A program to scan the whole keyboard:

```
10 POKE 260, 16: POKE 261, 00
20 A = USR(0)
30 B = PEEK(0)
40 B$ = CHR$ (B)
50 YOUR PROGRAM
```

```
ADDR
0010H — F5 C5 D5 E5 — PUSH REGISTER TO STACK
0014H — CD 18 E0 — CALL E0 (KEYBOARD ENTRY TO MONITOR)
0017H — 3200 00 — LD ADDR (0000) FROM REG A
001AH — EI DI CI FI — POP REGISTER FROM STACK
001EH — C9 — RETURN TO BASIC
```

This program uses the Monitor Program to scan and decode the keyboard so you gain access to all ASCII codes and graphics.

**The subroutine**

```
ADDR
0010 H  — F5
0011    — C5                PUSH REGISTERS ON TO STACK
0012    — D5
0013    — E5
0014    — DE  FE  LD  C  REG WITH FE (PORT NO)
0016    — 21 00 00 LD HL WITH 00 00 (RESULT ADDRESS)
0019    — 06 0d  LD B REG WITH 0D (BANK TO BE SCANNED)
001B    — 78  LDA WITH CONTENTS B
001C    — ED 79  OUT PORT IN REG C (FE) CONTENTS OF A REG
001E    — DB FE  INPUT PORT FE TO A REG
0020    — 00 00  SPARE
0022    — CB AF  RESET BIT 5 IN A REG
0024    — CB B7  RESET BIT 6 IN A REG
0026    — CB BF  RESET BIT 6 IN A REG
0028    — 77  LD (ADDRESS IN HL) FROM REG A
0029    — 23  INCREMENT IN HL
002A    — CB 55  TEST BIT 2 IN L REG
002C    — 2C 33 00 JUMP ON NOT ZERO, 00 33
002F    — 04       — INC B
0030    — C3 IB 00 — JUMP TO 001B

0033    — EI
0034    — DI                POP REGISTER FROM STACK
0035    — CI
0036    — FI
0037    — C9  RETURN FROM SUBROUTINE
              TO MAIN BASIC PROGRAM
SCAN OF ROW 13 (0D) RESULT IN ADDR 0000H
 "   "   "  14 (0E)    "     "    " 0001H
 "   "   "  15(OF)     "     "    " 0002H
```

*(continued from previous page)*

+ 8*X. Thus a question mark, which is character number 63, is in addresses -1544 through -1537. The routine: FOR J = -1554 TO -1537 : PRINT PEEK (J):NEXT will yield the numbers shown on the right of each of the binary numbers:

```
0 0 1 1 1 0 0 0 = 56
0 1 0 0 0 1 0 0 = 68
0 0 0 0 0 1 0 0 =  4
0 0 0 1 1 0 0 0 = 24
0 0 0 1 0 0 0 0 = 16
0 0 0 0 0 0 0 0 =  0
0 0 0 1 0 0 0 0 = 16
0 0 0 0 0 0 0 0 =  0
```

One can change the 64 ready-made graphic characters in the same way as one can create 64 of own's own. Beware of the fact, if changing any of them, that PRINT CHR$(12) will not only clear the screen but will also change them back to their original shape.

### Blinking

The techniques described can be combined to create some elaborate graphic effects. You can fill the screen with some pattern of characters and make them all change at once into some other character and then back into the first one. If you do this with character 192, for example, and use:

```
FOR U = 0 TO 600 : NEXT
```

as a Delay subroutine, the routine would be made up of the following components:

- Clear screen and show a pattern consisting of, or including, a do-it-yourself character, e.g. 192.
- Generate character 192 — e.g. a hollow square.
- Delay.
- Generate a different character 192 — e.g. a solid square.
- Delay.
- Go to (b).

All the squares in the pattern will then blink simultaneously from hollow to solid and back for as long as you can let the machine run. This is somewhat boring but the technique probably has all kinds of useful and amusing applications. It would be interesting to hear about them.

# How to represent your characters

**John Martin deals with the theme of user-defined characters in greater detail.**

THE SORCERER has great merit in that you can define your own graphic characters but the procedure detailed in the Sorcerer manuals, whereby hexadecimal code is placed into successive memory addresses using the monitor, is somewhat tedious. The equivalent Basic program listed makes the defining of graphic characters an easy process, so that each one can be done in a few seconds.

The first stage is to work out how to represent you desired character by an eight-column, eight-row arrangement of dark and light squares. One way is to use quarter-inch or similar graph paper and fill-in the squares which need to be dark with pen or pencil.

I find it more convenient to use a set of 64 pieces of card — mine are 2cm by 4cm — which are white on one side and black on the other. They are arranged in an 8 by 8 matrix on a tray and I can turn over individual cards and change the arrangement until it represents the graphic character I want.

The second stage is to decide where on the keyboard the new graphic is to be. Make a copy of the keyboard template and write your new character in the place where you would most likely look for it when you want ot use it. For example, the Greek letter delta would go on the D key, while the mathematical symbol not greater than would go on the greater than key.

Then we are ready to use the Basic program listed, When run, it first prompts with "Key NAME ?". That is not strictly necessary but is helpful when you are faced with a mass of similar-looking numbers later, to distinguish one set from another more easily.

The second prompt is "Which KEY ?". There you press the graphic key, the shift key, and the key of your choice. At first it will show a rectangular block but when the program is finished it turns into the character you want.

After printing "Column : 12345678", the third prompt is "Row 1 ?". You then type-in a string of eight characters, each of which is either one or other of those you use in the data statements of lines 300 to 315. I use the graphic characters on the - (minus) and 7 (seven) keys of the numeric keypad. My Anadex printer prints them as 1 and 2. Note that Sorcerer does not understand a space as the start of a string, while the use of a dot instead of graphic 7 is tedious in practice.

With a finger of the left hand on the graphic button, your right thumb on the return button, and your first and second fingers on those numeric keys, you will soon be entering graphic characters at great speed.

Should you make a mistake, you can either back-space or go under or over the required number of eight characters, when the program repeats the same row again. If you find a mistake after you have pressed return after an 8-character row, the only recourse is the press Control C and start again.

After eight rows you will have a large-scale version of your graphic on the screen. On pressing return, the program computes the decimal equivalent of the two-character hexadecimal code for each row and Pokes it into the memory locations for the key on which you decided.

The program will print-out the names of your key, the ASCII code of your graphic key, and eight decimal numbers. Unless you have a printer — for which lines 180 and 405 switch an Anadex printer on and off — these should be noted on a 10-column sheet of paper.

Once you have created all the characters you want, you can put the numbers noted in DATA statements in this keyboard program:

```
FOR K = 1 TO 64 (or the number of keys you have made)
READ M
  FOR R = 1 TO 8
  READ N
  POKE (-1024 + 8 x (M-128) + R-1), N
  NEXT R
NEXT K
DATA M,N1,N2,N3,N4,N5,N6,N7,N8
```

These programs will also work with the standard graphic keys but unless your keyboard program is made at the start of your main program, your graphics will be replaced by the standard graphic if a RUN command is given. This does not apply to the user-definable graphics, which remain in the keyboard memory until the power is switched-off.

```
5 REM A program to create graphic characters.
7 REM Copyright 1979 John K.Martin
10 CLEAR(500)
20 DIMG$(8)
30 CLEAR
40 PRINTCHR$(12):PRINT:PRINT:PRINT
50 INPUT"Key NAME";N$
60 INPUT"Which KEY";K$
100 PRINTTAB(20)"Column : 12345678"
110 FORR=1TO8
115 PRINTTAB(20)"Row ";R;
120 INPUTG$(R)
125 IF LEN(G$(R))()8THEN115
130 NEXTR
180 POKE32720,147:POKE32721,233
185 PRINT:PRINT N$
200 FORR=1TO8
210 M$=LEFT$(G$(R),4)
220 GOSUB320
230 L=M
240 M$=RIGHT$(G$(R),4)
250 GOSUB320
260 D=M
270 POKE(-1024+8*(ASC(K$)-128)+R-1),16*L+D
280 PRINT16*L+D;
290 NEXTR
300 DATA"2222",0
301 DATA"2221",1
302 DATA"2212",2
303 DATA"2211",3
304 DATA"2122",4
305 DATA"2121",5
306 DATA"2112",6
307 DATA"2111",7
308 DATA"1222",8
309 DATA"1221",9
310 DATA"1212",10
311 DATA"1211",11
312 DATA"1122",12
313 DATA"1121",13
314 DATA"1112",14
315 DATA"1111",15
320 READE$,E
340 IF M$()E$GOTO320
350 M=E
360 RESTORE
370 IF R(9 THENRETURN
400 PRINT"KEY ";ASC(K$)
405 POKE32720,27:POKE32721,224
410 INPUT"Another Key";X$
420 IF LEFT$(X$,1)="Y"GOTO030
500 ENDREADY
```

# Saving disc space with control programs

**Bryan White concludes his two-part series with a discussion of rapid techniques used in commercial and industrial applications.**

THE FLEXIBILITY of large or small disc-based systems can be determined solely by the methods used to store and retrieve information. In any system which will become more complex in terms of storing data, a significant saving of disc space and memory overhead can be achieved by starting with a powerful file control program.

Part one covered the basic concepts of assessing files, linking records according to their logical sequence, and so on. By using those concepts we can now discuss some typical and very useful file-management techniques used in industry and commerce. They are not as difficult to implement or understand as they may at first appear and after a time will become instinctive as you design your future systems.

The technqiue of partially-linked files stores information on a secondary file in "chains" of information, which each relate to one record on a main file. Each record in the main file contains pointers to the first and last record in the secondary file — figures 1(a) to 1(c).

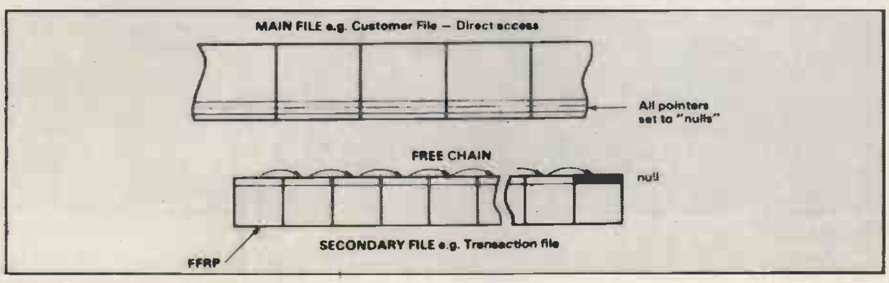



**Figure 1(a).**

This shows the initial set-up before use. The free chain of the secondary file is initialised, with the first free record pointer (FFRP) set to the first record on the file. The pointers on the main file are initially set to nulls, since the secondary file is empty.

This shows how the file may be structured after a little use. Customer A has three transactions outstanding, customer B has only one. Customer C has none and therefore does not use any disc space on the secondary file.

The last record in every chain in the secondary file has its "link" pointer set to a null to indicate to the processing programs that all transactions for the current main file record have been encountered.

The main advantages of using this storage technique are:

(a) For most processing applications the record access times can be as fast as those for direct files.

(b) Since each chain relates to only one main file record the search time for, say, a particular invoice number is minimised.

(c) New records can be inserted quickly and deleted records are released to the free chain for future use.

(d) If the physical location of the main file record is changed — e.g., a customer is transferred to another slot or the main file is re-organised (see index-sequential) — the secondary file remains intact, since the FRP and LRP are held on the main file.

(e) By monitoring the number of live records — held on the file directory — on a regular basis, the size of the secondary file can be "tuned" to a minimum.

This shows how partially-linked files may be cascaded for a typical production control system. For each product the sequence of departments through which it must pass is held on a secondary file and the sequence of operations within each department is held on yet another secondary file.

That method of cascading files may be repeated *ad infinitum*, thus enabling programs to 'hop' from file to file, collecting or searching for information very rapidly and with the minimum number of disc accesses. When inserting or deleting partially-linked records the new FRP and/or LRP must be returned to the main file record for disc update, or the logical chaining will be lost, leaving a 'cobweb' of meaningless pointers which may be impossible to unscramble.

A small program which checks all linked files is worth writing, especially for program development when 'bugs' are liable to corrupt pointers. The self-checking program should verify that all FFRP pointers on the directory eventually reach the end of the file — i.e., follow only the free chain — and that all LRP pointers are either null or point to a record containing a null.

When deleting a record which contains pointers to other files the program should check that the pointers are "nulls". For example, if in figure 1(c) the 'Dept 1' record is deleted and released to the free chain, then two records on the process file will be left unusable and inaccessible by "file hopping".

All records in a partially-linked file should be "accounted for" in terms of the FRPs, LRPs and the record chains, leaving the FFRP to account for the remaining free chain. Self-checking programs become invaluable in complex systems to verify that files are intact before taking security copies of discs.

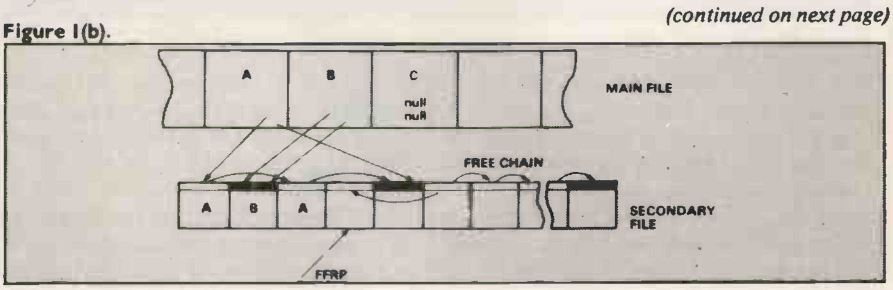
A good example of this technique can be described with the file structures in figures 1(a) and 1(b). Suppose that a customer's balance is held on the main file; it can be verified by the algebraic sum (debits and credits) on the transaction file.

Indexed files are used when the physical position of a record cannot be calculated by manipulation of the desired method of reference. Names and addresses, catalogue numbers, product descriptions and the like fall into this category. Imagine a product file to be referenced by a seven-digit code of the form 123/4567 where the first three digits are the product type and the last four are the size.

A direct file would require a file length

*(continued on next page)*

**Figure 1(b).**



*(continued from previous page)*

of 9999999 records which is clearly impracticable unless you wish to make the floppy manufacturers very rich. By using the seven-digit code as a "key" to a separate index file we can find the approximate position on the main product file.

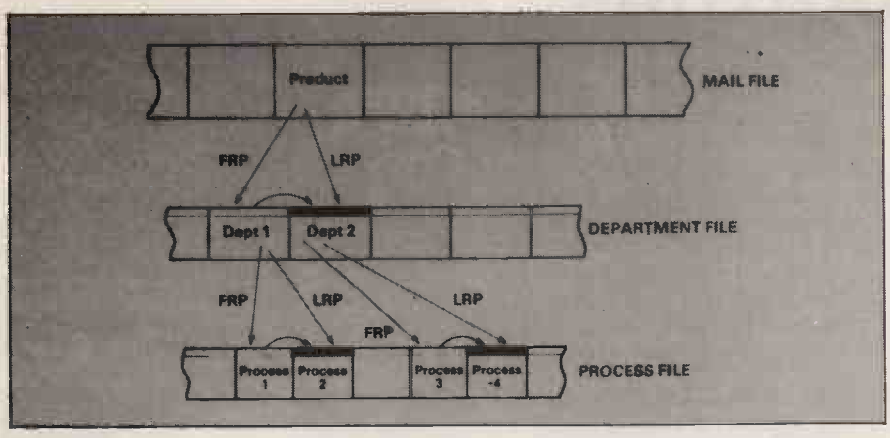



**Figure 1(c).**

The key must exist on every product record and whether it is an ASCII or binary pattern, the searching software will treat it as an integer number — AZOIC is numerically less than ZEBRA.

The main file is a sequential file, as described in part one, and is loaded initially with our product file in ascending key sequence — figure 2(a).

Do not confuse the record pointers with the key, or the key value with the slot number used to hold it. The file is now in physical and logical sequence with keys in ascending integer values. We can now copy the key value and the slot number holding the key to the index file for every nth record on the main file, where n is the index density which will determine the response time for the file and the size of the index file required.

A program is required to transfer the key and corresponding slot number from every nth record on the main file to the index file, which should be a serial file with a record length large enough to hold the key and the pointer to the slot on the main file.

The program needs to know the key length, the key position within the main file, the index density and the file names or file numbers of the main and index files. The program starts reading from the FRP on the main file and writes a record to the serial (index) file every nth access.

The first record on the main file should be an nth record otherwise slots 1 to n-1 will not be accessible. The program should also check that the keys ascend for all records and that none is repeated.

The link pointer in every record should be equal to the current slot number +1, except for the last one read, which ought to contain a null and its slot number should be equal to the LRP. Those checks will ensure that the index can be created only on a file which is in physical and logical sequence. For reasons which will become clearer, each indexed record must be marked in some way to indicate that it is indexed; choose the next free byte after the key and set it to a recognisable pattern, but do not mark the pointer or the key in any way.

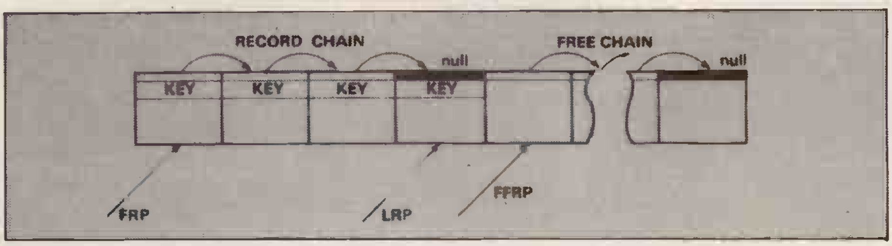



**Figure 2(a).**

We now have an index sequential file as shown in figure 2(b) with an index density of 4.

Records on the main sequential file can now be accessed via the index file using the key to search both files quickly. Given a key value, the index file is searched until either the desired key is found — in which case the desired record can now be accessed directly — or until a key of a higher value is encountered.

The previous record on the serial file will direct the search to within n-1 records of the desired record, starting from the indexed record and following the record chain until the record with the required key is located. If a key of a higher value than the required key is found or an indexed marker ($) is discovered during the search, the required record does not exist on the file and that fact must be returned to the calling software — this failure is useful to prove the non-existence of a new record we wish to add to the file.

Once a record has been located via the index, all records up to the LRP can be accessed sequentially without further reference to the index file. If, for example, we wish to print all products from, say, type 23 to type 92 using our seven-digit code, the limits given to the print program would be 0230001 to 0929999 and only the record with a key of 0230001 would have to be read via the index; subsequent records can be read using the pointers in the record chain of the sequential file until a key value greater than 0929999 is read.

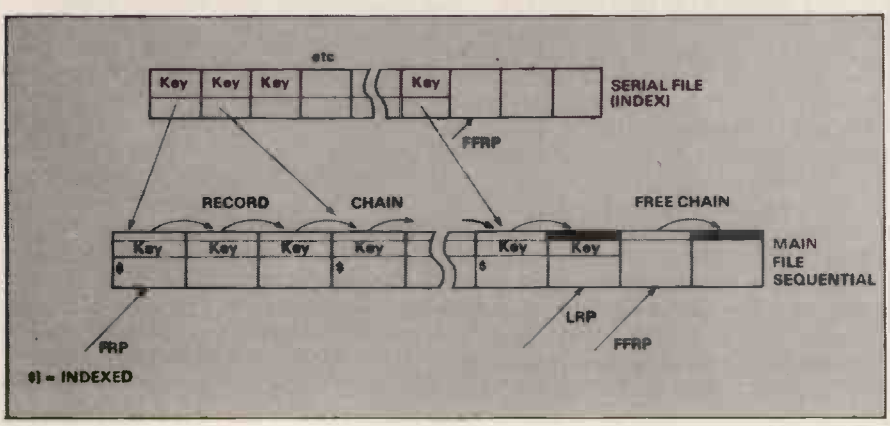



**Figure 2(b).**

When printing or searching a range of an index sequential file, the first record in the range must be a valid record, otherwise the "chain" through to the last cannot be located.

The file size, the key size and the index density will determine the number of sectors required for the index file, which, if numerous, will decrease the response times for records with a high key value. For large index files, further "levels" of index can be created using the same technique — see figure 2(c).

I shall not explain this technique in great depth, since it should rarely be required in floppy environments. Level 1 is searched until "n" records on level 2 are located; they are scanned to given 'n' records on the main file to search. Index searches can be very fast even with very large main files, typically 1.5 seconds on

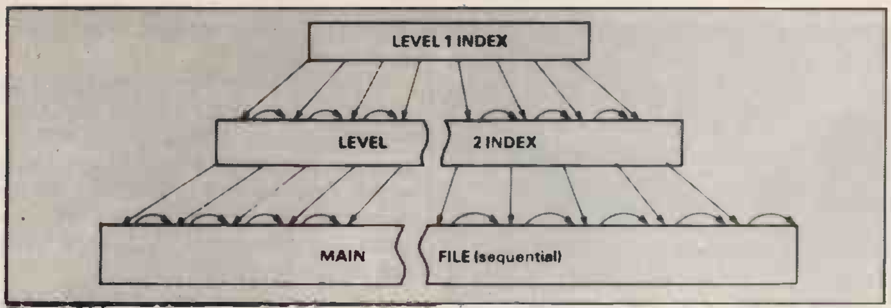



Figure 2(c).

fast minicomputers with more than one million main file records.

New records can be added to the file without having to re-create the index each time. They will fall automatically into logical sequence. The file should be read using the new key, which does not yet exist on the file. The search will fail, proving that the insertion is permissible. During the search the records which will logically precede and follow the new record can easily be determined — they will normally be the last two accesses on the main file before the search fails. The new record is now written to the slot denoted by the FFRP and the record pointers are updated in the normal manner for sequential files — see figure 2(d).

The index file remains unchanged and on sequential reading of the file, records A, B and C will be read in that order. The new record (B) can also be found via the index as easily as any other record in the file by using its key. Insertion of records logically preceding the FRP or following the LRP are a little more complex, since the index file may also need updating.

The memory requirements for the software to do this will be hard to justify on small systems since "dummy" first and last records can be loaded with minimum and maximum possible key values to overcome this problem; or if this is not practicable, a new index can be created after the file is re-organised into physical and logical sequence.

The removal of records which are not "indexed" i.e., do not have an entry on the index file — is as easy as for any sequential file. The deleted record is returned to the free chain and the FFRP is set to the slot deleted. The pointer in the logically preceding record becomes the pointer from the deleted record and the pointer in the new free slot becomes the old FFRP.

A record which is indexed cannot be deleted in this way since its physical position, pointer and key are still required for an index read to locate like records logically following it. The deleting software must check for the "indexed marker" ($) and change it to another pattern to be recognised, by software, as "indexed and dead". It must then be ignored in sequential prints and searches.

Index sequential files tend to be relatively static — customer files, product files and so on; but after a number of insertions and deletions they will take longer to access, since the physical sequence is lost. Logically-adjacent records may be separated by many sectors or tracks, increasing seek times for the disc unit. File re-organisation for indexed files is as follows:

(1) Copy the main file to a "scratch" file of equal length.
(2) Re-initialise the free chain on the main file.
(3) Read records logically from the scratch file — ignoring any marked as "dead" — and write them sequentially to the newly-initialised main file. Do not transfer any link pointers or index markers from the scratch file to the main file.
(4) Re-create the index on the main file.

We are now back to a file structure as in figure 2(b) with an (n-1) search time for any record.

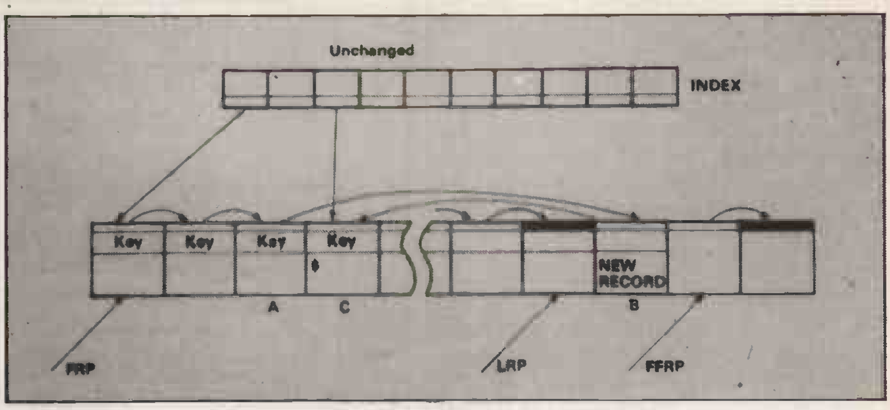



Figure 2(d).

As you can appreciate, index sequential files are an effective method of storing and retrieving information. Their speed and flexibility make them useful for a wide range of applications. They cannot be cascaded in the same way as partially-linked files, nor can any record be referenced from another file simply by a pointer, since records change their physical position after re-organisation.

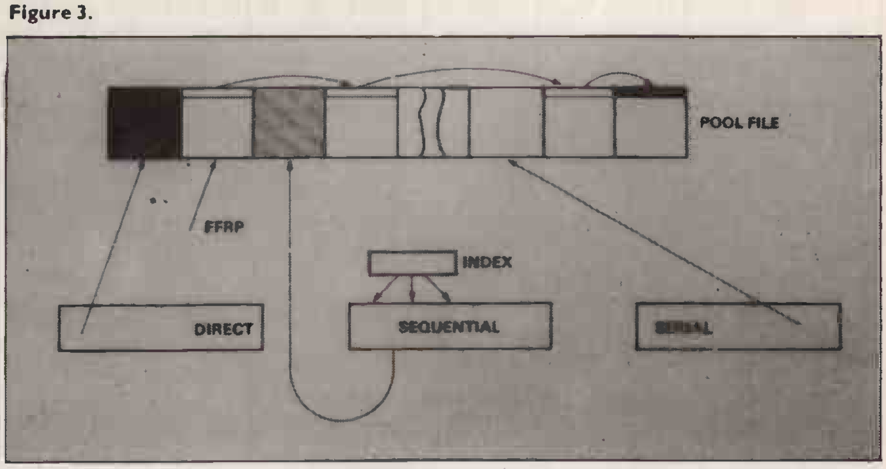
All external references to records should be by the key value unless it is a temporary situation which I shall cover when discussing spooled output files.

A Pool File, as its name implies, is a collection of records which form a file containing information of different types. It is simply a dumping area, usually for relatively transient records of different formats like delivery addresses, descriptive text and so on. The software writing a record to the file is, in effect, saying "Here is a record. Store it on the pool file — I don't care where — but tell me where you've put it, and don't 'free' it until I tell you."

The record is retrieved from the file as a direct access on the slot number returned by the writing software. The file initially is a linked file using only the FFRP. Records are written to the slot denoted by the FFRP which is then updated in the normal manner. The record written to the file does not form any chain within the file

*(continued on next page)*

Figure 3.



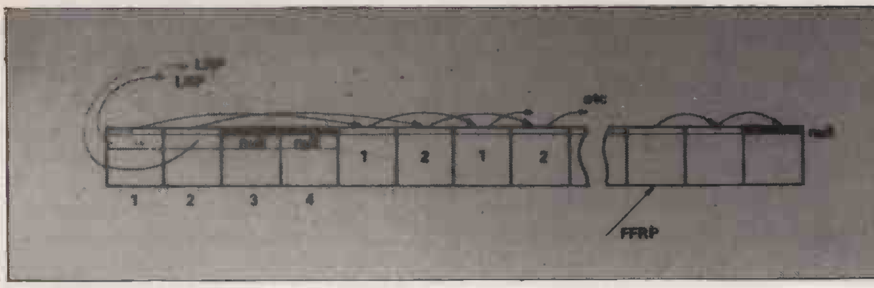


Figure 4.

(continued from previous page)

and simply awaits its retrieval and subsequent deletion, after which it becomes linked to the free chain again.

For continuity and ease of explanation, I have assumed fixed-length records for all file types I have discussed. This restriction is removed to some extent with pooled files, since the format and use of space within a record is totally defined by the user, subject to the restriction that it must be large enough to hold the largest record to be pooled. The record pointer may be used as an information area, as it is not required during its existence and will be restored — to the old FFRP — upon deletion.

Considerable disc space can be saved using this pooling technique, since main file records need allocate space only for the pointers to the pool file slots rather than its contents, which can be "trimmed" to a minimum in volatile environments.

For example, if a customer file is, say, 2,000 records in length and, say, only 100 of them use separate delivery addresses, then space for 1,900 main file delivery address requirements are saved and the only unused space on the main file is 1,900 null pointers.

Figure 3 shows a typical pool file containing records required by different files.

Spooling techniques are a method of storing data on disc to be retrieved and passed to its destination at a later time. The destination is usually a printer but may be any form of output—for example, a modern link. A typical business system can generate output for different print layouts — invoices, credit notes, delivery notes and so on, each of which must be de-spooled separately.

Some large systems spool information in character format in the same sequence as they would appear at the printer with a separate file for each information "set". This can be efficient with very large discs and very fast printers, since the proportion of the available disc space used is low and time taken to "empty" it is fast. It is not needed on small systems where the volume and speed of printing are much lower, especially if the output device has its own internal buffer — as many matrix printers do — which, as it is emptying, allows the de-spooling program to access main files for the bulk of its output without stopping the printer.

Figure 4 shows a method of spooling up to four separate chains of information using one file. It is fairly simple but sufficiently effective for most micro systems.

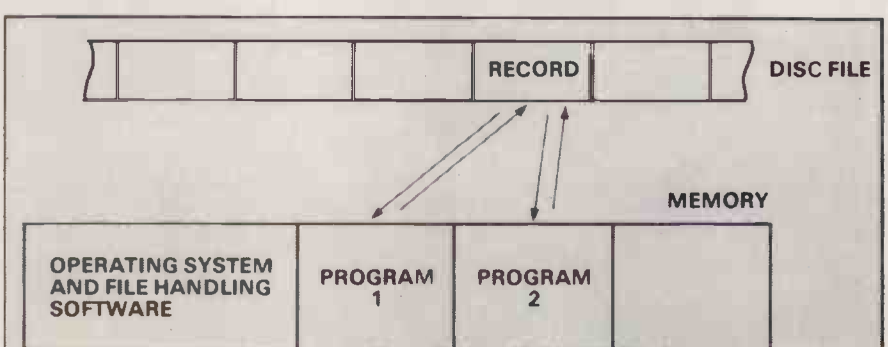
The first "n" records of the file are reserved by the software for pointers to separate "spooled chains" of records, where "n" is the maximum number of spool chains allowed on the file. In the diagram, when the spool file is empty the FFRP will point to an empty free chain — records 1-4 will contain null points to indicate to the software that there is nothing to print.

When a spool chain is processed and deleted finally, each record in the chain is released to the free chain, until the previous record is in the range 1-4, in which case the FFRP is set to the slot number of the last record deleted — as usual — but record (1, 2, 3, or 4) has its link pointers set to null.

The contents of each spooled record can now be the minimum — just pointed to other files — required to access all information to be output. Pointers to slot numbers on index sequential files will save holding full-length key values on the spool record, and will allow a direct access on the file rather than an index search.

The only restriction is that any spool chains containing such pointers must be "emptied" before file re-organisation. Spooling techniques, of which this is only one method, allow processing to continue while the output device is not available, and in situations where remote printers are used can greatly reduce the cost of "connect time".

Figure 5(a).





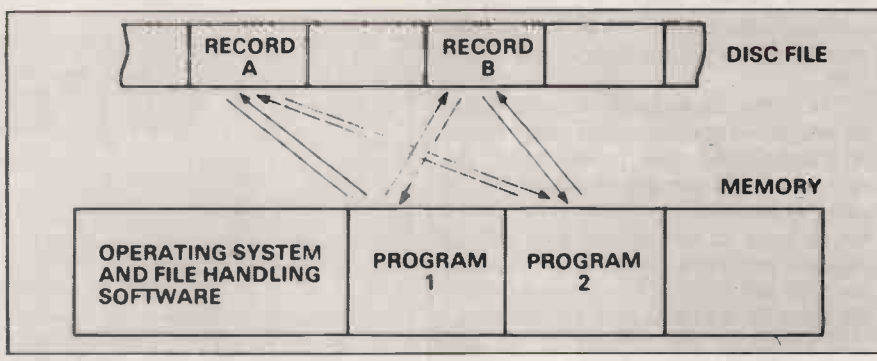




Figure 5(b).

Most or all of the file types I have explained in this series are used in typical industrial and commercial applications, usually in multi-programming environments. The philosophy of storing and retrieving information remains essentially the same, but some problems can occur when more than one program accesses the same files.

This deserves a brief explanation. Figure 5(a) shows two programs attempting to update the same record on a file "simultaneously". Each program will have the same record in its buffer and can updte it there. The first program to "re-write" the record will have the changes it made over-written by the second program to "re-write". To overcome this problem, the calling programs must inform the file control program that the record is to be "locked" until released or re-written to disc.

This now leads us to the second problem — figure 5(b) — where program 1 has read and locked RECORD A, and then needs to read and lock RECORD B, but program 2 has read and locked RECORD B and requires RECORD A. The solution, as textbooks have it, is left to the student.

# Taking the tedium from data analysis problems

**Owen Bishop continues his series, showing how even the MK-14 can be astonishingly powerful with certain statistical routines.**

TEN HOUSEHOLDS were selected to test WYTO, a new super detergent — no counter-claims, please, since this is an imaginary example — and 10 others selected to test the well-known brand X. At the end of the tests they were asked to score on a scale from 0 to 5 for each of four features — washing whites, washing coloureds, grease-removal, convenience in use.

The four scores were added, so that the maximum score from any one household was 20 points. The scores obtained are shown in table 1. Unfortunately, the washing machine belonging to household F broke down and the tests were not completed. When we calculate average scores it seems clear that 'WYTO washes better'. Not only has it the higher average score, but it also has the highest individual score (19), while brand X has the lowest individual score (9).

**Table 1**

| USING WYTO Household | Score | USING BRAND X Household | Score |
|---|---|---|---|
| A | 16 | K | 12 |
| B | 10 | L | 18 |
| C | 18 | M | 10 |
| D | 16 | N | 15 |
| E | 19 | O | 14 |
| F | — | P | 14 |
| G | 13 | Q | 17 |
| H | 18 | R | 9 |
| I | 15 | S | 14 |
| J | 17 | T | 15 |
| Total scores | 142 | | 138 |
| Average scores | 15.8 | | 13.8 |

Now let us look at this data from another viewpoint. Suppose we had selected 20 households, given them all the same brand of detergent and then chosen a group of nine families to make the group we call WYTO, how easily could we have obtained results like those of table 1? What are the chances of picking a group of households from those 19 purely at random, which would have an average score of 15.8 or even more?

If we can find a number of ways of doing this, the claims for the efficacy of WYTO are based on little more than good luck in the testing.

To simplify the thinking and to make the conclusions of more general applicability, we substitute ranks for the scores of table 1. In table 2 the rating by each household has been replaced by a rank, from one to 19 corresponding to the scores from 19 down to nine. Where two or more tests gave the same score, the ranks are tied, and we allocate the average rank to tests obtaining tied scores. For example, score 18 occupies places 2, 3, and 4 on the rank list, so the average rank is three. Score 17 occupies places 5 and 6 on the rank list, so the average rank is 5½. In table 2 it still appears that WYTO is better than brand X, even though it can be argued that 'average rank' does not have a great deal of meaning.

The results of table 2 might have been obtained by taking 19 households, giving them all the same detergent — or two brands of equal washing powders — and then picking a goup of nine households at random and calling them 'the WYTO would be unlikely to have the same average rank as the remainder, so almost always one group would be 'better' than the other.

The number of different ways of picking nines from 10 is 19!/10!9! = 92378. How many such groups give rank totals equal to or less then the 69 obtained by WYTO? This is not an easy question to answer offhand, though an enthusiastic reader may like to compile a program to calculate the answer.

## Random result

Calculations show that 95 percent of such groups have totals of 65 or more, and only five percent have totals of 64 or less. The WYTO total of 69 is thus not a particularly low one, for one can get a lower total in more than five percent of cases by picking scores at random from among 19 households with identical detergents. So much for the claim that 'WYTO washes better'.

If WYTO had done a little better in its test and obtained a rank total of 64 we could say:

There is no difference between the detergents, and this is a lucky one in 20 chance which gives WYTO the lead or WYTO washes better — but remember there is a one in 20 chance it is a random result and we could still be wrong to enthuse about WYTO.

To become really convinced about the virtues of WYTO, we might demand an even lower rank total, say, 58 or less, which can be obtained only by random selection once in 100 times. Then we could believe in WYTO with only a one percent chance of being wrong.

The Wilcoxon Rank Test, which can deal with analyses of the kind outlined, is also known as the Mann-Witney test. The data used can be actual measurements — weights of tomato crops from two sets of plants grown with different fertilisers; numbers — numbers of dental fillings required by two sets of children using different toothpaste; subjective scores — the WYTO data; or ranks — finishing positions of members of two teams of racing cyclists. The two groups can have different numbers of members. To perform the test we:

- Allocate ranks, allowing for ties.
- Total the ranks of the smaller group, and call it T. If groups are equal in size, total both and take the smaller.
- Calculate the conjugate total, T', which is the rank total obtained by ranking the data in the reverse order. If the smaller group has $n_1$ members and the larger group has $n_2$ members, $T' = n_1 (n_1 + n_2 + 1)-T$.

Take the lesser of T and T' and compare it with the tables of critical values. The tables give values below which the lesser rank total must lie if the difference between the two sets of data is to be regarded as significant at the five and one percent levels. For $n_1 = 9$, and $n_2 = 10$, the five percent table gives the value 65, which is why we can set little store in the claims of the WYTO trials.

Figure 1 gives the flow-chart for the MK-14 program which calculates ranks and then derives the lesser of T and T' — we will call this T''. The ranking part of the program can be used in conjunction with a modified version of the program for the Runs Test — see November issue — and its applications will be described in a later article.

**Table 2**

| USING WYTO Household | Rank | USING BRAND X Household | Rank |
|---|---|---|---|
| A | 7½ | K | 16 |
| B | 17½ | L | 3 |
| C | 3 | M | 17½ |
| D | 7½ | N | 10 |
| E | 1 | O | 13 |
| F | — | P | 13 |
| G | 14 | Q | 5½ |
| H | 3 | R | 19 |
| I | 10 | S | 13 |
| J | 5½ | T | 10 |
| Total ranks | 69 | | 120 |
| Average rank | 7.7 | | 12 |

This program can rank up to 30 items of data, entered in decimal — maximum value 99 — with $n_1$ taking any value from two to 15. It is easy to modify it to deal with larger numbers of items, though it is unlikely that the facility will be required in

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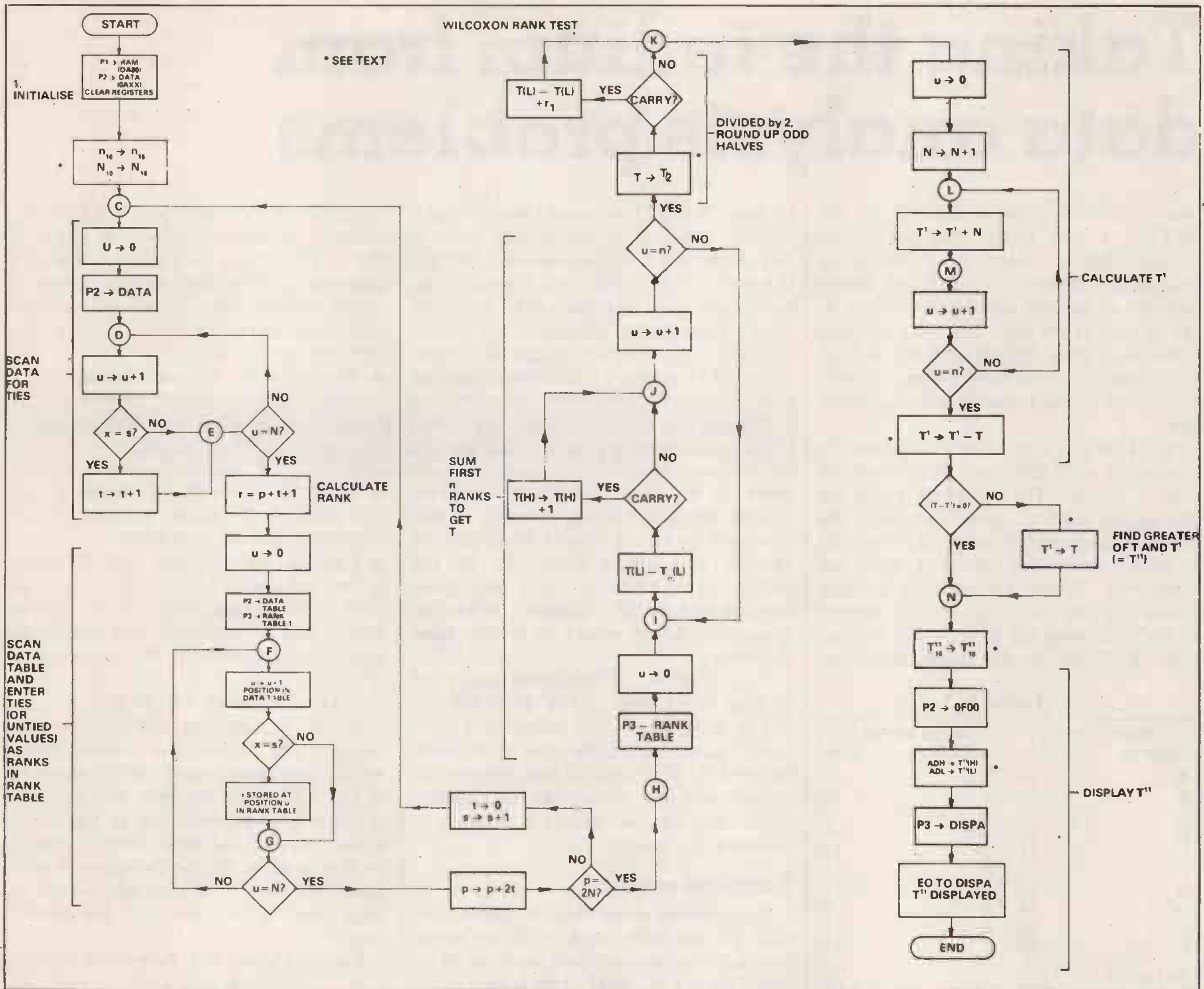



Figure 1.

*(continued from previous page)*

general use.

The operator enters $n_1$, then the total number of items ($n_1 + n_2 = N$), followed by the items, with then items of the smaller group, corresponding to $n_1$, entered first. Within each group order does not matter. The program is then run. First it converts n and N to hexadecimal. The data is not converted. Conversion is done by decrementing n or N decimally (+99 is equivalent to —1), while incrementing a counter hexadecimally.

Allocation of ranks using pencil and paper is a time-consuming operating, fraught with possibilities of error, as any teacher working out end-of-term positions will agree. Though the microcomputer routine is a very inefficient one, the ranking of 30 items takes only a fraction of a second. A search value, s, which is zero to begin with, is compared to each value of the data table in turn. If there is equality, a tie counter t is incremented.

## Final value

The final value of t is used for calculating the rank to correspond to the current value of s. To make calculation simpler, ranks are computed at twice their correct value (they run 2, 4, 6, 8) and tied ranks such as 7½ are ranked at 15. If the total number of items already ranked is p (= previous rank), the new rank is calculated from:

$$r = p + t + 1$$

As for most distribution-free tests, computation is simple and the tedious operation of sorting through the data and allocating ranks is only suited ideally to the abilities of a microprocessor. After all ties have been found — t = 1 if no ties — the data table is scanned a second time. When a datum equal to s is found, the corresponding location in the rank table is given the appropriate rank value.

A new value for p is then calculated — new p = p + 2t — and the program returns to scan the data table with an incremented value of s. Thus it scans with s = 0, s = 1, s = 2 and so on until all items have been ranked and the rank table completely filled. At that stage, p = 2N and the program proceeds to its second stage.

The program first sums the first n ranks of the rank table to get T; then it takes that value of T which, being based on doubled rank values, is double the true value of T, and divides it by two. This is done by a simple 'rotate right' operation, causing each binary digit to move one place to the right, and the rightmost to the carry-link register (CY/L).

If the sum of ranks included an odd half-rank, it would have been odd when in doubled form, and a '1' would be rotated into CY/L. If this happens, T is incremented by one to round-up the odd half, as mentioned earlier.

Next the value of ($n_1 + n_2 + 1$) is calculated or, to be more specific, the equivalent quantity, n(N+1). T is subtracted from that, giving T'. In subtracting T from T' the difference is not calculated but the subtraction is done so as to leave a position value in accumulator if T' › T.

## Two addresses

If T' › T, T' is replaced by T at address occupied previously by T' (OA89, OA8A). Note the use of two addresses for each of T and T', since they can exceed $127_{10}$, or $FF_{16}$. If T' ‹ T, the contents of its register are left unchanged. The contents of this register, the lesser of T and T', are now referred to as T'', but are still in hexademical.

The decimal conversion of T'' is performed by decrementing the hexadecimal T'' while incrementing the contents of addresses OA87 and OA88 decimally. When this process is complete, decimal T'' is held at OA87 and OA88; it is then transferred to the locations in RAM used by monitor for holding addresses to be displayed (ADH and ADL).

The program is then sent to the 'Display Address' sub-rotation (DISPA), causing the decimal value of T'' to be displayed. This may then be compared to the critical value from the tables.

The program could be extended to deal with more than 30 items of data. That would entail locating the data table in the basic RAM of the MK-14 from, say, OF80 onward. With more than 30 items of data, a special table of critical values is not necessary. The method of determining whether T is significant is described in *Statistical Methods*, by G W Snedecor and W G Cochran, Iowa State University Press.

The program does not calculate both Ts when $n_1 = n_2$. To do so would require more memory space than the MK-14 can make available. It is possible usually to tell from the original data which set will yield the lesser T and that set is put in the data table before the other. In case of doubt, run the program twice, once with one set first, then with the other set first, and base the interpretation on the run which gives the smaller T''.

Ranking is typical of the rather irksome organisation of data which generally precedes the actual analysis in a distribution-free test. The organisation of data is well within the logical powers of even a simple microprocessor system, as is the relatively small amount of calculation following it.

Readers who have encountered the t-test for comparing two samples will recognise that the test can be applied to similar circumstances. Being a distribution-free test, however, it does not make any assumptions about the distribution of the data. In the WYTO example the data is clearly not normally distributed, for it is skewed towards the top end of the scale. There are many scores of high value, and a tailing-off in the number of scores of lower value. Such data could not be satisfactorily analysed by the conventional t-test but there are no such objections to using the Rank Test.

```
    WILCOXON RANK TEST

Calculates and displays T or
T', whichever is the lesser.

OA80 = p, previous rank
OA81 = r, rank
OA82 = s, search value
OA83 = t, number of ties
OA84 = u, counter
OA85 = T (H)}
OA86 = T (L)} sum of n ranks
OA87 = T"(H)}
OA88 = T"(L)} lesser of T,T'
OA89 = T'(H)}
OA8A = T'(L)} conjugate total

s, in decimal, rest in hex

Enter data:
OA8B = n, number of items
in smaller group, maximum 28
items entered in decimal.
OA8C = N, total number of items,
maximum 30 items entered in
decimal.
OA8D to OAAA: data table,
30 items maximum, entered in
decimal, maximum value each
= 99. No entry required for
unused memories.

P1 to RAM (OA80)
P2 to data table (OA8D),
then to RAM (OFOO)
P3 to rank table (OF20),
then to DISPA-1 (0159)


INITIALIZE:
OAAB C40A    LDI'OA'
```

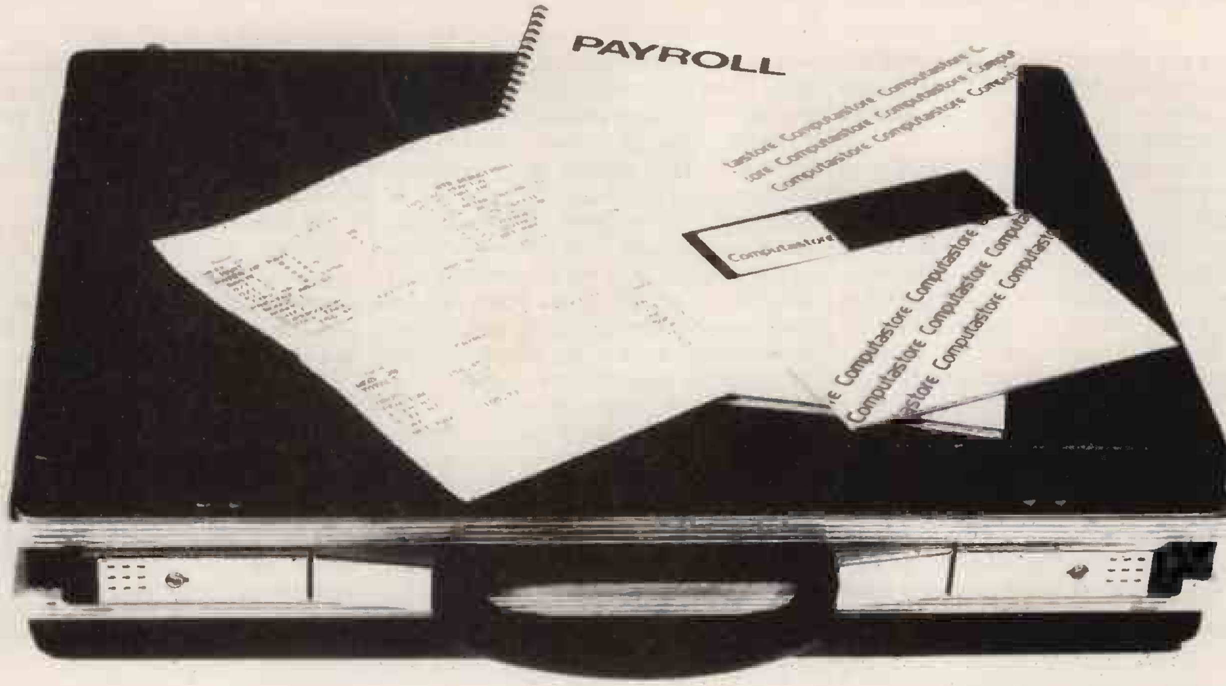
```
OAAD 35      XPAH P1
OAAE C480    LDI'80'
OABO 31      XPAL P1
P1 pointed to RAM (OA80)
OAB1 C400    LDI'00'
OAB3 C900    ST P1+00
OAB5 C902    ST P1+02
OAB7 C903    ST P1+03
OAB9 C904    ST P1+04
OABB C905    ST P1+05
OABD C906    ST P1+06
OABF C907    ST P1+07
OAC1 C908    ST P1+08
OAC3 C909    ST P1=09
OAC5 C90A    ST P1=OA

Clear registers for p,s,t,T,
T" and T':
OAC7 C40A    LDI'OA'
OAC9 36      XPAH P2
P2 pointed to OAXX (data)
n decimal to n hexadecimal:
OACA C10B    LD P1+OB n,dec
OACC 02      A:CCL
OACD EC99     DAI 99 decimal
OACF C90B     ST P1+OB n-1
OAD1 A904     ILD P1+04  u+1
OAD3 C10B     LD P1+OB n-1
OAD5 9CF5     JNZ to A,
conversion not complete yet
OAD7 C104     LD P1+04  u
OAD9 C90B     ST P1+OB, u= n,
in hexadecimal
OADB C400     LDI'00'
OADD C904     ST P1+04


Clear counter
N decimal to N hexadecimal:
OADF C10C     LD P1+OCNdec
OAE1 02       B:CCL
```

```
OAE2 EC99      DAI 99 decimal
OAE4 C90C     ST P1+OC N-1
OAE6 A904     ILD P1+04 u+1
OAE8 C10C     LD P1+OC N-1
OAEA 9CF5     JNZ to B,
conversion not complete yet
OAEC C104     LD P1+04 u
OAEE C90C     ST P1+OC, u=N,
in hexadecimal
SCAN DATA FOR TIES:
OAFO C400 C:LDI'00'
OAF2 C904     ST P1+04
Clear counter
OAF4 C48D     LDI'8D'
OAF6 32       XPAL P2
P2 pointed to data table
OAF7 A904 D:ILD P1+04 u
OAF9 C601     LD@ P2(+1) first
item of data, then next etc
OAFB E102     XOR  P1+02 s
Gives zero if x=s
OAFD 9C02     JNZ to E, x≠s
OAFF A903     ILD P1+03 t+1,
to count number of ties
OB01 C104 E:LD P1+04  u
OB03 E10C     XOR P1+OC N
Gives zero if x=N (last x)
OB05 9CFO     JNZ to D, to get
next x
CALCULATE RANK:
OB07 02       CCL
OB08 C100     LD P1+00 p
OBOA F103     ADD P1+03 t
OBOC F401     ADI'01' r=p+t+1
OBOE C901     ST P1+01 r
OB10 C400     LDI'00'
OB12 C904     ST P1+04
Clear counter
SCAN DATA TABLE AND ENTER
TIES AS RANKS IN RANK TABLE:
```

*(continued on page 101)*

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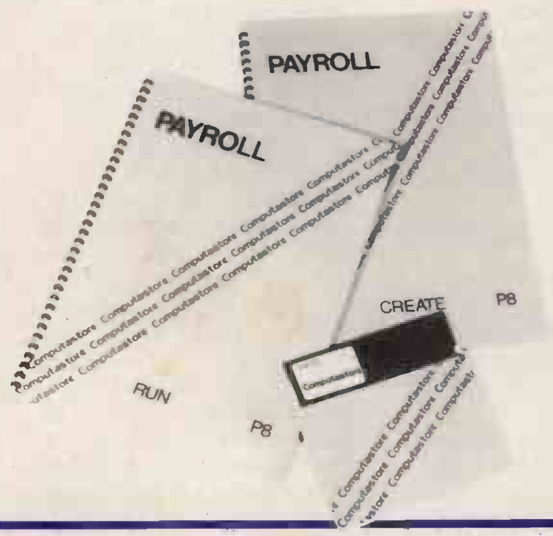


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**Acorn Computers announce with pride the fourth module in the series—a VDU interface on a Eurocard.** This unit uses two very powerful devices, the MC 6845 and the SAA5050. The 6845 programmable controller provides all the signals to drive a 625 line 50 frames per second VDU together with read addresses for the character RAM, the SAA5050 character generator then produces the necessary dot patterns to refresh the VDU. The SAA5050 produces standard teletext characters and graphics and has Red, Green and Blue outputs. This means that the Acorn system will be compatible with CEEFAX, ORACLE and PRESTEL transmissions.

The Acorn VDU module in kit form is complete with sockets and is supplied with listings for programs which set up the 6845, a miniature dissassembler which displays 25 hex instructions (double or treble byte) and graphics programs. All these may be loaded and run using the Acorn system 1 monitor.

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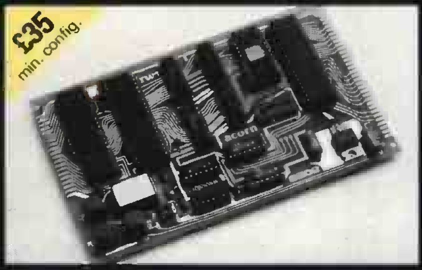
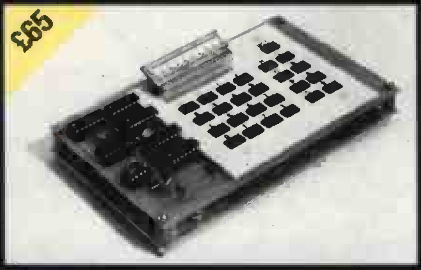



Acorn CPU




Acorn System 1


Acorn 8K Memory

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● Circle No. 189

(continued from page 97)

```
OB14 C48D    LDI'8D'
OB16 32      XPAL P2
P2 pointed to data table
OB17 C40F    LDI'OF'
OB19 37      XPAH P3
OB1A C41F    LDI'1F'
OB1C 33      XPAL P3
P3 pointed to rank table -1
OB1D A904 F: ILD P1+04 u, to
count position in table
OB1F C601    LD P2 (+1) first
item of data, then next etc
OB21 E102    XOR P1+02 s,
gives zero if x=s
OB23 9C07    JNZ to G, x≠s
OB25 C104    LD P1+04 u, to
get position in data table
OB27 01      XAE u to E
OB28 C101    LD P1+01 r
OB2A CB80    ST P3-80, at
corresponding position in
rank table
OB2C C104   G:LD P1+04 u
OB2E E10C    XOR P1+0C N,
gives zero if x=N (last x)
OB30 9CEB  JNZ u≠N, to F
to get next position
OB32 02      CCL
OB33 C103    LD P1+03 t
OB35 F103    ADD P1+03 t+t
OB37 F100    ADD P1+00 p,
gives new p=p+2t
OB39 C900    ST P1+00 new p
stored
OB3B 02      CCL
OB3C C10C    LD P1+0C.N
OB3E F10C    ADD P1+0C, N+N
OB40 E100    XOR P1+00 p,
gives zero if p=2N (last p)
OB42 980C    JZ to H ranking
completed
OB44 C400    LDI'00'
OB46 C903    ST P1+03 restore
t to zero
OB48 C102    LD P1+02 s
OB4A EC01    DAI'01' s+1
OB4C C902    ST P1+02
OB4E 90A0    JMP to C, begin
next search, incremented s
SUM FIRST n RANKS TO GET T:
OB50 C420    H:LDI'20'
OB52 33      XPAL P3
P3 pointed to rank table
OB53 C400    LDI'00'
OB55 C904    ST P1+04, restore
counter to zero
OB57 02      I:CCL
OB58 C106    LD P1+06 T(L)
OB5A F701    ADD@P3(+1)
first rank, then next etc
OB5C C906    ST P1+06 T(L)
OB5E 06      CSA to find if
CY/L is 0 or 1
OB5F 9402    JP to J if no
carry over required
OB61 A905    ILD P1+05 T(H)+1
OB63 A904  J:ILD P1+04 u+1
OB65 E10B    XOR P1+0B n
Gives zero if u=n (last rank
to be summed)
OB67 9CEE    JNZ ti I u≠n
DIVIDE T BY 2: ROUND UP:
OB69 C105    LD P1+05 T(H)
OB6B 02      CCL
OB6C 1E      RRL gives T(H)/2
with lowest digit to CY/L.
OB6D C905    ST P1+05 halved
value of T(H) stored
OB6F C106    LD P1+06 T(L)
OB71 1F      RRL gives T(L)/2
with lowest digit in CY/L;
lowest digit from T(H) is
found as most sig.  digit in
T(L), having been carried.
OB72 C906    ST P1+06 halved
value of T(L) stored
OB74 06      CSA to test if
rank total had 'odd half'
OB75 9402    JP to K no 'odd
half' found
OB77 A906    ILD P1+06 T(L)
rounded up for 'odd half'
CALCULATE T':
OB79 C400 K:LDI'00'
OB7B C904    ST P1+04 u
restore count to zero
OB7D A90C    ILD P1+0C N+1
OB7F 02     L:CCL
OB80 C10A    LD P1+0A T'(L)
OB82 F10C    ADD P1+0C N+1
OB84 C90A    ST P1+0A T'(L);
register incremented by N+1
OB86 06      CSA check for
carry-over
OB87 9402    JP to M, if no
carry-over
OB89 A909    ILD P1+09 T'(H)
incremented for carry-over
OB8B A904 M:ILD P1+04 u+1,
counting additions of N+1
OB8D E10B    XOR P1+0B,zero
if u=n (last addition)
OB8F 9CEE    JNZ to L, to
continue addition
OB91 03      SCL
OB92 C10A    LD P1+0A T'(L)
OB94 F906    CAD P1+06 T(L)
OB96 C90A    ST P1+0A T'(L)
OB98 C109    LD P1+09 T'(H)
OB9A F905    CAD P1+05 T(H)
OB9C C909    ST P1+09 T'(H)
T' now stored
FIND GREATER OF T AND T':
OB9E 03      SCL
OB9F C106    LD P1+06 T(L)
OBA1 F90A    CAD P1+0A T'(L)
OBA3 C105    LD P1+05 T(H)
OBA5 F909    CAD P1+09 T'(H)
OBA7 9408    JP to N, if T'
is greater than T'
OBA9 C106    LD P1+06 T(L)
OBAB C90A    ST P1+0A T'(L)
OBAD C105    LD P1+05 T(H)
OBAF C909    ST P1+09 T'(H)
T' now replaced by T, as
it was less than T: =T"
CALCULATE T" IN DECIMAL:
OBB1 02    N:CCL
OBB2 C108    LD P1+08 T"(L)
OBB4 EC01    DAI'01' T"+1
OBB6 C908    ST P1+08 T"(L)
decremented decimally by 1
OBB8 06      CSA test for
carry-over
OBB9 9407    JP to O, if no
carry-over
OBBB 02      CCL
OBBC C107    LD P1+07 T"(H)
OBBE EC01    DAI'01' carry
added to T"(H) decimally
OBC0 C907    ST P1+07 T"(H)
OBC2 02     O:CCL
OBC3 C10A    LD P1+0A hex
value of T"(L)
OBC5 F4FF    ADI'FF' subtract
1 in hexadecimal scale
OBC7 C90A    ST P1+0A
OBC9 9802    JZ to P, if
hex T" reduced to zero
OBCB 90E4    JMP to N, if not
yet reduced, for next cycle
OBCD C109   P:LD P1+09 hex
value of T"(H)
OBCF 9807    JZ to Q, hex to
decimal conversion complete
OBD1 02      CCL
OBD2 F4FF    ADI'FF' subtract
1 in hexadecimal scale
OBD4 C909    ST P1+09
OBD6 90D9    JMP to N for
next cycle
DISPLAY T":
OBD8 C40F   Q:LDI'OF'
OBDA 36      XPAH P2
OBDB C400    LDI'00'
OBDD 32      XPAL P2
P2 pointed to RAM (OF00)
OBDE C107    LD P1+07 T"(H)
OBE0 CA0E    ST P2+0E (ADH)
OBE2 C108    LD P1+08 T"(L)
OBE4 CA0C    ST P2+0C (ADL)
OBE6 C401    LDI'01'
OBE8 37      XPAH P3
OBE9 C459    LDI'59'
OBEB 33      XPAL P3
P3 pointe to Display
address routine in monitor
OBEC 3F      XPPC P3
Go to DISPA routine to
display T"
OBED = END
```

# Fault-finding with aid of self-test programs

**David Peckett suggests how a microprocessor can test itself.**

WITH a cunningly-designed program, a microprocessor can even test itself. The chip can fail but still 'work' and there is a way to generate a program to find such faults.

The microprocessor chip can fail in one of two ways. It can have a 'hard' failure, which stops it completely, or a gate deep within it can fail and cause intermittent defects. With a hard failure, self-test is no use — the system will not run at all. 'Soft' failures can be difficult to find; they may affect only certain instructions and then only when certain data is in the processor registers. The system may well run perfectly normally but hiccup occasionally for no apparent reason.

It is important to realise that it is impossible to test for every conceivable soft fault. A 100 percent test of a microprocessor must apply every possible set of inputs to every possible set of internal values. There are enough numbers in the universe but we don't have them all in stock.

- An 8080 has one 5-bit, seven 8-bit and two 16-bit internal registers accessible to the program, plus the ALU, and the like — say a total of around 120 bits. It thus has $2^{120}$ possible internal states.
- There are 256 possible instructions which may be applied, including the unlisted codes.
- Of these, 26 (with IN and OUT) have 8-bit operands, and 35 have 16-bit operands. There are thus $(195 + 26\times 256 + 35\times 2^{16})$ combinations of instructions.
- There are also 10 control lines; each can be in one of two states.
- A full test of the chip will therefore involve:
  $2^{120}\times 2^{10}\times (195 + 26\times 256 + 35\times 2^{16}) = 3.13 \times 10^{45}$ instructions.
- With an average instruction time of around 4μS, the 100 percent test would take about:
  $4 \times 10^{32}$ years, which is not very practical.

What we can do, though, is to check that we can read and write to every register in the chip, and that there are no bits stuck at '1' or '0'; and test every instruction at least once.

A test of this type will make sure that there are no major faults in the chip and will, in practice, detect the vast majority of soft faults.

How do we start to write a suitable self-test program and how do we continue? At the start, we must assume that a few basic instructions work, and use these to test others. As more and more instructions are checked, they can be used to bootstrap yet more. Finally, the initially 'assumed-good' instructions can be tested, using all the others.

Remember that there is no point to identifying the fault; if the micro is broken, all we can do is change it. Instructions can thus be chained together for testing, so long as the result can be monitored.

The order of trying the instructions is important. One method (1) is to give each one a score, which represents the proportion of the microprocessor it exercises. The scoring scheme I used for the 8080 was:

a. One point for each byte the instruction and operand take in the program (e.g. LXI H, abcd — 3 points).
b. One point for each register the instruction affects.
c. One point for each memory access, in addition to reading the instruction. (e.g., STA abcd writes to address abcd — 1 point).
d. One point for each clock cycle needed by the instruction.
e. One point if only one flag is affected, two if more than one flag can be changed. Giving one point per flag seemed like over-reaction.
f. One point for each microprocessor control line affected by the instruction.
g. One point each if the instruction affects the accumulator, stack pointer and/or the program counter, in addition

**Table 2.**

```
* THIS PROGRAM ASSUMES THAT MVI A, ; LXI SP, :JNZ: JC: JNC: JMP ALL WORK
* PROPERLY AT THE START. THEY ARE CHECKED LATER.
* A '@' IN THE COMMENTS COLUMN SHOWS WHERE EACH NEW INSTRUCTION IS TESTED.
*
          LXI  SP,STACK              'STACK' IS ANY SUITABLE SP POSITION
          MVI  A,FF
          CMA                      @ A=00
          CPI  00                  @
          JNZ  FAULT                 ON FAIL, CMA OR CPI WRONG.
          CPI  FF                    SET Z AND CY FLAGS.
          JNZ  LABEL1                Z SET THIS TIME.
          JMP  FAULT                 CPI OR JNZ DOES NOT WORK.
LABEL1    CMC                      @ CY=0
          JC   FAULT                 CMC OK?
          STC                      @ CY=1
          JC   LABEL2
          JMP  FAULT                 STC OR JC WRONG
LABEL2    MVI  A,43                  A/CY = 0100 0011/1
          RLC                      @        1000 0110/0
          RAL                      @        0000 1100/1
          CMC                               0000 1100/0
          RAR                      @        0000 0110/0
          RRC                      @        0000 0011/0
          CPI  03
          JNZ  FAULT                 FAULT IN ROTATES WILL CAUSE FAIL.
* TEST FOR ACCESS TO EACH REGISTER.
          MVI  A,01
          MOV  B,A                 @ B=1
          RLC
          MOV  C,A                 @ C=2
          RLC
          MOV  D,A                 @ D=4
          RLC
          MOV  E,A                 @ E=8
          RLC
          MOV  H,A                 @ H=10
          RLC
          MOV  L,A                 @ L=20
* MAKE SURE THEY ARE OK.
          MVI  A,01
          CMP  B                   @
          JNZ  FAULT
* DOES CMP R REALLY WORK?
          CMP  C                   @ SHOULD SET CARRY.
          JNC  FAULT
* CMP R WORKS FOR B AND C.  PROBABLY OK FOR THE REST.
          RLC
          CMP  C                   @
          JNZ  FAULT
          RLC
          CMP  D                   @
          JNZ  FAULT
```

(continued on next page)

to the normal PC action. (e.g. POP PSW — 2 points).

This scheme, modified in detail, will work for any micro. The result is a set of scores for the instructions; the lower the score, the more 'reliable' the instruction. Table 1 shows the scores I produced for the 8080 instruction set.

Obviously, we try the 'most reliable' instructions first and use these to check out the 'less reliable'. The initially 'assumed good' instructions must be chosen carefully to have scores as low as possible; there must also be as few of them as possible.

| SCORE | INSTRUCTIONS |
|---|---|
| 5 | NOP |
| 6 | CMA: CMC; DI; EI; STC |
| 7 | DCX SP; INX SP; RAL; RAR; RLC; RRC |
| 8 | CMP r; DAA; DCX (B,D,H); HLT; INX (B,D,H); MOV $r_1$, $r_2$ |
| 9 | ADC r; ADD r; ANA r; DCR r; INR r; ORA r; PCHL; SBB r; SPHL; SUB r; XCHG; XRA r |
| 10 | MVI r, |
| 11 | CPI |
| 12 | ACI; ADI; ANI; MOV r,M; ORI; SBI; STAX; SUI; XRI |
| 13 | CMP M; LDAX; MOV M,r; RST |
| 14 | ADC M; ADD M; ANA M; DAD H; IN; JMP; LXI SP, ; ORA M; OUT; RET; SBB M; SUB M; XRA M |
| 15 | DAD SP; JC; JM; JNC; JNZ; JP; JPE; JZ; LXI (B,D,H), ; POP |
| 16 | DAD (B,D); MVI M, |
| 17 | DCR M; INR M; PUSH |
| 18 | LDA; STA |
| 21 | LHLD |
| 23 | SHLD; XTHL |
| 24 | CALL |
| 10/16 | RC; RM; RNC; RNZ;) RP; RPE; RPO; RE ) See |
| 19/25 | CC; CM; CNC; CNZ;) Note. CP; CPE; CPO; CZ ) |

**Table 1. Instruction scores.**

**Note: conditional CALLS and RETURNS have two instruction cycle times, depending on whether or not the appropriate flag is set.**

When we write the test program, the more we know about the detailed internal working of the chips the better. Unfortunately, the manufacturers are in no hurry to give this kind of information away, so we must combine careful reading of the data books with some reasonable assumptions.

For instance, the Intel 8080 has 49 data transfer instructions of the form MOV $r_1$, $r_2$. Do they all have to be tested? I have assumed not; if we know that we can access each register, we need to test only a few different combinations (e.g., MOV A, H; MOV B, A; MOV C, L) to prove the whole family of similar instructions. That kind of assumption can simplify the test program considerably.

Having ranked the instructions, I began

*(continued on page 105)*

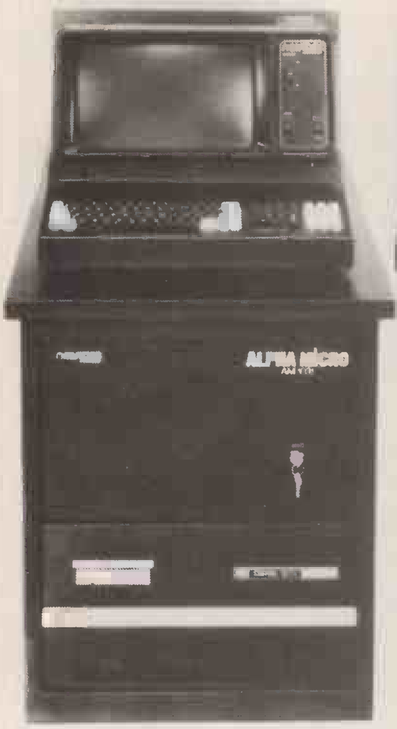
*(continued from previous page)*

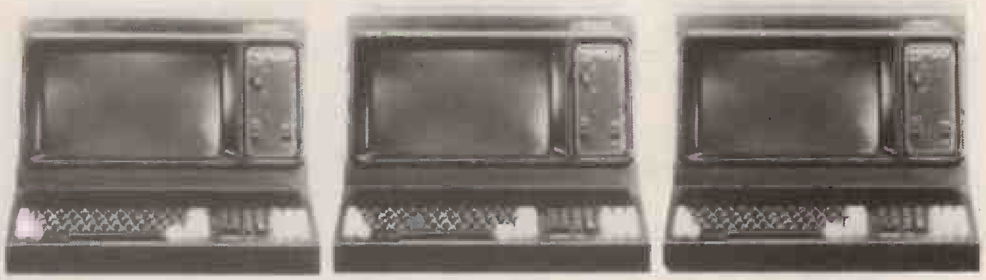
```
        RLC
        CMP  E               @
        JNZ  FAULT
        RLC
        CMP  H               @
        JNZ  FAULT
        RLC
        CMP  L               @
        JNZ  FAULT
* ALL REGISTERS CAN BE ACCESSED.  WE NOW HAVE A BASIC SET OF INSTRUCTIONS;
* CAN WE ADD JUMPS AND SUBROUTINES?
        MVI  A,77
        JMP  LABEL3          @
        MVI  A,00
LABEL3  CPI   77               A STILL = 77?
        JNZ  FAULT
        CALL SUB1            @ JMP IS OK.
        CPI  00                SUB1 SHOULD SET A = 00.
        JNZ  FAULT
* ANY STUCK BITS IN THE REGISTERS?
        MVI  A,AA              A=AA
        CALL SUB2              ALL REG AT AA?
        CMA                    A=55
        CALL SUB2              ALL REG AT 55?
        MVI  A,FF              A=FF
        CALL SUB2              ALL REG AT FF?
        CMA                    A=00
        CALL SUB2              ALL REG AT 00?
* MORE SP CHECKS.  (SUB2 DID SOME ALSO).
        PUSH PSW             @ 00 TO STACK
        CMA
        PUSH PSW               FF TO STACK
        INX  SP              @
        INX  SP              @ POINT TO FIRST PUSH PSW.
        POP  PSW             @ A=00?
        CPI  00
        JNZ  FAULT
        DCX  SP              @
        DCX  SP              @
        DCX  SP              @
        DCX  SP              @ POINT TO SECOND PUSH PSW.
        POP  PSW
        CPI  FF                A=FF?
        JNZ  FAULT
* SET DISCRETE CODES IN ALL THE REGISTERS.  (ALL STILL AT 00).
        INR  B               @ B=1
        INX  B               @
        INX  B               @ C=2
        INR  D               @
        INR  D               @
        INR  D               @
        INR  D               @ D=4
        MVI  A,08
LABEL4  INX  D               @
        DCR  A               @
        JNZ  LABEL4            E=8
        MVI  H,10            @ H=10
        MVI  L,20            @ L=20
* IF OK, THIS HAS DEMONSTRATED INR R, INX R, DCR A, MVI R,XX.  CHECK IT.
        CALL SUB3              SET A=B+C+D+E+H+L
        CPI  3F                (H,L) = 2A AFTER SUB3
        JNZ  FAULT
        DCX  B               @ (B,C) = 0101
        DCX  D               @ (D,E) = 0407
        DCX  H               @ (H,L) = 1529
        CALL SUB3              (H,L) = 1A31
        CPI  4B                A =     0100 1011
        JNZ  FAULT
* DCX R WORKS.  GENERALLY, WE ONLY NEED ONE OR TWO CHECKS OF OPERATIONS OF THE
* 'FCTN R' TYPE.  THIS SHOWS THE LOGIC WORKS, AND WE KNOW WE CAN ACCESS EACH REG.
        ANA  L               @ A =     0000 0001
        SUB  E               @         1111 1010
        ORA  C               @         1111 1011
        XRA  D               @         1111 1111
        STC
        SBB  B               @         1111 1101
        STC
        ADC  H               @         0001 1000
        ADD  H               @         0011 0010
        DAA                  @         0011 1000
        CPI  38
        JNZ  FAULT
* MULTIPLE FAULTS COULD GIVE A 'PASS', BUT UNLIKELY.
        LXI  D,LABEL5        @
        XCHG                 @ (H,L) = LABEL5
        PCHL                 @ CAUSES A JUMP
LABEL6  CPI  33                RETURN POINT.  JUMP OK?
        JNZ  FAULT
* MORE SP TESTS.
        LXI  H,STACKA        @ (H,L) = SUITABLE NEW SP
        SPHL                 @ SP = NEW SP
        PUSH PSW               SAVE A
        LXI  SP,STACK          RESTORE STACK
        MVI  H,((STACKA-1),MSBS)
        MVI  L,((STACKA-1),LSBS)  POINT TO STORED A.
```

*(continued on page 105)*

# THE ALPHA MICRO COMPUTER

## Multi-User, Multi-tasking, Timesharing, Memory Management





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*(continued from page 103)*

to write a test program for an Intel 8080. The result is table 2, and the program's flow-chart is figure 1.

Of the instructions in table one, 'NOP' is effectively untestable; you can put it in the program but you have to make many checks to show that it didn't do anything. Six more instructions (IN, OUT, EI, DI, HLT and RST n) are heavily-dependent on the system hardware. The program shows where they should be tested but the 'how' must depend on your system. I give some suggestions at the end of this section.

To start, I assumed that MVI A, xx; LXI SP, abcd; JNZ; JC; JNC and JMP all worked. The jump instructions are checked part way through the program, and MVI A, xx and LXI SP, abcd are tested at the end.

The first step is to prove a few more simple instructions. They permit comparisons to be made and the accumulator modified. The six general-purpose registers are then checked. Different codes are written to, and read from, each to see

```
*
*SET UP INPUT CHANNEL A TO
 VALUE NN.
*
PUSH PSW    SAVE A.
IN   A
CPI  NN
JNZ  FAULT
IN   B      B SHOULD BE AT
            ANYTHING BUT NN.
CPI  NN
JZ   FAULT  ASSUMES THAT JZ
            IS GOOD.
MVI  A,PP   SET UP A.
OUT  C      CONFIRM THAT
            PORT C IS AT PP.
POP  PSW    RECOVER A.
*
*CONTINUE WITH REST OF
 PROGRAM.
*
```

**Table 3.**

if they all work; the program then checks that there are no 'stuck bits'.

Basic jumps and subroutines are added to give more flexibility; these tests inevitably demonstrate yet more instructions. Once the basic data transfer and register control codes are satisfactory, the arithmetic and logical operations can be checked. The checks are grouped in families — all immediate, all inter-register, and the like — and only the final result of each stage is monitored. This approach shortens the program; it could be beaten by multiple faults but they are unlikely.

Having cleared most of the inter-register operations, the program checks the register/memory instructions. Note that all the way through each batch of 'new instructions' tests uses the data already in the accumulator; this shortens the program.

We now know that most of the simple

*(continued on page 107)*

*(continued from page 103)*

```
          CMP  M                @ DATA OK?
          JNZ  FAULT
* CHECK 'IMMEDIATE' INSTRUCTIONS
          STC                     A =   0011 0011
          ACI  10               @       0100 0100
          ANI  41               @       0100 0000
          ADI  15               @       0101 0101
          ORI  2C               @       0111 1101
          SUI  16               @       0110 0111
          STC
          SBI  11               @       0101 0101
          XRI  3D               @       0110 1000
          CPI  68
          JNZ  FAULT
* MULTIPLE FAULTS COULD CAUSE A 'PASS'.
*
* TEST IN, OUT, DI, EI, HLT, RST HERE.
*
* NOW TEST THE 'OP M' COMMANDS.
          STA  (STACKA-1)       @ (A=68). PREVIOUSLY 33 HERE.
          LXI  H,(STACKA-1)       SETS UP 'M',POINTER.
          MOV  B,M              @
          CMP  B                  B=68?
          JNZ  FAULT
          INR  A                  A = 69
          MOV  B,H
          MOV  C,L                (B,C) = (STACKA-1)
          STAX B                @ (STACKA-1) = 69
          INR  M                @ (STACKA-1) = 6A
          LDAX B                @ A=6A?
          CPI  6A
          JNZ  FAULT
          STC                     A =   0110 1010
          ADC  M                @       1101 0101
          ORA  M                @       1111 1111
          ADD  M                @       0110 1001
          CMC                     CY = 0
          SBB  M                @       1111 1111
          SUB  M                @       1001 0101
          DCR  M                  AVOIDS M AS THE FINAL ANSWER.
          XRA  M                @       1111 1100
          INR  M
          INR  M
          ANA  M                @       0110 1000
          CPI  68
          JNZ  FAULT              FAULT ANYWHERE?
* START TESTING THE FLAGS.
          LXI  H,0000
          DAD  SP               @ (H,L) = SP.  CHECKS DAD.
          PUSH PSW
          DCX  H                  (H,L) POINTS TO A IN STACK.
          CMP  M
          JNZ  FAULT              OK SO FAR?
          XTHL                  @ L CONTAINS THE FLAGS.
          MVI  L,D7               ALL FLAGS TO 1.
          XTHL
          POP  PSW                RECOVER THE FLAGS.
* ALL CONDITIONAL INSTRUCTIONS MUST BE TESTED WITH THE FLAGS BOTH SET AND CLEARED.
          JNC  FAULT            @ ASSUMED GOOD SO FAR
          JNZ  FAULT            @   "      "   "  "
          JPO  FAULT            @
          JP   FAULT            @
          JC   LABEL7           @   "      "   "  "
          INR  A                  CATCH WRONG PATH.
LABEL7    JM   LABEL8           @
          INR  A                  INR A WILL CHANGE THE FLAGS ALSO.
LABEL8    JPE  LABEL9           @
          INR  A                  EITHER WAY WE GET TO 'FAULT'.
LABEL9    JZ   LABEL10          @
          INR  A
LABEL10   MVI  L,00               L = 00
* CHECK CONDITIONAL 'CALL'S.
          CC   SUB4             @
          CM   SUB5             @
          CPE  SUB6             @
          CZ   SUB7             @ FIRST 4 CALLS SHOULD BE MADE.
          CNC  FAULT            @
          CNZ  FAULT            @
          CPO  FAULT            @
          CP   FAULT            @ CATCH ANY BAD CALLS.
          ADD  L                  L SHOULD = 01+02+03+04 = 0A
          CPI  72                 A SHOULD = 68+0A = 72
          JNZ  FAULT
*REPEAT THE TESTS WITH ALL THE FLAGS AT 0.  QUICKER WAY OF SETTING THEM:
          PUSH PSW
          XTHL
          MVI  L,02               ALL FLAGS TO 0.
          XTHL
          POP  PSW                SET FLAG REGISTER.
          JC   FAULT            @
```

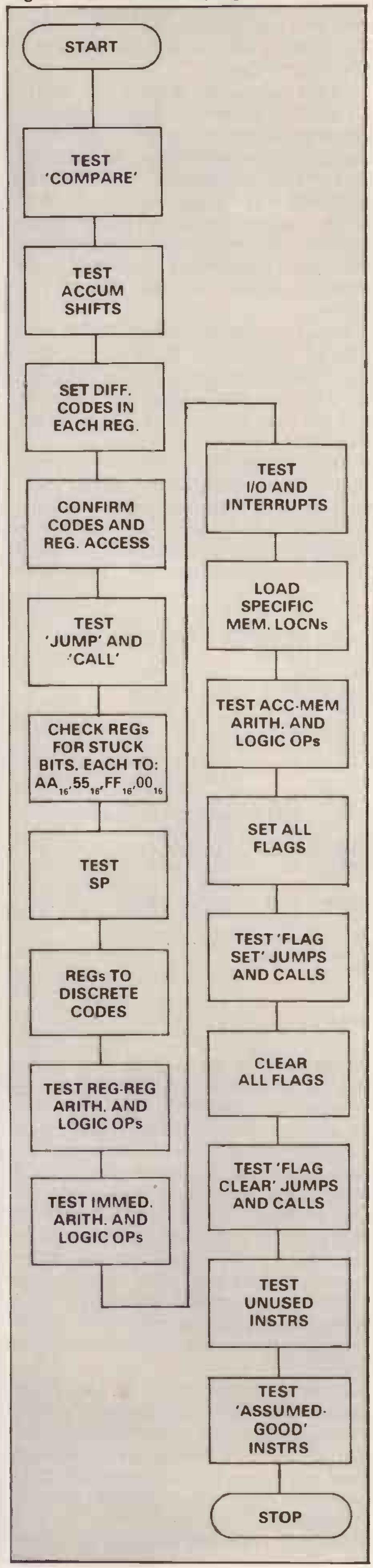
*(continued on page 106)*

(continued from page 105)

```
            JM   FAULT            @
            JPE  FAULT            @
            JZ   FAULT            @
            JNC  LABEL11          @
            INR  A
LABEL11     JNZ  LABEL12          @
            INR  A
LABEL12     JPO  LABEL13          @
            INR  A
LABEL13     JP   LABEL14          @
            INR  A
LABEL14     MVI  L,00               CLEAR L.
            CNC  SUB8             @
            CNZ  SUB9             @
            CPO  SUB10            @
            CP   SUB11            @ THESE 4 CALLS SHOULD BE MADE.
            CC   FAULT            @
            CM   FAULT            @
            CPE  FAULT            @
            CZ   FAULT            @ THESE 4 CATCH ERRORS.
            ADD  L                  L SHOULD = OA
            CPI  7C                 A SHOULD = 72+0A = 7C
            JNZ  FAULT
* CHECK THE REMAINING UNUSED INSTRUCTIONS.
            LXI  H,STACKA
            MOV  M,A                M = 7C
            MOV  B,A                B = M
            XRA  A                  A = 00
            LDA  STACKA           @
            CMP  B                  LDA WORKED?
            JNZ  FAULT
            INR  A                  A = 7D
            STA  (STACKA+1)
            LHLD (STACKA)         @ (H,L) = 7D7C
            CMP  H                  H=7D?
            JNZ  FAULT
            DCR  A                  A = 7C
            CMP  L                  L=7C?
            JNZ  FAULT
* LHLD WORKS.
            INR  H
            INR  L                  (H,L) = 7E7D
            SHLD STACKA           @
            LDA  STACKA             L SHOULD BE IN LOWER BYTE.
            CMP  L
            JNZ  FAULT
            LDA  (STACKA+1)
            CMP  H                  H IN HIGH BYTE?
            JNZ  FAULT
* CHECK SO-FAR UNTESTED, BUT ASSUMED GOOD, OPERATIONS:
*       MVI  A,   : LXI  SP,
            LXI  H,001B
            MVI  A,1B             @
            CMP  L
            JNZ  FAULT
            INX  H                  L = 1C
            MVI  A,1C             @ MAYBE 1B ALREADY IN A?
            CMP  L
            JNZ  FAULT
* MVI  A,   IS OK.
            LXI  H,STACKA
            SPHL                    SP = STACKA
            PUSH PSW                SAVE A, PSW.
            INX  SP                 SP = STACKA-1.
            XRA  A                  A = 00
            LXI  SP,(STACKA-2)    @ POINT TO PUSHED DATA.
            POP  PSW
            CPI  1C                 RECOVERED CORRECTLY?
            JNZ  FAULT
*
* THE TEST IS OVER; CHIP IS OK.
*
* PUT A SUITABLE STOP AND DISPLAY RESULT ROUTINE HERE.
*
* SUBROUTINES, ETC.
*
* CHECK THAT 'CALL' WORKS.
SUB1        MVI  A,00               A = 00
            RET                   @
            JMP  FAULT              RET MAY FAIL.
* SET ALL THE REGISTERS TO A, AND CONFIRM.
SUB2        MOV  B,A
            MOV  C,A
            PUSH B                @
            POP  D                @
            PUSH D                @
            POP  H                @ IF THESE FAIL, S/R WILL FAIL.
            CMP  B                  CMP R WORKS.
            JNZ  FAULT
```

(continued on next page)

Figure 1. Broad flow of program.



(continued from page 105)

instructions work but the vitally important conditional operations have to be checked. Each conditional command must be checked twice, once with the appropriate flag set, and once with it cleared. The tests emerge as a long string of jumps and calls, with traps at each possible failure point. The traps are either jumps to the fault routine, or changes to the accumulator which eventually will cause a CPI to fail.

To check the conditional instructions more thoroughly, we should set only one flag at a time and check for no false response to it. The test I have given here should detect most faults. Finally, the so-far-untested instructions are checked, as are those which were assumed to be satisfactory at the start.

The program of table one lacks two essential elements — a routine to show a 'GO', and a routine to show a 'NOGO'. How you write them will depend on your system and your preferences but the 'NOGO' must be as short as possible. Ideally, it will use only the 'assumed good' instructions to give the best chance of its working.

In testing 'IN' and the like I cannot offer any useful details for testing the interrupt instructions (EI, DI, HLT and RST n). Those tests will depend far too much on what is in your system but they should follow the basic approach I have used. Table 3 is a short routine which could test IN and OUT but you will need to tune it to match your system.

The program I have described should detect most soft faults which might occur in an 8080. Its abilities will depend however, on the support chips. They must use the status bits correctly, particularly when testing IN and OUT, and interrupts. For example, an 8225 fault could appear, wrongly, as a microprocessor fault. It is possible to test the support chips, PIAs, and the like, but the program will depend on the system hardware; I cannot give a general test routine.

The program in table one, is less than 1K long. It could be loaded from tape, but if you have the option, it would be better to put it in a self-test PROM. That way, you could be confident that it was loaded properly.

## Conclusions

**• It is fairly straightforward to write a program a micro can use to find the majority of 'soft' faults within itself. Instructions are tested in ascending order of complexity, with simple ones being used as bootstraps to check more complex operations. Support chip faults can confuse things but it is normally possible to test round them in any particular system.**

*Reference: (1) Srini, VP, Fault Diagnosis of Microprocessor Systems, Computer, January, 1977, pp 60-65.*

*(continued from previous page)*

```
          CMP  C
          JNZ  FAULT
          CMP  D
          JNZ  FAULT
          CMP  E
          JNZ  FAULT
          CMP  H
          JNZ  FAULT
          CMP  L
          JNZ  FAULT
* ALL REGISTERS ARE AT A.
          RET
*
* SET A = B+C+D+E+H+L
SUB3      DAD  B                 @ CHECKS DAD.
          DAD  D                 @   "    "
          MOV  A,H                 H = B+D+H.  L = C+E+L.
          ADD  L                 @ A = H+L.
          RET
*
* THE NEXT 4 SUBROUTINES ARE USED BY THE 'FLAGS SET' CHECKS.
* INITIAL CONDITIONAL RETURNS ENSURE THAT THE FLAGS ARE OBSERVED.
* THE USE OF INX  H AVOIDS AFFECTING THE FLAGS.
SUB4      RNC                    @
          INX  H                   L = L+1
          RC                     @
          JMP FAULT                CATCH ERRORS.
*
SUB5      RP                     @
          INX  H
          INX  H                   L = L+2
          RM                     @
          JMP  FAULT
*
SUB6      RPO                    @
          INX  H
          INX  H
          INX  H                   L = L+3
          RPE                    @
          JMP  FAULT
*
SUB7      RNZ                    @
          INX  H
          INX  H
          INX  H
          INX  H                   L = L+4
          RZ                     @
          JMP  FAULT
*
* NEXT 4 S/RS ARE 'COMPLEMENTS' OF THE LAST 4.
* THEY CHECK THE 'NO FLAG' STATES.
SUB8      RC                     @
          INX  H                   L = L+1
          RNC                    @
          JMP  FAULT
*
SUB9      RZ                     @
          INX  H
          INX  H                   L = L+2
          RNZ                    @
          JMP  FAULT
*
SUB10     RPE                    @
          INX  H
          INX  H
          INX  H                   L = L+3
          RPO                    @
          JMP  FAULT
*
                                        T2-7
SUB11     RM                     @
          INX  H
          INX  H
          INX  H
          INX  H                   L = L+4
          RP                     @
          JMP  FAULT
*
*
* CHECK XCHG AND PCHL.
 ABEL5    XCHG
          MVI  A,33                SET A = 33
          JMP  LABEL6              RETURN TO MAIN PROGRAM.
*
*
* SUITABLE FAULT DISPLAY ROUTINE
FAULT     xxx
```


PROF

**RATHER than provide the normal kind of fiction, here is a program which will generate thousands of personally-configured Sci-Fi stories. It will write, for example, Earth is attacked by tiny Moon reptiles which are not radioactive and cannot be killed by the coast guard, but a little boy tells them about God and they leave; or Earth freezes and everybody dies; or, by way of variation, Earth falls into the Sun and almost everybody dies.**

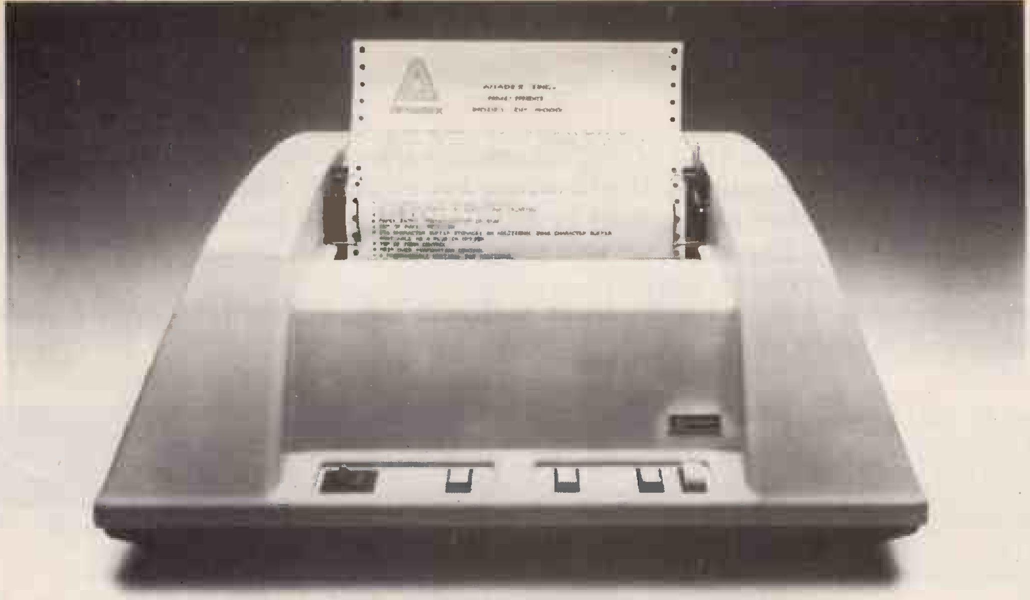
**Adapted by Bennet and Adam Laurie from a flowchart published by Sam Lundwell in *An Illustrated History of Science Fiction*.**

# DIY Sci-Fi

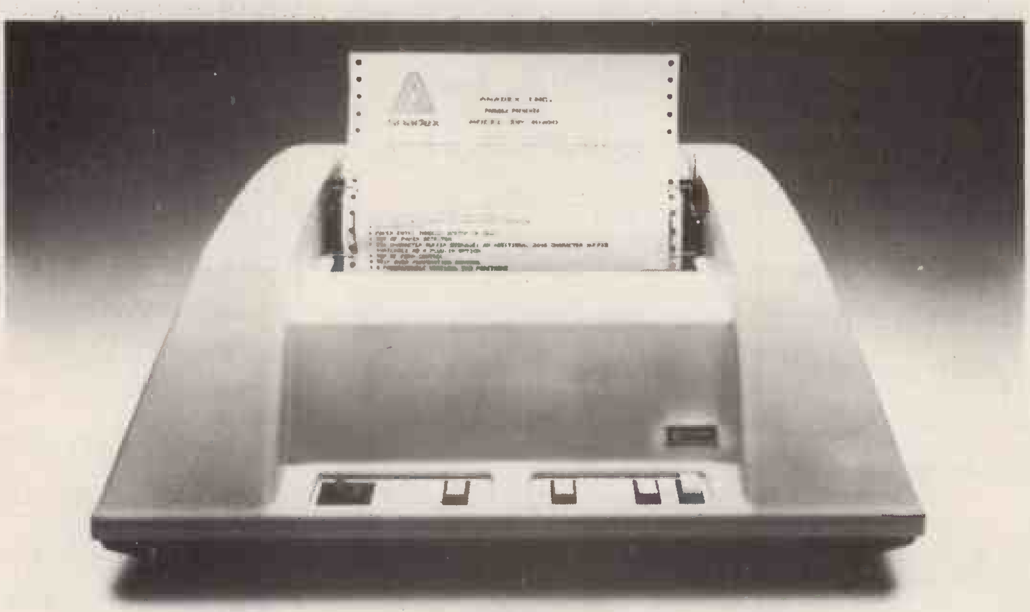
```
40 REM***'HOW TO WRITE A SCI
ENCE-FICTION NOVEL'
50 REM***COPYRIGHT 1977 BY S
AM LUNDWALL
60 REM ***PROGRAM BY B.LAURI
E AND A.LAURIE
70 DEF FNR(X)=INT(RND(10)*(X
-1E-03)+1)
80 ?:?"EARTH ";
90 ON FNR(4) GOTO 100,170,19
0,220
100 ON FNR(3) GOTO 110,130,1
50
110 ?"BURNS UP AND ";
120 ON FNR(2) GOTO 240,260
130 ?"FREEZES AND ";
140 ON FNR(2) GOTO 240,260
150 ?"FALLS INTO THE SUN AND
 ";
160 ON FNR(2) GOTO 240,260
170 ?"SCIENTISTS ";
180 ON FNR(2)GOTO 280,310
190 ?"IS ATTACKED BY ";
200 ON FNR(2) GOSUB 340,360
210 GOTO 460
220 ?"IS STRUCK BY A GIANT C
OMET AND ";
230 ON FNR(3) GOTO 380,400 ,
420
240 ?"EVERYBODY DIES."
250 GOTO 440
260 ?"ALMOST EVERYBODY DIES.
"
270 GOTO 440
280 ?"INVENT ";
290 ON FNR(2) GOSUB 340,360
300 GOTO 550
310 ?"DISCOVER ";
320 ON FNR(2) GOSUB 340,360
330 GOTO 550
340 ?"TINY ";
350 RETURN
360 ?"GIANT ";
370 RETURN
380 ?"DESTROYED. "
390 GOTO 440
400 ?"SAVED."
410 GOTO 440
420 ?"NOT DESTROYED BUT ";
430 ON FNR(2) GOTO 240,260
440 ?:?"    THE END"
450 END
460 ON FNR(4) GOTO 470,490,5
10,530
470 ?"MARTIAN ";
480 GOTO 550
490 ?"MOON ";
500 GOTO 550
510 ?"BETELGEUSIAN ";
520 GOTO 550
530 ?"EXTRA-TERESTIAL ";
540 GOTO 550
550 ON FNR(5) GOSUB 630,650,
670,690,710
560 GOSUB 1670
570 ?"WHICH(WHO) ";
580 ON FNR(7) GOSUB 730,790,
810,840,870,900,1610
590 ?"AND ARE ";
600 ON FNR(2) GOSUB 920,940
610 ?"AND ";
620 ON FNR(2) GOTO 960,990
630 ?"BUGS ";
640 RETURN
650 ?"REPTILES ";
660 RETURN
670 ?"MECHANICAL DEVICES ";
680 RETURN
690 ?"SUPERPERSONS ";
700 RETURN
710 ?"ICKY THINGS ";
720 RETURN
730 ON FNR(2) GOTO 740,760
740 ?"WANT OUR WOMEN ";
750 GOTO 780
760 ?"WANT OUR LITTLE SCHOOL
-BOYS ";
770 GOTO 780
780 ON FNR(2) GOTO 1020,1030
790 ?"ARE FRIENDLY."
800 GOTO 440
810 ?"ARE FRIENDLY BUT MIS-U
NDERSTOOD ";
820 ON FNR(2) GOTO 1310,830
830 RETURN
840 ?"MISUNDERSTAND US ";
850 ON FNR(2) GOTO 1310,860
860 RETURN
870 ?"UNDERSTAND US TOO WELL
 ";
880 ON FNR(2) GOTO 1310,890
890 RETURN
900 ?"LOOK UPON US ONLY AS A
 SOURCE OF NOURISHMENT ";
910 ON FNR(2) GOTO 1020,1050
920 ?"RADIOACTIVE ";
930 RETURN
940 ?"NOT RADIOACTIVE ";
950 RETURN
960 ?"CAN BE KILLED BY ";
970 ON FNR(4) GOSUB 1070,109
0,1200,1220

980 GOTO 440
990 ?"CANNOT BE KILLED BY ";
1000 ON FNR(4)GOSUB 1070,109
0,1200,1220
1010 ON FNR(7) GOTO 1240,127
0,1290,1330,1350,1370,1310
1020 RETURN
1030 ?"TAKE A FEW AND LEAVE.
"
1040 GOTO 440
1050 ?"AND EAT US WITH A SID
E DISH OF FRENCH FRIES(HOLD
THE ONIONS!)."
1060 GOTO 440
1070 ?"A CROWD OF PEASANTS W
ITH TORCHES."
1080 RETURN
1090 ON FNR(5) GOTO 1100,112
0,1140,1160,1180
1100 ?"THE ARMY ";
1110 RETURN
1120 ?"THE NAVY ";
1130 RETURN
1140 ?"THE AIR-FORCE ";
1150 RETURN
1160 ?"THE MARINE-CORPS ";
1170 RETURN
1180 ?"THE COASTGUARD ";
1190 RETURN
1200 ?"THE ATOMIC BOMB."
1210 RETURN
1220 ?"A BAG OF HIGH-VELOCIT
Y JELLY-TOTS ";
1230 RETURN
1240 ?"BUT ";
1250 ON FNR(3) GOSUB 1390,14
10,1430
1260 ON FNR(3) GOTO 1450,147
0,1500
1270 ?"SO SCIENTISTS INVENT
A WEAPON ";
1280 ON FNR(3) GOTO 1520,154
0,1560
1290 ?"SO THEY EAT US."
1300 GOTO  440
1310 ?"SO THEY TURN US INTO
";
1320 ON FNR(4) GOTO 1840,186
0,1880,1900
1330 ?"SO THEY PUT US UNDER
A BENIGN DICTATORSHIP."
1340 GOTO 440
1350 ?"SO THEY KILL US."
1360 GOTO 440
1370 ?"BUT THEY DIE FROM CAT
CHING CHICKEN POX."
1380 GOTO 440
1390 ?"A CUTE LITTLE KID CON
VINCES THEM PEOPLE ARE O.K.
";
1400 RETURN
1410 ?"A PRIEST TALKS TO THE
M OF GOD ";
1420 RETURN
1430 ?"THEY FALL IN LOVE WIT
H THIS BEAUTIFUL GIRL ";
1440 ON FNR(2) GOTO 1580,159
0
1450 ?"AND THEY DIE."
1460 GOTO 440
```

*(continued on next page)*



# Bargain.



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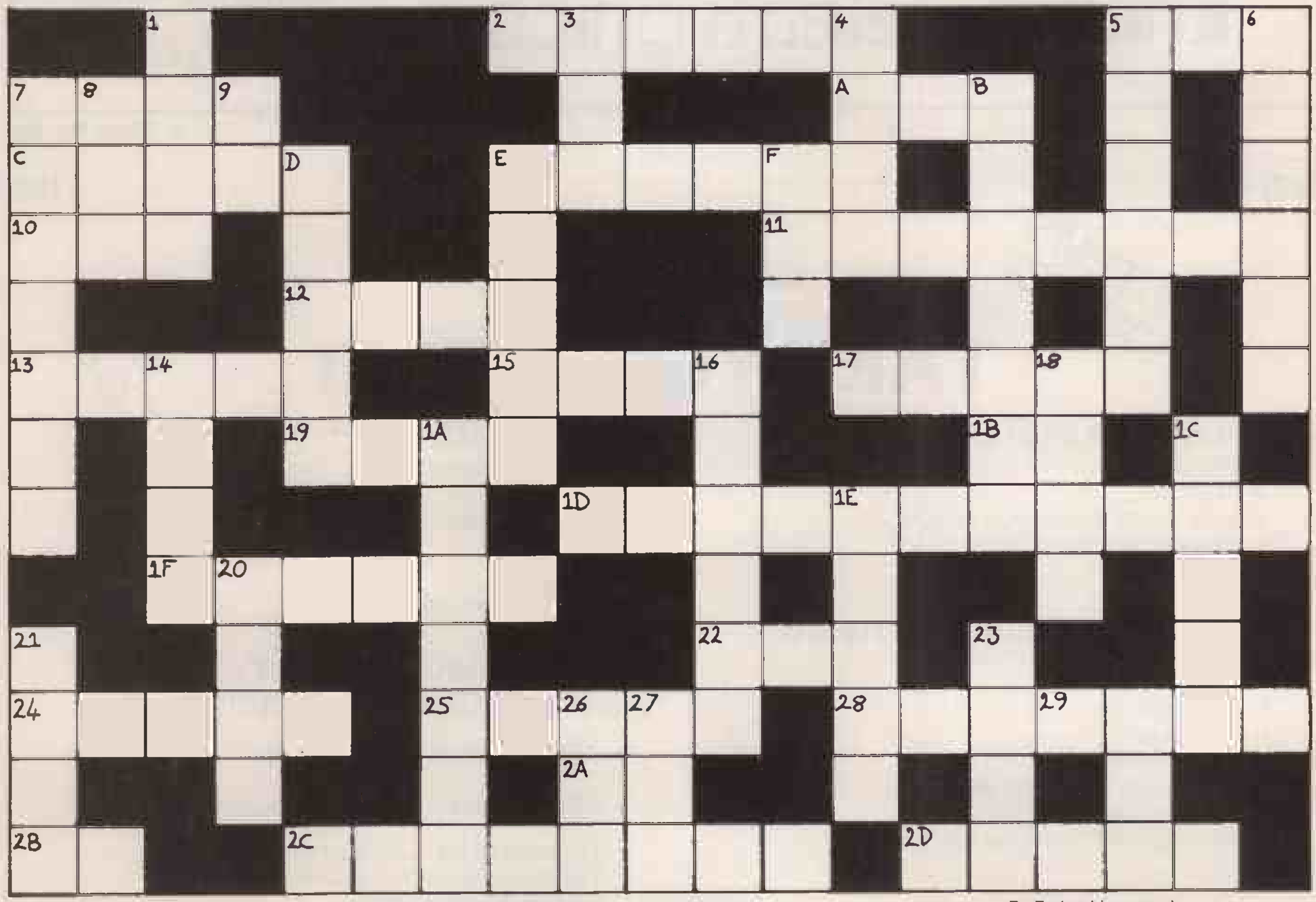
*(continued from previous page)*

```
1470 ?"AND THEY LEAVE ";
1480 ?"AND SEND US POSTCARDS
 AND FLOWERS ON OUR BIRTHDAY
 FOR QUITE A LONG TIME AFTER
WARDS."
1490 GOTO 440
1500 ?"AND THEY TURN INTO DI
SGUSTING LUMPS."
1510 GOTO 440
1520 ?"WHICH FAILS ";
1530 GOTO 1010
1540 ?"WHICH KILLS THEM."
1550 GOTO 440
1560 ?"WHICH TURNS THEM INTO
 DISGUSTING LUMPS."
1570 GOTO 440
1580 RETURN
1590 ?"AND THEY GET MARRIED
AND LIVE HAPPILY EVER AFTER.
"
1600 GOTO 440
1610 ?"DON'T WANT OUR WOMEN
";
1620 ON FNR(3) GOTO 1020,163
0,1650
1630 ?",DON'T ";
1640 GOTO1030
1650 ?"BUT REALLY GO APE OVE
R FORD CORTINAS AND MOVE TO
DAGENHAM ";
1660 GOTO 1020
1670 ON FNR(5) GOTO 1680,170
0,1720,1740,1760
1680 ?"WITH GREAT BIG PIMPLE
S ";
1690 RETURN
1700 ?"WITH REPULSIVE WAXY E
ARS ";
1710 RETURN
1720 ?"WITH FESTERING BOILS
ON THEIR ";
1730 GOTO 1770
1740 ?"WITH RIPPLING MUSCLEY
 BITS ";
1750 RETURN
1760 RETURN
1770 ON FNR(3) GOTO 1780,180
0,1820
1780 ?"NOSES ";
1790 RETURN
1800 ?"BOTTOMS ";
1810 RETURN
1820 ?"'YOU-KNOW-WHAT'S' ";
1830 RETURN
1840 ?"HOOD ORNAMENTS FOR TH
EIR ";
1850 ON FNR(4) GOTO 1920,194
0,1960,1980
1860 ?"QUITE OUTRAGOUSLY POO
FY POODLES."
1870 GOTO 440
1880 ?"ROLLS OF BRIGHT BLUE
FLOWERY CARPET."
1890 GOTO 440
1900 ?"GARDEN GNOMES."
1910 GOTO 440
1920 ?"ROLLS-ROYCE'S."
1930 GOTO 440
1940 ?"HONDA FIFTIE'S."
1950 GOTO 440
1960 ?"GLITTERING PUMPKIN CO
ACH."
1970 GOTO 440
1980 ?"MOTHERS' RELIANT ROBI
N'S."
1990 GOTO 440
```

## Crossword



### ACROSS

2 Opposite of 'loaded'.
5 Use packed for best arithmetic.
7 A Teletype is slow at 110.
A Both inputs true for this logic to work.
C An algebraic tongue.
E Specified organisation.
10 Route for signals.
11 A basic means of talking to your micro.
12 Bits unite!
13 First good colour graphics micro.
15 Electricity lights these up.
17 Best to check data at this time.
19 Transfer from backing store to memory.
18 In HEX, —1 is FF, —2 is FE, —26 is E6 so —82 must be?
1D Results of arithmetic generally here.
1F Sured to be bubbling soon.
22 Not even parity.
24 Reasoned to keep your programs going.
25 When to miss the next issue of *Practical Computing*.
28 Selected for data transfer.
2A Same as 9 DOWN.
2B Jump to.
2C One in every home!
2D American ciphers.

### DOWN

1 These crawl into your program when you are not thinking.
3 Change one to this by an arithmetic shift left.
4 Food for a program.
5 Two-state system.
6 Random access to data.
7 He invented the first for his lady to win on the horses.
8 Arithmetical genius in the CPU.
9 Repeat in Fortrtan.
B Watch it analogue!
D Find your place with this in assembler.
E Enclosed in a record.
F Same as 8 DOWN.
14 You can program it only once.
16 A hard one is started by a hole.
18 Get data from a list.
1A Meaningful abbreviation.
1C It was either true or false for him.
1E Chat over telephone with this.
20 Alter text.
21 Signal a special condition.
23 Fills up the field.
26 CRT forms its heart.
27 End of text.
29 Large scale integration.

*(Answers on page 120).*

# Seeking pools draws by golden button route

**Kay Floyd talks to Professor George of Brunel University, Uxbridge whose programs for predicting the outcome of horse races and football matches are regarded as successful by those who use them.**

FIVE YEARS AGO, Frank George was press-ganged into writing a program for football pools punters. "I was being nettled by the family. They were saying 'You're so clever, why don't you do something useful?'" So he did.

Since then the program has been rated an amazing success.

Professor George is head of cybernetics at Brunel University, which means working with Artificial Intelligence — "thinking in problems and logic-solving". He has always been interested in forecasting and has been known to advise NATO on odd occasions. His computing experience dates from the last war; in his time he has worked with the Ferranti Pegasus and the pioneering EDSAC at Cambridge University.

His first attempts at the pools program were not very successful. He made assumptions about the teams which he found later were not statistically significant and the program failed. So, he spent several years on a close statistical analysis of previous results by studying annuals and generally keeping in touch with the world of football. He tried various strategies for the second, third and eventually, the fourth programs.

## Own club

As well as the goodwill of his family, he was encouraged to continue with the program by Topaz Publishing. He wrote a book called *A Better Bet* which contained ways of applying logic to win on the pools, horse racing and casino games. He sent the book to several publishing houses and eventually Topaz recognised its merit.

The publishing house felt he was not presenting it in the correct way and suggested that he re-write it so that it would appeal other than to people with mathematical minds. Properly organised, his ideas could be used and understood generally.

That was done and the book was published in a limited edition of 2,000 copies. It is now no longer available but because of the favourable reception from readers, Topaz decided to reprint several chapters which related directly to the pools. They have been re-published under the title *Forecast Three.*

The book shows how to use the computer method. Many readers had no access to a computer, so Topaz implemented it on its own machine in Liverpool. People then wrote to Topaz asking for a copy of the computer printout to check form. An impromptu 'club' has grown from it; members pay 50p per week for the printout, which covers the cost of the extra print run and first-class postage.

There are now some 3,000 people in the club. Colin Rose of Topaz says: "We can't guarantee it works, but I don't think anybody in the club hasn't won something if they've used it for two months. We have tangible evidence that it works in some cases. Someone wrote to us saying that he was pleased with the system — he had won £5,400 one week and £730 the week before".

The system reduces the odds against you but they are still high. The club experienced a poor patch last season because of the bad weather, when the pools panel had to sit for many weeks. The form factor does not come into play; neither do the teams, for that matter.

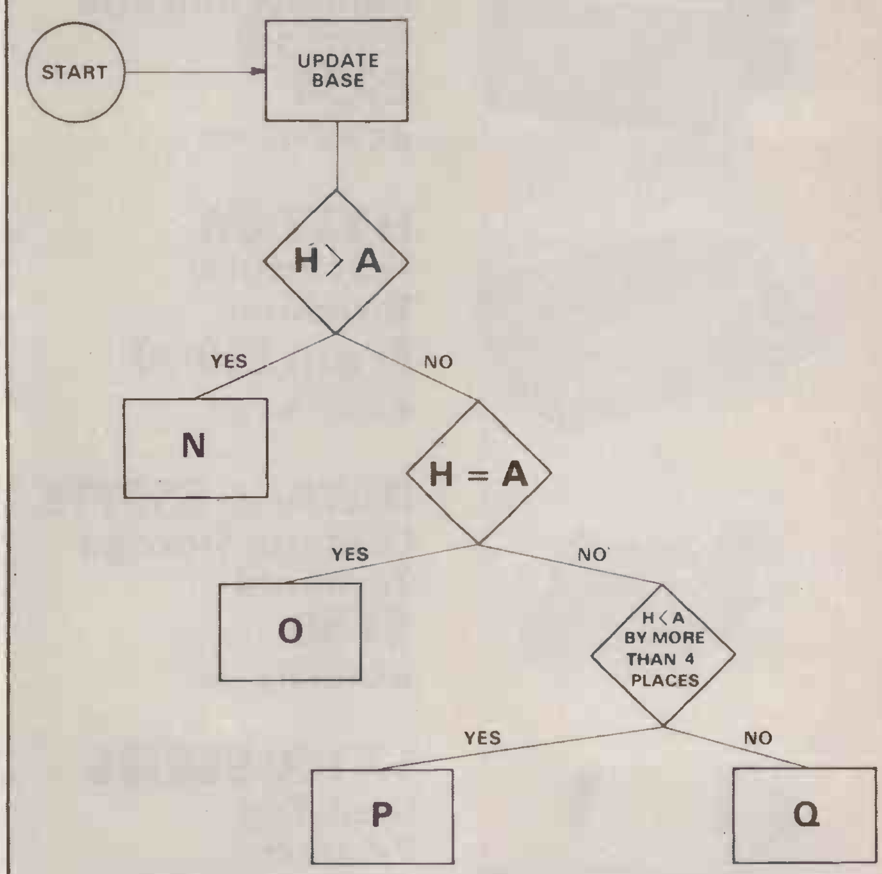
Topaz hopes soon to implement George's horse racing system in the same way. Meanwhile, the pools program is run every Monday and produces a list of likely draws in order of priority.

At present, the program is written in the high-level language Fortran and, runs on an ICL 1900 mainframe. But George maintains that it can be translated easily into any language, even machine code, so, in theory, it can be run on any machine. He explained how the system works:

"The main effort of the program was directed to the treble chance and four considerations have to be borne in mind.

"First, there is form. Football is dis-

*(continued on page 115)*




**Comment on figure 1. Each of these outcomes has to be repeated 89 times for full account of league position when conjoined to the result of the last two matches (see figure 2) for each time, making up 324 outcomes, all of which fall into three categories — 1, home win; 2, draw; 3, away win, and then you may distinguish score-draw from scoreless draw by a further test.**

# TERMINALS FOR YOUR MICRO

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**Low Cost Video Terminal**
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New low cost VDU featuring full cursor controls and 24x80 screen displaying high resolution upper case characters using a 5x7 dot matrix. Keyboard generates all 128 ASCII codes and unit interfaces through an RS232 interface at transmission rates up to 9600 baud.
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Magnetic tape cassette unit storing 150,000 characters per cassette, communicating at up to 2400 baud through terminal and modem/CPU RS232 interfaces with full local and remote device control. ECMA, TI and NCR format compatibility options available.

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New low cost range of desk top serial printers, printing over 80 or 132 columns at 100 or 180cps on standard listing paper using a 7x7 or 7x9 dot matrix. Options include VFU, second paper feed mechanism, 9x9 matrix with italic or expanded printing, buffed serial RS232 interface.

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*(continued from page 113)*

tinguished from other forms of betting, such as horse and greyhound racing, lotteries or roulette, in that it is not entirely random. The betting, and therefore the odds, reflect the form.

"Not all football teams play to form, if they did, it would make a nonsense of the game and remove the gamble. It would also mean that the favourites would always win and individual punters would win nothing of any real value. So some random element must be brought to bear on the proceedings, and that leads to the second consideration.

## Random element

"But let us stay with form for the moment. It depends on league position, last result, last-but-one result and perhaps the one before that. That leads to a Markov Net — a statistical technique of probablistic sequential analysis — of the form a/b/c/p, where a, b and c are the last three results and p is the weighting in the light of the team's league position. The same is compiled for the other team in any fixture — d/e/f/q, for example — and then we compare p to q.

"If $p > q$, the home team will win. If $p = q$ it will be a draw, and if $p < q$ the away team will win. One can, of course, adjust those inequalities slightly by using the condition where p and q are almost equal. By using the form method alone, you should be able to pick a high percentage of score draws each week.

"Now, the random element. The best approach is to select matches where no-one would forecast a draw and mix them on a 10 percent basis with 90 percent of the forecast draws — those which are expected, according to form. This means that a straight full permutation cannot be used; nor can any of the special plans.

"This is where the third consideration comes into play — how to sort the forecast to put them into the correct 'lines' or columns.

"The sort factor forces us to decide how much money we want to bet each week. If all things are equal, the more you spend the better the chance of winning. To illustrate this, let us assume that the bet will be £2.25 per week.

"You want a sort which includes only 10 percent of the unexpected plus 90 percent of the expected. In the following

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A | A | A | A | A | B | B | B | C | C |
| B | C | B | D | C | D | C | E | D | E |
| D | D | F | E | E | E | F | F | F | G |
| F | G | H | G | H | H | G | H | G | I |
| H | J | I | J | I | J | I | J | I | J |
| K | K | K | L | K | L | L | K | M | L |
| L | O | M | N | M | M | N | N | N | M |
| N | P | P | O | O | P | O | P | P | O |
| Q | R | R | Q | R | Q | R | Q | R | Q |
| $x_1$ | $x_2$ | $x_3$ | $x_4$ | $x_5$ | $x_1$ | $x_2$ | $x_3$ | $x_4$ | $x_5$ |

table A to R are expected and $x_1$ to $x_5$ are unexpected; this shows that you have to replace the letters by game numbers each week.

"In this table, you have to make sure that no two columns have more than seven letters in common. Each of A to R occurs equally often — five times; $x_1$ to $x_5$, the unexpected draws, each occur twice.

"You could plump for fewer than the 18 expected draws and that would give better coverage over a smaller number of forecast draws. That decision has to be made mainly in the light of evidence as to the forecasting ability of the system and the average distribution of score draws. You can have any number of such arrays, all different, according to how much you can afford to spend.

## Tests to apply

"You now perm eight from 10 in each column. You then find you have 450 lines in all, 45 for each column of the sort. At a state of ½p per line, that amounts to £2.25, hence our choice of this weekly amount.

"The fourth consideration is choice. Apart from choosing how much money you stake each week, you must also look at the sort you prefer. There are also other tests to consider, such as the historical test, where you look at the history of a club and see how it fared against a certain team at a certain ground. Often one finds a similarity in the score when two particular clubs meet on one or the other's ground.

"The other test you can apply is for a local derby. Those tests are not built into the program but there is some evidence that results between two teams, especially when they are local rivals, tend to form a pattern; and, in the case of a local derby, matches will often lead to a draw".

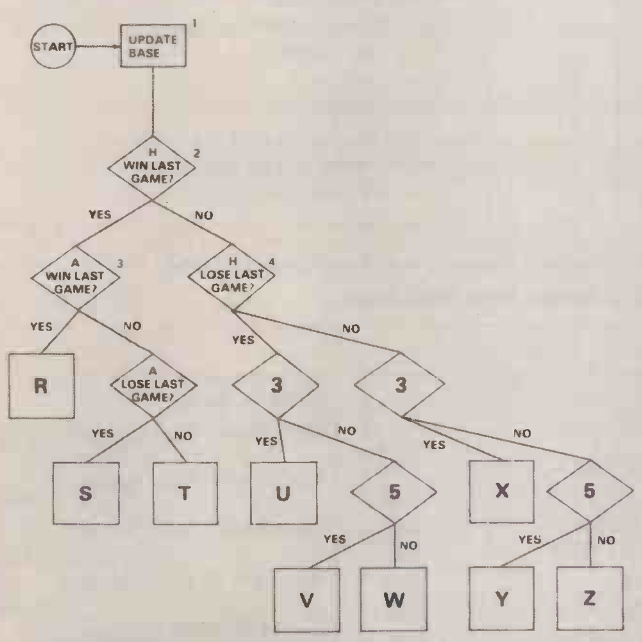
Microcomputers are well-suited to the computerisation of the program and the two flowcharts show the sort of structure you will obtain. The base data is available in the press, or obtained easily from other sources.

## Does not bet

Once you have decided how many score draws you need for your sort, you write them in order of priority — very likely, likely, possible and the like and apply the goal difference test if you choose to include it in your program. Then, of course, you follow the other procedures, deciding how much to invest, choose a sort of the kind described and then make further tests, such as local derby, if you wish to do so. Finally, don't forget to fill in your coupon — and post it.

Surprisingly, George does not bet on the pools. He leaves that to his wife. Using his method, she won more than £2,000 last year. The program is successful but George is working to improve it all the time: "I'm always doing a little bit of fine tuning".

*Forecast Three* is available from Topaz Publishing Ltd, Mulberry House, Canning Place, Liverpool 1, and costs £1.50.




**Comment on figure 2.**
**Latest games played (including midweek). H = home team; A = away team.**
**R = W v W**
**S = W v L**
**T = W v D**
**U = L v W**
**V = L v L**
**W = L v D**
**Y = D v L**
**Z = D v D**
**X = D v W**
**These nine outcomes can then be taken one step further to:**
**WW v WW**
**WW v WL**
**WW v WD**
**etc.**
**of which there are 81 outcomes.**
**It remains only to decide in the light of experience what the final outcomes are. N, O, P and Q are home win, home win/draw, away win and draw respectively. Depending on whether the weightings to go forward to figure two, are N, O, P or Q, so the sets of outcomes R-Z are adjusted and vary from "very likely home win" to "very likely away win".**

# The same simple problem tackled in three ways

*In this article we will be looking at three scientific programming languages. The first, Basic, is already available widely on anything from micros to mainframes. The second, Fortran 77, offers many improvements over its predecessor, Fortran 66, and without doubt will be just as successful. The third, Pascal, is gaining rapidly in popularity and, with more implementations being written for micros, it may well overhaul Basic as the small computer users' language.*

**Michael Farmer compares three scientific languages by making them do the same simple problem.**

```
HISTOGRAM PROBLEM
-----------------
 11 :       **                        :
 10 :**     **                        :
  9 :**     **                        :
  8 :**     **                        :
  7 :** **  **                 **     :
  6 :** **  **                 **     :
  5 :** **  ** **              **     :
  4 :** **  ** **     ** ** ** ** **  :
  3 :** **  ** ** **  ** ** ** ** **  :
  2 :** **  ** ** **  ** ** ** ** **  :
  1 :** **  ** ** **  ** ** ** ** **  :
----:---------------------------------:
    : 9 19 29 39 49 59 69 79 89 99    :
```

**Figure 1**

LET US DEFINE a problem for our languages to tackle. A company has a text data file containing the ages of its employees. The ages are represented as integers in the range (0 . . 99) and the file is structured so that there is one integer per line (record). It is required to print a histogram showing the distribution of the ages into the 10 percentiles (0 . . 9), (10 . . 19), . . . , (90 . . 99).

No assumptions can be made about the data or their distribution. Figure 1 illustrates a typical histogram and gives the required layout. To keep the programs reasonably short we will assume that the data file has been validated and is therefore not empty, and that all the ages are within the specified range.

## Important points

This problem can be broken-down into three distinct sections. In the first, the raw data is input sequentially and converted into a series of counts representing the histogram columns. Secondly, we compute the height of the histogram. Finally, we print the histogram with the correct layout.

Now we can go through the Basic program — figure 2 for those in doubt — and choose the important points. Variable names consist of a single letter followed optionally by a single digit — some implementations restrict array identifiers to just a letter. They are declared implicitly by their occurrence with arrays having a lower bound of 0 — some implementations may use 1 — and a default upper bound of 10.

It is good practice, however, to declare all arrays explicitly, as this helps define the problem more accurately and also aids documentation.

The control variable of a FOR statement must match the identifier in the corresponding NEXT statement. There is a default step size of 1 and both the step and limit values are evaluated once on entry to the loop. Although we have not done so, some implementations allow the keyword LET to be omitted. If your implementation does not support an end-of-file test (IF END . . .) it will be necessary to append the data with some number outside the specified range and then test for this (e.g., IF X = -99 THEN . . .).

As Basic supports only two data types — real and string, the latter denoted by a $ after the identifier — it is necessary to use the system function INT() to remove any remainder when dividing X by 10. The semicolon at the end of certain PRINT statements allows us to build up each output line until the terminating PRINT "!" is reached. This is termed stream-orientated I/O.

One final point — indentation highlights the control structures of your program. This language may not have an IF . . . THEN . . . ELSE statement but the indentation makes it easier to read your version using GOTOs.

Fortran 77, figure 3, does not possess

*(continued on next page)*

**Figure 2**

```
100 DIM S(9)
110 PRINT "HISTOGRAM PROBLEM"
120 PRINT "-----------------"
130 FOR J=0 TO 9
140   LET S(J)=0
150 NEXT J
160 INPUT X
170   IF END THEN 210
180   LET J=INT(X/10)
190   LET S(J)=S(J)+1
200 GOTO 160
210 LET M=S(0)
220 FOR J=1 TO 9
230   IF S(J)<M THEN 250
240   LET M=S(J)
250 NEXT J
260 FOR I=M TO 1 STEP -1
270   PRINT I; TAB(4); ":";
280   FOR J=0 TO 9
290     IF S(J)<I THEN 320
300       PRINT "** ";
310     GOTO 330
320       PRINT "   ";
330   NEXT J
340   PRINT ":"
350 NEXT I
360 PRINT "----:-------------------------------:"
370 PRINT "    : 9 19 29 39 49 59 69 79 89 99 :"
380 END
```

```
      INTEGER I, J, MAX, SCORE(0:9), X
      CHARACTER REC(0:9)*3
      WRITE(*,110)
 110  FORMAT(' HISTOGRAM PROBLEM',/,
     1       ' -----------------')
      DO 150 J=0,9
        SCORE(J)=0
 150  CONTINUE
 160  READ(*,170,END=210) X
 170    FORMAT(I2)
        J=X/10
        SCORE(J)=SCORE(J)+1
      GOTO 160
 210  MAX=SCORE(0)
      DO 250 J=1,9
        IF(SCORE(J).GT.MAX) MAX=SCORE(J)
 250  CONTINUE
      DO 350 I=MAX,1,-1
        DO 330 J=0,9
          IF(SCORE(J).GE.I) THEN
            REC(J)='** '
          ELSE
            REC(J)='   '
          ENDIF
 330    CONTINUE
        WRITE(*,340) I, (REC(J),J=0,9)
 340    FORMAT(' ',I3,' :',10A3,':')
 350  CONTINUE
      WRITE(*,360)
 360  FORMAT(' ----:------------------------------:',/,
     1       '     : 9 19 29 39 49 59 69 79 89 99 :')
      END
```

**Figure 3**

*(continued from previous page)*

the irritating quirks of its predecessor Fortran 66, which is almost a proper subset, and the enhancements make for a cleaner programming style. In fact, many Fortran 66 implementations included such extras. Fortran 77 allows a variable to be declared implicitly by its occurrence, at which point its type is determined by the initial letter of the identifier — I to N are integer, the others are real.

Again, explicit declarations make the program easier to read and modify. The lower bound of the CHARACTER array is declared to be 0 — the default would be 1 — and the length of each element is also specified. Input and output is record (line) -orientated with FORMAT statements controlling the layout. An asterisk instead of a unit number in READ or WRITE statement specifies that the system defaults for I/O are to be used.

The first character of each output record is interpreted as a carriage-control character. Although this is meant for controlling paper movement on a printer, many implementations also use it as a cursor-control character for VDU screens. The meaning of the various carriage-control characters is given in figure 4. Note that the output line has to be built-up internally before it can be printed out.

The label present in the DO statement determines the range of the loop and once again there is a default step size of 1. The step and limit values are evaluated once on entry to the loop. This is an incompatibility with Fortran 66 in which any DO loop was performed at least once, because the test for completion was executed at the end of the loop rather than at the beginning.

## Aids readability

If present, END=. . . specifies the label to which control is to be transferred when end-of-file is detected. Division of two integer operands produces a truncated integer result. The CONTINUE statement, labelled 250, is mandatory, as DO loops cannot finish on an IF statement. This practice is to be encouraged as it greatly aids program readability.

In Pascal, figure 5, spaces and end-of-line are ignored largely as the semicolon acts as a separator. Once again, good layout makes the program readable. The program heading must name formally any external files to be accessed by the program.

Here we are using the system-defined text I/O files. All identifiers must be declared explicitly, with the declarations being introduced by the symbol VAR. Input and output is stream-orientated except that writeln (and also readln) will terminate the current line-of text.

Again, the first character of every output line is interpreted as a carriage-control character. If no file name is present in read or write calls, it is assumed that that the text files 'input' and 'output' respectively are being used. No step size may be specified in FOR loops. The limit value is evaluated once on entry to the loop and either TO or DOWNTO specifies the direction.

## Similarity

The Boolean function eof() returns the value 'true' if we are at the end of the file. Note that we did not attempt to read past the end-of-file before testing as we did in Basic and Fortran. In fact, the program would, or should, abort if we did. As with other block-structured languages we can group a number of statements and form them into one compound statement by enclosing them between the symbols BEGIN and END. This is essential in some cases as the FOR loop controls only one statement whereas any number of statements may be enclosed between REPEAT and UNTIL. This inconsistency is a minor drawback to an otherwise excellent language.

similarity between the three languages. They have all achieved the same objective — producing a histogram — in much the same way. That is for two reasons. One, they are scientific languages and as such are capable of manipulating simple data items in similar ways. Two, our initial problem involved one data type — some people may argue that we used two — one

| Control character | Meaning |
|---|---|
| 0 | Advance two lines |
| 1 | Advance to next page |
| + | Overprint (no advance) |
| (Space) | Advance one line |

Any other character is usually treated as if it were a space.

**Figure 4**

data structure — the array — and only simple program control structures.

Even so Basic is already showing a lack of conditional statements. Later in this series we will introduce problems requiring richer data and control structures. Then we will see more contrast between the languages and also between the other languages we have yet to introduce. If one exists, the moral is that you should choose your programming language to suit your problem, but how many of use have access to the correct language at the right time?

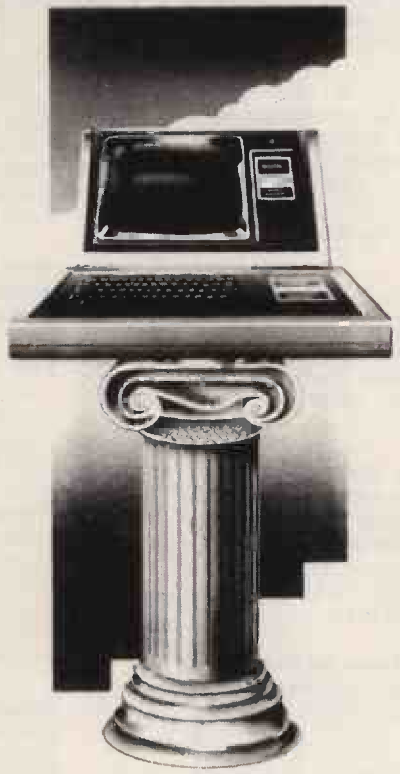
In the next article we will be presenting three more candidates to be the language of your choice.

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

## Disc system

A NEW disc operating system, called Newdos+, is being made available by A J Harding. The company has prepared its own manual for Newdos+ and claims the following features for the system:

- All errors, reboots and similar crashes which occurred with TRSDOS 2.1 are eliminated and the TRS-80 disc system is now a viable entity as a safe storage medium.
- Basic programs and commands can be entered from DOS.
- All DOS commands can be entered from Basic with an automatic return to Basic.
- A return to DOS from Basic, except in certain exceptional circumstances, leaves the Basic program intact and it may be accessed on return to Basic.
- A Renumber utility is included, with the added facility of checking of Basic program for validity of line numbering.
- A Reference utility is included whereby one can check whether or not variables have been used and, if so, in what line(s). It will also check for and display the line number in which any stipulated five digits appear. Excellent for checking branching origination.
- A Disassembler is included which will disassemble from memory or disc contents.
- An Editor Assembler is included.
- Level I is included. The user therefore, now has the full range of the Tandy Basics available on one machine.
- Disc Directories are not only listed but are also checked and any errors are displayed. Even the EOF byte number is given.
- A fairly extensive shorthand entry is provided, allowing for single key entries of a number of commands.
- The contents of a section of memory of disc may be offset and loaded to disc with a new location.
- An entirely new utility by the name of "Superzap" is supplied on the disc. It is an extremely wide application program which is best described as a tool by which complete surgery may be carried out on a disc. It is possible to get into the disc and change even a single byte. Discs which would not back-up under TRSDOS 2.1 will back-up under Superzap.
- By use of a special command, a line printer may fulfil the function of a screen printer. This is more useful than it sounds. For instance, one can now have hard copy of a disc directory. This command seems to over-ride other commands and may be used at any time, even while the machine is looping. Graphics and other representations can therefore be printed-out without the ubiquitous "Ready" prompt.
- In addition, there are many small



features such as automatic keyboard debounce, the ability to add to sequential files, and corrections to make the Append command work.

## Battle game

ADRIAN RUFF of Newcastle-on-Tyne sent this game. We have not been able to try it but it sounds fun.

The program simulates a battle between two opposing laser bases. The bases are place on opposite sides of a board which the computer "draws" on the computer graphics unit. The version of the program presented is for the TRS-80 Level II but can be modified easily for most computers with either a graphics unit of a memory mapped VDU. As high definition is not an essential requirement.

The object is to destroy your opponent as many times as possible and gain as many points as possible. This is achieved by firing your laser across the screen and hitting him — easier said than done — while he is trying to dodge and fire back.

To make things a bit more interesting, the laser bases are in constant motion and the only direction control possible is reverse. This is achieved by hitting one of the command keys at which the relevant laser base reverses its direction.

Each player has two command keys, one for reversing his laser base and one for firing his laser. The keys used are "Z" and "X" for one player and "." and "/" for the other.

The key functions are:
"Z" — reverse left laser base.
"X" — fire left laser.
"." — reverse right laser base.
"/" — fire right laser base.

There is one restraint. Only one laser burst may be "in the air" at any one time; the program sees to this i.e., any "fire" keys hit while a laser burst is on its way are ignored.

One interesting feature is the ability to control, slightly, the trajectory of a laser burst. This is achieved by hitting the reverse key for the laser base. This changes the vertical position of the laser burst. Thus hitting the reverse key more than once at a time produces zig-zagging laser fire and is hard to avoid.

The game can be varied for beginners or experts. The program as given is intended for faster play but can be made easier by changing the width of blocks on the board by altering the inner loop count in line 30 from "Y=O to 3" TO "Y=O TO 6", and by slowing the laser propogation speed by altering the step count in lines 1020 and 2020 from 12 and -12 to 6 and -6, respectively.

```
10 CLS
20 PRINT TAB(19); "LASER BATTLE"
30 FOR X=O 47 STEP 8;FOR Y=O TO 3:SET(2,X+Y:SET)125,X+Y:NEXT Y: NEXT X
40 P1=30:P2=30:D1=1:D2=-
55 F1=1: F2=1
60 SET (0.P1): SET (127,P2)
70 GOSUB 80: GOTO 70
80 A$=INKEY$:IF A$="" THEN 120
90 IF A$<>"Z" THEN 95
92 RESET (0,P1+D1): D1-D1* (-1): IF F1 THEN RETURN
93 IF (P+D1) <0 OR (P+D1)> 47 THEN RETURN
94 RESET (X,P). P=P+D1
95 IF A$= <> "." THEN 100
97 RESET (127,P2+D2):D2* (-1): IF F2 THEN RETURN
98 IF (P+D2) <0 OR (P+D2) > 47 THEN RETURN
99 RESET (X,P). P=P+D2: RETURN
100 IF A$="X:" AND F1 THEN 1000
105 IF A$="/" AND F2 THEN 2000
110 RETURN
120 REM MOVE
130 RESET (0,P1): RESET (0,P1+D1): IF (P1+D1) >46 OR (P1+D1)< THEN D1=D1*(-1)
140 P1=P1+D1: SET (0,P1): SET (0,P1+D)
150 RESET (127,P2): RESET (127,P2+D2): IF (P2+D2)> 46 or (P2+D2) < 1
THEN D2=D1*(-1)
160 P2=P2+D2: SET (127,P2): SET (127,P2+D2)
170,RETURN
990 REM ## FIRE 1
1000 IF POINT (2,P1) THEN RETURN
1005 F1=0: F2=0
1010 P=P1
1020 FOR X=1 TO STEP 12: SET (X,P): GOSUB 80: RESET (X,P): NEXT X
1024 F1=1: F1=1
1030 IF NOT (POINT 127,P) THEN RETURN
1040 FOR A=1 TO 100: RESET (127,P): SET (127,P: NEXT A?
1050 S1=S1+1;; PRINT @ 5,S1;; RETURN
1990 REM FIRE ## 2
2000 IF POINT (125,P2) THEN RETURN
2010 P=P2
2020 FOR X=126 TO 1 STEP -12: SET (X,P): GOSUB 80: RESET (X,P): NEXT X
2025 F1=1: F1=1
2030 IF NOT (POINT (0,P)) THEN RETURN
2040 FOR A=1 TO 100: RESET (0,P). SET (0,P): NEXT A
2050 S2=S2+1: PRINT @58,S2: RETURN
```

## December

**1** **Microelectronic revolution: Implications for Education.** Bognor Regis College. Including lectures on Electronics for schools and Technology in the curriculum. West Sussex Institute of Higher Education, The Dome, Upper Bognor Road, Bognor Regis, Sussex, PO21 1HR. Tel: 02433 5581.

**3-4** **Microprocessing, industrial applications.** Kensington Hilton, London. General course on applications in industry. Fee, £170 + VAT. S. McKibbin, 33 Warren Street, London, W1P 5DL. Tel: 388 4865.

**3-5** **Primary Basic.** Excelsior, Glasgow. Teaches fundamental programming skills, as well as the Basic programming language and enables participants without previous knowledge of computing to write competent, technical, commercial and domestic programs. With accommodation £175; without accommodation £125. Commodore Systems Information Centre, 360 Euston Road, London NW1 3BL. Tel: 388 5702.

**3-6** **High-level language programming** — MPL on the 6800. London. An advanced course designed for engineers familiar with programming microprocessors in assembler language. Fee, £220. Bleasdale Computer Systems Ltd, 7 Church Path, Merton Park, London, SW19. Tel: 828 6661.

**3-6** **High-level language programming course of Pascal 9900.** London. Includes the use of a robot. The course teaches languages and emphasises their application in real-time control and enables the participants to write software for a range of peripheral devices. Fee, £300 + VAT. Bleasdale Computer Systems Ltd, 7 Church Path, Merton Park, London, SW19. Tel: 828 6661.

**3-6** **High-level language programming, Pascal on the 9980.** London. Fee, £220. Bleasdale Computer Systems Ltd, 7 Church Path, Merton Park, London SW19. Tel: 828 6661.

**3-7** **Management in project development.** Cannock, Staffs. Designed for potential middle management staff and senior analysts and programmers. It covers management concepts, analysis techniques, communications, project control and management development. Fee, £255 + VAT. Compower Training School, Cannock, Staffs, WS11 3HZ. Tel: Cannock 2511.

**3-7** **APL programming course.** Cannock, Staffs. Enables staff with some experience to program in this powerful and increasingly-utilised language. Fee, £245 + VAT. Compower Training School, Cannock, Staffs, WS11 3HZ. Tel: Cannock 2511.

**3-7** **Troubleshooting microprocessor-based systems.** London. Designed for engineers and senior technicians involved in production testing, field service, and design of microprocessor based systems. Fee, £540 + VAT. ICS Publishing Company, (U.K.) Ltd, Pebblecoombe, Tadworth, Surrey, KT20 2PA. Tel: 03723 79211.

**3-14** **Designing systems with microprocessors.** London. Two-week workshop designed for engineers with a knowledge of microprocessors and how they work. The course covers designing and producing microprocessor-based systems and the design and development of structured software. Fee, £500. Bleasdale Computer Systems Ltd, 7 Church Path, Merton Park, London SW19. Tel: 828 6661.

**4-7** **Data communications.** London. Four-day course on digital techniques and system design. Covers fundamental principals of signal conversion, encoding/modulation, data transmission and error control. Fee, £470 + VAT. ICSP (U.K.), Pebblecoombe, Tadworth, Surrey, KT20 7PA. Tel: 03723 79211.

**4-7** **JCL/Utilities for operations staff.** Cannock, Staffs. Operations training course for all operations staff including control/set-up and planning staff. Fee, £215. Compower Training School, Cannock, Staffs, WS11 3HZ. Tel: Cannock 2511.

**4-8** **Breadboard exhibition.** London. Royal Horticultural Hall. Features extensive range of prototyping boards and accessories for circuit designers and several new ranges of low-cost digital trouble-shooting and test aids for the development, production or service environment. Continental Specialities Corporation, Shire Hill Industrial Estate, Saffron Waldon, Essex, CB11 3AQ.

**5** **Microprocessor seminar.** St Albans. Designed for the businessman. It gives a general introduction to the basic logic and basic technology with demonstration of microcomputers, showing their use in commercial applications. Naomi Buhai, Birklands Management Centre, 330, London Road, St Albans, AL1 1ED. Tel: St Albans 66661.

**6** **8080 homebrew system.** Berkshire. Meeting of The Thames Valley Amateur Club. C. J. Wallwork, Oak Cottage, Ecchinswalk, near Newbury, Berkshire.

**12** **3800 printing subsystem.** Cannock, Staffs. Operations training seminar; introduces operators to the concepts and mode of operating a 3800 subsystem. Fee, £50. Compower Training School, Cannock, Staffs, WS11 3HZ. Tel: Cannock 2511.

**10-14** **Advanced microprocessor design.** London. Advanced course for engineers with a good understanding of microprocessors and the aspects of software, how it works, and how it is produced. Deals with advanced hardware and software design techniques. Fee, £300. Bleasdale Computer Systems Ltd, 7 Church Path, Merton Park, London, SW19. Tel: 828 6661.

**10-14** **Interactive testing (CMS).** Cannock, Staffs. This programming course enables programmers to use a terminal to develop, edit, compile and test their Cobol programs. Fee, £245 + VAT (includes accommodation); Compower Training School, Cannock, Staffs, WS11 3HZ. Tel: Cannock 2511.

**10-14** **Microelectronics for non-electronic engineers.** London. For engineers with no previous experience of electronics and who are faced with the problem of designing microprocessors into their products. The course gives the participants an appreciation of the hardware of a microprocessor system and how to construct microprocessor-based systems. Fee, £250 + VAT. Bleasdale Computer Systems Ltd, 7 Church Path, London SW19. Tel: 828 6661.

**10-14** **System control language.** Cannock, Staffs. Operators' training course, designed for all data processing staff, to enable them to write and understand elementary job control programs. Fee, £250. Compower Training School, Cannock, Staffs, WS11 3HZ. Tel: Cannock 2511.

**11** **Principles of teleprocessing and VTAM/SNA concepts.** Cannock, Staffs. Designed as an introduction for operations staff. Fee, £50. Compower Training School, Cannock, Staffs, WS11 3HZ. Tel: Cannock 2511.

**11-14** **Distributed processing and computer networks.** London. Introduction to distributed processing and computer network sytem design techniques. Fee, £470. ICSP 1 (U.K.), Pebblecoombe, Tadworth, Surrey, KT20 7PA. Tel: 03723 79211.

**ANSWERS to crossword (page 111)**

Across: 2 STORED; 5 BCD; 7 BAUD; A AND; C ALGOL; E FORMAT; 10 BUS; 11 LANGUAGE; 12 BYTE; 13 APPLE; 15 LEDS; 17 ENTRY; 19 LOAD; 1B AE; 1D ACCUMULATOR; 1F MEMORY; 22 UDD; 24 LOGIC; 25 NEVER; 28 ENABLED; 2A DO; 2B GO; 2C COMPUTER; 2D ASCII. Down: 1 BUS; 3 TWO; 4 DATA; 5 BINARY; 6 DIRECT; 7 BABBAGE; 8 ALU; 9 DO; B DIGITAL; D LABEL; E FIELD; F ALU; 14 PROM; 16 SECTOR; 18 READ; 1A ACRONYM; 1C BOOLE; 1E MODEM; 20 EDIT; 21 FLAG; 23 PADS; 26 VDU; 27 EOT; 29 LSI.

## Top drawer

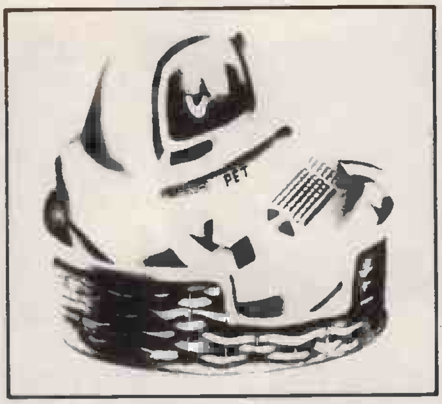
C B LAKE of Huddersfield was fascinated by the drawing program in the May Pet Corner and decided it could form the basis of a comprehensive program to draw anything on the screen of a Pet. His criteria for an enlarged program included the following:

- Diagonal lines should be able to be drawn easily.
- The drawing character should be able to be changed without re-starting the program.
- The program should cater for the printing of reverse characters.
- It should be possible to move the drawing bodily on the screen.

The original innovation of inputting from the keyboard using PEEK (515) is still there at line 1150; this enables continuous movement of the cursor by looping, something which cannot be achieved using the GET instruction. Not having a printer he removed the X = USR(0) instruction from the original program. As for the modifications outlined, they were achieved as follows:

- Diagonal lines: lines 1240-1270 do this by arranging the cursor control characters. They are accessed by pressing the 'diagonal' numeric keys — 7, 9, 1 and 3 respectively.
- Changing characters: lines 1400-1600. Control passes to this routine, RVS or a number. To turn 1 percent into a character he first tried Julian Allason's PEEK routine — see June Pet Corner. But does the Pet use the same values for the keyboard as the screen? It does not. The keyboard is matrix-encoded, which means that the sequence A = 1, B = 2, C = 3 becomes completely random to all intents and purposes. After much hair-tearing and further research, he discovered a table starting at 59227 which will do the conversion.

  A = PEEK(59227 + 1%) returns a quantity which enables CHR$ to return to a character. PEEK(516) is 128 when the shift key is depressed so that B checks for shift down. Keying SPACE returns A = 255, which gives a pi sign using CHR$: so line 1450 converts A to zero. Changing the drawing character to SPACE may seem pointless at first but it is important, as it can be used to delete incorrect parts of the drawing.
- Reverse characters: this took some time to crack. To POKE an inverse character, 128 is added to the POKE value. This does not work using CHR$; neither does adding 256 — the next logical step after consulting ASC conversion tables. Unfortunately, there seems to be no ASC value for reverse characters. The final solution is elegant and was determined after Lake had discovered that printing a reverse character causes all further characters in the same print statement to be reversed.



So he set up a string D$ to be either "" or "[R]" and printed it at the beginning of each of the PRINT statements on lines 1200-1270. Lines 1390 and 1395 change D$ each time the RVS key is pressed. The delays in those lines are to stop D$ changing back and further if RVS is pressed too long.

- Moving the drawing: the routine between lines 1700 and 2040 is entered when '5' is pressed during drawing. Lines 1720-1780 set up the direction of the loop in line 2000. D is the distance each character has to move in screen units; and CR$ is the direction the cursor is to move, depending on the direction of movement requested.

  CR$ is required because although the POKE statement of line 2010 moves the white square, the cursor must be moved by a PRINT statement. The FOR/NEXT loop is short-circuited in line 2005 if the position is a blank; otherwise the character found is POKEd into the new position and the old one blanked-out. Line 2030 checks to see if sufficient movement has been made; if it has (G$ = 5) drawing can continue.

Line 1180 is a delay to slow the speed of drawing; this delay could be programmable if desired. The instruction at the beginning of the program should be sufficient to give a good idea of how you use it.

The program apparently can become addictive as you see what you can draw. The program is also useful for the development of games and other graphics programs. You can experiment with any shapes beforehand, including large letters and numbers on the screen. In conclusion, here are some open questions from Lake:

- Why can't S = PEEK(SC)
  POKE (SC + D),S
  be written as POKE(SC + D),PEEK(SC) ?
- How do you print a " without using POKE?
- Can anyone devise a method of rotating the drawing?
- Can anyone produce a machine code routine — with explanation — to replace lines 2000-2040 to speed the movement? This could possibly include the rotation. Bear in mind that moving a drawing from the bottom of the screen makes it re-appear, offset, at the top; POKEing to locations greater than 33767 still affects the screen. This could be eliminated from the existing method using IF statements but it would slow the routine even more.

## Keyboard

A MEMBER of IPUG has tried the add-on keyboard from Northend Office Supplies, obtained with the intention of typing-in copy for the IPUG newsletter ready for word processing and production of masters for printing. He says that the unit is sound enough but does not provide a different output when the shift key is pressed, so it can be used only for input of upper-case characters. This seems a pity, especially in the light of the claims by Northend that the unit offers full "typewriter facilities".

## Copyright

THERE HAS BEEN a great deal of discussion recently on copyright as it affects computer software. Various methods have been tried to make it impossible for dishonest individuals to copy and sell other people's programs. The difficulty is that this also makes it impossible for you to take back-up copies of software. We have all had unsatisfactory cassettes and we are all now finding more and more programs organised so that taking a back-up copy is impossible.

Let us be very clear about what copying means. Any copy made for the purpose of giving or selling it to someone else is illegal if the original is subject to copyright. The restriction applies to many other items — books, records, TV programs. In those cases, though, a copyright declaration is normally made — in the case of a record it is printed on the paper disc in the middle of the record — and the rest is left to the law. Anyone in breach of copyright may be sued by the copyright owner.

Suppliers of computer software do not seem to be content with this arrangement. All kings of tricks are tried to make copying impossible. We are therefore faced with a problem. Many are quite capable of finding out how all the tricks work, since we want to know all there is to know about our machines and how they operate.

The problem comes when we communicate the information to other users. Are we thereby encouraging them to break the law and make illegal copies? If you teach someone how to use a shotgun and he or she then proceeds to rob a bank with it, are you guilty of armed robbery?

Anyone who copies computer software in contravention of copyright should be punished; after all, copyright is the only protection under the law for those who write software but the legal protection seems sufficient.

*(continued on page 123)*


# Two Apples Newton would have been proud of

## The Pascal System

A complete system for the development and use of applications programs in Pascal, Basic or Assembly language.

## 48K APPLE II PLUS

Apple II Plus, with extended(Applesoft) Basic in ROM, 48K of RAM, High-resolution Black and White graphics on a matrix of 280 x 192 individually addressable points, Autostart ROM with on-screen editing, power-on books to application programs, and reset key protection. 2K system monitor, fast 1500 baud cassette interface, hand controllers.

## Disc System

This consists of an intelligent interface card, a powerful D.O.S. and one mini-floppy drive.

Features

- Storage capacity of 116K Bytes/ Diskette (140K with language card installed)
- Powered directly from the Apple
- Fast access time — 600 m sec (max) across 35 tracks.
- Random or sequential file access.

## Pascal Language System

Includes

The Language Card — 16K Bytes of RAM memory which replaces Apples ROM firmware in the memory map.

Auto-start ROM.

5 Discs containing the Pascal compiler editor, macro assembler, linker, filer and runtime utilities, Applesoft and Integer Basic interpreters.

The language system provides the most powerful set of software development tools available to the microcomputer programmer.

| | |
|---|---|
| Apple II Plus 48K | £988.00 |
| Disc System with Controller | £398.00 |
| Pascal Language System | £296.00 |
| | £1662.00 |
| Plus 15% V.A.T. | £249.30 |
| Total | £1911.30 |

## The Graphics System

A complete, hi-resolution colour graphics system using the ITT 2020

## ITT 2020

48K RAM, PALSOFT Basic on ROM high resolution graphics on a matrix of 360 x 192 points. Low resolution graphics in 15 colours on a matrix of 40 x 48 points. Fast 1500 baud cassette interface to normal domestic cassette recorder.

| | |
|---|---|
| ITT 2020 16K Colour Board | £822.00 |
| 32K RAM | £128.00 |
| | £955.00 |
| Plus 15% V.A.T | £143.25 |
| Total | £1098.25 |

## Peripherals

| | Nett | V.A.T. | TOTAL |
|---|---|---|---|
| Parallel Printer Card .... | 110.00 | 16.50 | 126.50 |
| Applesoft Card | 110.00 | 16.50 | 126.50 |
| Integer Basic Card ...... | 110.00 | 16.50 | 126.50 |
| Communications Card .. | 132.00 | 19.80 | 151.80 |
| Clock Card ............. | 140.00 | 21.00 | 161.00 |
| Light Pen .............. | 165.00 | 24.75 | 189.75 |
| Voice Recognition Card . | 127.00 | 19.05 | 146.05 |
| Eurocolour Card ........ | 69.00 | 10.35 | 79.35 |
| Carrying Case .......... | 25.00 | 3.75 | 28.75 |
| Supertalker ............ | 190.00 | 28.50 | 218.50 |
| Lower Case Adapter .... | 40.00 | 6.00 | 46.00 |

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apple computer Sales and Service

• Circle No. 201

*(continued from page 121)*

## Business packages

THE ERA of professional programs is with us. PETACT has now announced its new business program, sales accounting and purchase accounting. It is complete with detailed documentation and is available for use with either cassette or floppy disc systems. All output special stationery for printers is available from PETACT and the system is very similar to that which one would normally expect to see running to hardware costing more than £10,000.

The importance that PETACT places on dealers being fully-informed about the packages is shown by the offering of one-day courses for dealers before the packages may be sold.

The programs are certainly not inexpensive by the normal £5-£20 standard to which we have become used for games. They are true business progams which required a considerable investment to produce, and their prices are justified by their quality; each costs in the region of £175.

## Random numbers

RANDOM NUMBERS are produced in Pet Basic by the use of a mathematical formula process (algorithm), probably using the linear congruential method. It

```
USING A RANDOM SEED

10 X=RND(.5)
20 Y=INT(RND(X)*11)+1
30 IF Y>10 GOTO 20
40 ? Y "RANDOM NUMBER.SEED-"X
50 GOTO 10
```

generates a sequence of numbers which is the same, starting with power on, writes **Rex Tingay**. A sequence of accessed numbers will be the same, and predictable, if taken at a precise time and given free run of production, but will appear to be random due to the distribution of variations.

These are pseudo-random numbers and can be produced using a seed value (in brackets) which can be negative, zero, or a positive number, and the number produced by random generation, before being modified, is between 0 and 1.

On using a random number generator in a program, your seed number breaks the cycle of operations and generates a

```
SIMPLE GENERATOR - 1 TO 10

20 Y=INT(RND(.6)*11)+1
30 IF Y>10 GOTO 20
40 ? Y "RANDOM NUMBER"
50 GOTO 20
```

single true random number after which a new pseudo-sequence, if formed, will be the same dependent on time, and program usage. Let us see how we can thwart the pseudo using RND.

The simple generator is shown, modified to give the random number as an integer, with no tail of decimal placed, between 1 and 10. The seed value is (·6) and the pseudo-random number is multiplied by 11 to bring it from its 0 to 1 value up to 0 to 10.

The integer then has 1 added to discard zero and bring the range to 1 to 11. The value of Y is checked by line 30, all the values above 10 are discarded, and the next line prints the number produced and "RANDOM NUMBER". Those using other Basics will realise that the ? on line 40 is the Pet simplified print statement.

The numbers produced are distributed normally and the chopping-off of a number or two will make no difference to the distribution of those used, unlike numbers of normal distribution. If the + 1 is omitted, a range from 0 to 10 is produced, distributed uniformly; this means that if the occurrence of a number is counted over a long time it will be approximately the same as the occurrence of any other number.

## Reciprocal jiffies

If a program has no interactive involvement with the user the pseudo-random output could become fixed. If there are any inputs of "gets" in the program, the response time to them will alter the sequence point which is used by the program. By timing the "make your mind up and press a key" response in jiffies and using the figure as a seed means that a true random number is generated every required time.

Taking the jiffy and dividing it into 1 turns-out a long decimal fraction, most times, and by adding it to a small constant the seed is kept within the range of ·1 to 1, which I prefer.

The program starts with the standard "get" sequence after zeroing time and

```
USING RECIPROCAL JIFFIES AS SEED

10 TI$="000000"
20 ?"INTERACTIVE WORK TAKING TIME"
30 GET A$:IF A$="" GOTO 30
40 T=TI
50 S=1/T+.5
60 Y=INT(RND(S)*11)+1
70 IF Y>10 GOTO 60
80 ?Y"RANDOM NUMBER.SEED="S
90 GOTO 10
```

holds the print message on the screen, inactive. On pressing any key, after time, the jiffy value is extracted as an assigned T on line 40. Line 50 takes the reciprocal jiffy and adds it to a constant to become assigned S for seed.

Remember that S and T become fixed values once the program pointer has passed. The random number generator will now respond to the new seed, S, changed each time it is used, so producing a true random number. The little program here prints both the produced number and the seed variable.

Only the first number in a sequence using a fixed seed is a true random number. Then if two sequences are generated simultaneously and the first used to seed the second, the seed will vary each time, and the second generator will produce a true random number. Or will it?

Does this second generation of generation become a pseudo-pseudo-random number sequence? This device will be so close to a true random that arguments are pointless and it can be used in fixed time where jiffies could be repetitive.

In the program the first numbers produced are in the range 0 to 1, obtained unmodified and assigned to X. X is used to seed the second generator, the seed being different most of the time. The program prints both the random number output and the seed.

## Ranging limits

I designed the Random Time Tumbler (RTT) for use with interactive games which require response time from the player and the machine. It is most easily seen as a feedback random number generator whose output has a window out of which some numbers can tumble, all the rest bouncing back from the wall around the window. The opening of the window can be varied to allow more, or fewer, numbers to tumble out.

The numbers need not be used at all, the device being merely a random time-

```
RANGING UPPER AND LOWER LIMITS

10 A=51
20 B=50
30 C=33
40 Y=INT(RND(.3)*A)
50 IF Y>B GOTO 40
60 IF Y<C GOTO 40
70 ?Y,"RANDOM NUMBER"C"TO"B
80 GOTO 40

THIS TAKES ITS TIME!
```

stopping stage in the program where otherwise it would gallop on. It is used most usefully with a "get" statement where the statement is void, and passed over, unless a decision is made and completed within the random time produced by the generator. The value Y can be ignored; you can use the Y as a variable again later in the program.

The program consists first of three assignment statements, which can be on one line, separated by colons. The seed is a constant here as the pseudo-random function does not matter, and the other figures go in as assigned variables so that they can be accessed easily from outside the little package, and their values changed.

In this program try changing A to 501 and see how long it takes for a number to fly out of the window. Within the program a variation can be made from Input. If Input I has been given a value of 10, then a line 34 can say C = C + I, making the value of C = 43, partly-closing the window and generally increasing the random time length.

Step 40 is the random number generator seeded ·3, and 50 and 60 are the wall either side of the window. Both sides are not really required and you can pull the window right over to one end and still have the same effect.

I have used the true random number generator in Pet poetry programs I have written. The program random-selects word data from several banks run by random selection, giving what I call a Random Language Tumbler(RLT) effect.

## Not all Apples

ANDY WITTERICK, of the Apple Users' Group, is concerned about a number of computer retailers importing Apples, among others, into this country, by-passing the usual distribution network.

Those Apples are not exactly the same as those on sale from officially-appointed dealers and require certain, albeit straight-forward, modifications. Not only are those Apples being sold cheaply, but some, it would appear, are not being modified.

If you have experienced similar problems write to me with full details —serial numbers, proof of purchase, name of dealer and history — if it concerns an Apple. If it concerns another micro, write to the Computer Retail Association, giving the same information.

## Speeding discs

IT APPEARS that a fault is occuring in a number of disc drives purchased recently. It occurs during long periods of disc drive usage as the interior warms-up. The heat build-up can cause certain components to change values and the result is a speeding of the motor and disc errors. Microsense believes that fault effects only about 1,000 drives and traced it to a glass capacitor of a value of 0.015 microfarad, 50V.

The component is located on the small vertical board at the rear of the drive, with one end going to pin 2 on LM2917. To cure the fault, the capacitor should be replaced by one of the same value but made of 10 percent polystyrene.

They can be obtained from Microsense but a word of warning — the modification should be carried-out only by a qualified engineer. Don't attack your disc drive with a hammer and soldering iron — you will cause more problems and invalidate the warranty.

## Motor-boating clock

THOSE with a clock card may be experiencing a peculiar problem which results in your system going down and "motor-boating" from the area of the power supply — a rising and falling hum. The cause is unknown, except that the symptoms occur when the clock card is placed in a slot which is numercially one higher than a serial interface card.

So long as the serial interface is in a higher-numbered slot than the clock, all is well, or if the serial card is placed with at least one slot between it and a clock card in a higher-numbered slot, again all is well.

## Wang Basic

A NUMBER of users have asked for information on converting some of the published listings written in Wang Basic into a form suitable for use with the Apple.

It is perhaps unfortunate that Wang Basic is the most advanced Basic around

**This section is open to the Apple user. In every issue we hope to print ideas, hints and comments about the Apple and its suppliers. They must come from you, so write and tell us what you know.**

and converting to Apple Basic may not be easy. The main features of Wang Basic which cause problems are:

- PRINTUSING.

e.g. 100 PRINTUSING 110, A, B, C.
110% ### #.#-##

This means PRINT USING line 110 as a format statement. The numbers will fit the format as indicated by the #. You will have to use tabs.

- HEX (03)

The HEX codes used are numerous and are control codes for the computer. If you print a code it may affect the screen,
e.g. PRINT HEX (03)
Equivalent of HOME
e.g. PRINT HEX (01)
Equivalent to HTAB1; VTAB1
Incidentally, A$ = HEX (10) in Wang is equivalent to A$ = CHR$/(16) in Applesoft. Applesoft uses decimals, whereas Wang Basic uses Hexadecimal.

- PACK AND UNPACK

These are used to reduce the amount of storage required by arrays of numbers by packing them into alphanumeric arrays in binary coded decimal format (BCD).

- The matrix commands are a built-in matrix algebra. They will have to be substituted using subroutines.

- DEFFN'1(A,B,C)
GOSUB'1(A,B,C)

The ability exists to pass parameters to subroutines as arguments. They are not returned, however, and the following two equivalent routines should explain what is happening:

Wang
```
10  GOSUB '2(4,5,A,B,)
20  END
100 DEFFN'2 (X,Y,Z,Q)
100 S=X+Y+Z+Q
120 RETURN
```
Apple
```
10  X=4: Y=5: Z=A; Q=B
20  GOSUB 100
30  END
100 S=X+Y+Z+Q
100 RETURN
```

There is another feature which allows the user to enter a program at a point using a special function key. If for the above program we pressed special function 2 we would effectively have typed directly on to the keyboard, GOTO 100. This would have failed because the Wang could expect values for X,Y,Z,Q, and so we would have to type:

4,5,6,7, (special function 2)

This would be equivalent of
x = 4: Y = 5: Z = 6: u = 7: GOTO 100.

Clearly there is no equivalent feature in Apple.

- AND., OR NOT., XOR

These are handled in a different way on different Wangs. Early models use:
20 AND (L$, L2$) and
later ones 20 L$ = L$ AND L2$

A significant difference is that Wang logic algebra operates on STRINGS and Apple operates on REALS. This can make life difficult. Apple logic is very good but recent Wang Basics are more flexible in many ways.

- Notes on conversion

Wang is incapable of accepting variables other than one letter and one number. Any variables you introduce can be double letters, e.g. AB or PZ$ and will not interfere with the variables already assigned.

There is no equivalent of A% in Wang Basic. The cumbersome PACK command is used often to economise on storage of integer arrays. This is automatic using A% ( ) with the Apple.

The worst disadvantage is that Wang assumes a 64-character display, so event if you run a program successfully it may appear jumbled on the screen. Screen-handling is more sophisticated on the Apple and a long string of HEX codes may be alleviated by one simple VTAB command.

## Music machine

K HOWTON of Southport offers an Apple II music machine. He writes: No doubt may of you have been intrigued by the prospect of using your Apple II to generate music. The Apple II reference manual gives a suggestion for a simple tone routine. *The Best of Micro* Vol 1 contains three pieces of tone and music generation, and in particular the article by Richard Suitor makes fascinating reading — but it looks to be heavy weather for those of us not experienced in machine code work.

Nick Hampshire's article in *Practical Computing,* May, 1979, explains how it works in priciple but it will not get your Apple making music.

Apple Inc has foreseen the headache. Included in the Programmers' Aid No. 1

is a music generation program — only one of several utility programs in this ROM and strictly light entertainment by comparison with some of the other material. The Programmers' Aid, incidentally, is now becoming widely-available here.

The music feature is run from within Apple Integer Basic. It is necessary to tell the computer only three things to generate a note — pitch, duration, and timbre. A CALL will then play the note.

Pitch, duration and timbre are set by POKES into various registers:

| | | | |
|---|---|---|---|
| | PITCH | = | 767 |
| | TIME | = | 766 |
| | TIMBRE | = | 765 |
| and | CALL | = | 10473 |

Apple can produce 50 notes, numbered 1 to 50. The statement PITCH, 32 will produce middle C; increments — or decrements — of 1 will shift the note by a semitone — so, POKE PITCH, 33 will produce C sharp. The range 1 to 50 gives just over four chromatic octaves.

Whenever I have transcribed music, I have always indexed the notes and durations from a common base. So let C = 32, approximately middle C; then for C sharp you can POKE PITCH (C + 1). I have found this very useful; in fact, it is almost a necessity, for when there is a wide range of notes an improvement in quality can be made by shifting C up or down a few semitones.

It is good practice to lay-out the treble and bass clef staves with the scale written in code for rapid fault-free encoding. This is worth the effort. Figure 1 shows the values in absolute code: but Figure 2 shows the same notes in code relative to Middle C, and it does not take any great genius to see just how easy it is to encode using the relative mode.

The same principle applies when setting the duration of the note: examine your music score to find the shortest duration note that you will want. The tempo of the music will decide the best value, and this determined by trial and error.

Following are the first few bars of *The British Grenadiers*, where the shortest note is a semi-quaver and the value I have assigned to this it 22, (S = 22). Most of the notes are coded in BCD.

| | | | |
|---|---|---|---|
| QUAVER | = 1 | | = 1 |
| CROTCHET | = 2 × QUAVER | | = 2 |
| MINIM | = 2 × CROTCHET | | = 4 |
| SEMIBREVE | = 2 × MINIM | | = 8 |

Watch for the dotted notes which are 1½ times the note value.

Another tip to make life a little easier — examine the score and put all identical bars into subroutines; if there are repeated sets of bars use a few conditional jumps.

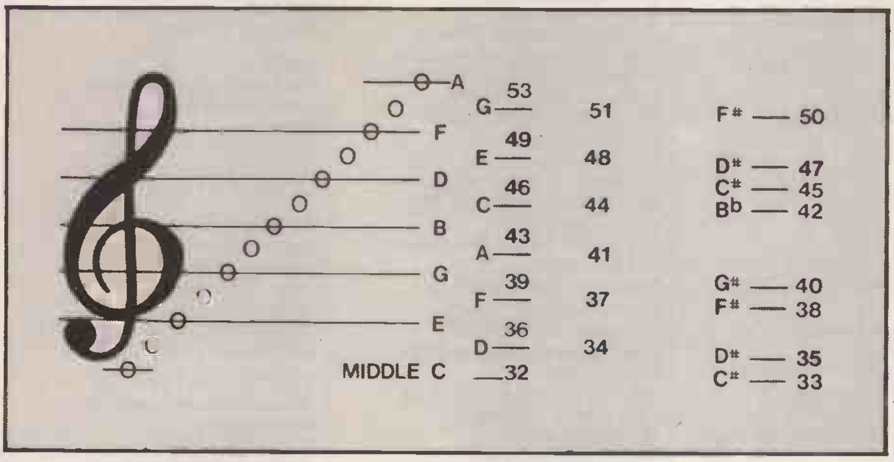


**Figure 1. Coding of treble clef.**

Apple claims it can manage five timbres represented by 2, 8, 16, 32, 64. In fact, there is little difference between them, and I am hard put to tell any difference, but I do not have a particularly musical ear. A typical line in the program may well read:

100 POKE TIMBRE 8
120 POKE PITCH, 32: POKE TIME 25: CALL MUSIC

This will sound just one note.

| | C | C | D | D | E | F | G | G | A | B | B | C | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 32+ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |

**Note: B flat is shown in preference to A sharp as it is more common in most music scores.**

**Figure 2. Relative coding of treble clef to to Middle C (= 32).**

Unfortunately, the computer is capable of playing only one voice and there is no control over volume, which tends to make the music a little dull. Changing the tempo and timbre can, however, go some way to improving this limitation.

I made most use of the Repeat key and the Auto Number features of the Apple II to reduce the amount of typing. Putting together a program is not nearly so monotonous as it may appear, nor does it take very long, once you have set-out the code.

To make the music more interesting, display the appropriate lines of words with the music but watch that it does not upset the timing. If you are keen, mix in some high-resolution graphics using another feature of the Programmers' Aid.

```
    5 GOSUB 999
   10 M=-10473:P=767:T=766:TIMBRE=765
   40 LET S=22
   45 C=32
   50 POKE TIMBRE,32
   51 LET AGAIN=0
   70 POKE T,(2*S): POKE P,(C+2): CALL M
   80 POKE T,(2*S): POKE P,(C+7): CALL M
   90 POKE T,(2*S): POKE P,(C+2): CALL M
  100 POKE T,(2*S): POKE P,(C+7): CALL M
  110 POKE T,(2*S): POKE P,(C+9): CALL M
  120 POKE T,(4*S): POKE P,(C+11): CALL M
  130 POKE T,(2*S): POKE P,(C+9): CALL M
  140 POKE T,(1*S): POKE P,(C+11): CALL M
  150 POKE T,(1*S): POKE P,(C+12): CALL M
  160 POKE T,(2*S): POKE P,(C+14): CALL M
  170 POKE T,(2*S): POKE P,(C+7): CALL M
  180 POKE T,(1*S): POKE P,(C+11): CALL M
  190 POKE T,(1*S): POKE P,(C+9): CALL M
  200 POKE T,(1*S): POKE P,(C+7): CALL M
  210 POKE T,(1*S): POKE P,(C+6): CALL M
  215 IF AGAIN=1 THEN GOTO 260
  220 POKE T,(6*S): POKE P,(C+7): CALL M
  250 LET AGAIN=AGAIN+1
  255 GOTO 70
  260 POKE T,(4*S): POKE P,(C+7): CALL M
  270 POKE T,(6*S): POKE P,(0): CALL M
  280 POKE T,(1*S): POKE P,(C+11): CALL M
  290 POKE T,(1*S): POKE P,(C+12): CALL M
  300 POKE T,(3*S): POKE P,(C+14): CALL M
  310 POKE T,(1*S): POKE P,(C+16): CALL M
  320 POKE T,(2*S): POKE P,(C+14): CALL M
  330 POKE T,(2*S): POKE P,(C+12): CALL M
  340 POKE T,(3*S): POKE P,(C+11): CALL M
  350 POKE T,(1*S): POKE P,(C+12): CALL M
  360 POKE T,(2*S): POKE P,(C+14): CALL M
  370 POKE T,(2*S): POKE P,(C+14): CALL M
  380 POKE T,(2*S): POKE P,(C+16): CALL M
  390 POKE T,(2*S): POKE P,(C+16): CALL M
  400 POKE T,(1*S): POKE P,(C+14): CALL M
  410 POKE T,(1*S): POKE P,(C+12): CALL M
  420 POKE T,(1*S): POKE P,(C+11): CALL M
  440 POKE T,(1*S): POKE P,(C+9): CALL M
  450 POKE T,(4*S): POKE P,(C+7): CALL M
  460 POKE T,(2*S): POKE P,(C+6): CALL M
  470 POKE T,(1*S): POKE P,(C+2): CALL M
  480 POKE T,(1*S): POKE P,(C+2): CALL M
  490 POKE T,(2*S): POKE P,(C+7): CALL M
  500 POKE T,(1*S): POKE P,(C+6): CALL M
  510 POKE T,(1*S): POKE P,(C+7): CALL M
  520 POKE T,(2*S): POKE P,(C+9): CALL M
  530 POKE T,(1*S): POKE P,(C+7): CALL M
  540 POKE T,(1*S): POKE P,(C+9): CALL M
  550 POKE T,(2*S): POKE P,(C+11): CALL M
  560 POKE T,(1*S): POKE P,(C+9): CALL M
  570 POKE T,(1*S): POKE P,(C+11): CALL M
  580 POKE T,(2*S): POKE P,(C+9): CALL M
  590 POKE T,(1*S): POKE P,(C+11): CALL M
  600 POKE T,(1*S): POKE P,(C+12): CALL M
  610 POKE T,(2*S): POKE P,(C+14): CALL M
  620 POKE T,(2*S): POKE P,(C+7): CALL M
  630 POKE T,(1*S): POKE P,(C+11): CALL M
  640 POKE T,(1*S): POKE P,(C+9): CALL M
  650 POKE T,(1*S): POKE P,(C+7): CALL M
  660 POKE T,(1*S): POKE P,(C+6): CALL M
  670 POKE T,(6*S): POKE P,(C+7): CALL M
  680 END
  999 CALL -936
 1000 FOR I=1 TO 7: PRINT : NEXT I
 1005 PRINT " **************************"
 1010 PRINT " *                        *"
 1015 PRINT " * THE BRITISH GRENADIERS *"
 1020 PRINT " *                        *"
 1025 PRINT " *      16TH CENTURY      *"
 1030 PRINT " *                        *"
 1035 PRINT " *    TRANSCRIBED BY      *"
 1040 PRINT " *                        *"
 1045 PRINT " *      K.D.HOWTON        *"
 1050 PRINT " *                        *"
 1055 PRINT " *      18 FEB 1979       *"
 1060 PRINT " *                        *"
 1065 PRINT " **************************"
 1070 FOR I=1 TO 5000: NEXT I: RETURN
10000 RETURN
```

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*



*

### CONTENTS

# 8 SYNTAX

## SYNTAX

THIS IS A SUMMARY OF THE SYNTAX — THE WRITTEN FORM — OF *BASIC* AS DESCRIBED IN THIS BOOK. YOUR VERSION PROBABLY DIFFERS, BUT IF IT HAS A DEFINITION OF SYNTAX SET OUT LIKE THIS ONE THEN MOST DIFFERENCES SHOULD BE EASY TO SPOT BY COMPARISON.

A BASTARDIZED "BACKUS-NAUR" NOTATION IS USED FOR THE SUMMARY. MANY SUCH BASTARDS HAVE BEEN CREATED FOR DEFINING THE SYNTAX OF *BASIC* AND SOME ARE VERY AWKWARD TO READ. I HAVE TRIED TO MAKE THIS ONE AS READABLE AS POSSIBLE WITHOUT LOSS OF RIGOUR BUT EVEN SO YOU MAY FIND IT HARD GOING.

### SYMBOLS *IN THE DEFINITIONS.*

| | |
|---|---|
| → | SAYS "IS DEFINED TO BE". |
| \| | SAYS "OR". |
| [ ] | SQUARE BRACKETS ENCLOSE ANYTHING THAT MAY APPEAR *ONCE* OR *NOT AT ALL* FOR THE DEFINITION TO HOLD GOOD. |
| { } | BRACES ENCLOSE ANYTHING THAT MAY APPEAR *ONCE* OR *SEVERAL TIMES* OR *NOT AT ALL* FOR THE DEFINITION TO HOLD GOOD. |

### PRINTING STYLES *IN THE DEFINITIONS.*

| | |
|---|---|
| small letters | ARE USED TO GIVE ENGLISH DESCRIPTIONS WHERE THE MATTER IS OBVIOUS OR WHERE THE SPECIAL NOTATION CAN'T REASONABLY COPE. |
| CAPITALS<br>( + - / * ↑ )<br><= : ; , . $ ' " ><br>0 1 2 | ARE USED FOR LETTERS, DIGITS AND SYMBOLS WHICH MUST BE COPIED AS THEY STAND TO CREATE A VALID EXAMPLE OF THE THING BEING DEFINED. |
| *Italics* | ARE USED TO GIVE NAMES TO THE THINGS BEING DEFINED. |

### COMMENTS + EXAMPLES.

| | |
|---|---|
| ( ) | "SHADOW" BRACKETS ENCLOSE COMMENTS & EXAMPLES WHICH ARE NOT PART OF THE DEFINITIONS. |

FIRST THE *ELEMENTS* OF *BASIC* : PAGE:

*digit* ⇒ one of the digits 0 to 9

*letter* ⇒ one of the letters A to Z

*sign* ⇒ + | -

*operator* ⇒ + | - | * | / | ↑ 20

*separator* ⇒ , | ; 28

*comparator* ⇒ = | < | > | <= | >= | <> 41

*text* ⇒ " any characters except quotation marks " 12

*line* ⇒ an integral line number from 1 to 9999 7

*function* ⇒ SGN | SIN | COS | TAN | ATN | EXP | ABS | LOG | SQR | INT | RND | FN*letter* 22,24

*constant* ⇒ RND | FN*letter* 25,26

( THIS DEFINITION ALLOWS BOTH RND AND RND(X); ALSO FNA & FNA(X) )

NEXT THE *COMPOUNDS* ( ARBITRARILY DISTINGUISHED FROM *ELEMENTS* ) :

*integer* ⇒ *digit* { *digit* }

( *e.g.* 0 , 012 , 87654 : LENGTH LIMITED BY PARTICULAR VERSION )

*exponent* ⇒ E [ *sign* ] *integer*

*number* ⇒ *integer* [.] [ *integer* ] [ *exponent* ] | . *integer* [ *exponent* ] 9

( *e.g.* 12 , 12.2 , 12.2E+6 , .12E-6 , 12. , 12.E6 )

*datum* ⇒ [ *sign* ] *number* | *text* 16

( *e.g.* 2 , -2.5 , "ABC" : AS IN "DATA" STATEMENTS )

*variable* ⇒ *numerical* | *textual*

*numerical* ⇒ *letter* [ *digit* ] | *letter* ( *expression* [ , *expression* ] ) 10,60

( *e.g.* A, A5, A(4*I), A(I,2*J) )

*textual* ⇒ *letter* $ [ ( *expression* ) ] ( *e.g.* A$ , A$(2+I) ) 13,60

*lexical* ⇒ *text* | *textual* 41

( *e.g.* "ABC" , A$, A$(2+I) : AS IN "IF" STATEMENTS )

*term* ⇒ *number* | *numerical* | *function* ( *expression* ) | *constant* | ( *expression* ) ( *e.g.* 6.5 , A(I,J), RND, INT(2+B), (-3*I+J) )

*expression* ⇒ [ *sign* ] *term* { *operator* *term* } 20

( *e.g.* A , + A(I,J) , + A(I, J) * INT(3*A+B) )

*declaration* ⇒ *letter* ( *integer* [ , *integer* ] ) | *letter* $ ( *integer* ) 62

( *e.g.* A(4) , A(2,30) , A$(26) : AS IN "DIM" STATEMENTS )

*printable* ⇒ *expression* | *lexical* | TAB( *expression* ) 28

( *e.g.* A(I,J) * INT(ABS(I+P)) , "ABC" , A$(Q), TAB(X) )

*adjustment* ⇒ ( *expression* , *expression* ) 79

( *e.g.* (2*A , B(I,J)/6) : AS IN CERTAIN "MAT" INSTRUCTIONS ) P.T.O

CHAPTER 8

# SYNTAX (CONTINUED)

NOW THE STATEMENTS OF *BASIC*

| DIMENSIONS OF ARRAYS: | PAGE: |
|---|---|
| *line* DIM *declaration* {, *declaration*} | 62 |

| ASSIGNMENT: | |
|---|---|
| *line* LET *numerical* = *expression* | 11 |
| *line* LET *textual* = *textual* \| *text* | 13 |
| *line* DEF FN*letter* [(*letter* [*digit*])] = *expression* | 26 |

| INPUT: | |
|---|---|
| *line* DATA *datum* {, *datum*} | 16 |
| *line* READ *variable* {, *variable*} | 16 |
| *line* RESTORE (FOR "DATA" STATEMENTS) | 17 |
| *line* INPUT [*integer* :] *variable* {, *variable*} | 18, 120 |
| *line* RESET *integer* {, *integer*} (FOR FILES) | 121 |

| OUTPUT: | |
|---|---|
| *line* PRINT [*integer*:] USING *line* {, *variable*} | 34, 120 |
| *line* : (STRUCTURE OF IMAGE LINE TOO VARIED FOR DEFINITION) | 34 - 37 |
| *line* PRINT [*integer*:] [*printable* {*separator printable*} [*separator*]] (AVOID USING A COMMA AFTER TAB( )) | 28-32, 120 |

| MATRICES: | 76 |
|---|---|
| *line* MAT *letter* = *letter* | 78 |
| *line* MAT *letter* = *letter* + *letter* | 80 |
| *line* MAT *letter* = *letter* - *letter* | 80 |
| *line* MAT *letter* = (*expression*) * *letter* | 82 |
| *line* MAT *letter* = TRN (*letter*) | 84 |
| *line* MAT *letter* = ZER [*adjustment*] | 86 |
| *line* MAT *letter* = IDN [*adjustment*] | 87 |
| *line* MAT *letter* = CON [*adjustment*] | 87 |
| *line* MAT *letter* = *letter* * *letter* | 88 |
| *line* MAT *letter* = INV (*letter*) | 90 |
| *line* MAT READ *letter* [*adjustment*] {, *letter* [*adjustment*]} | 94 |
| *line* MAT INPUT [*integer*:] *letter* [*adjustment*] {, *letter* [*adjustment*]} | 96 |
| *line* MAT PRINT [*integer*:] *letter* {*separator letter*} [*separator*] | 98 |

| SUNDRY : | PAGE: |
|---|---|
| *line* REM {any character} | 8 |
| *line* END | 7 |
| **CONTROL :** | 39 |
| *line* GO TO *line* ("GOTO" USUALLY PERMITTED) | 40 |
| *line* GO SUB *line* ("GOSUB" USUALLY PERMITTED) | 52 |
| *line* RETURN | 52 |
| *line* ON *expression* GO TO *line* {, *line*} | 46 |
| (WATCH OUT FOR DIFFERENT FORMS OF THE ABOVE) | |
| *line* IF *expression comparator expression* THEN *line* | 41 |
| *line* IF *lexical comparator lexical* THEN *line* | 41 |
| ("GO TO" IS COMMON IN PLACE OF "THEN") | |
| *line* FOR *letter* [*digit*] = *expression* TO *expression* [STEP *expression*] | 48 |
| *line* NEXT *letter* [*digit*] | 48 |
| *line* STOP | 42 |
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| (TOO DIVERSE FOR DEFINITION HERE) | |
| **COMMANDS :** | 111 |
| RUN | 114 |
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| CATALOG[UE] | 115 |
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| UNSAVE *file* | 116 |
| OLD *file* | 116 |
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*file* → file name with syntax local to the installation

(COMMANDS DIFFER WIDELY IN NUMBER AND SYNTAX AMONG INSTALLATIONS OFFERING *BASIC*)

# INDEX



(CONTINUED)

*(CONTINUED)*

# INDEX (CONTINUED)



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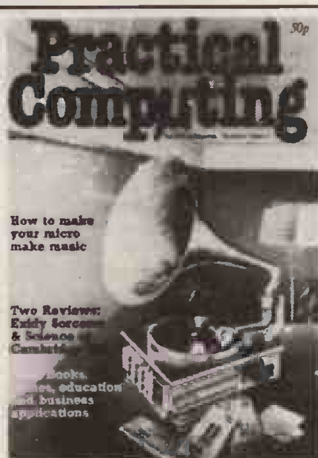


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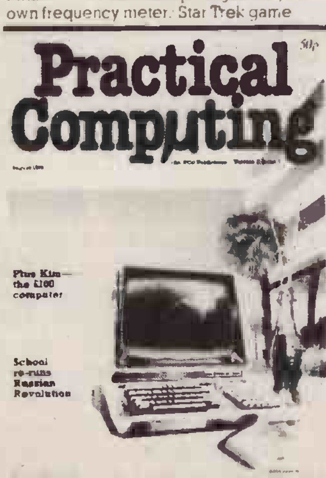


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# Possum on the Pet

**This is part two of the article on the Possum system to turn the Pet into an aid for the disabled.**

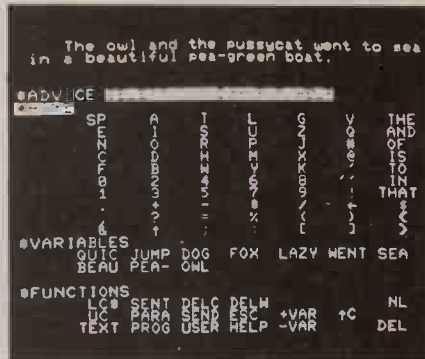
IN PART ONE we went into some detail about the design of a microprocessor-based aid for the disabled. In addition to some photographs from a Commodore Pet screen of the program in operation, a listing of part of the code, complete in itself, was presented.

At the same time it was promised that in part two the remainder of the program would be given, along with fuller documentation and information about the design of the program. This includes the listings of two subsystems, first the 'User' system, which allows control of external electrical equipment — a lamp, television, radio or even an automatic tea-maker.

Second, a 'Help' system, which will provide information about the whole system and about how to use it to the best effect. Anyone reasonably knowledgeable about computer equipment should have little difficulty with this system; once the switch was placed in their hands it was only minutes before most of the people who were invited to try the program were busy constructing text in the buffer area at the top of the screen.

Once prompted to try the various 'Functions' boxes at the bottom of the screen, good familiarity with the whole set-up was soon achieved. Initially, frequent reference to the 'Help' box was made, a practice which soon fell into disuse as the relatively self-evident effects of most selections became apparent.

While the program was being tested, a simple lever-type microswitch was




connected to channel seven of the user port to provide the interface. Most of us found that the air-pressure switches usually supplied to the disabled required somewhat more skill in use, due to the delays in their operation.

For those less used to electronic and computerised equipment, a longer period of introduction and familiarisation will almost certainly be necessary. In any case, the 'Help' system allows this process to continue in a more relaxed manner.

The program is a fairly complex piece of code, nearly 500 lines long, and anyone who intends to use it will almost certainly wish to modify it to personal requirements. If the individual is not interested in computing, the 'Programming' frame could be omitted.

To facilitate modification and to assist anyone trying to understand and follow the coding, a series of tables, one to five, has been drawn-up. Table one shows the use of the 20 or so numeric variables included in the program. Most are either flags to indicate the status of some aspect of the program execution — HP, the 'Help' flag, M the 'frame' flag, or UC the 'upper/lower-case' flag — or counter variables in FOR loops used to initialise, access or modify arrays and step the cursor across the screen (I,J,K and L), or to act as time delays — PD and PQ.

Some are program constants, needed to increase speed. Basic variables are accessed more rapidly than constants can be converted and then used — such as UX and UP. Other constants are chosen for convenience, such as MC and PR. In

**Table One — The variables used in the program, their use and the meanings of some of the values they may assume.**

| | |
|---|---|
| ED | Special edit mode flag; would be used for adding and deleting text from the middle of A$ (not implemented). |
| FM | |
| HP | Help mode flag. Normally zero, if 1, 'select any box for help', if 2, jump to help routines. |
| I, J, K, L | Loop counters. |
| II | Used to calculate which variable or function has been chosen from the values of various loop counters. |
| M | Frame flag. 0 for text mode, 1 for programming mode (see DA$ and TA$). |
| MC | File channel number for I/O to second microprocessor (6). |
| NV | If greater than zero, then in variable delete mode. |
| PD | Cursor down speed (70). |
| PQ | Cursor across speed (50). |
| PR | File channel number for I/O to printer (5). |
| SS | Used to calculate selected function from loop counter values. |
| TV | |
| UC | If zero, convert letters being added to the buffer into lower-case; if one, leave upper- and lower-case letters unaffected — text is stored in upper-case; if three, the next letter only is set to upper-case for SENT. |
| UP | User port address (59471). |
| UX | Value to be ANDed with UP to leave input switch status (128). |
| VN | Number of variables currently defined — in use, out of a possible 21. |

**Table Two — The string arrays, their use and dimensions.**

| | |
|---|---|
| DA$(M,9,6) | Contains all the fixed letters and words as they will be displayed on the screen directly below the 'HOME' location. Each of the 70 strings is five characters long — padded-out with spaces — formed into a 10 x 7 matrix, the second and third dimensions of the array. M specifies the 'frame', zero for text, letters and words and one for programming in Basic. |
| DF$(2,6) | Contains the function name strings to be displayed on the screen in a 3 x 7 matrix, zero to two down and zero to six across. |
| DV$(20) | Stores the first four characters of each of the 21 variables to be displayed on the screen; they are always padded out to five spaces. A currently-unused variable location will contain five spaces. |
| TA$(M,9,6) | Contains the actual strings which will be added to the buffer and then printed corresponding to the representations stored in DA$. |
| TV$(20) | Contains the actual variable strings which will be added to the buffer when a particular variable is selected. They correspond to the display representations stored in DV$. A currently-unused location in TV$ is set to the empty null string "". |

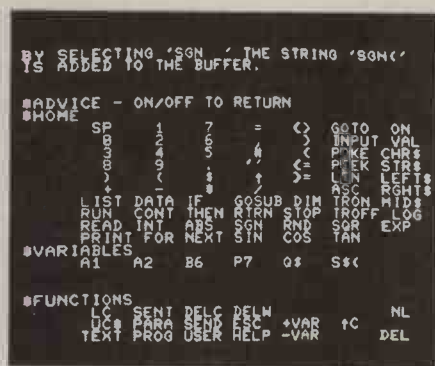
*(continued from previous page)*

those cases, changing a single statement will re-define all instances of a particular channel number.

Table two shows the five string arrays which hold all the information appearing on the screen. DA$ and TA$ form a pair; the first contains what is displayed on the screen in the 70 boxes, and the second contains what will be added to the buffer — and they may or may not be the same.

In the present example both frames — 'text' and 'programming' — follow the same format; the second and third dimensions are the rows and columns of the display. The first dimension is controlled by the M flag. If it is zero, any reference to an element is from the 'Text' set; if M is one then it comes from the 'programming' set. So, throughout the program, there are no special cases to worry about — set the flag and all the code is the same. In a similar manner, DV$ is the outward representation of the contents of TV$: the values the variable strings have been assigned.

They are stored as a vector — one dimensional array — even though they are displayed in a rectangle of three by seven. The first row is elements zero to six, the second seven to 13, and the third 14 to 20. DF$ is the two-dimensional array containing the names of the functions which will appear on the screen. Unlike




DA$ and DV$, there is no equivalent array for output strings, as each function has a small program segment which effects the action requested when a 'function' box is selected.

Table three shows the various string variables used in the program. Most are concerned with 'housekeeping', and some are not used, although their presence makes certain improvements to the text buffer editing facilities much easier. A$ is by far the most important of the strings, since it is the buffer string which is added to by selecting any 'text', 'programming' or 'variable' box, and modified, printed or sent to the second microprocessor with the 'function' boxes.

It is displayed normally at the top of the screen and if for any reason the screen must be changed temporarily, such as going to the USER frame, or printing some HELP information, it must be restored unchanged when you return to the more usual mode.

Tables four and five show some of the more significant points and areas of code. Because of the length of the program, it is not possible to give full flow charts. Instead, table four will permit anyone wanting to know how it works to locate major portions of the program text, and table five shows where all the code specific to the functions is to be found.

Locations in table four which are underlined are those which have special significance. All the tables should be used in conjunction with the program listings, those given last month and those in this issue.

Starting at the beginning of last month's listings — this month's can be added to the end — only four statements

*(continued on next page)*

**Table Three — The strings used in the program, their use and meaning.**

| | |
|---|---|
| A$ | Current contents of the text buffer; may be added to, deleted from and printed finally to the external printer or the second microprocessor. Appears at top of screen. |
| FL$ | Set to a number of spaces equivalent to the length of text deleted with DELC and DELW; used to tidy up the text buffer area after an edit function. |
| N$ | Character or string just selected; to be added to the text buffer A$. |
| NB$ | Used as temporary character and string storage at various points in the program. |
| Y$ | Middle part of buffer string if it is being edited by ED type commands — not implemented. |
| Z$ | End part of buffer string if being edited with an ED type editor command — not implemented. |

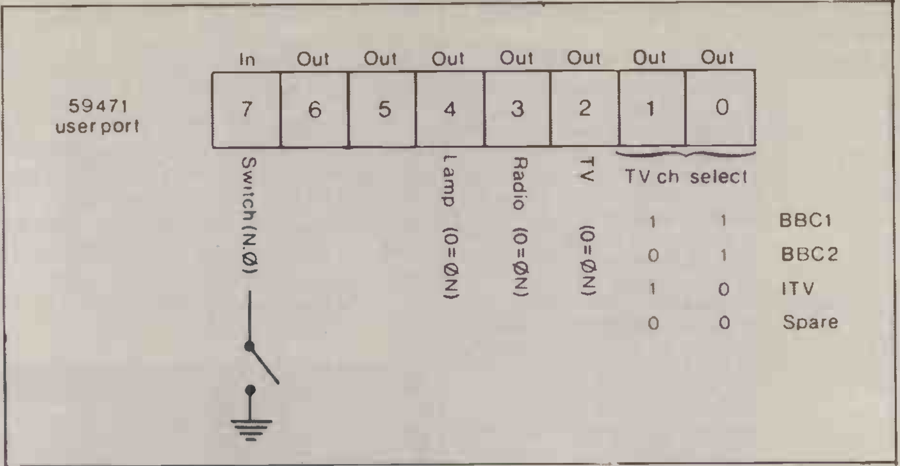



**Figure 1. Connections for Pet user port.**

*(continued from previous page)*

have to be altered within last month's code to add both the USER frame and the HELP sub-system. The first few statements are concerned with setting-up the system.

First, the input/output lines of the user port are set so that bit seven is an input to which the switch will be connected; all the rest are outputs. As a convention, all outputs will be active-low, which means that a device is ON if that output is at a low logic level, and OFF if it is high.

That is because the I/0 port defaults to a logic high whenever the Pet is re-set. Figure 1 shows the connections. The second line of code sets the Pet character generator ROM to display upper- and lower-case letters rather than upper-case and graphics. The third statement defines the printer to be channel five on the IEEE port communications system and the second microprocessor to be channel six.

**Table Four — Major code blocks in the program. Important addresses are underlined; see table five for more detailed information about the addresses of the code for the functions and their descriptions within the HELP sub-system.**

| | |
|---|---|
| 1-9 | System set-up. |
| 10-99 | Data areas. |
| <u>1000</u> | Program start, use RUN. |
| 1000-1220 | Read data into DF$, DA$, TA$, DV$ and TV$. |
| 1700-1720 | Initialise variables. |
| <u>2000</u> | Change frame re-start, display new contents on the screen. |
| 2000-2160 | Print screenful. |
| <u>3000</u> | Add new text to buffer and continue. |
| 3000-3199 | Help?/string too long?/upper-case?, add new string to buffer. |
| <u>3200</u> | Home, wait for switch. |
| 3200-3230 | Set-up HOME, wait for switch. |
| 3240-3310 | Move cursor down screen. |
| 3400-3510 | Move cursor across text area. |
| 3600-3690 | Move cursor across variables area. |
| 3800-3880 | Move cursor across functions area. |
| 4000-4040 | Function jump table. |
| 4100-8110 | Functions code. |
| 10000-10000 | No help message (not used in HE!.P version). |
| 20000-22040 | Subroutines. Including set UC/LC and clear buffer area. |
| <u>30000</u>-31710 | USER frame sub-system. |
| <u>40000</u>-49060 | HELP sub-system. |
| 40000-40070 | Help with letters and text. |
| 42000-42090 | Help with variables. |
| 44000-47000 | Help with functions, jump table at 44010. |
| <u>49000</u> | Wait for ON/OFF to return to 3000, from HELP. |

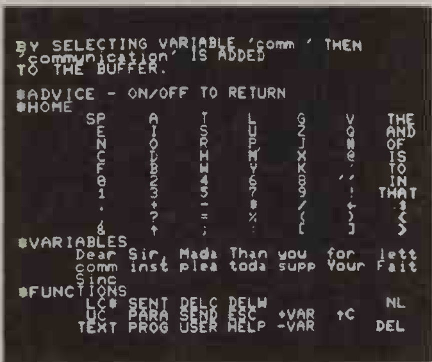
The next section, lines 10 to 999, are the data areas which contain all the strings to appear on the screen and all to which they will correspond, as in table two. The functions first; note how each of the 21 strings is exactly five characters long. Next, the display portion of the text frame, followed by the strings. Next comes the display and strings for the programming mode. If one wished to add another mode, perhaps utilising the Pet graphics capabilities, in conjunction with the Commodore 2020 printer, a third, or fourth frame could be added by including further data statements after 590 and before 1000.

Between 1000 and 1220 the program reads in these data areas: first DF$, then the 'text' frame DA$ (O,J,K) and TA$ (O,J,K), followed by DA$ (I,J,K) and TA$ (I,J,K) the second time around the outer loop; 1170 and 1190 are two special cases.

Because it is impossible to read in the double-quote symbol """ the two elements — one in the 'text' and the other in the 'programming' frame which must contain this character — are set to CHR$ (34), which is equivalent. The variable arrays are cleared, the display array to five spaces and the actual to the null string. Finally, in this section, some of the integer variables are initialised.

The code between 2000 and 3000 prints-out the 'text' frame on the screen if M is zero, as it is at the beginning of a program run.

The start of the main action loop is 3000. It is between 300 and 3200 that any additions to the buffer are made. It also checks to see if the HELP function box has just been selected, in which case HP will equal one — normally it would be zero. When HP is one the message "*ADVICE SELECT ANY BOX FOR HELP" is shown in the appropriate place (see figure 1) and HP is set to two. When a box is selected next time, control




will jump into the Help subsystem and nothing else will happen.

Statements 3040 and 3050 check that the combined length of the current buffer contents and those to be added do not exceed the largest size which can be fitted into the buffer area, currently four lines or 160 characters. Printers usually have a width of between 72 and 120 positions and it might be more sensible to limit the buffer size to that of the printer.

Moreover, the user will be unable to add anything to the buffer until something has been deleted, or the contents of the buffer have been transferred to a printer or similar device. This condition is heralded by the advice line reading "*WARNING PRINT STRING — NOW".

Statements 3070 to 3143 are concerned with checking the upper/lower-case flag and converting letters to lower-case if the LC function has been selected more recently than the UC one. To do this, each character to be added to the buffer is separated from the string N$, converted, if need be, by its ASCII value

**Table Five — Addresses of the start of the code for each of the functions (column one), and their descriptions within the HELP sub-system (column two).**

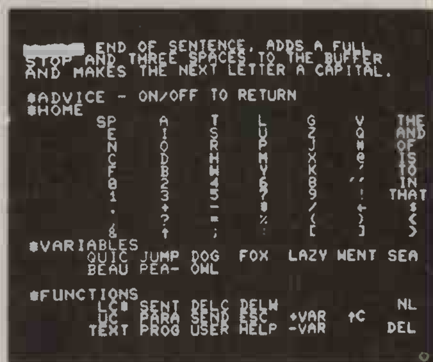
| | Function | Help sub-system |
|---|---|---|
| LC | 4100 | 45000 |
| SENT | 4300 | 45100 |
| DELC | 4500 | 45200 |
| DELW | 4700 | 45300 |
| SPARE1 | 4900 | 45400 |
| SPARE2 | 5100 | 45500 |
| NL | 5300 | 45600 |
| UC | 5500 | 45700 |
| PARA | 5700 | 45800 |
| SEND | 5900 | 45900 |
| ESC | 6100 | 46000 |
| +VAR | 6300 | 46100 |
| C | 6500 | 46200 |
| SPARE3 | 6700 | 46300 |
| TEXT | 6900 | 46400 |
| PROG | 7100 | 46500 |
| USER | 7300 | 46600 |
| HELP | 7500 | 46700 |
| —VAR | 7700 | 46800 |
| SPARE4 | 7900 | 46900 |
| DEL | 8100 | 47000 |

three, the next letter only is set to be a appropriately and then added to the buffer string A$. If UC had been set to capital; the value two in UC is only an intermediate stage in this process.

The ED flag would allow the user to edit the buffer in the middle, and not, as at present, only at the end.

One character directly after the edit point would be reversed to show the current edit position (Y$ at statement 3170), and then the remainder would be printed on the screen (Z$).

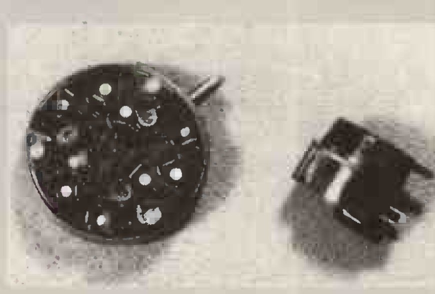
To indicate that the program is ready to accept cursor control commands via the




switch input it reverses the "*HOME" message (also 3200). Statement 3205 waits by looping round to itself if the switch is pressed and then 3210 waits if the switch is released. In this way the program waits until the switch has been released before it will continue.

This is particularly noticeable if the cursor is allowed to wrap round from the bottom or right-hand edge of the screen with no box having been selected. When the switch is pressed again it will clear the advice line (3215), to remove any redundant advice from the last cycle. Unless, of course, the HP, ED or NV flags are set, in which case the advice is still valid and useful (3212, 3213 and 3214).

Next the "*HOME" line is restored to its former, unreversed, self (3220). Statements 3240 to 3290 form a loop which counts down the 16 rows of boxes. For each row a pointer is printed in the five clear positions to the left of the row (3250) and it waits there for about half a



second (3260-3265). If during that time the switch is released, the code jumps to 3400. Otherwise the pointer is wiped-out (3270) and moves down to the next line — two to jump over the lines "*VARIABLES" and "*FUNCTIONS" (3280). If all 16 rows have been scanned and the switch has not been released it

*(continued on next page)*

SHOPWINDOW



*(continued from previous page)*

jumps back to 3200 to start again (3310).

Three sections of code can move the cursor across the columns to select the individual box required, and they are all very similar — 3440 to 3510 for text, 3610 to 3690 for variables and 3800 to 3880 for functions. In each case a loop will count across the columns zero to nine (3440, 3620 and 3810). Each of the boxes in the row selected previously is reversed in turn (3450, 3620 and 3810). Then the program again enters a loop which checks continually the status of the switch (3460, 3630 and 3830). If it has not been released the cursos is moved back five places and prints-out the box again in non-reversed form (3470, 3650 and 3840).

If the switch was released, control jumps to code to tidy-up the box (3490, 3670 and 3860). If the HP flag is set it is intercepted at this point and control jumps to locations within the Help sub-system — 40000 for text, 42000 for the variables and 44000 for help with the functions.

The NV flag determines whether a variable is to be deleted; this is valid only if a variable box has been selected, in which case it would jump to 7740 from 3690. Otherwise it will jump to 7720, which provides suitable advice (from 3505 and 3875). For text (3510) and variable (3690) selections, the string selected will be placed normally in N$ and then added to A$ at 3000.

When a function box is selected a computer GOTO (ON — GOTO —) is

used to jump to the relevant piece of code. Table five shows where the code for each of the functions is to be found. In all cases it is fairly straightforward.

When the switch is pressed the asterisk moves down each option in turn. A particular option is selected by releasing the switch as the asterisk waits by it. The speed of movement is the same as for normal row selection in the other modes.

As with the functions, a computed GOTO jump table is used to translate the number of times the asterisk moved into the desired effect. By using the logical AND and OR operators in this Basic, individual bits on the user port may be set or cleared without affecting any of the others — figure 1.

The return option jumps to 2000 and since M has not been changed the screen is restored exactly as it was before the USER frame was called.

The HELP sub-system at 40000 onwards is divided into three sections. The first, from 40000 to 40070, prints both a text box and also what will be added to the buffer by selecting that box (photograph two). From 42000 to 42090 it prints the contents of any of the variable locations (photograph three).

Photograph five shows two air-pressure-activated switches. The one of the left is a pressure regulator switch from a washing machine. It requires only a light pressure and has three changeover switch contacts, each operating at slightly different pressure.

The dual-level pressure switch on the right is marketed by RS Components (316-951) and is constructed from a pair of standard micro-switches operated by a small rubber balloon connected to the air inlet.

It would be possible to control the speed at which the cursor moved by wiring the multi-pressure switches to unused channels on the user port (5 and 6).

In cases where the user still has some movement, photograph six shows a joy-stick-type switch and some of the 'gates' which can be used to constrain the directions the switch can be moved (RS Components (337-352).

An increase in typing speed could be expected with this type of input. The program would require considerable modification, particularly around the 3200 to 3880 area, and such decisions as to how the cursor will wrap round and if all eight directions will be allowed would have to be considered.

**Listing 1. The user-frame subsystem.**

```
7300 REM USER MODE
7310 GOTO30000
READY.
30000 REM USER FRAME
30010 PRINT"^S *** SELECT FUNCTION ***"
30020 PRINT
30030 PRINT"  T.V. ON"
30040 PRINT"  T.V. OFF"
30050 PRINT"  B.B.C. 1"
30060 PRINT"  B.B.C. 2"
30070 PRINT"  I.T.V."
30080 PRINT"  RADIO ON"
30090 PRINT"  RADIO OFF"
30100 PRINT"  LAMP ON"
```

```
30110 PRINT"  LAMP OFF"
30120 PRINT"  DOWN FASTER"
30130 PRINT"  DOWN SLOWER"
30140 PRINT"  ACROSS FASTER"
30150 PRINT"  ACROSS SLOWER"
30160 PRINT"  RETURN"
30170 PRINT"^S^Q *";
30180 IF(PEEK(UP)AND UX)=0 GOTO 30180
30190 IF(PEEK(UP)AND UX) GOTO 30190
30200 PRINT"← ←";
30210 FOR I=1 TO 14
30220 PRINT"^Q*";
30230 FOR J=1 TO PD
30240 IF(PEEK(UP)AND UX) GOTO 30300
30250 NEXT J
30260 PRINT"← ←";
30270 NEXT I
30280 PRINT"← ";
30290 GOTO 30170
30300 PRINT"← ";
30310 IF I>7 GOTO 30330
30320 ON I GOTO 30400,30500,30600,30700,30800,30900,31000
30330 ON I-7 GOTO 31100,31200,31300,31400,31500,31600,31700
30400 REM TURN TV ON
30410 POKE UP,PEEK(UP)AND 251
30420 GOTO 30600
30500 REM TURN TV OFF
30510 POKE UP,PEEK(UP)OR 4
30520 GOTO 30170
30600 REM BBC1
30610 POKE UP,PEEK(UP)OR 3
30620 GOTO30170
30700 REM BBC2
30710 POKE UP,(PEEK(UP)OR3)AND254
30720 GOTO30170
30800 REM ITV
30810 POKE UP,(PEEK(UP)OR3)AND253
30820 GOTO30170
30900 REM RADIO ON
30910 POKE UP,PEEK(UP)AND247
30920 GOTO30170
31000 REM RADIO OFF
31010 POKE UP,PEEK(UP)OR8
31020 GOTO30170
31100 REM LAMP ON
31110 POKE UP,PEEK(UP)AND239
31120 GOTO30170
31200 REM LAMP OFF
31210 POKE UP,PEEK(UP)OR16
31220 GOTO30170
31300 REM DOWN FASTER
31310 PD=PD-10:IF PD<30 THEN PD=30
31320 GOTO30170
31400 REM DOWN SLOWER
31410 PD=PD+10
31420 GOTO30170
31500 REM ACROSS FASTER
31510 PQ=PQ-10:IF PQ<30 THEN PQ=30
31520 GOTO30170
31600 REM ACROSS SLOWER
31610 PQ=PQ+10
31620 GOTO30170
31700 REM RETURN
31710 GOTO2000

READY.
```

**Listing 2. The help subsystem.**

```
3500 IFHF=2GOTO40000
READY
3680 IFHF=2GOTO42000
READY.
3880 IFHF=2GOTO44000
READY
40000 REM HELP WITH LETTERS
40010 GOSUB 20900
40020 PRINT"^SBY SELECTING '";DA$(M,I,J);
40030 IF LEN(TA$(M,I,J))=0THEN PRINT"' NOTHING"
40040 IF LEN(TA$(M,I,J))=1THEN PRINT"' THE CHARACTER '";TA$(M,I,J);"'"
```

*(continued on next page)*

```
40050 IF LEN(TA$(M,I,J))>1THEN PRINT"' THE STRING '";TA$(M,I,J);"'"
40060 PRINT"^QIS ADDED TO THE BUFFER."
40070 GOTO49000
42000 REM HELP WITH VARIABLES
42010 GOSUB 20900:PRINT"^S";
42020 IF LEN(TV$(II*7+J))>0 THEN 42060
42030 PRINT"THIS VARIABLE (";II*7+J;") IS EMPTY;"
42040 PRINT"^QSEE +VAR AND -VAR."
42050 GOTO49000
42060 PRINT"BY SELECTING VARIABLE '";DV$(II*7+J);"' THEN"
42070 PRINT"^Q'";TV$(II*7+J);"' IS ADDED"
42080 PRINT"TO THE BUFFER."
42090 GOTO49000
44000 REM HELP WITH FUNCTIONS
44005 GOSUB 20900:PRINT"^S";
44010 IF SS>7 GOTO 44030
44020 ON SS GOTO45000,45100,45200,45300,45400,45500,45600
44030 IF SS>14 GOTO 44050
44040 ON SS-7 GOTO 45700,45800,45900,46000,46100,46200,46300
44050 ON SS-14 GOTO 46400,46500,46600,46700,46800,46900,47000
45000 PRINT"^R LC  ^R FOLLOWING LETTERS WILL BE LOWER"
45010 PRINT"^QCASE.  ALSO SEE ' UC  '."
45020 GOTO49000
45100 PRINT"^RSENT ^R END OF SENTENCE, ADDS A FULL"
45110 PRINT"^QSTOP AND THREE SPACES TO THE BUFFER"
45120 PRINT"AND MAKES THE NEXT LETTER A CAPITAL."
45130 GOTO49000
45200 PRINT"^RDELC ^R DELETES THE MOST RECENT"
45210 PRINT"^QCHARACTER IN BUFFER."
45220 GOTO49000
45300 PRINT"^RDELW ^R DELETES THE MOST RECENT WORD"
45310 PRINT"^QIN THE BUFFER, NOT INCLUDING SPACES."
45320 GOTO49000
45400 PRINT"NOT DEFINED - CODE AT 4900"
45410 GOTO49000
45500 PRINT"NOT DEFINED - CODE AT 5100"
45510 GOTO49000
45600 PRINT"^R NL  ^R NEWLINE ON PRINTER, DOES NOT"
45610 PRINT"^QAFFECT BUFFER."
45620 GOTO49000
45700 PRINT"^R UC  ^R FOLLOWING LETTERS WILL BE"
45710 PRINT"^QUPPER CASE - ALSO SEE ' LC  '."
45720 GOTO49000
45800 PRINT"^RPARA ^R END OF PARAGRAPH, PRINTS"
45810 PRINT"^QBUFFER, THREE NEWLINES, AND SETS"
45820 PRINT"BUFFER TO THREE SPACES."
45830 GOTO49000
45900 PRINT"^RSEND ^R PRINTS CONTENTS OF BUFFER,"
45910 PRINT"^QERASES BUFFER AND TAKES A NEWLINE."
45920 GOTO49000
46000 PRINT"^RESC  ^R SENDS BUFFER TO 2ND. MICRO,"
46010 PRINT"^QAND ESCAPE CHARACTER."
46020 GOTO49000
46100 PRINT"^R+VAR ^R SAVES THE CONTENTS OF THE BUFFER"
46110 PRINT"^QIN THE NEXT FREE VARIABLE LOCATION."
46120 PRINT"SHOWS FIRST FOUR CHARACTERS."
46140 GOTO49000
46200 PRINT"^R ^C  ^R SENDS CONTROL C (ASCII(3)) TO"
46210 PRINT"^QTHE 2ND. MICRO, ACTS AS A BREAK IN."
46220 GOTO49000
46300 PRINT"NOT DEFINED - CODE AT 6700"
46310 GOTO49000
46400 PRINT"^RTEXT ^R GOTO TEXT MODE, DISPLAYS ASCII"
46410 PRINT"^QCHARACTER SET AND A SELECTION OF"
46420 PRINT"FREQUENTLY USED WORDS."
46430 GOTO49000
46500 PRINT"^RPROG ^R PROGRAMMING MODE, DISPLAYS CHAR-"
46510 PRINT"^QACTERS AND WORDS USED IN BASIC. SETS"
46520 PRINT"UC, VARIABLES MAY BE DEFINED IN TEXT."
46540 GOTO49000
46600 PRINT"^RUSER ^R USE TO CONTROL EXTERNAL"
46610 PRINT"^QEQUIPMENT (T.V., RADIO ETC.) AND"
46620 PRINT"ALTER CURSOR SCAN SPEED."
46630 GOTO49000
46700 PRINT"^RHELP ^R A HELP SYSTEM. USE AT FIRST FOR"
46710 PRINT"^QGENERAL INFORMATION, THEN TO CHECK"
46720 PRINT"CONENTS OF VARIABLES - HELP/VARAIBLE."
46730 GOTO49000
46800 PRINT"^R-VAR ^R REMOVES SELECTED VARIABLE AND"
46810 PRINT"^QSHIFTS REMAINING ONES TO FILL SPACE."
46820 GOTO49000
46900 PRINT"NOT DEFINED - CODE AT 7900"
46910 GOTO49000
47000 PRINT"^RDEL  ^R CLEARS BUFFER - NO OTHER EFFECT."
49000 PRINT"^S^Q^Q^Q^Q*ADVICE - ON/OFF TO RETURN             ";
49010 IF(PEEK(UP)AND UX)=0 GOTO 49010
49020 IF(PEEK(UP)AND UX) GOTO49020
49030 GOSUB 20900
49040 PRINT"^S^Q^Q^Q^Q*ADVICE - O.K.               ";
49050 HP=0
49060 GOTO 3000
READY.
```

# BUYERS' GUIDE

**The Buyers' Guide is a summary of low-cost computers available in this country. It appears each month; we add new computers and amend existing information, as required, to keep it up-to-date. Systems are listed by manufacturer.**

## ACORN COMPUTERS

**Acorn.** Single Eurocard-sized microcomputer with 6520 processor, IKB RAM, 16-way I/O. Max size; a second Eurocard adds hex keypad and CUTS cassette interface. Monitor and machine-code programming now. Basic and disc operating system in the future. "Highly cost-effective basis for a computer or an industrial development system". Available from Acorn (0223) 312772 or Microdigital (051) 236 0707.

*£74.75 kit, £86.25 assembled*

## APPLE COMPUTERS

**Apple II.** Min size: 16K memory; 8K ROM; keyboard; monitors; mini assembler; colour graphics; Pal card; RF modulator; games; paddles and speakers; 4 demo cassettes. Max size; Expandable to 48K memory; floppy discs and printers are now available. Two versions of Basic, PASCAL; Assembler; games; business packages. An American system regarded as suitable for any kind of aplications. Maintenance contracts offered. Microsense Computers is the sole U.K. distributor and has a national dealer network. Tel: (0442) 41191/48151 (24-hour answering service).

*Around £1,000*

## ATTACHE

**Attache.** Min size: system with 10 slots, S100 bus, 8080 processor and 16KB housed in desk-top case with built-in keyboard. Max size: 64KB, parallel printer interface, two single- or double-density 8in. floppies, video screen. Disc Basic; business applications produced by Moncoland, the sole U.K. agent. Distributors include Keen, GBH, Alba, and Lion.

*From £1,737. Full business system about £5,000*

## BRUTECH ELECTRONICS

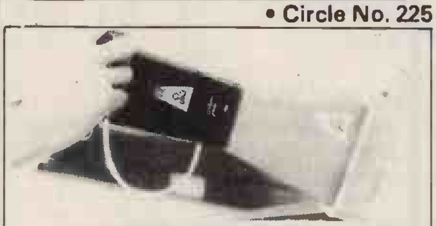
**BEM-CPUI.** Single-board processor with 6502 and no RAM. Applications software. Available from Data Precision Equipment (04862 67420). (Reviewed March, 1979.)

*£133 exc VAT*

## BYTRONIX MICROCOMPUTERS

**Megamicro.** 8080A/Z-80 processor. 64K. Double-sided discs, two-page addressable VDU, 140 cps printer. Software includes Basic, Fortran, Cobol and Pascal, all running under CP/M. Applications include automatic letter writer, sales ledger and stock control, payroll and bought ledger. Self-diagnosis utilities. Aimed at business and university user. Available from Bytronix (0252) 726814.

*From £6,080.*







## COMART

| | |
|---|---|
| **Microbox.** Chassis with three to six PCB sockets for S100 boards, plus fan. Several S100 boards available. Aimed mainly at OEM industrial users and perhaps the serious hobbyist. It will take Cromemco, North Star and other processors. Available from Comart (0480 215005). | *£255* |

## COMMODORE SYSTEMS DIVISION

| | |
|---|---|
| **Pet.** Single unit containing screen, tape cassette and keyboard. Floppy disc, printer and full-size keyboard are options, as are external cassettes. Basic; games; business packages. The British subsidiary of Commodore Systems of the U.S. sells Pet for home, educational and small business applications. About 80 distributors. | *£460-£795 exc VAT* |
| **Kim-1.** processor (6502 chip); small calculator-type keyboard; LED six-digit display; built-in interfaces for audio-cassette and Tele-type; IK RAM; 2K ROM (can add up to 64K). No software available, but it has three good manuals. An American import which gives Pet-type capabilities with a maximum configuration. For the hobbyist but used mainly as an evaluation board for the 6502 chip. Twelve to 15 dealers. (Reviewed October, 1978.) | *£99.95* |

## COMPELEC ELECTRONICS

| | |
|---|---|
| **Series I.** Z-80 processor 512MB floppy, 32KB, Centronics printer, VDU. Up to 4MB disc and 64KB. CP/M, Basic, Cobol, PASCAL, Fortran IV, Assembler, Business and word processing packages available. From Compelec (01-580 6296), which is also sole supplier of Altair systems. | *Less than £5,000 for basic system* |

## COMPUCOLOR

| | |
|---|---|
| **Compucolor II.** Packaged system including 13in. eight-colour display with alphanumerics and graphics, 72-key detachable keyboard, 8KB, and bult-in mini-floppy. Max size: 32KB. Extended disc. Basic in ROM, graphics progams and games. The system now ranks fourth behind Pet, TRS-80 and Apple in personal computer sales. Abacus (01-580 8841) is sole U.K. agent and is arranging distributors, including the Byte Shop and Transam. (Reviewed June, 1979.) | *From £1,390* |

## COMPUCORP

| | |
|---|---|
| **610:** desk-top unit using Z-80 and incorporating screen, 150KB floppy, 48KB. Up to 60 KB memory, four floppies, printers. Basic, Assembler, DOS, text editor, file manager; business packages. Nine dealers. | *From £3,890* |

## COMPUTER CENTRE

| | |
|---|---|
| **Mini kit:** Z-80 CPU, CTC, USART, serial and parallel I/O, 16 bytes memory, Western Digital disc controller, SA400 5in. drive plus CP/M, cables and connectors. | *Mini kit: £786* |
| **Maxi kit:** As above but with DRI 7100 8in. drive instead of 5in. drive. All (33) volumes of CP/M user group library available for cost of media. Library includes utilities, games. Basic compilers/interpreters and Algol compiler. Microsoft Basic, Cobol, Fortran also available. Computer Centre (02514 29607). | *Maxi kit: £886* |

## COMPUTER WORKSHOP

| | |
|---|---|
| **System I.** Typical size: 40K memory; dual 8in. floppy disc, total storage capacity 1.2MB; Ricoh daisywheel printer. | *System I, £5,000 plus* |
| **System 2.** Typical size: 24K memory; dual minifloppy discs of 80K bytes each; Centronics 779 dot matrix printer; VDU. | *System 2, around £3,000* |
| **System 3.** 12K memory, cassette interface; 40-column dot matrix printer. Editors, Assemblers, Basic, games, information retrieval package. The systems were designed and built in Peterborough and are suitable for educational and small business users and perhaps the more serious hobbyist. Twenty-five dealers. | *System 3, from £1,300* |

## CROMEMCO

**Single-card computer.** 4MHz Z-80 CPU, S100 bus, 1KB RAM, sockets for 8K ROM. 20mA/RS232 serial interface and parallel bidirectional interface. Basic in ROM and Z-80 monitor. For OEM and industrial users; used with backplane for "full computer capability". Datron Interform and Comart are agents, the latter with 12 distributors. (Reviewed February, 1979.) — *£247—£281*

**Z-2.** Min size: chassis, 31A power supply, motherboard, Z-80 processor, 16KB memory. Max size: 512KB, 21 sockets, three minifloppies or four 8in. floppies. Basic, Fortran, Cobol, assemblers. For serious hobbyists, OEMs, educational applications, and industrial/scientific users. — *£372 (in kit form) to more than £4,000*

**System Two.** Min size: factory-assembled system with 32KB, dual 90K minifloppies, dual printer interface, serial interface. Max size: two additional floppies, 512KB, up to seven terminals, CP/M-compatible operating system (CDOS), Fortran, Cobol, Basic, assemblers, word processing, database manager. Multi-user system for software development, or scientific/industrial/business users. — *£1,995 upwards*

**System Two/64.** New configuration featuring mini-diskette drives and 64K bytes memory. Software and applications as System Two. — *£1,995*

**System Three.** Min size: 32KB, dual 256KB floppies, dual printer interface, 20mA/RS232 serial interface, Z-80 processor. Max size: two additional discs, 12KB, seven terminals, multi-channel A/D and D/A interface, PROM programmer. Software as for System Two. Described as appropriate for small to medium business, scientific and industrial users — "rivals minicomputers at more than twice the price". — *£2,995 to more than £8,000*

**System Three/64.** New configuration featuring dual 8in. diskette drives; Z-80A processor; 64K of 4MHz memory; console and printer interfaces. Macro Assembler, Fortran IV, Extended Basic, Cobol, Multi-user Basic. Prices quoted by Micro Centre (031-225 2022). — *£3,293*

## DYLE HOUSE

**Business Computing System 2000.** Z-80A. Dual 8in. discs, 140 cps 132 char printer. Dyle House Business Basic, and disc operating system. Accountancy, payroll and parts control suites. Applications: Sales acknowledgments, sales invoices, delivery notes, purchase orders, customer statements, remittance advice. Dyle House Ltd (01-529 2436). — *No price announced*

## EQUINOX

**Equinox 300.** Min size; 48K memory; dual floppy discs giving 600K bytes of storage; 16-bit Western Digital m.p.u. Max size; up to 256K memory; up to four 10MB hard discs. Basic, Lisp, PASCAL, Macro Assembler, Text Processor. All software bundled. The system is a multi-user, multi-tasking, time-sharing system for two to 12 users. Application software available for general commercial users. Sole distributors Equinox Computers Ltd (01-739 2387). — *£5,000-£40,000 plus*

## EXIDY

**Sorcerer:** based on Z-80, 16K and 32K; cartridge and cassette interfaces; 79-key keyboard; 256-character set (128 graphics symbols), 12in. video monitor; expandable with Micropolis floppy discs. Basic, Assembler and Editor; games, word processor. Other pre-packaged programs plus EPROM Pack for your own programs on cartridges. Factor One is sole distributor for U.K. (Reviewed March, 1979.) — *From £760 without VDU to £1,200 with floppy discs*

## HEATH SCHLUMBERGER

**H8.** 8080 CPU. 4664K PAM. Serial/cassette I/O; front parallel monitor; keypad; optional parallel I/O; serial multiport; breadboard I/O and disc system. Basic, Ext. Basic, Mierosoft Basic, HDOS, CPM. — *From £262 (in kit form)*

**WH89.** All-in-one computer. Z-80 processor plus Z-80-controlled VDU. 16K expandable to 48K, user-accessible. Two RS232 I/O ports. Operating system includes Benton Harbour Basic, two-pass absolute assembler, text editor, utility programs, Mierosoft Basic and Fortran word processor package. Heath Schlumberger (0452 29451). — *About £1,600*

# SHOPWINDOW

## HEWART MICROELECTRONICS

**Mini 6800 Mk II.** IK monitor; IK user RAM, IK VDU RAM; CUTS. Upper- and lower-case VDU with graphics option. 128-byte scratchpad; decoder/buffer; power supply; Basic in ROM; monitor command summary. SWTPC programs; Newbear 6800; Scelbi 6800 Cookbook. Markets are small business, education and home user. Cash with order to Hewart. (0625) 22030.

*From £127.50 plus VAT*

**6800S.** 16K dynamic RAM; IK Mikbug-compatible monitor; room for 8K Basic in ROM; upper- and lower-case graphics; single floppy disc drive; printer and high-speed tape interfaces. "Mountains of software available." Test tape with CUTS test tones, test message and games with kit.

*From £275 plus VAT*

## DIGITAL MICRO SYSTEMS

**DSC-2.** Min size; 32KB, but 64K standard; Z-80; over IMB floppy disc on two single-sided 8in. drives; four programmable RS232 and one parallel interface. CP/M and Basic included in price. Extended Basic, Fortran, Cobol, text processing, Macro Assembler, Link Loader, business packages and CAP-CPP business software. Add-on rigid disc system (14 and 28MB) available soon. Modata (0892 39591) is sole U.K. distributor; dealers being appointed.

*From £4,465*

## IMSAI

**VDP 40:** 32K or 64K RAM memory; 9in. display screen, standard keyboard. Two 5¼in. floppy disc drives; serial I/O. Full software support, and packages available for the VDP 42, which has larger disc capacity. Packages for VDP 80 could be converted for smaller systems. This would be from about £700 per package. Two main dealers in the country.

*£4,507 for 32K model. £4,950 for VDP 42*

## ITT

**2020.** Identical to Apple II. Min. size: 4K memory; 8K ROM; keyboard, monitor, colour graphics, mini assembler; Powell card; RF Modulator, games, paddles and speaker; Max size: 48K with floppy discs and printers. Basic, Assembler, games, business packages. Generally suited to any type of application. Fifteen wholesalers, including Fairhurst Instruments.

*From £827 to £3003 for 48K, two floppies and printer*

## LUXOR

**ABC 80.** Min size: 35K with keyboard, CPU 12in. screen and cassette. Max size: 40K RAM with discs. Z-80 processor, loudspeaker with 128 effects, real-time clock. Options: printers, plotter, discs, module cards, digitiser, modem. 60 compatible I/O memory boards. Software: Basic with resident editor; assembler; games; business and educational packages. Personal computer aimed at home market, small business and education. CCS Microsales is U.K. agent and is looking for distributors.

*£795 plus VAT*

## MICRONICS

**Micros.** Typical size: IK monitor; 47-key solid state keyboard; interfaces for video, cassette, printer and UHF TV; serial I/O, dual parallel I/O parts; 2K RAM; power supply. 2K Basic; British-designed and manufactured system. Claimed to be the cheapest data terminal — a system with an acoustic coupler and VDU for £1,020. Prospective applications for small businesses, process controllers and hobbyists. Manufacturer is sole distributor (01-892 7044).

*From £400, assembled*

## MICRO V

**Microstar.** Single box with twin 8in. flopy discs, 64K RAM, three RS232 serial inputs, STARDOS operating system enables system to have three VDUs, plus a fourth job running simultaneously. Word processing software available. Packages being developed include invoicing system, payroll; accountancy type system. Price includes a reporter generator language. Imported by a Data Efficiency subsidiary, Microsense Computers, Microsolve is London agent; other distributors being arranged.

*£4,950 machine and software*

## MIDWEST SCIENTIFIC INSTRUMENTS

**MSI 6800.** Min size: 16K memory Act I termnal; cassette interface. Max size: three disc systems — minifloppy system with triple drives of 80 bytes each and 32K memory, large floppy system with up to four 312K-byte discs and 56K of memory mounted in a pedestal desk, or hard disc system with 10MB and 56K. Basic interpreter and compiler; editor; assembler; text processor on small disc system. American-designed system being manufactured increasingly in the U.K. Sole U.K. agent is Strumech (SEED) (05433 4321) but a distributor network is being established.

*Basic system: £1,100 (£815 as kit); Minidisc, £2,500; floppy disc £3,200; hard disc, £8,000-£12,000*

## NASCOM MICROCOMPUTERS

**Nascom I.** Min size: CPU; 2K memory; parallel I/O; serial data interface; 1K monitor in EPROM. Max size: CPU, 64K memory; up to 16 parallel I/O ports. Mostly games, but also a dedicated text editor system written by ICL Dataskil. Nascom is working on large versions of Basic, and 8K Microsoft Basic should be available soon. Eleven distributors in U.K. Nascom is negotiating to increase the number. (Reviewed January, 1979.)

*£165 exc VAT*

## NATIONAL MULTIPLEX

**Pegasus.** Min size: 48K, Z-80; double-density floppies (320KB); S100 bus; 12in. CRT; 58-key keyboard; two serial and one parallel interfaces; bi-directional printer. Options: 8in. drives; 1·2MB additional drives; digital recorder 9,600 baud. Assembler, Cobol, Fortran, Extended Basic. General business package available as well as text editing and mailing list. All run under CP/M. Suitable for education, business and home users. London Computer Store (01-388 5721) sole supplier.

*£2,700 exc VAT*

## NETRONICS

**Elf II:** single-board computer in kit form or assembled. RCA Cosmac 1802 processor, hex keyboard, 256 bytes RAM; options include up to 64KB, ASCII keyboard, cassette and RS232 I/O, and video output. Machine code or Tiny Basic. Promoted as a teaching system in minimal form, but expandable for more general use. Sole U.K. distributor HL Audio (01-739 1582).

*Basic kit £79.95. Assembled £99.95. I/O board £35*

**Explorer 85:** Min size: 4K. Max. size: 64K. 8085A processor, VDU board, ASCII Keyboard, S100 expansion. Cassette, RS232, TTY interface on board. I/O ports, programmable timer. Disc software, Microsoft Basic on cassette, 8080 and Z-80 software can be used. Aimed at hobbyist, OEM and small business. Available from Newtronics (computer division of HL Audio).

*From £297 plus VAT*

## NEWBEAR

**7768.** CPU board, 4K memory, cassette and VDU interfaces. Range of Basics and games. British-manufactured system for hobbyists. Expandable to 64K memory available only in kit form. From Newbear; also from Bearbag dealers, Microdigital, Microbits.

*From £45*

## NORTH STAR

**Horizon.** Min size: 16K memory; Z-80A processor, single minifloppy disc drive (180KB). Max size: 56K memory, four minifloppy disc drives (180KB), any acceptable S100 peripheral boards. Basic (includes random and sequential access), disc operating system and monitor. Options: Basic Compiler, Fortran, Cobol, Pilot, PASCAL and ISAM. The system is suitable for commercial, education and scientific applications. Application software for general commercial users. Twenty distributors. (Reviewed April, 1979.)

*£995 to £2,500*

## OHIO SCIENTIFIC

**Ohio Superboard II.** Min size: 6502 processor, 8K Basic in ROM; 2K monitor in ROM; 4K RAM; Cassette I/F, full keyboard; 32 x 32 video I/F, 8K Basic in ROM; Assembler/Editor; American single-board system with in-board keyboard. Aimed at hobbyist/small business. Ohio makes games, personal maths tutors, and business programs. This and other Ohio products have six U.K. distributors. (Reviewed June, 1979.)

*From £298*

## PERTEC

**System 1300.** Min size: 32K memory; dual minifloppy discs 71 bytes each, formatted; serial interfaces. Max size: 64K memory; four serial parts. Basic (single and multi-user), Fortran, Cobol. The hardware for Compelec Altair systems is from Pertec but the software is Anglo-Dutch. Sole distributor Compelec (01-580 6296). — *£3,000-£5,000*

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## PROCESSOR TECHNOLOGY

**Sol.** 808-based S100 microcomputer packaged with cassette and video interfaces (including graphics), keyboard with numeric pad, and 16KB RAM. Basic, assembler, word processors. Floppy disc systems available. Several distributors including Comart (0480 215005), which can offer nationwide maintenance contracts (Reviewed July, 1979.) — *From £1,750 (excluding monitor and cassette). Complete floppy disc systems with word processing about £5,000*

## RAIR

**Black Box.** Min siz: 32K memory dual minifloppy discs, 80K bytes each; two programmable serial I/O interfaces. Max size: 64K memory; eight serial interfaces; IMB disc storage (or 10MB hard disc); range of peripherals. Basic, Fortran IV, Cobol, Hardware distributors are being signed and agreements made with software houses to add software. A warranty and U.K.-wide. on-site maintenance is given. From manufacturer (01-836 4663) and systems houses. — *From £2,300*

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**380-Z.** Min size: 4K memory; 380-Z processor, keyboard. Max size: 56K memory. Options: cassette, single or dual minifloppy discs, dual 8in. double-sided discs (IMB); serial interfaces; parallel interfaces; analogue interface; printer available. Basic Interpreter, Z-80 Assembler; interactive text editor; terminal mode software; data logging routines; CP/M, DOS, text processor, CBasic, Fortran, Algol, Pilot, Cobol, CP/M users' club library. Sold principally to higher and secondary education, and for scientific research, data processing and data logging. Available from Sintel and the manufacturer. (Reviewed December, 1978.) — *From £830-£3,500*

**280-Z.** Board version of 380-Z system, 4K or 32K (identical in performance to the 380-Z). Interfaces, software as for 380-Z. — *4KB version at £398; 32KB for £722*

## RCA

**Cosmac.** 1802 micro with hex keypad and output to TV screen. Assembler and machine code programming; options include Tiny Basic. Available by mail order from HL Audio (01-739 1582). — *Kit £79.95. Assembled £99.95 exc VAT*

## ROCKWELL

**Aim-65.** Kim-compatible with full keyboard and on-board printer. 1K or 4K RAM. The 4K version is described as a development system rather than a personal computer. Assembler, editor, Basic. Available from Pelco, Microdigital and Portable Microsystems (Reviewed July, 1979.) — *1K — £249.50; 4K — £315*

## SCIENCE OF CAMBRIDGE

**Mk 14.** SC/MP processor, 256 bytes user memory; 512-byte PROM with monitor program; hex keyboard and eight-digit, seven-segment display; interface circuitry; 5V regulator on board. To this can be added: ¼K RAM (£3.60); 16 I/O chip (£7.80); cassette inferface kit — *£39.95 basic*

(£5.95); cassette interface and replacement monitor (£78.95); PROM Programmer (£9.95). No software provided but a 100-page manual includes a number which will fit into 256 bytes covering monitors, maths, electronics systems, music and miscellaneous. Based on American National Semiconductor chips. Science will soon have a VDU Interface and large manual on user programming. Mail order from manufacturer (0223 312919) and by selected dealers. (Reviewed May, 1979.)

## SDS

**SDS 100.** Single unit containing 32K memory (expandable to 46K); up to 8K PROM; twin double-sided floppy disc drives of 500 bytes each, serial and parallal RS232 interfacing; keyboard; 12in. video display; power supplies; SD monitor program: line printer available. CP/M, 8080 assembler, E Basic, Editor supplied with system; M Basic, Fortran, Cobol available for business use, industrial process monitoring and control (with additional hardware). All CP/M games and business packages. Sole supplier Airamco (0294 65530).

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## SEMEL

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# A PRACTICAL GLOSSARY

## Continuing the terminological gamut with P

### Parameter
Much-used buzzword meaning an item of information which can be changed according to what you want to do. Or if you want a heavy definition, it's a constant with variable values. For instance, you might have a parameter called 'height' and you might try giving it a succession of values.

### Parity
A clever way of checking each character as it is moved around the electronic internals of a computer system. Remember binary encoding? One character is made up of a group of 0s or 1s, so if one bit is altered accidentally, somehow it's bad news. Such accidents can happen — the computer is shifting around many bits at very fast speeds with all kinds of electrical interference possible.

Parity checking is a way of making reasonably sure that the character hasn't changed in getting from A to B, usually from memory into the processor, though sometimes to and from tape, cassette or disc. What happens is that an extra bit is tacked-on to the character — the 'parity bit' set to 0 or 1 according to whether the character has an odd or even number of 1s in its bit pattern. *Odd parity* means that the parity bit is set to 1 when there's an odd number of 1s. Given that information, you should have no difficulty guessing *even parity*.

At the end of some operations the computer makes sure the parity bit is still set appropriately; if it isn't, there is clearly an error and the computer will tell you. It's generally your job to correct it.

There's one obvious problem with parity checking. Clearly one troublesome bit will show as a parity error but equally, a two-bit error will appear as a perfectly good parity check. Still, single-bit errors are much more common. If there is one chance in a million of a single-bit error, there is something like a one in one billion chance of a two-bit error.

### Partition
Check *multiprogramming* again. Some operating systems organise the computer's memory into distinct areas, called partitions, and have different programs running in different partitions. Several micros allow you to run a *foreground* partition with one interactive program at the same time as another program, typically a batch job, runs in a *background* partition. They are not running at the same time; the computer gives most of its attention to the foreground partition, occasionally snatching a few nanoseconds to execute some instructions of the program in the background partition.

### Pascal
Blaise Pascal (1623-1662) was French and lived in the 17th century, at a time when Frenchmen in particular were distinguished by their breadth of vision. Even so, Pascal was an exceptional polymath — writer, mathematician, scientist, religious thinker, natural philosopher.

He also built the world's first mechanical calculator — about 1647 — to help his father, who was a taxman in Rouen. It used wheels marked with digits and turning a wheel through a full revolution — from 0 to 9 — caused its neighbour on the left to move one notch.

Pascal apparently built about 50 but they suffered from mechanical problems because the interlocking cogs were not cut accurately enough. So he invented the hypodermic needle, the hydraulic press, the basis of probability theory, and the first public transport system in Paris.

He was as eminent as a theologian as he was a mathematician and also as an author. It was he who said: "The heart has its reasons which reason knows nothing of", which would, in itself, be enough to ensure his fame.

### Pascal
Pascal language first appeared in the late '60s, the brain child of Nicklaus Wirth and others at the Zurich Technical Institute. It is a clear descendant of the Algol family, which was popular in Europe before being steam-rollered by the Fortran-Cobol bandwagon.

The essential idea of Pascal is to produce a structured algorithmically-orientated language which matches realistically the abilities of both man and computer. The result is an elegant language which enables long programs to be written with few errors. Pascal executes programs quickly compared to other languages, especially in comparison with interpretative languages like Basic, though that also applies to any worthwhile *compiler* language.

The big problem with Pascal is that its impenetrably cryptic notation and syntax rules means a hefty learning task before you can start using it.

### Password
This one is obvious. It's a string of characters which allows you to run restricted programs or to read restricted files. Handling passwords is a function of the operating system and not all of them have it; usually a computer, or rather its operating system, will request your password, you type it in, it is checked and access is either granted or denied.

### Patch
A patch is a correction, usually a group of instructions added to correct a mistake in a program.

### PC
Printed circuit, as in PCB, or sometimes program counter — that is a memory location inside the computer which keeps track of where you are in the program being executed.

### PCM
Plug-compatible manufacturer: Someone who makes *plug-compatible* equipment. In practice, the term is used most often to refer to people who make IBM-compatible peripherals.

### PDP-11
The world's best-selling minicomputer family from the world's top mini manufacturer. The PDP-11 has more or similar internals all the way from the LSI-11 microcomputer to the six-figure VAX-11/780.

In fact, that is somewhat simplistic; there are distinct subdivisions along the way, with significant developments in the basic architecture producing four or five family groups. At one end there is the LSI-11, which is called the PDP-11/03 when it's in a box.

The 11/23 is a bigger micro, a bridge between the LSI-11 and the 11/34; the latter is the company's mainstream mini. It has its own line of development, with the small 11/04 at one end and the big 11/60 at the other. The bigger 11/70 and the forthcoming 11/44 are another group, and the VAX system — a 32-bit mini, unlike the rest — is also out on its own.

### PE
Phase-encoded. A way of storing data on mag tape. Forget it. Some people use PE as an abbreviation for parity error, but not many.

### PEEK
Most Basics have a handy statement which allows you to read the contents of a specified memory address. A companion statement is POKE to put a value into a specific memory address. David Lien's *BASIC Handbook* quotes this example:

X = PEEK 18370 assigns the numeric value stored in memory address 18370 to the variable X.

### Parallel
A type of *interface*. Generally a specific plug-and-socket connection between two parts of a computer system, like a printer and the processor. Interfaces are in two varieties, serial and parallel.

A serial interface moves data one bit after another, serially. A parallel interface uses cable containing enough wires to carry each bit in a character simultaneously; so if the computer uses an eight-bit pattern to encode one character, the parallel interface will contain eight wires, each carrying one bit.

Within the two groups, however, there are several philosophies about which wire carries what, and so on.

Parallel interfaces are faster because they deliver eight bits at a time instead of one. Parallel interfaces tend to be specific to one computer manufacturer. Phrases you might hear include:

**Centronics-compatible:** Centronics has for some time been the leading supplier of matrix printers and because many of the U.S. minicomputer makers brought their printers from this company, its parallel interfaces became another *de facto* industry standard. It was adopted by several computer vendors and it is also offered by

*(continued on next page)*

(continued from previous page)

several printer suppliers, the inference being that it is a simple matter to replace a Centronics unit with another.

**Dataproducts-compatible:** Dataproducts has been the top independent vendor of line printers and a similar situation obtains.

**Digital-compatible:** Again, several printers can attach directly to the parallel interface socket on a PDP-11 minicomputer from Digital Equipment. That also applies to many of the systems incorporating a PDP-11.

**IBM-compatible:** Check this claim very carefully. IBM has so many printers attached via so many interfaces to so many types of computers.

Other popular parallel interface options which may be offered with printers broadly follow the league table of minicomputer manufacturers. Compatibility with Data General and Hewlett-Packard minis is common; Perkin-Elmer (Interdata) and General Automation are encountered occasionally.

**RS 232:** Sometimes known in ICL circles as V24 — is yet another 'standard' interface. Check carefully. The 'data in', 'data out' and 'common return' pins usually are standard, but others, like 'printer busy; — very useful for stopping the flow of data while a printer gets on with things — can vary.

Parallel interfaces are used generally for printers, in fact. This is largely because the electro-mechanical printer can often be the bottleneck in a system which otherwise operates at electronic speeds. Anything which optimises the performance of the printer, like presenting it with eight data bits at a time rather than once, is a good thing.

## Pet

Be thankful that nobody calls it the Personal Electronic Transactor 2001 any more. The clever Commodore piece of consumer electronics is probably the world's best-selling personal computer. It is a pioneering, table-top design with graphics, a good clear screen, a very good Basic, and the 6502 processor among its better-liked attributes.

The calculator-style keyboard on small models and the idiosyncratic use of the IEEE interface are probably its least-respected qualities. The newer business-orientated version has a more reasonable typewrite-type keyboard and no built-in cassette.

Commodore, which makes Pet, also sells pocket calculators and digital watches. It used to sell office furniture, too, but that is past now. Commodore also make *peripherals* for the Pet, notably a plug-in floppy disc unit and some printers.

## Peripheral

Almost anything connected to a computer. Generally a peripheral is a discrete and physically separate I/O or storage device of some kind attached by cable to the processor. Some people legitimately use the term for almost anything which isn't the processor, including internal, invisible parts of the computer system. You will be safe if you use the term to mean disc units, VDUs and printers.

## Petal printer

Some people use this phrase instead of 'daisywheel'. They are correct, really, since it refers to impact printer mechanisms where the characters are formed on the end of a kind of stem attached at the other end to a central boss of sorts, not unlike petals on a flower. Daisywheels are just one example.

Others you might encounter are the Perkin-Elmer Carousel mechanism — more like a roundabout than a daisy; and the DRI/NEC Spinwriter, which has a print element which looks like a thimble.

All petal printers deliver reasonably good quality printing for word processor use.

## Philips

Giant Dutch conglomerate in electrics and electronics. Philips also makes smallish office computers and word processors. It owns a Californian microprocessor company, Signetics; and it has a minicomputer line called the P800, which is used principally by other Philips divisions for incorporation into its products.

## Picoprocessor

What is smaller than a microprocessor? The term picoprocessor, however, should be reserved for an LSI element Computer Automation puts into some of its interface cables; that company thought of the word first.

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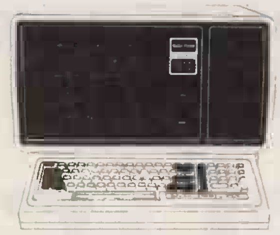

## TRS 80

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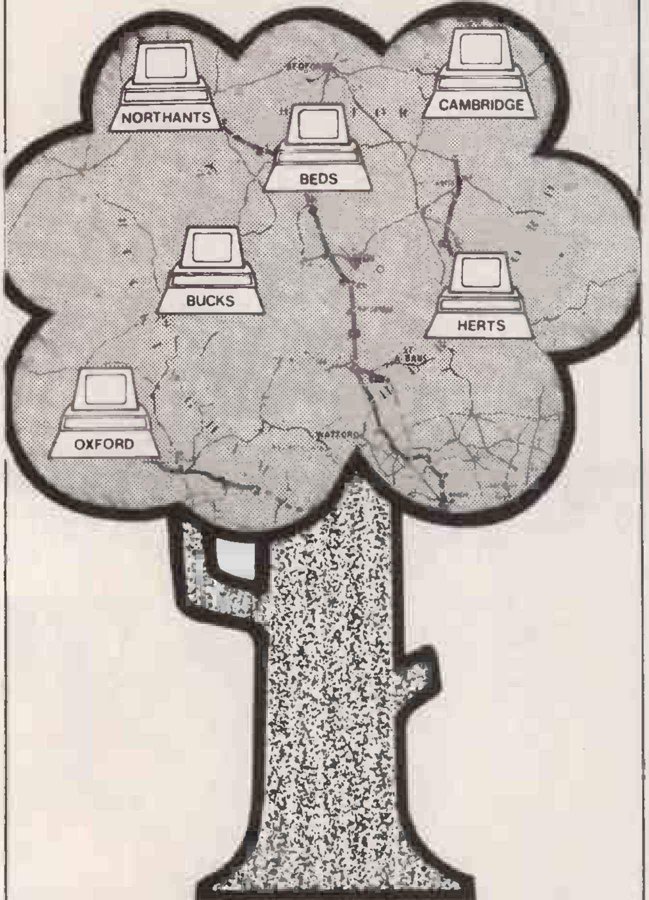


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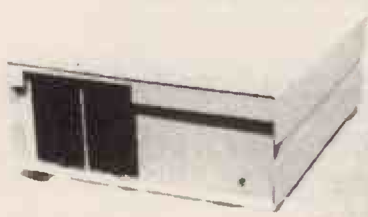

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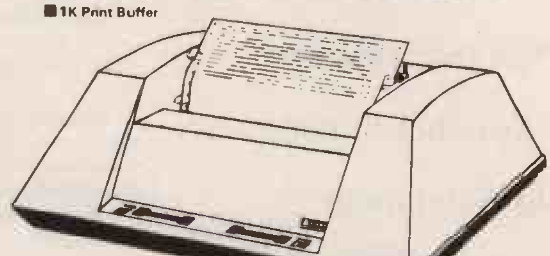

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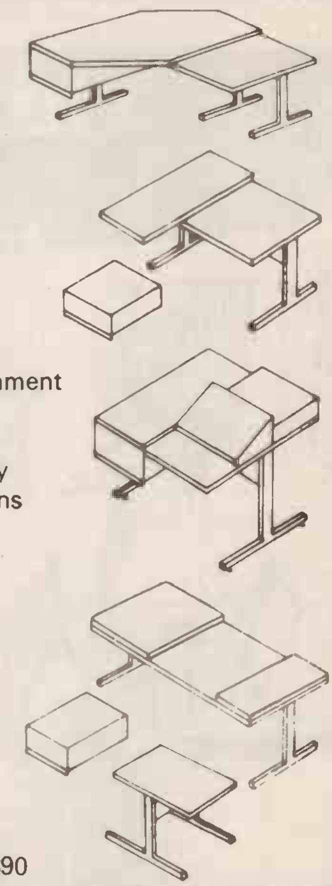

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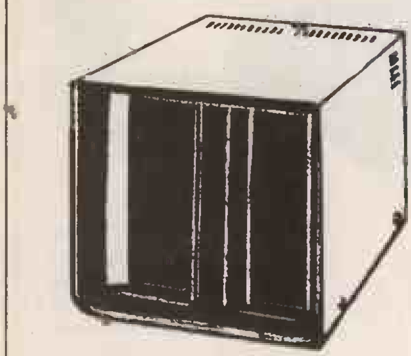

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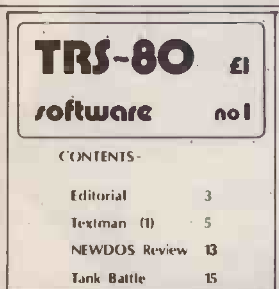

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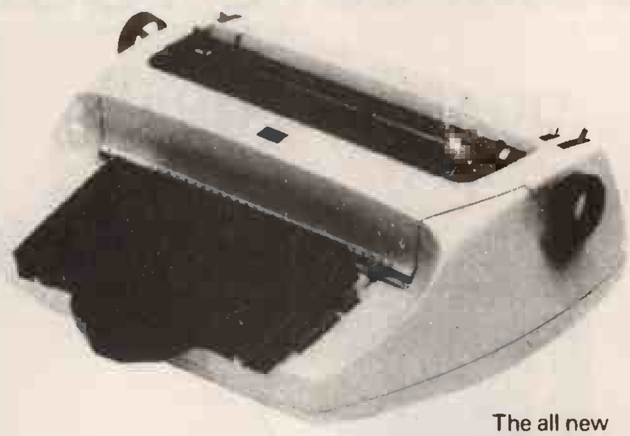

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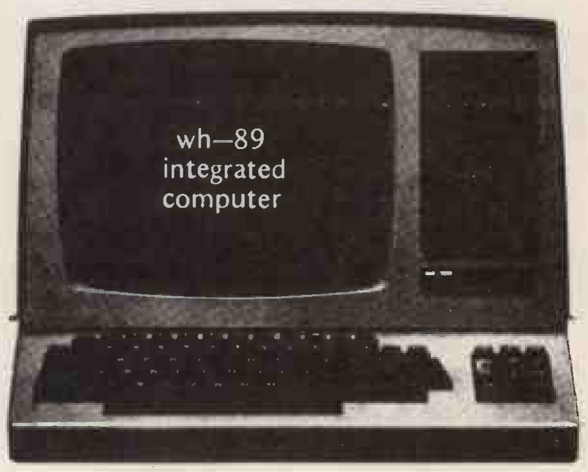


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The input and output sides of the UART are independently switchable between any of the options —
i.e. it is possible to house input on the cassette and output on the printer.

**PIO**
There is also a totally uncommitted Parallel I/O (MK3881) giving 16, programmable, I/O lines. These are addressable as 2 x 8 bit ports with complete handshake controls.

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

**DOCUMENTATION**
Full construction article is provided for those who buy a kit and an extensive software manual is provided for the monitor and Basic.

# Break the language barrier ONLY £138 + VAT


At a price equivalent to learning one language, LEXICON offers you, English, Spanish, French, German, Italian and Greek. The LK3000 comes to you with the person to person module which contains 6 languages, de-luxe carrying case and a charger adaptor using its own power source which will give you 4 - 5 hours continuous use, and can easily be re-charged from the mains supply, wherever you may be in the world. Every additional module carries a concise and understandable instruction book. Your deluxe carrying case has room for two additional modules.

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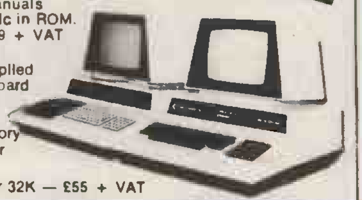

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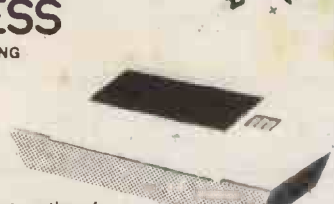

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The printer's 9 x 7 dot matrix head gives the user the ability to produce variable text and format. These combined with the tabulator facility are extremely useful to users engaged in management report writing. The ability to print double size characters enhances formatting, and it is particularly suited to the preparation of shipping/freight labels and materials handling tags.

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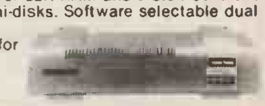

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